EXTERNAL SCIENTIFIC REPORT

Food of plant origin: production methods and microbiological hazards linked to food-borne disease. Reference: CFT/EFSA/BIOHAZ/2012/01 Lot 1 (Food of plant origin with high water content such as fruits, vegetables, juices and herbs)\(^1\)

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ABSTRACT

Food-borne diseases caused by food of non-animal origin (FoNAO) contaminated with pathogenic bacteria, viruses and parasites are a major health concern worldwide. The present study was set up as an extensive literature review aimed at evaluating biological hazards associated with FoNAO with high water content. Data were extracted from 432 publications to identify the most critical FoNAO/pathogen combinations. The number and severity of outbreaks of disease provided the basis for a primary evaluation, and qualitative criteria relating to pathogen prevalence, food/pathogen interaction, and the production of FoNAO items were used for defining three priority groups. Highest priority levels worldwide were defined for leafy green vegetables contaminated with pathogenic *E. coli*, *Salmonella* on/in leafy greens and tomatoes were also most highly graded. While strawberries and raspberries infected with Norovirus were graded priority one within the EU, cantaloupe melon and tropical fruit contaminated with *Salmonella* were included in the priority one combinations for non-EU countries. Level two and level three priority groups differed for EU and non-EU countries, including lettuce/Norovirus, basil/*Salmonella* spp., semidried tomatoes/Hepatitis A virus, grated carrots/*Yersinia pseudotuberculosis* for EU and lettuce/Norovirus, spinach/pathogenic *E. coli*, cantaloupe melon/*Listeria monocytogenes*, and Hepatitis A virus combined with unpasteurized orange juice and green onion for non-EU countries, respectively. The study provides an extensive scientific database that will be instrumental in the conceptualization of specific measures for preventing and efficiently controlling outbreaks of disease linked to FoNAO.

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KEY WORDS

Food borne outbreak, food of non animal origin (FoNAO), food/pathogen combination, biological hazard, pathogen, extensive review

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SUMMARY

Food-borne diseases caused by pathogenic bacteria, viruses and parasites are a major health concern worldwide. Although traditionally food of animal origin has been primarily implicated in outbreaks, incidences caused by contaminated food of non-animal origin (FoNAO) have been increasing, reflecting rising consumers’ demands for fresh and minimally processed fruit and vegetables. This highlights the need for an in-depth evaluation and characterization of the hazards posed by contaminated FoNAO.

The present study was set up as an extensive literature review addressing biological hazards associated with FoNAO with high water content. Search strategies were defined a priori and involved systematic searches in bibliographic databases and grey literature sources. Thereby, pathogenic bacteria, viruses and parasites that have been found associated with FoNAO were identified on a worldwide level and further characterised regarding their prevalence and colonisation behaviour. Reports on food-borne outbreaks caused by biological hazards encompassing the last ten years were compiled. Critical steps in the production and processing of particular FoNAO items were determined, and consumption patterns as well as trade volumes from third countries into the European Union were assessed.

In total, 7710 entries (Lot 1 and Lot 2) from scientific databases were retrieved and 51 grey literature sources were taken into account. Following screening according to a set of relevance and quality criteria, this resulted in 432 publications used for collecting data and extracting them into an Excel-based compendium of tables. A synopsis of the collective data set was formed for prioritising FoNAO/pathogen combinations. While the number and severity of outbreaks of disease provided the basis for a primary evaluation, qualitative criteria relating to pathogen prevalence and their colonisation behaviour as well as to the production of FoNAO items were used for defining three priority groups. Level 1 priority worldwide was assigned to leafy green vegetables (in particular lettuce and spinach) in combination with pathogenic *E. coli*, *Salmonella* spp. on/in leafy greens and on/in tomatoes, respectively, were also given priority one for EU and non-EU countries, respectively. In the EU, berries (in particular frozen strawberries) linked to Norovirus were also attributed level 1 priority. In non-EU countries, the level 1 priority group included also melon (cantaloupe) with *Salmonella* and tropical fruit (mango and papaya) with *Salmonella*. Priority group two for EU countries comprised the combinations lettuce/Norovirus and fresh herbs (basil)/Salmonella spp., while semidried tomatoes combined with Hepatitis A virus, grated carrots combined with *Yersinia pseudotuberculosis*, and cucumber in combination with parasites were rated priority 3. For non-EU countries, priority group 2 included lettuce/Norovirus, spinach/pathogenic *E.coli* and cantaloupe melon/*Listeria monocytogenes*, while level 3 priority was assigned to Hepatitis A virus both in unpasteurized orange juice and on/in green onion.

The study provides a broad scientific database that will be instrumental in the conceptualisation of specific measures for improving the safety of FoNAO. Ultimately, it may contribute to the prevention and a better control of food borne diseases.
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BACKGROUND AS PROVIDED BY EFSA

In May 2011 a major outbreak of STEC O104 infections occurred in Germany. More than 4,000 people were reported ill with symptoms and the outbreak resulted in the death of more than 46 people. Other countries reported a small number of people becoming ill by the same strain, most of whom had recently visited the region of northern Germany where the outbreak occurred. At the end of June, there was a second outbreak in Bordeaux, France, which was caused by the same \textit{E. coli} strain. In both cases, investigations implicated sprouted seeds.

According to the 2009 European Union Summary Report on trends and sources of zoonoses, zoonotic agents and food borne outbreaks, the majority of verified outbreaks in the EU were associated with foodstuffs of animal origin. Fruit and vegetables were implicated in 43 (4.4 \%) verified outbreaks. These outbreaks were primarily caused by frozen raspberries contaminated with norovirus. In addition, 8.1 \% outbreaks were associated with mixed or buffet meals where foods of plant origin could not be excluded.

According to the US Centre for Disease Control and Prevention (CDC) 2008 report on surveillance for food borne disease outbreaks, the two main commodities associated with most of the outbreak-related illnesses originating from food of plant origin were fruits-nuts and vine-stalk vegetables. One of the main pathogen-commodity pair responsible for most of the outbreaks was norovirus in leafy vegetables. The pathogen-commodity pairs responsible for most of the outbreak-related illnesses were \textit{Salmonella} in vine-stalk vegetables and \textit{Salmonella} in fruits-nuts. In addition, in September 2011, a multistate outbreak of listeriosis linked to cantaloupe melon caused 29 deaths in the US.

These outbreaks indicate the need to consider more specific measures for food of plant origin. Thus, EFSA wants to outsource preparative work of an extensive search of scientific and technical literature for future activities related to risk posed by pathogens in food of plant origin.

Regulation (EC) No 852/2004 on the hygiene of foodstuffs lays down general hygiene requirements to be respected by food businesses at all stages of the food chain. All food business operators have to comply with requirements for good hygiene practice in accordance with this Regulation, thus preventing the contamination of food of animal and of plant origin. Establishments other than primary producers and associated activities must implement procedures based on the HACCP principles to monitor effectively the risks. In addition to the general hygiene rules, several microbiological criteria have been laid down in Regulation (EC) No 2073/2005 for food of plant origin.

The overall objectives of the present contract work are as follows: to provide an extensive literature search of available data for microbiological hazards, that may contaminate food of plant origin in the food chain (from primary production to retail), which can be used for risk assessment activities such as hazard identification, hazard characterization and exposure assessment.

An extensive literature search must be structured in a way to identify as many relevant studies as possible. The fundamental aspects of an extensive literature search are the tailored search strategy/ies (i.e. combination of search terms and Boolean operators) and the extensive list of information sources used (i.e. bibliographic databases and other sources such as e.g. journal tables of content etc.). The process of extensive literature search is clearly reported to allow transparency and reproducibility. The output of extensive literature search is an extensive collection of evidence (to be screened for relevance). An extensive literature search followed by a study selection process should be performed by the tenderer(s), to produce a set of relevant evidence, in particular to identify specific food/pathogen combinations most often linked to food borne disease originating from food of plant origin.
TERMS OF REFERENCE AS PROVIDED BY EFSA

For Lot 1, the scope of the work is:

- To carry out an extensive literature search for available data on:
  (i) production methods (farming and processing including post-harvest practices such as cutting, washing and packaging) and trade volumes from third countries to the European Union of food of plant origin with high water content such as fruits, vegetables, juices and herbs;
  (ii) consumption of all food items considered for each subcategory of food of plant origin. Literature search on consumption data shall cover, for each food subcategory, where possible, age of consumers, amounts consumed (e.g. grams/day; grams/kg body weight/day) and how the food is consumed (e.g. raw, cooked). The approach used shall be consistent, as far as possible, with the Food Classification and Description System for exposure assessment used by EFSA.
  (iii) microbiological hazards (bacteria, parasites and viruses) in the food chain (from primary production to retail) that may contaminate food of plant origin with high water content such as fruits, vegetables, juices and herbs in particular:
    - hazard identification,
    - hazard characterisation,
    - prevalence and enumeration data of foodborne pathogens as part of exposure assessment;
  (iv) specific food/pathogen combinations most often linked to foodborne disease originating from food of plant origin with high water content.
- Literature searches for data regarding point (ii) shall cover all European Union Member States (including EU candidate and pre-accession countries). For points (i), (iii) and (iv) literature shall be searched at worldwide level.
- Furthermore, the literature search should include published scientific articles and academic dissertations, proceedings of conferences as well as the grey literature (national and international reports, public health institute publications, project or research reports, unpublished reports e.g. from ongoing research projects, other documents, data published on web sites and any other source relevant to the subject under assessment).
- The literature search should be conducted including multiple bibliographic databases (e.g. PubMed, CAB abstracts, Web of Science, Medline, Scopus).
- The searches should cover at least the last 10 years and should be updated, as far as possible, throughout the entire duration of the resulting contract from this tender.
- The process used for the extensive literature searches should be clearly reported to allow transparency and reproducibility. EFSA should be provided with methodologies proposed for the:
  - extensive literature search (i.e. screening criteria used in the search proposal, how many experts will screen titles, abstracts and full text; expertise of the reviewers; whether the examination of the studies will be done independently by the reviewers; how potential disagreements on study eligibility will be solved);
  - criteria used to generate the structured tables summarising the data from the selected literature and
  - identification of specific food/pathogen combinations most often linked to foodborne disease originating from food of plant origin with high water content.

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- References not considered pertinent after the screening process should be listed and reasoning should be provided why these references were not considered pertinent. References for which full text could not be retrieved on time will also be listed.

This contract was awarded by EFSA to:

Contractor: AIT Austrian Institute of Technology GmbH

Contract: CFT/EFSA/BIOHAZ/2012/01

Contract: CT 1 LOT 1
1. Introduction

Outbreaks of gastrointestinal disease caused by the consumption of raw or minimally processed vegetables contaminated with biological hazards have increasingly been reported worldwide and within the EU. This is partly due to consumers’ increased demands for fresh produce, and especially for ready-to-eat pre-cut vegetables and fruits. For implementing future activities for mitigating risks posed by pathogens in food of non-animal origin (FoNAO), we need to pin-point the microbiological hazards linked to food-borne disease implicating FoNAO. Thus, there is a need for identifying and characterizing the bacteria, viruses and parasites that may contaminate food of plant origin together with the identification of the food items concerned. In addition, data are required that allow thorough exposure assessment, considering for instance various subcategories of food and different groups of consumers.

The present study was carried out in the frame of an assignment for a tender responding to the invitation to open tender (Ref. CH/MH/cm (2012)-out-6206701) by the EFSA Biological Hazards Unit (BIOHAZ). This study relates to Lot 1 of the tender, and thus addresses risks regarding food of non-animal origin (FoNAO) with high water content (such as fruits, vegetables, juices and herbs), while FoNAO with low water content are dealt with in a separate study relating to Lot 2 of the same tender.

Classification of the food items considered in the present study follows the categorization of FoNAO commodities set up by EFSA/BIOHAZ. FoNAO items that were allocated to Lot 1 of the tender (addressing FoNAO with high water content) and thus were included in the present study are presented in Table 1. Basically, the individual commodities categorized by EFSA were assigned to either Lot 1 or Lot 2 according to the water content of the respective food item as it is most frequently consumed. Thus, dehydrated fruits and vegetables were allocated to Lot 1 because fruits are mostly consumed fresh and vegetables are more often reported as not dehydrated. “Other processed products” were addressed as a category either in Lot 1 or Lot 2, depending on the water content of the primary food item they were made of. In addition to the categories defined by EFSA, where “fruits non specified” are given as category 1, it was necessary in the process of data extraction to set up the categories “other” and “1/other”, which include vegetable items that are not specified and (collective) fruit and/or vegetable items that are not specified, respectively (see Table 1).

By performing the present study we aimed to assist in the conceptualization of future activities that are needed for securing the microbiological safety of food of plant origin. We carried out extensive literature searches to provide a comprehensive dataset of the currently available information relating to biological hazards associated with FoNAO with high water content. We employed methods of the systematic literature review, involving that a structured literature search strategy was applied that was developed a priori. Data extraction into a database was accomplished following multi-phase reviewing of the retrieved scientific and grey literature, involving relevance screening of abstracts and quality assessment of full text literature.

The objectives and specific tasks of the present study are described in chapter 2, and the methods employed for completing the project tasks are presented in chapter 3. The study results are given in chapter 4, referring to the associated structured tables shown in the appendices A to D. Conclusions resulting from the study are summarized in chapter 5.
Table 1: Classification of commodities of FoNAO with high water content as included in the present study, based on BIOHAZ classification.

| General commodity category | Specific categories | Examples of commodities |
|---------------------------|--------------------|-------------------------|
| 1. Fruit (non specified)  | 2. Strawberries     | Açaí berries, barberry, bearberries, bilberry, blackberries, blackcurrant blueberries, boysenberry, chokeberries, chokecherry, cloudberry, cranberries, crowberry, elderberries, goji berries, gooseberries, huckleberries, juneberry, juniper berries, lingonberries, loganberries, marionberries, mulberries, nannyberry, ollaliberries, oregon grape, red currants, red and green grapes, salmonberry, sea-buckthorn berries, serviceberries, tayberries |
|                           | 3. Raspberries      | Açai berries, barberry, bearberries, bilberry, blackberries, blackcurrant blueberries, boysenberry, chokeberries, chokecherry, cloudberry, cranberries, crowberry, elderberries, goji berries, gooseberries, huckleberries, juneberry, juniper berries, lingonberries, loganberries, marionberries, mulberries, nannyberry, ollaliberries, oregon grape, red currants, red and green grapes, salmonberry, sea-buckthorn berries, serviceberries, tayberries |
|                           | 4. Other berries    | Açaí berries, barberry, bearberries, bilberry, blackberries, blackcurrant blueberries, boysenberry, chokeberries, chokecherry, cloudberry, cranberries, crowberry, elderberries, goji berries, gooseberries, huckleberries, juneberry, juniper berries, lingonberries, loganberries, marionberries, mulberries, nannyberry, ollaliberries, oregon grape, red currants, red and green grapes, salmonberry, sea-buckthorn berries, serviceberries, tayberries |
| 5. Citrus fruit           | Citrus fruit        | Citron, grapefruit, lemon, lime, mandarin, orange |
| 6. Apples and related fruit | Apples, hawthorn, loquat, medlar, pears, quince |
| 7. Stone fruit            | Apricots, asian plums, cherries, elderberry, European plums, nectarines, peaches, plums |
| 8. Tropical fruit         | Asian palmaya palm, avocado, bael, breadfruit, cashel, coconut, date, dragon fruit, durian, guava, figs, jackfruit, jujube, kiwifruit, langsat, longan, longkong, lychee, mafai, mango, mango, mangosteen, maprang, passion fruit, papaya, pineapple, pitaya, pomegranate, rambutan, rosele, santol, sapodilla, soursop, star apple, starfruit, sugar apple, tamarind, tangerine, velvet apple |
| 9. Melons                 | Bitter melon, horned melon, muskmelon (cantaloupe, wintermelon, galia), watermelon |
| 10. Fruit mixes           | Cut fruit, fruit salad |
| Vegetable fruits          | 11. Tomatoes        | Aubergines, bell pepper, peppers (fresh), sweet pepper |
|                           | 12. Peppers, and aubergines | Buttercup squash, button squash, cucumber, green spaghetti squash, hubbard squash, ivy gourd, kabocha, marrow, muscat, pepita squash, pumpkin, red hokkaido, tinda, zucchini |
|                           | 13. Gourds and squashes | Azuki bean, black-eyed pea, chickpea, common bean, dolichos bean, drumstick, fava bean, green bean, horse gram, indian pea, lentil, lima bean, moth bean, mung bean, okra, pea, pigeon pea, ricebean, snap pea, snow pea, soybean, sweet corn, tepary bean, urad bean, velvet bean, winged bean, yardlong bean |
| Leaves                    | 15. Leafy greens eaten raw as salads | Arugula, beet greens, bitterleaf, bok choy, cabbage, celery, celtuce, ceylon spinach, chard, chicory, Chinese cabbage, collard greens, coleslaw, cress, endive, epazote, garden cress, garden rocket, komatsuna, lamb’s lettuce, land cress, lettuce, mizuna greens, mustard, New Zealand spinach, pak choy, radicchio, rapini, spinach, tatsoi, watercress, water spinach, wrapped heart mustard cabbage |

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| General commodity category | Specific categories | Examples of commodities |
|----------------------------|---------------------|------------------------|
| 16. Fresh herbs            | Basil, cilantro, celery, coriander, dill, fresh tea, marjoram, mint, parsley, peppermint, rosemary, sage, thyme |
| 17. Mixed fresh-cut salad leaves |                      | Brussel sprouts, kale, other cabbage not eaten raw |
| 18. Other leaves           |                      |                        |
| 19. Carrots                |                      |                        |
| 20. Potatoes               |                      |                        |
| 21. Other root and tuberous vegetables | Ahipa, arracacha, bamboo shoot, beetroot, burdock, cassava, Chinese artichoke, chufa, daikon, elephant foot yam, ginger, gobo, hamburg parsley, horseradish, Jerusalem artichoke, jicama, komatsuna, manioc, mooli, parsnip, radish, rutabaga, salsify, scorzonera, skirret, swede, sweet potato, taro, tigernut, turnip, ulluco, water chestnut, wasabi, yacón, yam |
| 22. Bulb and stem vegetables | Asparagus, cardoon, celeriac, celery, elephant garlic, Florence fennel, garlic, kohlrabi, kurrat, leek, lotus root, nopal, onion, Prussian asparagus, shallot, spring onion, welsh onion |
| 23. Flowers and flower buds | Artichoke, broccoflower, broccoli, broccoli romanesco, cauliflower, Chinese broccoli, courgette flowers, squash blossoms, wild broccoli |
| 29. Mushrooms, fungi and yeasts | Blewit, boletus, chanterelle, Gypsy mushroom, hedgehog mushroom, lion's mane mushroom, matsutake, morels, saffron milk cap, trompette du mort, truffles |
| 30. Sea vegetables         | Aonori, carola, dabberlocks, dulce, hijiki, kombu, laver, mozuku, nori, ogonori, sea grape, sea kale, sea lettuce, wakame |
| 34. Vegetable oils         | Sesame oil, soya oil, sunflower oil |
| 35. Fermented, salted, or acidified vegetables or fruit | Olives, pickles, sauerkraut, soy sauce, tempeh |
| 36. Mixed salads           | Potato salad         |
| 37. Other processed products, sauces and dressings, purées, soup, and pastes (including canned and bottled products) | Canned bottled products, falafel, pesto, tahini, tapenade, tomato sauce, tomato soup, vegetables in oil, vegetable soups |
| 38. Dehydrated vegetables and fruit | Dehydrated vegetable soups, dried fruits, porcini mushrooms, (sun)-dried tomatoes |

**Additional categories added by the contractor**

| other | Vegetables non specified |
|-------|--------------------------|
| 1/other | Fruits and/or vegetables non specified |
2. **Objectives and Research Questions**

Following the objectives expressed in the tender specifications, the present study aimed (i) to carry out extensive literature searches, (ii) to provide summary reports on the currently available information, and (iii) to provide EFSA with a set of relevant evidence addressing points as detailed in the tender specifications.

Specific project tasks were formulated for research areas A, B, C, and D that were indicated in the tender specifications. Tasks within research areas A, B, and C were addressed by carrying out structured literature searches that were based on specific research questions (RQs). The collective dataset obtained via the searches was then used for addressing the tasks within research area D.

**Area A. Identification and characterization of biological hazards associated with food of non-animal origin (FoNAO) with high water content.**

Project tasks within research area A were to identify and characterize pathogenic bacteria, viruses, and parasites associated with FoNAO with high water content. This involved exploring the prevalence of the biological hazards found in association with FoNAO with high water content and collecting data on relevant food-borne outbreaks.

Associated RQs:
- Which bacteria, viruses, and parasites, have been found associated with the food items addressed (FoNAO with high water content)?
- What is the prevalence of the hazards identified in the food commodities?
- What are the growth characteristics/requirements of the hazards identified and what is their persistence under various conditions prevailing in the food commodities?
- What is the colonisation/adhesion/internalization behaviour of the hazards identified in food of non-animal origin?
- Which outbreaks have been reported or otherwise addressed concerning the individual pathogens in association with the individual food commodities (FoNAO with high water content)?

**Area B. Production methods (farming and processing including post-harvest practices such as cutting, washing and packaging) of FoNAO with high water content and information on trade volumes from third countries to the European Union.**

The primary task within research area B was to identify FoNAO with high water content that were associated with biological pathogen contamination. Then, critical steps in the production line of these FoNAO regarding contamination with biological hazards had to be investigated. In addition, data on trade volumes of the food items from third countries to the European Union had to be provided.

Associated RQs:
- Which food items (FoNAO with high water content) have been found associated with microbiological hazards regarding contamination by pathogenic bacteria, viruses or parasites?
- Which procedures are used for the production and processing of the food items identified, including agricultural practices and post-harvest procedures?
- What are the critical steps in the production and processing procedures that are linked to risks of biological contamination?
- What are the trade volumes of the food items identified from third countries to the European Union?
Area C. Consumption of FoNAO with high water content associated with biological pathogen contamination.

The principal project task within research area C was to collect consumption data of FoNAO with high water content, including, where possible, data on the age of consumers, amounts consumed (grams/day), and how the food is consumed (e.g. raw, cooked, meals).

Associated RQs:

- What amounts of the food items identified are consumed in countries of the European Union?
- When are the food items consumed (time of day, meal)?
- Where are the food items consumed (at home or in the public)?
- Which population groups (especially age groups) consume the food items identified and in what amounts?

Area D. Food/pathogen combinations that are most often linked to food borne disease originating from FoNAO with high water content.

The major project task within area D was to form a synopsis of the data retrieved in tasks 1 to 3, involving that relevant information was extracted that allowed evaluating the most important food/pathogen combinations regarding criteria such as pathogen prevalence, outbreak data, risks introduced in food production, and consumption modes.

Evaluation of food/pathogen combinations should consider the following aspects:

- What are the criteria that define the relevance of the food/pathogen combinations identified as being most critical regarding human health issues?
- Which food/pathogen combinations can be identified as most critical in EU versus non-EU countries?
- How do the hazards identified affect human health?
- What are the outbreak incidences specifically for the set of hazards identified in combination with the set of food items identified?
3. Materials and Methods

3.1. Overall research strategy

The overall research strategy followed within the present study involved that a series of literature searches were performed, addressing the research questions that were defined in correspondence with the thematic areas given in the tender specifications (see chapter 2). Thus, the literature searches were aimed at identifying and characterizing biological hazards, exploring production methods, and collecting consumption data.

The individual searches performed were inter-related and built upon each other. Within each thematic area, a set of research questions formed the basis of the specific search strategy applied. The research questions determined the key words in the bibliographic searches, and they were also used to retrieve information by scanning the grey literature sources and by using various ad-hoc strategies. Finally, the research questions set the frame for the organization of the structured tables in the appendix section (Tables 12 to 35) presenting the results of the searches.

Specific search strategies were developed for the thematic areas A, B, and C (see below). Each search strategy was set up as a comprehensive overall plan for the entire search process, as defined in Zins (2000). The various searches consisted each of a sequence of interrelated actions, which determined the course of the searches and thus affected the final search results. Essential steps in the search process were to ask the right questions, then to proceed with the search while inferring optional outcomes of alternative actions, to evaluate the search results, and to eventually repeat and modify the process (Zins, 2000). This means, for instance, that the lists of key words related to the food commodities and microbiological hazards addressed were defined during the course of the searches and were continuously extended to address the research questions as specifically as possible.

Searches within the research areas A, B, and C were carried out in bibliographic databases by using the systematic review methodology as well as via directed searches performed in various grey literature sources. Research area D was addressed by evaluating the collective search results as described in section 3.6. Thus, a synopsis of the data retrieved via multiple searches was formed as the final outcome of the study.

3.2. Extensive literature review

The principles of the “systematic literature review” (EFSA, 2010) were applied to fulfil the project tasks formulated for research areas A, B, and C. This involved that a protocol was developed a priori that defined in advance the research question and scope and the search methods, including the eligibility criteria for the inclusion of studies into the review. Thereby, biases in the selection of research studies were reduced and reproducibility of the search strategy was granted. Figure 1 illustrates the various steps of the reviewing process, comprising literature searches and screening procedures as well as data extraction and documentation.
3.2.1. Searches in bibliographic databases and other literature sources

Depending on the research question, one or several bibliographic databases were used for searching scientific literature, as indicated specifically for the individual research areas (Chapter 3.3 to 3.5).

In addition, hand searching of relevant sources was performed for the various research areas concerned, including the following strategies:

- screening of websites of relevant organizations (e.g. ECDC, CDC, WHO, ProChildren Project – see individual search descriptions for details)
- checking the tables of content of relevant journals or special issues of specific journals
- obtaining “related articles” suggested during searches in PubMed/Web of Knowledge
- searching relevant literature cited in comprehensive review articles in the respective fields
- including relevant articles found during other bibliographic searches in the collection of citations used in the abstract screening (e.g., articles about outbreaks found during the search for pathogen enumeration)

Searches were performed on a worldwide level, except for consumption data, which were retrieved only from EU countries. In all searches, publications from the last ten years were considered as
Food of plant origin with high water content

relevant for the present study. The cut-off date for the searches, when no more literature entries were added to the database, was set with 31 October 2012.

3.2.2. Screening abstracts for relevance

A relevance screening tool consisting of short series of questions was applied to quickly determine if an article or other literature source was relevant to answer the research question. Hence, decisions about inclusion or exclusion of articles were made according to a pre-determined method. In the first reviewing process, only the titles and abstracts of the papers or other literature entries retrieved were screened. Separate relevance screening tools were designed for the various search strategies relating to research questions in topic (A) to (D).

The relevance screening was applied to data entries collected in a Zotero 3.0.8. database (http://www.zotero.org/; Roy Rosenzweig Center for History and New Media of the George Mason University, Virginia). Corresponding to the series of questions defined in the screening tool, number codes (“tags”) were assigned to the literature entries. Subsequently, the entries were sorted according to the codes applied, allowing distinguishing relevant from non-relevant entries and collecting entries for hand-searching or further screening of the full texts.

In the screenings performed for the searches A to C, specific codes were given according to the various exclusion criteria, and a specific code was applied for inclusion regarding the research question considered. In addition, a specific code was given if inclusion or exclusion could not be decided based on the abstract, so that full text screening or discussion in the panel were necessary.

As in some cases the articles retrieved were appropriate (also) for another research question than the one actually considered, additional codes were given for collecting these references in a hand-searching pool. This was done to ensure that the information obtained was not lost, even if eventually the same reference was also retrieved via specific bibliographic searches regarding the respective research question. In particular, review articles, which often referred to more than one research question, were collected in the hand searching pools. While review articles obtained via the various searches were not used for direct data extraction, they were used to retrieve the original articles containing relevant data.

Prior to running the reviewing process, the screening tool was validated for reliability and reproducibility by having two reviewers independently apply the same selection criteria to a randomly selected set of at least twenty studies. Eventually, the selection tool was further modified in order to yield reproducible and reliable results, and was then tested again as described above.

3.2.3. Quality assessment

Full text versions of all citations identified as relevant in the first reviewing process were obtained (as far as available to the contractor) and subjected to a quality assessment step, aimed at excluding studies whose quality was too low to provide meaningful data to address the research question. A pre-determined method was established for assessing the eligibility and quality of the studies collected, and only studies that were of appropriate quality were used for data extraction.

The quality assessment tools were used to explore the study quality. It was checked whether the study addressed the research question (e.g., microbiological hazard), if the study outcome (e.g., hazard identification or hazard characterization) was meaningful and whether the data presentation was conclusive. Moreover, the suitability of the study design was addressed. Hence, it was checked
whether the type of study was appropriate to yield meaningful information for the present extensive literature review.

As in the first reviewing process, two reviewers performed a validation step by testing the quality assessment tool on a set of randomly selected studies prior to the assessment process.

Two reviewers assessed the quality of each study in both reviewing processes, with one reviewer being primarily responsible for the screening and the other reviewer holding controlling function. Any disagreements that arose (in spite of the prior validation step) were resolved in consensus among all reviewers or (if this was not possible) were finally resolved by the project lead.

3.2.4. Data extraction

Data from all articles considered relevant in the full text quality check were extracted into multiple tables set up in Excel data sheets addressing the thematic areas A to C. The format of the Excel database was defined *a priori*. Basically, it was designed for assembling the research findings (results), which were then transferred to the results section in the present report document. Thus, following the eligibility screenings executed on full texts, data from a final set of literature that fulfilled all selection criteria were extracted into structured tables.

Descriptive data on the studies and on the search process were collected from the Zotero database by sorting the literature entries according to the codes (corresponding to the various inclusion and exclusion criteria) applied in the screenings. These data were filled into flow diagrams for documentation of the various searches performed.

Zotero is fully compatible with the EndNote bibliographic software system, and thus allowed that the comprehensive reference lists were finally exported into the EndNote format as requested in the tender specifications.
3.3. **Search strategy used within thematic area (A) Microbiological hazards**

The search strategy employed within thematic area (A) was built on the four components “hazard identification” (A1), “prevalence” (A2), “food/pathogen interaction” (A3), and “hazard characterization” (A4), corresponding to four individual searches (see below). In the process of the searches, a keyword-list of food items (FoNAO with high water content) was set up, which was used for designing the search strategies applied within the various research areas.

The searches were performed independently in three databases, i.e.

- PubMed/Medline
- Web of Knowledge (WoK)
- CAB Abstracts

WoK was used because it contains information that is carefully evaluated and selected, and thus was expected to deliver access to the most relevant resources. In most cases, WoK was used in combination with the PubMed database, which allowed accessing citations and abstracts for biomedical literature from MEDLINE, besides containing additional life science journals. In search A3, however, CAB was selected as a complementary database to WoK because it covers the applied life sciences including agriculture, environment, veterinary sciences, food science and nutrition, and was thus expected to provide information on pathogen behaviour in a varied context. Searches were performed within the last 10 years.

The initial search for identifying biological hazards (A1) was performed independently for FoNAO with high and low water content (addressed in Lot 1 and Lot 2 of the assignment, respectively). However, since many of the publications retrieved contained information on multiple food items corresponding to both lots, and hence were included in the relevance and full text screening for both lots, this strategy was changed in the following searches. Thus, for convenience all subsequent searches were carried out for the collective food commodities listed for Lot 1 and Lot 2, so that publications relating to both lots could be evaluated during the same screening procedure. This enabled us to efficiently review publications dealing with multiple food items with both high and low water content. The information extracted in the various searches (for areas A2 to A3) was assigned to either Lot 1 or Lot 2 during the relevance check. Hence, the data were used for constructing separate tables for Lot 1 and Lot 2, dealing exclusively with FoNAO of high and low water content, respectively.

3.3.1. **Development of a keyword-list of food items (FoNAO with high water content)**

Based on the FoNAO list provided by EFSA (see chapter 1), a list of keywords of food items identified as relevant regarding issues of biological contamination was developed. Results from the various searches within area A (see below) were used for generating the keyword list, which was continuously extended during the following searches. The keywords compiled comprised general categories, sub-categories and a detailed list of food items, and were subsequently used in the various bibliographic and other searches throughout the project.
Table 2: List of food commodities (FoNAO with high water content) for the use as key words in bibliographic searches, where either categories, sub-categories or individual commodities (detailed list of commodities) were applied.

Categories
- fruits OR vegetables OR produce OR juices OR herbs

Sub-categories
- fruits OR vegetables OR produce OR soft fruits OR strawberries OR raspberries OR berries OR citrus fruits OR apples OR stone fruit OR tropical fruit OR melons OR fruit mixes OR tomatoes OR peppers OR aubergines OR gourds OR squashes OR pods OR legumes OR leaves OR leafy greens OR salads OR herbs OR mixed fresh-cut salad OR roots OR tuberous vegetables OR carrots OR potatoes OR bulb vegetables OR stem vegetables OR cruciferous vegetables OR mushrooms OR sea vegetables OR beverages OR fermented vegetables OR fermented fruits OR salted vegetables OR acidified fruits OR acidified vegetables OR mixed salads OR products OR dressings OR purees OR soups OR pastes OR dried fruits OR dried vegetables OR food supplements OR plant extracts

Detailed list of commodities
- fruits OR vegetables OR produce
  - OR soft fruits OR berries OR raspberries OR strawberries OR Acai berries OR barberry OR bearberries OR bilberry OR blackberries OR blackcurrant blueberries OR boysenberry OR chokeberries OR chokecherry OR cloudberry OR cranberries OR crowberry OR elderberries OR goji berries OR gooseberries OR huckleberries OR juneberry OR juniper berries OR lingonberries OR loganberries OR marionberries OR mulberries OR nannyberry OR ollaliberries OR oregon grape OR oregano OR red currants OR grapes OR salmonberry OR sea-buckthorn berries OR serviceberries OR tayberries
  - OR citrus fruit OR citrus OR grapefruit OR lemon OR lime OR mandarin OR tangerine OR orange
  - OR apples OR hawthorn OR loquat OR medlar OR pears OR quince
  - OR stone fruit OR apricots OR asian plums OR cherries OR elderberry OR European plums OR nectarines OR peaches OR plums
  - OR tropical fruit OR asian palmya OR palm OR avocado OR baobab OR breadfruit OR canistel OR coconut OR date OR dragon fruit OR durian OR guava OR figs OR jackfruit OR jujube OR kiwifruit OR langsat OR longan OR longkong OR lychee OR mafai OR mango OR mangosteen OR maprang OR passion fruit OR papaya OR pineapple OR pitaya OR pomegranate OR rambutan OR roselle OR santol OR sapodilla OR sourpome OR star apple OR starfruit OR sugar apple OR tamarind OR tangerine OR velvet apple
  - OR melon OR bitter melon OR horned melon OR muskmelon OR cantaloupe OR wintermelon OR galia OR watermelon
  - OR fruit mixes OR cut fruit OR fruit salad
  - OR tomatoes
  - OR aubergines OR bell pepper OR peppers OR sweet pepper
  - OR squash OR gourds OR pepper OR buttercup squash OR button squash OR cucumber OR green spaghetti squash OR hubbard squash OR ivy gourd OR kabocha OR marrow OR muscat OR pepita squash OR pumpkin OR red hokkaido OR tinda OR zucchini
  - OR fresh pods OR legumes OR grains OR azuki bean OR black-eyed pea OR chickpea OR common bean OR dolichos bean OR drumstick OR fava bean OR green bean OR horse gram OR indian pea OR lentil OR lima bean OR moth bean OR mung bean OR okra OR pea OR pigeon pea OR ricebean OR snap pea OR snow pea OR soybean OR sweet corn OR tepary bean OR urad bean OR velvet bean OR winged bean OR yardlong bean
  - OR leafy greens OR salad OR arugula OR beet greens OR bitterleaf OR bok choy OR cabbage OR celery OR celtuce OR ceylon spinach OR chard OR chicory OR Chinese cabbage OR collard greens OR coleslaw OR cress OR endive OR epazote OR garden cress OR garden rocket OR komatsuna OR lamb's lettuce OR land cress OR lettuce OR Mizuna greens OR mustard OR New Zealand spinach OR pak choy OR radicchio OR rapini OR spinach OR taisoi OR watercress OR water spinach OR wrapped heart mustard cabbage
  - OR fresh herbs OR herbs OR basil OR cilantro OR celery OR coriander OR dill OR fresh tea OR marjoram OR mint OR parsley OR peppermint OR rosemary OR sage OR thyme
  - OR mixed fresh-cut salad OR mixed salad OR fresh-cut salad OR brussel sprouts OR brussels sprouts OR kale OR cabbage

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3.3.2. Search regarding “hazard identification” (A1)

The aim of search A1 was to establish a comprehensive list of pathogens (bacteria, viruses, and parasites) that have been found associated with FoNAO with high water content. Bibliographic searches were performed in the PubMed and WoK bibliographic databases by using eight different search strings (Table 3). Since search A1 was performed separately for FoNAO of high water content (addressed in the present report), Table 3 gives the search results (hits) in PubMed and WoK, respectively, referring only to these commodities. In addition, the numbers of merged hits from both databases (without duplicates) are shown.

By introducing exclusion criteria via the Boolean operator “not”, search results in both WoK and PubMed were narrowed down to those food items that were of non-animal origin (see Table 3). It was verified that no hits were missed that related to food items of both animal and non-animal origin.

In addition to the use of search engines as shown below, hand searching was performed on “related articles” listed with publications retrieved via PubMed. All articles within the Internet Journal of Food Safety (http://internetjfs.org/currentissues.html) available online were screened by title.

All hits retrieved via bibliographic searches and hand searching were subjected to relevance and (if selected) to subsequent full text screening by using the respective tools presented in Figures 2 and 3.

In the relevance screening, it was checked if the publications retrieved referred to either Lot 1 or Lot 2 (or to both lots), even though the searches were performed separately for both lots. Thus, the publications could be assigned codes for either of the lots or for both lots.
Table 3: Search A1 (hazard identification) for FoNAO with high water content in two bibliographic databases.

| Search string | Pubmed Key words, Boolean operators, Settings, Time frame | WoK Key words, Boolean operators, Settings, Time frame | Hits (PubMed) | Hits (WoK) |
|---------------|----------------------------------------------------------|--------------------------------------------------------|--------------|------------|
| #1            | microbiological quality OR microbial quality [Title] AND (food Items) ** [Topic] NOT (a) [all fields]; from 2002-2012 | microbiological quality OR microbial quality [Title] AND (food Items) ** [Topic] NOT (a) [Topic]; from 2002-2012 | 31           | 261        |
| #2            | *** examination [Title] AND (food items) **[all fields] NOT (a) [all fields]; from 2002-2012 | *** examination [Title] AND (food items) **[Topic] NOT (a) [Topic]; from 2002-2012 | 2            | 8          |
| #3            | ***survey [Title] AND (food items) ** [all fields] NOT (a) [all fields]; from 2002-2012 | ***survey [Title] AND (food items) ** [Topic] NOT (a) [Topic]; from 2002-2012 | 3            | 19         |
| #4            | ***contamination [Title] AND (food items) ** [all fields] NOT (a) [all fields]; from 2002-2012 | ***contamination [Title] AND (food items) ** [Topic] NOT (a) [Topic]; from 2002-2012 | 8            | 101        |
| #5            | ***risk [Title] AND (food items) ** [all fields] NOT (a) [all fields]; from 2002-2012 | ***risk [Title] AND (food items) ** [Topic] NOT (a) [Topic]; from 2002-2012 | 8            | 48         |
| #6            | ***hazard [Title] AND (food items) ** [all fields] NOT (a) [all fields]; from 2002-2012 | ***hazard [Title] AND (food items) ** [Topic] NOT (a) [Topic]; from 2002-2012 | 1            | 13         |
| #7            | ***assessment [Title] AND (food items) ** [all fields] NOT (a) [all fields]; from 2002-2012 | ***assessment [Title] AND (food items) ** [Topic] NOT (a) [Topic]; from 2002-2012 | 0            | 84         |
| #8            | ***safety [Title] AND (food items) ** [all fields] NOT (a) [all fields]; from 2002-2012 | ***safety [Title] AND (food items) ** [Topic] NOT (a) [Topic]; from 2002-2012 | 7            | 50         |

** categories in the list of FoNAO with high water content
*** microbial OR microbiological OR bacterial OR bacteriological
(a) animal OR chicken OR egg OR poultry OR pork OR beef OR cattle OR milk OR pork OR cheese OR seafood OR mussels
### Table

| Question                                                                 | Code | Answer                                              |
|--------------------------------------------------------------------------|------|-----------------------------------------------------|
| Do we understand the article language?                                   | 10   | We do not comprehend the article language.          |
| Is the article about a food item of plant origin?                        | 20   | The article is not about a food item of plant origin. |
| Is the article about biological hazards?                                 | 30   | The article is not about biological hazards.         |
| To which research field in Lot 1 does the article fit?                   | 40   | The article can be used for Lot1, research area A.   |
|                                                                           | 41   | The article can be used for Lot1, research area B.   |
|                                                                           | 42   | The article can be used for Lot1, research area C.   |
|                                                                           | 43   | The article can be used for Lot1, research area D.   |
| To which research field in Lot 2 does the article fit?                   | 50   | The article can be used for Lot2 research area A.    |
|                                                                           | 51   | The article can be used for Lot2 research area B.    |
|                                                                           | 52   | The article can be used for Lot2 research area C.    |
|                                                                           | 53   | The article can be used for Lot2 research area D.    |
| Should the inclusion of the article be discussed in the panel?           | 60   | The inclusion will be further discussed in the panel.|
| Should the full text be checked for details?                            | 70   | The full text has to be checked for clarification.   |

**Figure 2:** Relevance screening tool for search A1 Hazard identification.

- Data appropriate for insertion in results table.
- No pathogen incidence.
- No (relevant) pathogens analysed according to list of pathogens\(^1\).
- Study type not appropriate
  - (e.g., laboratory inoculation study, review\(^2\), statistical modelling study)
- Weak methodology or data presentation insufficient
  - (e.g., inconsistent data, analysis of single samples)

**Figure 3:** Full text screening tool for search A1 Hazard identification.

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\(^1\) This list was based on the searches “pathogen identification” and “pathogen prevalence” and includes the pathogens shown in Tables 12 to 14 in Appendix A.

\(^2\) Review articles were used to collect additional relevant articles that were not found via the bibliographic search, but they were not used for direct data extraction.
3.3.3. Search regarding “pathogen prevalence” (A2)

Search A2 was aimed at obtaining prevalence data of the pathogens identified in search A1, considering the complete list of food commodities given in Table 2. Other than in search A1, key words of FoNAO of both high and low water content were included in search A2 and all following searches. This was done to avoid redundancy in the search results, which often referred to FoNAO of both high and low water content (corresponding to Lot 1 and Lot 2 of the assignment). Search results were allocated to either Lot 1 or Lot 2 during the subsequent relevance check. Hence, Tables 4 and 5 show the numbers of hits referring to FoNAO of high and low water content, respectively. As for area A1, bibliographic searches within area A2 were carried out in the PubMed and Web of Knowledge databases. Search results from both databases were combined for each pathogen and duplicates were removed.

Depending on the pathogen concerned, some search strings contained exclusion criteria via the Boolean operator “not”. Search results were narrowed down to those relating to food items that were of non-animal origin in searches relating to Campylobacter sp., Listeria sp., Shigella spp. and Salmonella spp., which are commonly associated with animal-derived food commodities. In searches relating to Staphylococcus aureus, because this pathogen is often reported in a clinical context, results were excluded that referred to the respective pathogens in a clinical environment. Regarding searches involving E. coli, both exclusion criteria were used because of strong associations of pathogenic E. coli with food of animal origin and because of its high clinical relevance. It was verified that no relevant hits were missed by introducing the exclusion criteria (see Table 4, Table 5).

Table 4: Search A2, prevalence and enumeration data of pathogenic bacteria associated with FoNAO with high and low water content in two bibliographic databases.

| Search string | Pubmed Key words, Boolean operators, Settings, Time frame | WoK Key words, Boolean operators, Settings, Time frame | Hits (PubMed) | Hits (WoK) |
|---------------|----------------------------------------------------------|------------------------------------------------------|-------------|-------------|
| #1            | Food items A, B [all fields]                             | Food items A, B [topic]                              | 53 (A)      | 104 (A)     |
|               | AND Bacillus cereus [all fields]                         | AND Bacillus cereus [topic]                           | 40 (B)      | 89 (B)      |
|               | AND prevalence [all fields]; from 2002-2012              | AND prevalence [topic]; from 2002-2012                 |             |             |
| #2            | Food items A, B [all fields]                             | Food items A, B [topic]                              | 49 (A)      | 40 (A)      |
|               | AND Clostridium botulinum [all fields] AND prevalence [all fields]; from 2002-2012 | AND Clostridium botulinum [topic] AND prevalence [topic]; from 2002-2012 | 23 (B) | 29 (B) |
| #3            | Food items A, B [all fields]                             | Food items A,B [topic]                              | 53 (A)      | 75 (A)      |
|               | AND Clostridium perfringens [all fields] AND prevalence [all fields]; from 2002-2012 | AND Clostridium perfringens [topic] AND prevalence [topic]; from 2002-2012 | 23 (B) | 39 (B) |
| #4            | Food items A, B [all fields]                             | Food items A, B [topic]                              | 52 (A)      | 63 (A)      |
|               | AND Aeromonas [all fields]                              | AND Aeromonas [topic]                                | 23 (B)      | 29 (B)      |
|               | AND prevalence [all fields]; from 2002-2012              | AND prevalence [topic]; from 2002-2012                 |             |             |
| #5            | Food items A, B [all fields]                             | Food items A, B [topic]                              | 94 (A)      | 82 (A)      |
|               | AND Campylobacter [all fields]                           | AND Campylobacter [topic]                             | 18 (B)      | 36 (B)      |
|               | AND prevalence [all fields]                             | AND prevalence [topic]                                |             |             |
|               | NOT (a) [all fields]; from 2002-2012                     | NOT (a) [topic]; from 2002-2012                        |             |             |
### Search strings

| Search string | Pubmed Key words, Boolean operators, Settings, Time frame | WoK Key words, Boolean operators, Settings, Time frame | Hits (PubMed) | Hits (WoK) |
|---------------|--------------------------------------------------------|------------------------------------------------------|---------------|------------|
| #6            | Food items A, B [all fields] AND Escherichia [all fields] AND prevalence [all fields] NOT (a),(b) [all fields]; from 2002-2012 | Food items A, B [topic] AND Escherichia [topic] AND prevalence [topic] NOT (a),(b) [topic]; from 2002-2012 | 205 (A) | 192 (A) |
|               |                                                        |                                                      | 52 (B) | 99 (B) |
| #7            | AND (Enterobacter sakazakii OR Cronobacter) [all fields] AND prevalence [all fields]; from 2002-2012 | Food items A, B [topic] AND (Enterobacter sakazakii OR Cronobacter) [topic] AND prevalence [topic]; from 2002-2012 | 26 (A) | 33 (A) |
|               |                                                        |                                                      | 79 (B) | 30 (B) |
| #8            | Food item A, B [all fields] AND Listeria [all fields] AND prevalence [all fields] NOT (a) [all fields]; from 1992-2012 | Food items A, B [topic] AND Listeria [topic] AND prevalence [topic] NOT (a) [topic]; from 1992-2012 | 71 (A) | 147 (A) |
|               |                                                        |                                                      | 34 (B) | 120 (B) |
| #9            | Food item A, B [all fields] AND Salmonella [all fields] AND prevalence [all fields] NOT (a) [all fields]; from 2002-2012 | Food items A, B [topic] AND Salmonella [topic] AND prevalence [topic] NOT (a) [topic]; from 2002-2012 | 315 (A) | 231 (A) |
|               |                                                        |                                                      | 347 (B) | 104 (B) |
| #10           | Food item A, B [all fields] AND Shigella [all fields] AND prevalence [all fields] NOT (a) [all fields]; from 2002-2012 | Food items A, B [topic] AND Shigella [topic] AND prevalence [topic] NOT (a) [topic]; from 2002-2012 | 57 (A) | 62 (A) |
|               |                                                        |                                                      | 38 (B) | 24 (B) |
| #11           | Food item A, B AND Staphylococcus [all fields] AND prevalence [all fields] NOT (b) [all fields]; from 2002-2012 | Food items A, B [topic] AND Staphylococcus [topic] AND prevalence [topic] NOT (b) [topic]; from 2002-2012 | 206 (A) | 152 (A) |
|               |                                                        |                                                      | 102 (B) | 114 (B) |
| #12           | Food item A, B AND vibrio [all fields] AND prevalence [all fields]; from 2002-2012 | Food items A, B [topic] AND Vibrio [topic] AND prevalence [topic]; from 2002-2012 | 140 (A) | 90 (A) |
|               |                                                        |                                                      | 34 (B) | 56 (B) |
| #13           | Food item A, B [all fields] AND Yersinia [all fields] AND prevalence [all fields]; from 2002-2012 | Food items A, B [topic] AND Yersinia [topic] AND prevalence [topic]; from 2002-2012 | 171 (A) | 100 (A) |
|               |                                                        |                                                      | 35 (B) | 64 (B) |

A Key words (detailed list) of FoNAO with high water content (Lot 1)
B Key words (detailed list) of FoNAO with low water content (Lot 2). For details see Lot 2 report.
(a) “(animal OR chicken OR egg OR poultry OR pork OR beef OR cattle OR milk OR pork OR cheese OR seafood OR mussels)”
(b) “(patient OR hospital OR resistance OR infection)”

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Table 5: Search A2/prevalence and enumeration data of viruses and parasites associated with FoNAO with high and low water content in two bibliographic databases.

| Search string | Pubmed Key words, Boolean operators, Settings, Time frame | WoK Key words, Boolean operators, Settings, Time frame | Hits (PubMed) | Hits (WoK) |
|---------------|----------------------------------------------------------|-------------------------------------------------------|--------------|-----------|
| # 1 | Food item A [title], B [all fields] AND (aichi virus OR astrovirus OR coronavirus OR enteric adenovirus OR rotavirus) [all fields] AND prevalence [all fields]; from 2002-2012; | Food item A,B [topic] AND (aichi virus OR astrovirus OR coronavirus OR enteric adenovirus OR rotavirus) [topic] AND prevalence [topic]; from 2002-2012; | 216 (A) | 83 (B) |
| # 2 | Food item A [title], B [all fields] AND (norovirus OR norwalk OR norwalk-like virus OR calicivirus OR sapovirus) [all fields] AND prevalence [all fields]; from 2002-2012; | Food item A,B [topic] AND (norovirus OR norwalk OR norwalk-like virus OR calicivirus OR sapovirus) [topic] AND prevalence [topic]; from 2002-2012; | 250 (A) | 74 (B) |
| # 3 | Food item A, B [all fields] AND (hepatitis A OR hepatitis E) [all fields] AND prevalence [all fields]; from 2002-2012; | Food item A,B [topic] AND hepatitis A OR hepatitis E [topic] AND prevalence [topic]; from 2002-2012; | 206 (A) | 90 (B) |
| # 4 | Food item A,B [all fields] AND cyclospora [all fields]; from 2002-2012; | Food item A,B [topic] AND cyclospora [topic]; from 2002-2012; | 62 (A) | 21 (B) |
| # 5 | Food item A,B [title] AND cryptosporidium [all fields] AND prevalence [all fields]; from 2002-2012; | Food item A,B [topic] AND cryptosporidium [topic] AND prevalence [topic]; from 2002-2012; | 190 (A) | 50 (B) |
| # 6 | Food item A,B [title] AND giardia [all fields] AND prevalence [all fields]; from 2002-2012; | Food item A,B [topic] AND giardia [topic] AND prevalence [topic]; from 2002-2012; | 141 (A) | 31 (B) |
| # 7 | Food item A,B [all fields] AND helminth [title] AND prevalence [all fields]; from 2002-2012; | Food item A,B [topic] AND helminth [topic] AND prevalence [topic]; from 2002-2012; | 24 (A) | 8 (B) |

A  Key words of FoNAO (detailed list) with high water content (Lot 1)
B  Key words of FoNAO (detailed list) with low water content (Lot 2). For details see Lot 2 report.

Additional hand searching performed within search A2 included the 2009 special issue on food poisoning from raw fruit and vegetables in Epidemiology and Infection (Vol. 137, Issue 3), which was screened for relevant papers. Review articles that had been collected in the hand-searching pool were also screened for relevant articles (Duffy and Moriarty, 2003; Shields and Olson, 2003; Dawson, 2005; Crépet et al., 2007; Moore et al., 2007; Doyle and Erickson, 2008; Erickson, 2010; Olaimat and Holley, 2012; Zweifel and Stephan, 2012; Baert et al., 2011; Bari et al., 2011).

All hits were subjected to relevance screening by using the tool given below (Figure 4). Articles retrieved for full-text screening were subsequently checked by using the respective tool (Figure 5).
Question 1 Do we understand the article language?  10 We do not comprehend the article language.

Question 2 Is the article about a FoNAO?  20 The article is not about a FoNAO.

Question 3 Is the article about the prevalence of the searched biological hazard on a FoNAO with high water content (LOT1)?  30 The article is about the prevalence of the searched pathogen on a FoNAO with high water content (Lot1).

Question 4 Is the article about the prevalence of the searched biological hazard on a FoNAO with low water content (LOT2)?  40 The article is about the prevalence of the searched pathogen on a FoNAO with low water content (Lot2).

Question 5 Should the inclusion of the article be discussed in the panel?  50 The inclusion will be further discussed.

Question 6 Should the full text be checked for details?  60 The full text has to be checked for clarification.

Figure 4: Relevance screening tool for search A2 Prevalence and enumeration data.

- Data appropriate for insertion in results table.
- No pathogen incidence.
- No (relevant) pathogens analysed according to list of pathogens\(^1\).
- Study type not appropriate (e.g. laboratory inoculation study, review\(^2\), statistical modelling study)
- Weak methodology or data presentation insufficient (e.g., inconsistent data, analysis of single samples)

\(^1\) This list was based on the searches “pathogen identification” and “pathogen prevalence” and includes the pathogens shown in Tables 12 to 14 in Appendix A.

\(^2\) Review articles were used to collect additional relevant articles that were not found via the bibliographic search but were not used for direct data extraction.

Figure 5: Full text screening tool for search A2 Prevalence and enumeration data.
3.3.4. Search regarding food/pathogen interaction (A3)

Search A3 was aimed at collecting data on the persistence and colonisation behaviour of the pathogens in the food commodities given above. Thus, besides exploring the growth characteristics/requirements of the hazards identified, the colonisation/adhesion/internalization behaviour in FoNAO with high water content and relevant mitigation options were addressed. Bibliographic searches were carried out in the WoK and CAB Abstracts databases.

Table 6 presents the strategy used in search A3/interaction of bacteria, viruses and parasites with FoNAO. The searches were performed for both FoNAO of high and low water content. In the subsequent relevance screening, articles were assigned to either Lot 1 or Lot 2 according to the water content of the food items addressed. Results from both bibliographic databases were combined and duplicates removed.

Table 6: Search A3/interaction of pathogenic bacteria, viruses and parasites with FoNAO with high and low water content in two bibliographic databases.

| Pathogen | Search strategy | Hits (WoK) | Hits (CAB Abstracts) |
|----------|----------------|------------|----------------------|
| **Bacteria** | A) and B) [title] AND Bacillus cereus or Clostridium botulinum or Clostridium perfringens or Aeromonas or Campylobacter or Escherichia coli O157:H7 or Shiga-toxin producing E. coli or STEC or Enteroaggregative E. coli or EAEC or enterotoxigenic E. coli or ETEC or Enterobacter sakazakii or Cronobacter or Listeria or Salmonella [title] AND growth or growth profile or dynamics or growth potential or bacterial counts or bacterial count or viability or viable or survival or proliferation or bacterial load or presence or occurrence or incidence or enumeration or persistence or pathogen number or colonisation or adhesion or internalization or invasion or attachment or infestation or plant host or non-animal or infection or plant colonisation or plant colonization [title] Years 2002-2012 (current) | 864 | 441 |
| **Viruses** | A) and B) [title] AND Calicivirus or Norovirus or Norwalk or Norwalk-like Virus or Sapovirus or Aichi virus or Astrovirus or Coronavirus or Enteric adenovirus or Rotavirus or Hepatitis A or Hepatitis E [title] AND growth or growth profile or dynamics or growth potential or bacterial counts or bacterial count or viability or viable or survival or proliferation or bacterial load or presence or occurrence or incidence or enumeration or persistence or pathogen number or colonisation or adhesion or internalization or invasion or attachment or infestation or plant host or non-animal or infection or plant colonisation or plant colonization [title] Years 2002-2012 (current) | 44 | 11 |
Pathogen | Search strategy | Hits (WoK) | Hits (CAB Abstracts)
--- | --- | --- | ---
Parasites | ) and B) [title] AND Protozoan parasite OR Cyclospora OR Cryptosporidium OR Giardia OR Isospora OR Helminth parasite OR parasitic worm OR Ancylostoma or Necator americanus OR hookworm OR Ascaris OR Hymenolepis OR Strongyloides stercoralis OR Taenia OR Trichinella OR Trichuris [title] AND growth or growth profile or dynamics or growth potential or bacterial counts or bacterial count or viability or viable or survival or proliferation or bacterial load or presence or occurrence or incidence or enumeration or persistence or pathogen number or colonisation or adhesion or internalization or invasion or attachment or infestation or plant host or non-animal or infection or plant colonization or plant colonization [title] Years 2002-2012 (current) | 23 | 12

A Key words of FoNAO (detailed list) with high water content (Lot 1)
B Key words of FoNAO (detailed list) with low water content (Lot 2). For details see Lot 2 report.

All hits were subjected to relevance screening by using the tool given below (Figure 6). Articles retrieved for full-text screening were subsequently checked by using the respective tool (Figure 7).

| Question | Code | Answer |
| --- | --- | --- |
| Question 1 Do we comprehend the article language? | 10 | We do not comprehend the article language. |
| Question 2 Is the article about a FoNAO? | 20 | The main subject of the article is not about a FoNAO from Lot1 or Lot2. |
| Question 3 Is the article about a pathogen? | 30 | The article is not about a pathogen. |
| Question 4 Aspect of pathogen enumeration on a FoNAO of Lot1? | 40 | The article is about survival, growth or persistence on a FoNAO of Lot1. |
| | 41 | The article is about attachment, adhesion or internalization to a FoNAO of Lot1. |
| | 42 | The article is about mitigation of a pathogen on a FoNAO of Lot1. |
| | 43 | The article is about another aspect on a pathogen on a FoNAO of Lot1. |
| | 44 | The article is about prevalence of a pathogen on a FoNAO of Lot1. |
| | 45 | The article fits into another research area (Lot1). |
| Question 5 Aspect of pathogen enumeration on a FoNAO of Lot2? | 50 | The article is about survival, growth or persistence on a FoNAO of Lot2. |
| | 51 | The article is about attachment, adhesion or internalization to a FoNAO of Lot2. |
| | 52 | The article is about mitigation of a pathogen on a FoNAO of Lot2. |
| | 53 | The article is about another aspect on a pathogen on a FoNAO of Lot2. |
The article is about prevalence of a pathogen on a FoNAO of Lot2.
The article fits into another research area (Lot2).
Inclusion of the article will be discussed in the panel.
The full text is required to find out about the contents.

**Figure 6:** Relevance screening tool for search A3 Food/pathogen interaction.

- Data inserted in table
- Study type not appropriate (e.g. laboratory inoculation study, review*, statistical modelling study)
- Weak methodology or data presentation

* Review articles were used to collect additional relevant articles that were not found via the bibliographic search but were not used for direct data extraction.

**Figure 7:** Full text screening tool for search A3 Food/pathogen interaction.
3.3.5. Search regarding “hazard characterization” (A4)

The aim of search A4 was to collect data on food-borne outbreaks that could be traced back to the consumption of FoNAO with high water content.

Besides performing bibliographic searches (Table 7) using two different search engines (WoK, PubMed), information was collected from grey literature, including data from US multistate outbreaks of the Center of Disease Control (CDC) USA (2006-2012) and from the European Centre for Disease Prevention and Control (ECDC) reports (2009, 2010). Searches were performed simultaneously for FoNAO with low and high water content. During the relevance screening, articles were allocated to Lot1 or Lot2 depending on the water content of the food items addressed.

Table 7: Search A4/Outbreaks caused by food borne pathogens related to FoNAO with high and low water content in two bibliographic databases.

| Search string | Pubmed Key words, Boolean operators, Settings, Time frame | WoK Key words, Boolean operators, Settings, Time frame | Hits (PubMed) | Hits (WOK) |
|---------------|----------------------------------------------------------|------------------------------------------------------|---------------|------------|
| # 1 Outbreak [Title] OR food-borne outbreak [Title/Abstract] OR foodborne outbreak [Title/Abstract] OR food borne outbreak [Title/Abstract] AND A) B) [title]; from 2002-2012 | Outbreak [title] OR food-borne outbreak [topic] OR foodborne outbreak [topic] OR food borne outbreak [topic] AND A) B) [title]; from 2002-2012 | 778 (A) | 308 (A) |
|               |                                                          |                                                     | 283 (B)       | 63 (B)     |
|               |                                                          |                                                     | (total 823)   | (total 336) |

A Key words of FoNAO (detailed list) with high water content (Lot 1)
B Key words of FoNAO (detailed list) with low water content (Lot 2). For details see Lot 2 report.

Furthermore, review articles were screened for additional references describing food-borne outbreaks related to FoNAO (Tribst et al., 2009; Olaimat and Holley, 2012; Pexara et al., 2012; Zweifel and Stephan, 2012).

The relevance and full text screening tools applied within search A4 are presented in Figures 8 and 9.

| Question | Code | Answer |
|----------|------|--------|
| Question 1 Do we understand the article language? | 10 | We do not comprehend the article language. |
| Question 2 Is the article about a FoNAO? | 20 | The article is not about a FoNAO and/or source of outbreak has not been identified. |
| Question 3 Does the article describe a food-borne outbreak between 2002 and 2012? | 30 | The article does not describe a food-borne outbreak between 2002 and 2012. |
| Question 4 Is the food-borne outbreak already listed? | 31 | The outbreak has been already listed due to information extracted from grey literature. |
| Question 5 To which research field in LOT1 does the article fit? | 40 | The article can be used for Lot1, research area A4 (outbreaks). |
| Question 6 | 41 | The article can be used for Lot1, research area A2 (prevalence). |
| Question 7 | 42 | The article can be used for Lot1, other research areas. |

Supporting publications 2013:EN-402

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Food of plant origin with high water content

| Question 6 | To which research field in LOT2 does the article fit? | 50 | The article can be used for Lot2 research area A4 (outbreaks). |
| --- | --- | --- | --- |
| | | 51 | The article can be used for Lot2 research area A2 (prevalence). |
| | | 52 | The article can be used for Lot2, other research areas. |
| Question 7 | Should the inclusion of the article be discussed in the panel? | 60 | The inclusion will be further discussed in the panel. |
| Question 8 | Should the full text be checked for details? | 70 | The full text has to be checked for clarification. |
| Question 9 | Is the article a review article in which outbreak data might be found? | 80 | The article is a review and outbreak data might be extracted in a hand searching approach. |

Figure 8: Relevance screening tool for search A4 Hazard characterization (outbreaks).

- Data appropriate for insertion in table
- Outbreak before 2002
- Not about a FoNAO
- Study type not appropriate (e.g. review*, statistical modelling, laboratory study, results revised**)
- Weak methodology or data presentation insufficient (e.g., inconsistent or missing data)
- Outbreak already documented (article added as further reference)
- Food source or pathogen not unambiguously identified

*Review articles were used to collect additional relevant articles that were not found via the bibliographic search but were not used for direct data extraction.
** Outbreak initially traced back to a wrong source - later articles revise these findings.

Figure 9: Full text screening tool for search A4 Hazard characterization (outbreaks).
3.4. **Search strategy used within thematic area (B) Production**

The aim of the search performed within thematic area (B) was to identify critical points in the primary production and processing of the food items that have been found associated with pathogens. Production processes for the same food item can vary considerably between, and sometimes even within countries (FAO, WHO, 2008, online). Therefore, the search was focused on the identification of critical points and contamination sources during primary production and processing rather than on a description of complete production processes.

“Critical points” have to be distinguished from “Critical Control Points (CCPs)” as determined by the “Hazard Analysis Critical Control Point (HACCP)” system. The term “critical point” as used in the present report describes a production step which was identified as possible entry point for biological contamination. The critical points in the production processes for food items belonging to the same FoNAO category were assumed to be comparable.

A systematic search was carried out in the WoK, CAB Abstracts and PubMed databases by using the following search string:

Food item (A) AND (production or plantation or cultivation or harvest or manure or “sewage sludge” or irrigation or processing or cooling or washing or transport or storage or "quality control" or hygiene or pasteurization or pasteurisation) AND (haccp or "good agricultural practice" or "good manufacturing practice" or “critical control point” or guidelines).

(A) Key words of FoNAO (detailed list) with high water content (Lot 1)

WoK was used because it was expected to deliver access to the most relevant resources, while the PubMed database allowed accessing citations and abstracts for biomedical literature. CAB was selected as a complementary database because it covers the applied life sciences, and was thus expected to provide information that is of practical relevance concerning the production of FoNAO commodities.

The relevance of the documents (hits) was assessed by screening titles and abstracts of the search results. Due to the extremely low number of relevant hits in the scientific databases (only 2% relevant according to article title), a systematic relevance and full text check was not feasible and therefore not performed. The few relevant articles were obtained as full text and used for data extraction.

The same key words were combined to obtain information from grey literature on the internet (www.google.com). The main focus of the search was set on obtaining GAP/GMP/HACCP documents and guidelines that addressed the mitigation of risks within the production process. By using this search strategy, mainly documents were collected that are meant for the use by producers and thus are of practical relevance.
3.5. Search strategy used within thematic area (C) Consumption

The aim of the search was to collect data related to the consumption of FoNAO associated with microbiological pathogens as identified in research area A. The most detailed compilation of consumption data of FoNAO is given in the Comprehensive European Food Consumption Database by EFSA (http://www.efsa.europa.eu/en/date-foodcdb/date-fooddb.htm), which at the request of the EFSA was not considered in the present study (since this database can be consulted internally). Instead, specific information on consumption habits and the dietary intake of FoNAO by specific population groups (e.g., elderly, children, toddlers, pregnant women) was retrieved from scientific publications.

Thus, bibliographic searches were performed in WoK, SciVerse Scopus and CAB abstracts, aimed at retrieving information from multiple and varied sources involving various different search algorithms. In addition to the comprehensive WoK and CAB Abstract databases, Scopus was selected as the largest abstract and citation database of peer-reviewed literature.

Corresponding search strings were used for the three databases (Tables 8 and 9). In all cases, the exclusion criterion “cancer” was introduced to exclude studies focusing on anti-cancerogenic effects of vegetable-derived compounds such as polyphenols, which did not deliver any quantitative consumption data of FoNAO.

Table 8: Search C1/Consumption habits (frequency, place) regarding FoNAO.

| Database          | Search Strategy                                                                 | Results |
|-------------------|---------------------------------------------------------------------------------|---------|
| Scopus*           | Categories A, B [title, abstract and keywords] AND consumption OR frequency OR  | 121     |
|                   | time OR routine OR daily OR monthly OR meal OR breakfast OR lunch OR tea OR     |         |
|                   | dinner OR supper OR snack OR home-made OR restaurant OR canteen OR coffee shop  |         |
|                   | OR cafeteria OR school OR kindergarten OR nursery [title, abstract and keywords] |         |
|                   | AND Europe [title, abstract and keywords] NOT cancer [title, abstract and keywords]; |         |
|                   | time-frame 2002-2012                                                           |         |
| WoK               | Subcategories A, B [title] AND consumption OR frequency OR time OR routine OR   | 34      |
|                   | daily OR monthly OR meal OR breakfast OR lunch OR tea OR dinner OR supper OR   |         |
|                   | snack OR home-made OR restaurant OR canteen OR coffee shop OR cafeteria OR     |         |
|                   | school OR kindergarten OR nursery [title] AND Europe or European [title] NOT   |         |
|                   | cancer [topic]; time-frame 2002-2012                                           |         |
| CAB Abstracts     | Subcategories A, B [title] AND consumption OR frequency OR time OR routine OR   | 10      |
|                   | daily OR monthly OR meal OR breakfast OR lunch OR tea OR dinner OR supper OR   |         |
|                   | snack OR home-made OR restaurant OR canteen OR coffee shop OR cafeteria OR     |         |
|                   | school OR kindergarten OR nursery [title] AND Europe or European [title] NOT   |         |
|                   | cancer [all fields]; time-frame 2002-2012                                      |         |

A Key words of FoNAO with high water content (Lot 1)
B Key words of FoNAO with low water content (Lot 2). For details see Lot 2 report.
*Note that only the food categories list, (i.e. fruits, vegetables, produce, juices, herbs) could be used in this search due to the limited amount of search words that can be entered in Scopus.
Table 9: Search C2/Consumption of FoNAO by various population groups

| Database       | Search Strategy                                                                                                                                                                                                 | Results |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| Scopus*        | Categories A, B [title] age OR baby OR toddler OR children OR infant OR adolescent OR teenager OR junior OR juvenile OR adult OR grown-up OR very elderly OR senior OR young OR old OR man OR woman OR health* OR pregnant OR breastfeeding OR boys OR girls OR mother OR maternal [title] AND Europe OR European [title, abstract and keywords] AND NOT cancer [title, abstract and keywords]; time-frame 2002-2012 | 12      |
| WoK (keywords, Boolean operators, settings) | Subcategories A, B [title] AND age OR baby OR toddler OR child OR children OR infant OR adolescent OR teenager OR juvenile OR junior OR adult OR grown-up OR elderly OR very elderly OR senior OR aged OR young OR old OR man OR man OR woman OR women OR patient OR patients OR health* OR pregnant OR “breast feeding” OR breastfeeding OR boys OR girls OR mother OR maternal [title] AND Europe OR European [title] NOT cancer [topic]; time-frame 2002-2012 | 67      |
| CAB Abstracts  | Subcategories A, B [title] AND age OR baby OR toddler OR children OR infant OR adolescent OR teenager OR junior OR juvenile OR adult OR grown-up OR very elderly OR senior OR young OR old OR man OR woman OR health* OR pregnant OR breastfeeding OR boys OR girls OR mother OR maternal [title] AND Europe OR European [title] NOT cancer [all fields]; time-frame 2002-2012 | 12      |

A  Key words of FoNAO with high water content (Lot 1)
B  Key words of FoNAO with low water content (Lot 2). For details see Lot 2 report.
*Note that only the food categories list, (i.e. fruits, vegetables, produce, juices, herbs) could be used in this search due to the limited amount of search words that can be entered in Scopus.

Search results from both searches (C1 and C2) using the three databases were combined to avoid redundancy, and were subjected to relevance and full text screening by using the tools presented below (Figures 10 and 11).

| Questions                        | Code | Answer                                                                 |
|----------------------------------|------|----------------------------------------------------------------------|
| Question 1: Do we comprehend the article language? | 10   | We do not comprehend the article language.                           |
| Question 2: Is the article about food consumption patterns in a European Country? | 20   | The article is not about food consumption patterns in a European Country. |
| Question 3: Does the article contain quantitative data (food frequency, amounts) about food consumption? | 30   | The article describes quantitative data about food consumption. |
| Question 4: Is the article about toddlers, children, and adolescents? | 40*  | The article is about toddlers, children or adolescents.              |
| Question 5: Is the article about adults? | 60*  | The article is about adults.                                         |
| Question 6: Is the article about elderly people? | 70*  | The article is about elderly persons.                                |
| Question 7: Is the article about food consumption patterns, but does not describe quantitative data? | 80   | The article might contain relevant data, but not quantitative ones. |
| Question 8: Should the inclusion of the article be discussed in the panel? | 100  | The inclusion will be further discussed in the panel.                |

* Codes were given in addition to code “30” if applicable.

Figure 10: Relevance screening tool for search C1 Consumption.
3.6. Methodology for ranking FoNAO/pathogen combinations (thematic area D)

3.6.1. Method development

The methodology applied for identifying FoNAO/pathogen combinations that were considered as most important regarding risks to human health involved that a synopsis of the results from the individual searches in research areas A to C was formed. Thus, the collective data retrieved in searches A to C were used to evaluate the FoNAO/pathogen combinations regarding multiple qualitative and quantitative criteria as described in sections 3.6.2 and 3.6.3.

Following data extraction into structured tables, it became evident that outbreak incidences reported for the various FoNAO/pathogen combinations presented the primary basis for evaluation. Reports on outbreaks yielded the most comprehensive data set assembled within the present study, and allowed a clear and unambiguous association of biological hazards with FoNAO commodities. Furthermore, numbers of cases reported together with information regarding the severity of outbreaks (i.e. number of hospitalisations and number of deaths) allowed that a quantitative analysis of the outbreak data was performed.

By contrast, the data on pathogen prevalence obtained via search A2 depended very much on parameters such as type of study performed, type and extent of survey, number of samples analyzed, methodology used, etc. Similarly, information on food/pathogen interaction and on mitigation strategies (search A3) was fragmented and biased for methodology and study design. This was because studies on food/pathogen interaction and hazard mitigation as reported in the retrieved publications had not been performed in the same way (using the same methodology) for the various pathogens considered in the present report, and data were partly not available or not comparable. While numbers of publications on pathogen prevalence and outbreaks also gave a comprehensive data set, they were not considered as equally appropriate criteria because they also contained study-related biases. Data relating to production and consumption issues (searches B and C) were not equally comprehensive for the various food items considered. Hence, outbreak incidences represented the basis for a primary evaluation step, and the collective data on pathogen prevalence, food/pathogen interaction, and production were used in a qualitative way for evaluating the FoNAO/pathogen combinations.

3.6.2. Evaluation based on outbreak data

Outbreak information was used in a quantitative manner for the primary evaluation of FoNAO/pathogen combinations.

Specifically, FoNAO/pathogen combinations were identified that were associated with outbreaks involving the ten highest numbers of cases, the ten highest numbers of hospitalisations, and involving cases of death. This selection process was performed separately for bacteria-, virus- and parasite-related outbreaks, and distinct rankings were carried out for outbreak cases reported for EU and non-EU countries.
In this primary evaluation procedure, those FoNAO/pathogen combinations that were involved in outbreaks that could not be allocated to a single specific FoNAO commodity and that included composite FoNAO commodities (that were composed of multiple food items) were excluded. This was done because we aimed to identify FoNAO/pathogen combinations implicating specific, individual food items that are considered most critical regarding contamination with pathogenic bacteria, viruses or parasites.

The primary evaluation procedure resulted in two comprehensive sets of FoNAO/pathogen combinations for EU and non EU countries, respectively, which formed the basis for the second evaluation step. Results of the ranking of FoNAO/pathogen combinations involved in outbreaks according to the number of cases, the number of hospitalisations, and the number of deaths are presented in the results section (with the associated tables 30 to 35 being presented in appendix D).

3.6.3. Evaluation based on multiple qualitative criteria

In the scope of the second evaluation step, the complex information collected via searches A to C was used in a qualitative way to evaluate the FoNAO/pathogen combinations selected in the primary ranking procedure.

Specifically, information obtained via the searches in areas A to C was used to define criteria that allowed a grading of the FoNAO/pathogen combinations within the four aspects “outbreaks”, “production”, “prevalence”, and “food/pathogen interaction”. Additionally, the relative infectivity of the relevant pathogens was evaluated based on information provided in Kothary and Babu (2001) and Koopmans and Duizer (2004) and by screening relevant fact sheets by the CDC. This information was used for characterising food/pathogen interaction (see below).

The following procedure was applied for the prioritisation of FoNAO/pathogen combinations, considering the four criteria “outbreaks”, “production”, “prevalence”, and “food/pathogen interaction” (see also Fig. 12):

**Outbreaks.** As the most important criterion for prioritisation, FoNAO/pathogen combinations were graded in relation to outbreaks with “A” (“highly critical”) if (i) cases were high (among the top 10 rankings), (ii) hospitalisations were high (among the top 10 rankings) and/or cases of death were involved, and if (iii) multiple outbreaks involving the given combination had been reported. “B” grading (“critical”) was applied if two of the three above criteria (i) to (iii) were fulfilled, and “C” grading (“moderate critical”) was applied if one of the three criteria (i) to (iii) was fulfilled.

**Production.** A given FoNAO/pathogen combination was graded “A” if multiple critical factors in the production and/or processing were identified as important regarding biological contamination. “B” grading was applied if a single factor was identified as critical for the given FoNAO/pathogen combination. This was done because control measures supposedly are more easily introduced and followed when focusing on a single factor as compared to multiple factors.

**Prevalence.** If prevalence data for the given FoNAO/pathogen combination had been retrieved via search A2, an additional grade “A” was applied regarding the prevalence criterion.

**Food/pathogen interaction.** If a critical interaction (namely attachment, biofilm formation, or internalisation) had been evidenced for the pathogen in a given FoNAO/pathogen combination, an additional grade “A” was applied regarding this criterion. Similarly, high infectivity of the pathogen (meaning a low infectious dose) resulted in “A” grading, based on the evaluation by Kothary and Babu (2001) and according to Koopmans and Duizer (2004) as well as specific CDC fact sheets.
The following **classification scheme** was applied for the prioritisation of FoNAO/pathogen combinations (see also Fig. 12):

**Level 1 Priority** was given to combinations yielding at least triple A grading, with A grading in outbreaks being a precondition.

**Level 2 Priority** was given to combinations yielding double A grading, with A or B grading in outbreaks being a precondition.

**Level 3 Priority** was given to combinations that had at least one A grade in either of the four criteria together with some other distinctive feature (i.e. any other grading in another aspect). Hence, FoNAO/pathogen combinations that were not assigned any A grade or were assigned only one A grade without any other grade regarding some other aspect were excluded from the priority list.

The prioritisation method applied combined a quantitative ranking procedure (i.e. ranking of FoNAO/pathogen combinations according to quantitative outbreak data) with a qualitative approach (i.e. the evaluation of FoNAO/pathogen combinations regarding the criteria “outbreaks”, “production”, “prevalence”, and “food/pathogen interaction”). This strategy allowed evaluating FoNAO/pathogen combinations regarding multiple aspects that were explored in the study areas A to C. Since the specific data used for the prioritisation were heterogeneous and inconsistent for the various combinations, criteria were defined that were applicable to all combinations. By using the classification scheme described above, FoNAO/pathogen combinations were allocated to priority groups.

The specific criteria used to assign the various FoNAO/pathogen combinations to priority groups are shown below. This methodology was applied separately for EU and non-EU countries, respectively.

**Figure 12:** Scheme applied for the prioritisation of FoNAO/pathogen combinations. A, B and C grading corresponds to factors that are “highly critical”, “critical” and “moderately critical” regarding food safety, respectively, within each of the four criteria “outbreaks”, “production”, “prevalence” and “food/pathogen interaction”. For further details see text.
4. Results

4.1. Microbiological hazards that may contaminate FoNAO with high water content

Data concerning research area A were retrieved via four individual searches, and consequently were extracted into tables presenting data on hazard identification (A1), hazard prevalence (A2), food/pathogen interaction (A3), and hazard characterisation (A4).

In the following sections, the study selection procedures underlying the various searches are described and the information contained in the tables is summarized. The associated tables are shown in the appendix A.

4.1.1. Hazard identification (A1)

In search A1, separate bibliographic searches using scientific databases were carried out especially for FoNAO with high and low water content, respectively, relating to Lot 1 and Lot 2 of the assignment. However, literature entries obtained for Lot 1 and Lot 2 were combined for performing the relevance check, because many publications dealt with a combination of food items of both high and low water content.

As depicted in Figure 13, in total 702 abstracts collected via bibliographic searches were subjected to the relevance screening, 171 of which were screened in full text in the following quality check. 23 publications retrieved via hand-searching were added to the quality screening. Finally, 52 publications relating to Lot 1 and 27 publications relating to Lot 2 met the quality criteria and were selected for data extraction. Thus, for the present study only data relating to FoNAO with high water content were extracted into the tables shown in Appendix A.

Tables 12 to 14 in appendix A show the various bacterial pathogens, viruses, and parasites that have been identified as being associated with items of FoNAO with high water content, listed in alphabetical order. The food/pathogen combinations presented were initially derived from the results of search A1, but were then extended with data from the following, more specific searches (mainly A2). Search A1 was carried out on a worldwide scale, and data are given collectively for EU and non-EU countries. Besides FoNAO categories, the food item(s) concerned and the sources of the food, also the countries are given where the food commodities were found in association with a biological contaminant (e.g. site of survey or location of the outbreak, not necessarily the place of origin/production of the food commodity analysed). Thus, the tables give an overview of the biological hazards as they have been described in association with multiple FoNAO items with high water content that are included in the various FoNAO categories (see Table 1) considered in the present study.

Bacterial pathogens found associated with FoNAO with high water content comprise representatives of the genera Aeromonas, Bacillus, Campylobacter, Clostridium, Cronobacter, Enterobacter, Klebsiella, Salmonella, Shigella, Vibrio as well as various pathogenic Escherichia coli, Listeria monocytogenes, Pseudomonas aeruginosa, Staphylococcus aureus and Yersinia enterocolitica. However, of in total 394 bacterial pathogen/ FoNAO associations indicated in the literature, 109 have been found with Salmonella spp., including multiple serovars (i.e. Agona, Durban, Enteritidis, Gustavia, Montevideo, Newport, Typhi, Typhimurium, Umbilo, and unspecified serovars) (Table 12).

Regarding viruses, only Norovirus (in association with soft red fruits, leafy greens, and produce non specified) and Rotavirus have been described on/in FoNAO with high water content (Table 13). By contrast, multiple parasites have been described in association with FoNAO with high water content, including among others Ascaris, Blastocystis, Cryptosporidium, Entamoeba, Giardia, Taenia, and Toxocara species. 94% (177 out of 189) of the reports on parasites on/in FoNAO refer to non-EU
Food of plant origin with high water content

countries. However, Encephalitozoon intestinalis on berries, Enterocytozoon bieneusi on raspberries and lettuce, Microsporidia spores on berries and non specified vegetables and Toxoplasma gondii on lettuce, carrots and radish were found in Poland. Intestinal helminths on cabbage, black nightshade, kale, and spider flower, were reported also for Italy (Table 14).

The list of pathogens established via search A1 was used in subsequent keyword searches concerning specific research questions in areas B and C.

Figure 13: Flow chart of the study selection process underlying search A1. *The respective articles were then assigned to categories for inclusion or exclusion.

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4.1.2. Hazard prevalence and enumeration data (A2)

Bibliographic searches regarding the prevalence of bacterial pathogens, viruses and parasites on/in items of FoNAO were performed in the WoK and PubMed databases by using 20 search strings each for the set of bacteria, viruses, and parasites that have been identified via search A1. Searches were done for the collective food items relating to Lot 1 and Lot 2 of the assignment, resulting in 4751 potentially relevant abstracts that were subjected to the relevance check. The vast majority of 4283 abstracts were excluded because they did not deal with FoNAO or because of language restrictions, and only 280 articles were identified as relevant for Lot 1 (since they related to FoNAO with high water content). However, in total 670 articles were found to potentially contain information that may be of relevance not only for research area A2 but also for other areas, and were hence added to the respective hand searching pools for further evaluation. Together with 12 articles retrieved via hand searching, in total 438 full text articles were accessed and checked in the quality check. Of those, 81 articles were finally selected for extracting prevalence data in Lot 1 (Figure 14).

Tables 15 and 16 in appendix A present the data extracted from scientific articles retrieved via search A2. Additionally, data collected via search A1 were included, which had been deposited in the hand searching pool (because they reported on detection rates, see Figure 14). The tables show prevalence data (detection rates) for pathogenic bacteria, viruses, and parasites that were reported in association with FoNAO with high water content. While table 15 gives the information for EU countries, data from non EU countries are shown in Table 16.

The scope of tables 15 and 16 is to demonstrate the association of various pathogenic bacteria, viruses and parasites with specific food items found in scientific publications. Furthermore, the tables illustrate what are the specific prevalences (detection rates) of the biological hazards, considering sources and processing states of the food items. The pathogens are listed in alphabetical order, and additional information is given on the various FoNAO categories concerned and on the country where the studies or surveys were performed. Like the data on hazard identification shown in Tables 14, prevalences of parasites were mainly reported in non-EU countries. By contrast, detection rates of viruses on/in FoNAO were available only for EU countries.

Detection rates of biological hazards varied considerably, ranging from 0.02 to 100%. This reflects the various methodologies applied in the studies and surveys, and that the sample numbers investigated were in a broad range. Thus, while the information on detection rates of biological hazards on/in FoNAO provides a detailed database on surveys and studies performed in EU and non-EU countries, the detection rates are not suited for comparison regarding the relative importance of the FoNAO item/pathogen combinations. Still, studies reporting on detection rates give an indication that the FoNAO/pathogen combination concerned may potentially represent a food safety problem.
Figure 14: Flow chart of the study selection process underlying search A2. *The respective articles were then assigned to categories for inclusion or exclusion.
4.1.3. Food/pathogen interaction (A3)

Bibliographic searches regarding the interaction of bacterial pathogens, viruses and parasites with FoNAO were done in the WoK and PubMed databases, yielding 953 potentially relevant abstracts. The searches were done for the collective food items relating to Lot 1 and Lot 2 of the assignment, however, search results were assigned to either Lot 1 (217 relevant publications) or Lot 2 (55 relevant publications) during the relevance check. Following quality checking of the full text publications, 150 articles were used for data extraction in Lot 1. Of those, 75 articles gave data on the growth characteristics of biological pathogens, 39 gave data on the colonisation behaviour of pathogenic bacteria on/in FoNAO items, and 36 contained information on the mitigation of pathogen contamination (Figure 15).

Table 17 in appendix A presents the results of search A3, comprising data relating to the growth characteristics of pathogenic bacteria and persistence of viruses on/in items of FoNAO under various experimental conditions (e.g. temperature, pH, various amendments) and exposure times. In cases where multiple treatments were addressed, only the most effective conditions within a specific study were extracted. Since data were mostly derived from inoculation studies, in most cases the initial inoculation dose is given together with the increase or decrease in colony forming units (cfu) numbers.

Table 18 in appendix A contains data on the colonisation behaviour of pathogenic bacteria associated with FoNAO with high water content. Information was collected from studies that related to the attachment, biofilm formation and/or the internalisation of the bacteria. Specific information on colonisation is shown in the “details” column. For instance, biofilm formation has been described for pathogenic E.coli, Bacillus cereus, Listeria monocytogenes, Salmonella spp. and Staphylococcus aureus on various items of FoNAO with high water content. In addition, internalisation into FoNAO with high water content has been reported in multiple studies for several Salmonella serovars and pathogenic E.coli. This implicates a critical behaviour of the pathogens regarding food safety, which has to be considered when evaluating their importance regarding food safety issues.

Treatments applied for the mitigation of biological contamination are shown in Table 19 in appendix A. For the various pathogenic bacteria, viruses, and parasites the associated food commodities are given where treatments have been applied for reducing pathogen loads. In most studies either chemical or physical treatments were applied, and hence, the specific conditions are detailed (including concentrations of additives, treatment time, inoculation details) together with the reduction effects of the treatment on the pathogens.
Figure 15: Flow chart of the study selection process underlying search A3. *The respective articles were then assigned to categories for inclusion or exclusion.
4.1.4. Hazard characterization (A4)

The WoK and CAB bibliographic databases were searched for data on outbreaks of disease that could be traced back to bacterial pathogens, viruses, and parasites linked to FoNAO with high water content. Of 1091 potentially relevant abstracts identified via the searches, 141 and 46 were considered as relevant for providing information on outbreak data relating to Lot 1 and Lot 2 of the assignment, respectively. In addition to scientific literature entries identified via the bibliographic searches, hand searching of various scientific and grey literature sources (e.g. CDC and ECDC reports) yielded 42 documents that were screened for relevance. Following quality checking of the full text publications, 115 articles were used for data extraction in Lot 1 (Figure 16).

Tables 20 and 21 in appendix A present the outbreak data obtained via search A4 for EU and non EU countries, respectively. In both tables data are given for pathogenic bacteria, viruses, and parasites as reported in the publications as being associated with FoNAO with high water contents, including both scientific and grey literature. However, the individual outbreaks are listed only once with references of all documents relating to it. For both EU and non EU countries, various serovars of *Salmonella* were the bacteria most often implicated in outbreaks. Of in total 51 records from the EU, 16 were on *Salmonella*-related outbreaks, and 23 out of 47 reports on outbreaks outside of the EU were associated with *Salmonella* spp. Other bacteria involved in outbreaks comprise *Bacillus cereus*, *Campylobacter jejuni*, *Clostridium botulinum*, *Clostridium perfringens*, *Listeria monocytogenes*, pathogenic *E.coli*, *Shigella dysenteriae*, *Shigella flexneri*, *Shigella sonnei*, *Staphylococcus aureus*, *Staphylococcus aureus*, *Vibrio cholerae*, *Yersinia enterocolitica*, and *Yersinia pseudotuberculosis*. Among the viruses, Norovirus and Hepatitis A virus were reportedly associated with outbreaks in both EU and non EU countries, while outside of the EU outbreaks were also related to Nipah virus. Parasites that have been found involved in FoNAO-related outbreaks in the EU include *Cryptosporidium hominis*, *Cryptosporidium parvum*, *Cyclospora cayetanensis*, *Enterocytozoon bieneusi*, and *Fasciola hepatica*. In non-EU countries, parasites associated with FoNAO-related outbreaks are *Cryptosporidium parvum*, *Cyclospora cayetanensis*, *Trichostrongylus spp.*, and *Trypanosoma cruzi*.

Besides FoNAO categories and food items linked to the outbreaks, in Tables 20 and 21 comments are given on food sources and processing states of the implicated FoNAO items if available, together with the countries where the outbreaks occurred. The tables contain information on the year of the outbreak, on the number of cases reported, the number of hospitalisations, and the number of deaths, if indicated in the publications. Here, all FoNAO food items with high water content that were reported as associated with outbreaks were considered, even if the individual food items were not further specified or if composite food items were concerned that did not allow exact source tracking. This was done to provide an extensive database of all outbreak incidences where FoNAO commodities with high water content were implicated.
Figure 16: Flow chart of the study selection process underlying search A4. * The respective articles were then assigned to categories for inclusion or exclusion.
4.2. **(B) Production methods and trade volumes of FoNAO with high water content from third countries to the European Union**

Production methods for FoNAO with high water content vary enormously in different countries and regions, depending among other factors on climate, cultivars, regional prerequisites, traditions and production facilities (FAO, WHO, 2008, online). Therefore, search B was focused on the critical steps within the primary and post-harvesting production processes regarding contamination with pathogens based on GMP/GAP/HACCP documents and producer guidelines (for details see Chapter 3.4). The systematic searches carried out in WoK, CAB Abstracts and the PubMed database by using defined search strings, yielded only low numbers of relevant hits, which were identified by broad title and abstract screenings rather than applying elaborate screening tools. Thus, data were extracted from few scientific publications. However, the same key words as used in the bibliographic search were used for internet searches (www.google.com), enabling that GAP, GMP and HACCP documents and other producer guidelines were obtained, which were used for data extraction.

Tables 22, 23 and 24 in appendix B show all the food items which are of concern regarding contamination with pathogenic bacteria, viruses, and parasites, as identified during the previous searches (research areas A1 and A2). Food items that were found strongly involved in outbreaks due to biological contamination (top 10 ranking regarding number of cases, number of hospitalisations, and cases of death, see 4.4) are highlighted in the table, because they subsequently were analyzed in detail regarding critical steps in the production chain both in primary production as well as post-harvest processing. It can be assumed that the critical production steps are comparable for food items within the same FoNAO category, due to similar texture, growth, ripening times, and harvesting and production requirements. Therefore, in some cases one representative FoNAO item was selected per category for further investigation.

Table 25 in appendix B shows the critical points and/or contamination sources in the primary production of the food items highlighted in the previous tables, which have been identified in scientific and grey literature sources. Critical points during post-harvest processing of FoNAO with high water content are presented in Table 26 in appendix B. Again, data are based on various scientific and grey literature sources. If available, corrective actions during primary production and processing of the food items are given. In primary production, critical steps for all FoNAO items listed include irrigation/watering, fertilisation practices, contaminated soil or equipment, harvesting/sorting and sanitation. Additional points listed include contact with animals (e.g. birds, insects, rodents) for berries, tropical fruits, tomatoes, cucumber, and leafy greens as well as contact with humans for berries, tomatoes and leafy greens. Critical points in post-harvest procedures comprise among others for most FoNAO items the equipment used, packing, washing, storage, sorting and cooling. In most cases, multiple points in primary production and/or processing were identified which were considered as equally critical regarding food safety issues. However, in some cases one dominant point was highlighted, for instance hand hygiene was evidenced as most critical for preventing viral contamination in the processing of semidried tomatoes.

The influencing factors identified via search B are in many cases important for multiple FoNAO items with high water content (e.g., workers hygiene, manure application). Hence, the critical points listed in Tables 25 and 26 were extracted from various general survey documents on fruit and vegetable production (EC, 2002, online, CAC, 2003, online, FDA, online (a)) as well as from specific documents dealing with individual food items. Table 27 shows some exemplary guidelines and standards documents dealing with improving the quality of the FoNAO items listed in Tables 22 to 24.

Table 28 in appendix B shows trade volumes of FoNAO with high water content from third countries into the EU during the last ten years (2002-2011). This information may implicate on the exposure of EU citizens to potentially contaminated imported commodities. Tropical fruit is the commodity imported in the highest quantity, with an increasing trend between 2002 and 2008, followed by citrus

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fruit with a similar trend. Also fresh pods, legumes and grains are imported in high quantities, but with a decreasing trend since 2005. Strawberries, raspberries and other berries are imported in lower total amounts, but with an increasing trend over the past ten years.

4.3. (C) Consumption of FoNAO with high water content

The search strategy applied for search C1 (consumption habits) and search C2 (population group) is illustrated in Figure 6. This strategy was used for retrieving data relating to food items of both high and low water content to avoid redundancy. However, of the 213 abstracts considered as potentially relevant, only 31 were selected for full text checking. Finally, only eight articles were maintained after the full text quality check and were used for data extraction into tables of both Lot 1 and 2.

Data from relevant articles were extracted into Table 29 in appendix C. However, scientific publications contained mainly information on fruit and vegetable consumption in general but generally did not report on consumption patterns regarding individual items of FoNAO. Screening the websites of major pan-European nutrition studies (HELENA Health Lifestyle in Europe by Nutrition in Adolescence, http://www.helenastudy.com/; HBSC Health behaviour in school aged children, http://www.hbsc.org/publications/journal/; ProChildren project http://www.prochildren.org/; ISAFRUIT, http://www.isafruit.org) yielded information on consumer groups and regional aspects of fruit and vegetable consumption, but gave only few data relating to individual food items. Due to time and resource limitation it was not possible to access the raw data of the nutrition studies by contacting individual researchers. The most detailed compilation of consumption data of FoNAO is given in the Comprehensive European Food Consumption Database by EFSA (http://www.efsa.europa.eu/en/date-foodcdb/date-fooddb.htm), which in accordance with EFSA was not considered in the present study since it is internally available by EFSA.
Figure 17: Flow chart of the study selection process underlying search C1 (consumption habits) and search C2 (consumption by population groups).
4.4. (D) Ranking of food/pathogen combinations

The present study explored multiple aspects of biological contamination of FoNAO with high water content, aimed at identifying the most critical FoNAO/pathogen combinations regarding food safety. Thus, research area D was dedicated to evaluating the data collected in the previous research areas and forming a conclusive synopsis of all search results.

However, while the various data retrieved via searches A, B and C were all considered for the final evaluation of food/pathogen combinations, data on outbreak incidences formed the primary basis for an evaluation regarding their overall importance. The occurrence and severity of outbreaks are solid indications of a health concern, which is of utmost importance for human societies. Similarly, estimated health risks of the hazards for the consumer were considered as an output adopted by the Authority. The European Food Safety Authority reserves its rights, view and position as regards the issues addressed and the conclusions reached in the present document, without prejudice to the rights of the authors.

Tables 30 to 32 in appendix D present the food item/pathogen combinations identified that were associated with outbreaks involving the ten highest numbers of cases, the ten highest numbers of hospitalisations, and the most (up to ten) cases of deaths reported for EU countries. Correspondingly, Tables 33 to 35 in appendix D show food/pathogen combinations with the ten highest numbers of cases, hospitalisation, and death for non-EU countries. Outbreaks caused by pathogenic bacteria, viruses and parasites were treated individually. Outbreak data were collected globally, from reports originating from both EU and non-EU regions. For the scope of the evaluation, outbreaks were listed separately for EU and non EU countries according to the outbreak location. Regarding EU data, EFSA/BIOMO data from EUSR were generally not considered, since it is internally available by EFSA; and only literature data was used for this purpose. It is notable that most publications on outbreaks in non EU regions are dealing with outbreaks in the United States, which may also be due to language restrictions.

In the EU (Tables 30-32), bacterial pathogen-related outbreaks involving the highest numbers of outbreak cases were caused by *Salmonella* spp. and pathogenic *E. coli* on lettuce and fresh basil, and by *Yersinia pseudotuberculosis* O:1 on grated carrots. Multiple outbreaks have been reported with these FoNAO (high water content)/pathogen combinations, which involved also high numbers of hospitalisations. In addition, high numbers of cases were reported in single outbreaks associated with the combination mung beans/*Salmonella Bareilly*/S. Virchow. Virus-related outbreaks caused by far the highest numbers of cases, involving norovirus on berries (strawberries, raspberries, blackberries) and lettuce. These outbreaks had also high numbers of hospitalisations. Fewer cases but even higher numbers of hospitalisations were reported for outbreaks involving semidried tomatoes and Hepatitis A virus. Other norovirus-related outbreaks concerned raw onion, fruits (unspecified) and carrots. Regarding parasite-borne outbreaks, *Enterocytozoon bieneusi* on cucumber and *Cryptosporidium hominis* on carrot and red peppers caused considerable outbreak cases, which were however restricted to single outbreaks with the given combinations. In the EU, cases of death have been reported in an outbreak involving *Salmonella* spp. on iceberg lettuce (Table 32).

In non-EU countries (Tables 33-35), highest outbreak cases were caused by *Vibrio cholerae* on vegetables which were not further specified, and thus did not implicate a specific FoNAO/pathogen combination. Furthermore, *Salmonella* spp. on peppers, tomatoes, salad, and cantaloupe melon as well as pathogenic *E. coli* on lettuce, celery/cabbage, and spinach and *Shigella sonnei* on carrots caused multiple outbreaks, partly with high numbers of cases and hospitalisations. Individual outbreaks were caused by Hepatitis A virus on green onion, semidried tomatoes and orange juice as well by norovirus on lettuce and radish, involving considerable numbers of cases and eventually hospitalisations. Single outbreaks with high numbers of cases were also reported for FoNAO combinations involving parasites, including Apple cider/*Cryptosporidium parvum*, fresh basil and snow peas/*Cyclospora cayetanensis*, and Guava and sugar cane juice/*Trypanosoma cruzi*. In non-EU countries, five bacteria-
related outbreaks (involving \textit{Vibrio cholera}, \textit{Listeria monocytogenes}, \textit{E.coli}, and \textit{Salmonella} spp.), four virus-related outbreaks (involving Nipah virus and Hepatitis A virus) and two parasite-related outbreaks (both involving \textit{Trypanosoma cruzi}) included cases of death (Table 35).

The FoNAO/pathogen combinations listed in Tables 30 to 35 formed the primary basis for the subsequent prioritisation regarding multiple qualitative factors. The focus of this prioritisation analysis was on ready-to-eat, unprocessed FoNAO, excluding composite products. Hence, FoNAO items belonging to category 1 (fruits non-specified), 36 (mixed salads), 37 (other processed products), other (vegetables non-specified), and 1/other (fruits or vegetables non-specified) were excluded from the evaluation process because no unambiguous food item/pathogen association could be formed.

Tables 10 and 11 presented below show the food/pathogen combinations that have been attributed level 1 to 3 priorities. Again, separate evaluations were done for EU and non EU countries. Priority groups were defined based on multiple factors specified within the criteria “outbreak”, “pathogen prevalence”, “production”, and “food/pathogen interaction” (see Tables 10 and 11 and Chapter 3.6). The approach followed for evaluating the importance of FoNAO/pathogen combinations regarding food safety used a qualitative prioritisation scheme. Specifically, FoNAO/pathogen combinations were rated as highly critical (A), critical (B) or moderately critical (C) with respect to food safety regarding multiple aspects, including outbreaks of disease, production and processing procedures, hazard prevalence in the food commodity concerned, and food/pathogen interaction (see also Chapter 3.6). FoNAO/pathogen combinations that were rated as highly critical regarding at least three criteria (including outbreaks), were assigned highest priority. Combinations that showed two highly critical characteristics (with outbreaks being rated either highly critical or critical) were allocated to priority group 2. If a combination had one highly critical characteristic together with some other critical factor, priority level 3 was applied. Defining priority groups was preferred over a ranking of all food/pathogen combinations in a numeric order, because the information corresponding to the classification criteria was heterogeneous and varied for the various combinations.

Priority group one was assigned to food/pathogen combinations involving leafy greens (FoNAO category 15/17) and pathogenic \textit{E.coli} for both EU and non-EU countries. For EU countries, also \textit{Salmonella} spp. on/in leafy greens were assigned level one priority due to multiple outbreaks with high numbers of cases and hospitalisations, while for non-EU countries \textit{Salmonella} spp. on/in tomatoes were highly graded. Combinations of berries (especially raspberries and strawberries, but with less outbreak cases also blackberries) with norovirus contamination were graded priority one within the EU based on criteria related to outbreaks, production methods and food/pathogen interaction. Notably, while outbreaks involving berries have been highly reported in the literature, there were no publications found addressing the prevalence of viruses on/in this commodity. This is most probably due to methodological issues related to virus detection. Similarly, prevalence data of viruses on/in leafy greens have rarely been reported, in spite of multiple outbreak cases.

Combinations of melons (cantaloupe) with \textit{Salmonella} spp. were often reported in the U.S. and caused multiple outbreaks, and thus were included in the non-EU listing with the highest priority. Similarly, tropical fruit (mango and papaya) in combination with \textit{Salmonella} was assigned level 1 priority for non-EU countries. Notably, tropical fruits were not included in the prioritisation of food/pathogen combinations for the EU, since no outbreaks involving tropical fruit consumption were reported in the EU. However, import data of tropical fruits from third countries into the EU indicate a continuous increase.

Priority group two for EU countries comprises the combinations lettuce/Norovirus and fresh herbs (basil)/\textit{Salmonella} spp. For non-EU countries this priority group includes lettuce/Norovirus based on a major outbreak in Norway, in addition to spinach/pathogenic \textit{E.coli}.
FoNAO/pathogen combinations with level three priority differ for EU and non-EU countries. In the former, semidried tomatoes combined with Hepatitis A virus and grated carrots combined with *Yersinia pseudotuberculosis* were involved in multiple outbreaks. In both cases, level 3 grading was given based on the allocation of grade A regarding only one criterion (i.e. outbreaks). The FoNAO/pathogen combinations were rated B regarding the criterion “production” because only one major critical factor was identified. In addition, cucumber in combination with parasites in general was rated priority 3 for EU countries, since a severe parasite-related outbreak was caused by *Enterocytozoon bieneusi* on cucumber, various studies have reported on helminth prevalence on/in cucumber, and multiple factors are critical regarding contamination of cucumber by biological hazards.

For non-EU countries, level 3 priority was assigned to Hepatitis A virus in unpasteurized orange juice and on/in green onion, respectively. In both cases single but severe outbreaks were reported involving these combinations, and multiple factors in the production processes have been described as critical. In addition, the combination cantaloupe melon/*Listeria monocytogenes* was assigned priority 3 for non-EU countries. Regarding combinations with melons, both outbreaks and prevalences have been documented for *Salmonella*, while no prevalence data have been given for *Listeria monocytogenes*. 
Table 10: Priority groups of food/pathogen combinations in EU countries based on criteria related to outbreaks\(^3\), pathogen prevalence, food/pathogen interaction, and to the production of the food item(s) concerned. “High number” means position in top ten list (Tables 30-32). For details on the classification scheme applied ((A) “highly critical”, (B) “critical”, (C) “moderately critical”) see methods section. NR= not reported.

| FoNAO Category | Food item (raw, mixed fresh cut salad leaves) | Pathogen | Outbreaks | Production | Prevalence | Food/pathogen interaction | Priority group |
|----------------|---------------------------------------------|----------|-----------|------------|------------|---------------------------|----------------|
| 2/3/4 Berries  | Raspberries/ Strawberries/ Blackberries      | Norovirus| (A) Highest number of cases in the EU in multiple outbreaks. Outbreak with the highest number of cases reported worldwide caused by Norovirus on strawberries (Germany). High number of hospitalisations. | (A) Multiple critical factors (related to irrigation, fertilization, contact with animals/humans); special recommendations for berry harvesting (Bower et al., 2003 online). | NR          | (A) Norovirus is highly infectious and shows resistance to heat and disinfection agents (Koopmann and Duizer, 2004) | 1              |
| 15/17 Leafy greens (raw, mixed fresh cut salad leaves) | Lettuce | E.coli (EHEC) | (A) Multiple outbreaks in various EU countries involving high numbers of cases and hospitalisations. | (A) Multiple factors related to production are critical for microbial contamination of leafy greens. | (A) Several studies reporting on pathogenic E.coli on/in leafy greens, prevalence ranging from 0.2 to 8%. | (A) E.coli O157:H7 attaches to lettuce leaves, evidence for internalization into edible plant parts; proliferation on lettuce leaves at 12 °C. | 1              |
| 15/17 Leafy greens (raw, mixed fresh cut salad leaves) | Lettuce | Salmonella spp. | (A) The highest numbers of cases and hospitalisations in multiple outbreaks in several EU countries, two deadly cases in Finland. | NR | (A) Twelve studies with Salmonella spp. on/in leafy greens, nine studies on Salmonella spp. presence in lettuce samples (detection rate 0.1-8%) | (A) Attachment, biofilm formation and internalisation into lettuce leaves have been reported. Salmonella growth was inhibited at refrigerator temperatures. | 1              |
| 15/17 Leafy greens (raw, mixed fresh cut salad leaves) | Lettuce | Norovirus | (A) High numbers of cases and hospitalisations in the North of Europe (Denmark, Finland). | NR | NR | (A) Norovirus is highly infectious and shows resistance to heat and disinfection agents (Koopmann and Duizer, 2004). | 2              |

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| FoNAO Category          | Food item                      | Pathogen                      | Outbreaks                                                                 | Production | Prevalence | Food/pathogen interaction | Priority group |
|-------------------------|--------------------------------|-------------------------------|---------------------------------------------------------------------------|------------|-------------|--------------------------|---------------|
| 16 Fresh herbs          | Basil (fresh)                  | *Salmonella* spp.             | (A) High number of cases and hospitalisations in multiple outbreaks       | NR         | (A) Two studies report *Salmonella* spp. detection in basil samples (1-3% detection rate). | NR            | 2             |
|                        |                                |                               |                                            |            |             |                          |               |
| 38 Dehydrated vegetables and fruit | Tomatoes (semidried)                      | Hepatitis A virus               | (A) High numbers of cases and highest number of hospitalisations in the EU (France, UK, Netherlands) |            |             | (B) Manual sorting of semi-dried tomatoes is a critical factor regarding viral contamination. | NR            | 3             |
|                        |                                |                               |                                            |            |             |                          |               |
| 13 Gourds and squashes | Cucumber                       | Parasites                     | (C) Parasite-related outbreak with the highest number of cases was caused by *Enterocytozoon bieneusi* on cucumber |            |             | (A) Multiple factors including water sanitation, worker hygiene, equipment and container sanitation, and maintenance of the cold chain are critical regarding contamination of cucumber by biological hazards. |            | 3             |
|                        |                                |                               |                                            |            |             |                          |               |
| 19 Carrots              | Carrots (grated)               | *Yersinia pseudotuberculosis* | (A) High number of cases and hospitalisations in multiple outbreaks.      |            |             | (B) Sanitation (worker hygiene and container/equipment sanitation) is a critical factor regarding microbial contamination | NR            | 3             |

*Outbreaks traced back to the consumption of highly processed food items (containing FoNAO mixed with other ingredients of animal origin, e.g. meat, milk or egg products) were not included in the ranking.*
Table 11: Priority groups of food/pathogen combinations in non-EU countries based on criteria related to outbreaks\(^1\), pathogen prevalence, food/pathogen interaction, and to the production of the food item(s) concerned. “High number” means position in top ten list (Tables 30-32). For details on the classification scheme applied ((A) “highly critical”, (B) “critical”, (C) “moderately critical”) see methods section. NR= not reported.

| FoNAO Category | Food item                      | Pathogen          | Outbreaks                                                                 | Production                                                                                               | Prevalence                                                                                           | Food/pathogen interaction                                                                 | Priority group |
|----------------|--------------------------------|-------------------|---------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|----------------|
| 8 Tropical fruit | Mango/Papaya                  | *Salmonella*      | (A) High number of cases in multiple outbreaks, partly involving hospitalisations. | (B) Imported mangoes in the US undergo postharvest disinfection to prevent introduction of tephritid fruit fly. *Salmonella* can be internalized in mango during this heating and rapid cooling process (Penteado et al., 2004). | (A) Nine studies on *Salmonella* detection in various tropical fruits (e.g. mango, papaya, jackfruit, pineapple) in non-EU countries. | (A) *Salmonella* can attach to mango surfaces; biofilm is formed after longer contact; active internalisation into intact fruit was observed. | 1              |
| 9 Melons        | Cantaloupe                     | *Salmonella*      | (A) High number of cases in multiple outbreaks, partly involving hospitalisations. | (B) Surface contamination is critical regarding microbial contamination                                | (A) Four studies report on *Salmonella* prevalence in melons, with a detection rate of up to 22%. | (A) Cantaloupe melon rind is an ideal place for pathogen attachment; pathogens can internalise into the flesh through mechanically damaged rind (CAC, 2011). | 1              |
| 11 Tomatoes     | Tomatoes (raw)                 | *Salmonella*      | (A) High number of cases and hospitalisations, including the highest number of hospitalisations and two cases of death, in multiple outbreaks caused by *Salmonella* on tomatoes and on peppers and/or tomatoes. | (B) Irrigation water has been evidenced as source of *Salmonella* contamination.                      | (A) Two studies reporting *Salmonella* prevalence on/in tomatoes with detection rates of 1 and 8%, respectively. | (A) *Salmonella* attaches to tomato surfaces and occasionally forms biofilms. Active internalisation into phyllosphere and fruits, preferentially via trichomes, was detected. | 1              |
| 15/17 Leafy greens eaten raw as salads/Mixed fresh-cut salad leaves | Lettuce | *Escherichia coli* (EHEC) | (A) Several multi-state outbreaks in the U.S. involving high numbers of cases and hospitalisations. | (A) Multiple factors related to production are critical for microbial contamination of leafy greens. | (A) Several studies on the prevalence of pathogenic *E.coli* on/in leafy greens, detection rates 0.2-8%. | (A) *E.coli* O157:H7 attaches to lettuce leaves, evidence for internalization into edible plant parts; proliferation on lettuce leaves at >12 °C. | 1              |
| FoNAO Category | Food item | Pathogen | Outbreaks | Production | Prevalence | Food/pathogen interaction | Priority group |
|----------------|-----------|----------|-----------|------------|------------|---------------------------|----------------|
| 15/17 Leafy greens eaten raw as salads/Mixed fresh-cut salad leaves | Spinach | *Escherichia coli* (EHEC) | (B) One multi-state outbreak in the U.S. caused high numbers of cases and hospitalisations. | (A) Multiple factors related to production are critical for microbial contamination of leafy greens. | (A) Several studies on the prevalence of pathogenic *E. coli* on/in leafy greens, detection rates 0.2-8%. | (A) *E. coli* O157:H7 attaches to lettuce leaves, no evidence for internalization; proliferation on lettuce leaves at >12 °C. | 2 |
| 15/17 Leafy greens eaten raw as salads/Mixed fresh-cut salad leaves | Lettuce | Norovirus | (B) Outbreak in Norway with high numbers of cases and hospitalisations. | (A) Multiple factors related to production are critical for microbial contamination of leafy greens. | | (A) Norovirus is highly infectious and shows resistance to heat and disinfection agents (Koopmann and Duizer, 2004) | 2 |
| 5 Citrus fruit | Orange juice (unpasteurized) | Hepatitis A virus | (B) High numbers of cases and highest number of hospitalisations due to viral contamination. | (A) Multiple factors related to production (harvesting) and processing (transport, storage, sorting) of orange juice are critical for microbial contamination of non-heat-treated orange juice. | | | 3 |
| 9 Melons | Cantaloupe | *Listeria monocytogenes* | (B) One multi-state outbreak in the U.S. caused high numbers of cases and hospitalisations and involved the highest number of deaths caused by a single food commodity. | (B) Surface contamination is critical regarding microbial contamination. | (A) Cantaloupe melon rind is an ideal place for pathogen attachment; pathogens can internalise into the flesh through mechanically damaged rind (CAC, 2011). | 3 |
| 22 Bulb and stem vegetables | Green onion | Hepatitis A virus | (B) A virus-related outbreak in the U.S. with the highest number of cases caused by Hepatitis A virus on green onion involved a high number of hospitalisations and three cases of death. | (A) Multiple factors related to production and processing of green onion are critical for microbial contamination of green onions. | | | 3 |

1) Outbreaks traced back to the consumption of highly processed food items (containing FoNAO mixed with other ingredients of animal origin, e.g. meat, milk or egg products) were not included in the ranking.
5. Conclusions

Biological hazards linked to FoNAO are of considerable public concern, which is reflected in the abundant scientific and grey literature retrieved in the present study. Our extensive review addressing pathogenic bacteria, viruses, and parasites associated with FoNAO with high water content yielded 7710 scientific literature entries in the study database (relating to FoNAO with both high and low water content), together with 51 grey literature documents (relating specifically to FoNAO with high water content). 432 documents were finally selected for data extraction from full texts into structured tables of Lot 1, relating to FoNAO with high water content. Information referring to pathogen identification and characterisation and to the consumption of FoNAO was derived mainly from scientific publications, while data relating to the production and processing of FoNAO were predominantly contained in grey literature sources.

Bacterial pathogens that were reported in association with FoNAO with high water content were similar for EU and non-EU countries, comprising representatives of the genera *Aeromonas*, *Bacillus*, *Campylobacter*, *Clostridium*, *Cronobacter*, *Enterobacter*, *Klebsiella*, *Salmonella*, *Shigella*, and *Vibrio* as well as various pathogenic *Escherichia coli*, *Listeria monocytogenes*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Yersinia enterocolitica*. However, by far the most (109 out of 394) associations of FoNAO with high water content were found with various serovars of *Salmonella* spp. Prevalence data for viruses on/in FoNAO with high water content were available only for EU countries, while detection of parasites on/in FoNAO with high water content was mainly reported for non-EU countries.

Studies on food/pathogen interaction have evidenced biofilm formation by pathogenic *E. coli*, *Bacillus cereus*, *Listeria monocytogenes*, *Salmonella* spp., and *Staphylococcus aureus* on FoNAO with high water content. Multiple studies reported on the internalisation of pathogenic *E. coli* and *Salmonella* into FoNAO with high water content, implicating a critical behaviour of the pathogens regarding food safety. For both EU and non EU countries, *Salmonella* were the bacteria most often implicated in outbreaks associated with FoNAO with high water content.

Critical steps in the production and processing of FoNAO items were identified primarily based on GAP, GMP and HACCP documents and other producer guidelines, and included irrigation/watering, fertilisation practices, harvesting/sorting, the equipment used, packing, washing, storage, and cooling. In most cases, multiple points in primary production and/or processing were considered as equally critical regarding food safety issues. However, in some cases a single dominant point was highlighted.

The number and severity of outbreaks of disease caused by the consumption of contaminated FoNAO provided the basis for a primary evaluation of the multiple food/pathogen combinations identified within the study where biological hazards were implicated. Additional qualitative criteria relating to pathogen prevalence, their interaction with the FoNAO items, and to the production of FoNAO items were included to define three priority groups of critical food/pathogen combinations for EU and non-EU countries, respectively.

Highest priority was given to leafy green vegetables (in particular lettuce and spinach) in combination with pathogenic *E. coli* for their strong involvement in outbreaks on a worldwide level. For EU and non-EU countries, also the combinations of *Salmonella* spp. on/in leafy greens and on/in tomatoes, respectively, were assigned level one priority. A WHO-based evaluation by experts from multiple countries supports the prioritisation of leafy greens (FAO/WHO 2008, online).

Several food/pathogen combinations were not considered equally critical regarding food safety in EU versus non-EU countries based on our evaluation. In the EU, berries (in particular frozen raspberries and strawberries) linked to Norovirus outbreaks were assigned level 1 priority, while in the U.S. melon...
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(cantaloupe) infected with *Salmonella* were evidenced as a major health hazard, causing several severe outbreaks in the past ten years. Although both commodities were classified as second priority by FAO/WHO (2008, online), recent outbreak incidences and the evaluation done within the present study justify highest priority grading. In addition, tropical fruit (mango and papaya) in combination with *Salmonella* was assigned level I priority for non-EU countries.

Priority group two for EU countries was assigned to the combinations lettuce/Norovirus and fresh herbs (basil)/*Salmonella* spp. For non-EU countries this priority group includes lettuce/Norovirus, based on a major outbreak in Norway, in addition to spinach/pathogenic *E.coli*.

For EU countries, semidried tomatoes combined with Hepatitis A virus and grated carrots combined with *Yersinia pseudotuberculosis* as well as cucumber in combination with parasites were rated priority 3. For non-EU countries, level 3 priority was assigned both to Hepatitis A virus in unpasteurized orange juice and on/in green onion as well as to cantaloupe melon/*Listeria monocytogenes*.

This report provides a broad scientific database that will be instrumental in the conceptualization of specific measures for improving the safety of FoNAO with high water content. Ultimately, it may contribute to the prevention and a better control of food borne diseases.
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## APPENDICES

### A. APPENDIX SPECIFIC TO THEMATIC AREA A

Table 12: Bacterial pathogens identified in association with FoNAO with high water content, listed in alphabetical order. “Country” signifies the place where the food commodity was found in association with the biological contaminant (e.g. site of survey or screening).

| Pathogen                  | FoNAO Category | Food item(s)       | Source(s)* | Country    | Reference(s)                  |
|---------------------------|----------------|--------------------|------------|------------|-------------------------------|
| *Aeromonas caviae*        | 15             | Lettuce            | n.s.       | Brazil     | Castilho et al., 2009         |
| *Aeromonas hydrophila*    | 15             | Lettuce            | n.s.       | Brazil     | Castilho et al., 2009         |
|                           | 36             | Mixed salads       | Manufacturer | Greece     | Xanthopoulou et al., 2010    |
| *Aeromonas sobria*        | 15             | Lettuce            | n.s.       | Brazil     | Castilho et al., 2009         |
| *Bacillus cereus*         | 13             | Zucchini           | Manufacturer | France     | Guinebretiere et al., 2003   |
|                           | 16             | Parsley            | Local retail/super-market | Brazil | Moreira et al., 2009         |
|                           | 20             | Potato             | n.s.       | Argentina  | Fangio et al., 2010          |
|                           | 22             | Onion              | Local retail/supermarket | Brazil | Moreira et al., 2009         |
|                           | 36             | Salad              | Restaurant/take-away | Nigeria | Isara et al., 2010           |
|                           | 36             | Salad mix          | Supermarket | Portugal | Santos et al., 2012          |
|                           | 37             | Potato meal        | Catering | Italy | Bonerba et al., 2010        |
|                           | 37             | Sunsi              | Local retail | Korea | Lee et al., 2012            |
|                           | 38             | Dehydrated potato flakes | Supermarket | New Zealand | Turner et al., 2006          |
|                           | 1/-other       | Fruits and vegetables | Supermarket | Korea | Chung et al., 2010          |
|                           | 13/20          | butter nut squash, potato | n.s.       | Argentina | Fangio et al., 2010         |
|                           | other          | Vegetables         | Manufacturer, supermarket | Korea, Taiwan | Thapa et al., 2008; Fang et al., 2003 |
|                           | 10             | Fruit juice        | Pharmacy | Poland | Mostafa et al., 2002        |
| *Bacillus cereus* group   | 12             | Paprika            | Local retail | Belgium | Samapundo et al., 2011      |
| *spp.*                    | 15             | Chinese cabbage    | Local retail | Belgium | Samapundo et al., 2011      |

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### Pathogen

| Pathogen                     | FoNAO Category | Food item(s)                          | Source(s)* | Country    | Reference(s)                |
|------------------------------|----------------|---------------------------------------|------------|------------|-----------------------------|
| **Bacillus cereus like organism** |                |                                       |            |            |                             |
| 19                           |                | Carrots                               | Local retail | Belgium    | Samapundo et al., 2011     |
| 22                           |                | Celery                                | Local retail | Belgium    | Samapundo et al., 2011     |
| 1                            |                | Fruits                                | Local retail | Denmark    | Rosenquist et al., 2005    |
| 17                           |                | Lettuce                               | Local retail | Denmark    | Rosenquist et al., 2005    |
| 11/13                        |                | Cucumbers, Tomatoes                   | Local retail | Denmark    | Rosenquist et al., 2005    |
| **Campylobacter coli**       |                |                                       |            |            |                             |
| 14                           |                | Winged bean (Psophocarpus tetragonolobus) | Local retail/supermarket | Malaysia | Chai et al., 2007          |
| 14                           |                | Yardlong bean (Vigna unguiculata)     | Local retail/supermarket | Malaysia | Chai et al., 2007          |
| 15                           |                | Water spinach                         | Local retail/supermarket | Malaysia | Chai et al., 2007          |
| 16                           |                | Coriander, Vietnamese (Polygonum minus) | Local retail/supermarket | Malaysia | Chai et al., 2007          |
| 16                           |                | Indian pennywort (Centella asiatica)  | Local retail/supermarket | Malaysia | Chai et al., 2007          |
| 16                           |                | Parsley, Japanese (Oenanthe stolonifera) | Local retail/supermarket | Malaysia | Chai et al., 2007          |
| 16                           |                | Wild cosmos (Cosmos caudatus)         | Local retail/supermarket | Malaysia | Chai et al., 2007          |
| **Campylobacter fetus**      |                |                                       |            |            |                             |
| 16                           |                | Indian pennywort (Centella asiatica)  | Local retail/supermarket | Malaysia | Chai et al., 2007          |
| 16                           |                | Wild cosmos (Cosmos caudatus)         | Local retail/supermarket | Malaysia | Chai et al., 2007          |
| **Campylobacter jejuni**     |                |                                       |            |            |                             |
| 14                           |                | Winged bean (Psophocarpus tetragonolobus) | Local retail/supermarket | Malaysia | Chai et al., 2007          |
| 14                           |                | Yardlong bean (Vigna unguiculata)     | Local retail/supermarket | Malaysia | Chai et al., 2007          |
| 15                           |                | Cabbage                               | Manufacturer | Malaysia | Chai et al., 2009          |
| 15                           |                | Water spinach                         | Local retail/supermarket | Malaysia | Chai et al., 2007          |
| 16                           |                | Coriander, Vietnamese (Polygonum minus) | Local retail/supermarket | Malaysia | Chai et al., 2007          |
| 16                           |                | Coriander, Vietnamese (Polygonum minus) | Manufacturer | Malaysia | Chai et al., 2009          |
| Pathogen               | FoNAO Category | Food item(s)                                      | Source(s)*        | Country       | Reference(s)                           |
|-----------------------|----------------|--------------------------------------------------|-------------------|---------------|----------------------------------------|
|                       | 16             | Indian pennywort (*Centella asiatica*)           | Local retail/supermarket | Malaysia      | Chai et al., 2007                      |
|                       | 16             | Parsley, Japanese (*Oenanthe stolonifera*)       | Local retail/supermarket | Malaysia      | Chai et al., 2007                      |
|                       | 16             | Wild cosmos (*Cosmos caudatus*)                  | Local retail/supermarket | Malaysia      | Chai et al., 2007                      |
|                       | 21             | Radish                                           | Manufacturer       | Malaysia      | Chai et al., 2009                      |
| *Clostridium botulinum*| 14             | Green beans                                      | Manufacturer       | France        | Sevenier et al., 2012                  |
|                       | 19             | Carrots                                          | Manufacturer       | France        | Sevenier et al., 2012                  |
|                       | 16             | Parsley                                          | Local retail/supermarket | Mexico       | Gomez-Govea et al., 2012               |
|                       | 22             | White asparagus                                  | n.s.               | Spain         | Valero et al., 2006                    |
| *Clostridium perfringens*| 22             | White asparagus                                  | n.s.               | Spain         | Valero et al., 2006                    |
| *Clostridium septicum* | 36             | Mixed salad                                      | Local retail       | Germany       | Weiss et al., 2005                     |
| *Cronobacter sakazakii*| 37             | Other food (various ingredients)                 | Canteen            | Korea         | Ryu et al., 2011                       |
|                       | 38             | Coconut                                          | Supermarket        | Czech Republic | Hochel et al., 2012                   |
| *Cronobacter spp.*    | 1              | Fruits                                           | Local retail/supermarket; manufacturer | Korea, Switzerland | Lee et al., 2012; Althaus et al., 2012 |
|                       | 15             | Leafy greens                                     | Supermarket        | Ireland       | Molloy et al., 2009                    |
|                       | 17             | Lettuce                                          | Manufacturer       | Switzerland   | Althaus et al., 2012                   |
|                       | 17             | Salad                                            | Local retail/supermarket | Korea       | Lee et al., 2012                       |
|                       | 21             | Root vegetables (Sunshik ingredients)             | Local retail       | Korea         | Kim et al., 2011b                      |
|                       | 30             | Seaweed                                          | Local retail/supermarket | Korea       | Lee et al., 2012                       |
|                       | 38             | Vegetables                                       | Manufacturer/local retail | Netherlands | Kandhai et al., 2010                   |
|                       | 1/-other        | Fruits and vegetables                            | Local retail       | Korea         | Kim et al., 2011b                      |
|                       | other           | Vegetables                                       | Local retail/supermarket; manufacturer; | Korea, Switzerland, Slovakia | Lee et al., 2012; Althaus et al., 2012; Kim et al., 2008; Chon et al., 2012; Turcovský et al., 2011 |
### Pathogen

| Pathogen                                           | FoNAO Category | Food item(s)                          | Source(s)* | Country   | Reference(s)                  |
|----------------------------------------------------|----------------|---------------------------------------|------------|-----------|-------------------------------|
| *Enterobacter aerogenes*                           | 8              | Paw-Paw (Asimina)                     | Local retail | Nigeria  | Chukwu et al., 2010          |
|                                                    | 9              | Watermelon                            | Local retail | Nigeria  | Chukwu et al., 2010          |
|                                                    | 36             | Mixed salad                           | Local retail | Germany  | Weiss et al., 2005           |
| *Enterobacter cloacae*                             | 16             | Basil                                 | Local retail | USA      | Wetzel et al., 2010          |
| *Escherichia coli*                                 | 15             | Lettuce, spinach                       | Local retail | Colombia | Rugeles et al., 2010         |
| (Enteroaaggregative - EAEC)                        | 36             | Mixed salad                           | Restaurant  | Mexico   | Castro-Rosas et al., 2012    |
| *Escherichia coli* (Entero-invasive and Shiga-toxin producing) | 36             | Mixed salads                          | Restaurant  | Mexico   | Castro-Rosas et al., 2012    |
| *Escherichia coli* (Entero-invasive)               | 17             | Lettuce                               | Manufacturer | Switzerland | Althaus et al., 2012 |
| *Escherichia coli* (EPEC)                          | other          | Vegetables                            | Manufacturer | Switzerland | Althaus et al., 2012 |
| *Escherichia coli* (ETEC)                          | 36             | Salad mix (raw spinach, tomato, mushrooms) | Restaurant  | Mexico   | Castro-Rosas et al., 2012    |
| *Escherichia coli* (Shiga-toxin producing - STEC) | 15             | Vegetable (lettuce, spinach)          | Local retail | Colombia | Rugeles et al., 2010         |
|                                                    | 17             | Lettuce                               | Manufacturer | Switzerland | Althaus et al., 2012 |
|                                                    | 36             | Mixed salads (lettuce, avocado, water cress, wheat sprouts, tomato, cucumber, radish, carrot) | Restaurant  | Mexico   | Castro-Rosas et al., 2012    |
|                                                    | 36             | Salad mix (raw spinach, tomato, mushrooms) | Restaurant  | Mexico   | Castro-Rosas et al., 2012    |
| *Escherichia coli* (VTEC)                          | 15             | Endive                                | n.s.        | Netherlands | ECDC, 2008                    |
|                                                    | 15             | Mixed lettuce                         | n.s.        | Netherlands | ECDC, 2008                    |
|                                                    | 36             | Salad mix (romaine lettuce, various spinach and mixed salads) | Supermarket | Portugal | Santos et al., 2012         |
| *Escherichia coli* (VTEC)                          | other          | Vegetables                            | n.s.        | Belgium, Spain | ECDC, 2010; ECDC, 2008 |

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| Pathogen                  | FoNAO Category | Food item(s)          | Source(s)* | Country   | Reference(s)      |
|--------------------------|---------------|-----------------------|------------|-----------|-------------------|
| *Escherichia coli* O157:H7 (Enterohaemorrhagic - EHEC) | 1             | various               | Take-away  | India     | Lewis et al., 2006 |
|                          | 4             | Grape                 | Take-away  | India     | Lewis et al., 2006 |
|                          | 5             | Orange                | Take-away  | India     | Lewis et al., 2006 |
|                          | 8             | Mango                 | Take-away  | India     | Lewis et al., 2006 |
|                          | 8             | Pineapple             | Take-away  | India     | Lewis et al., 2006 |
|                          | 12            | Green peppers         | Manufacturer | USA     | Mukherjee et al., 2004 |
|                          | 15            | Lettuce               | Manufacturer | USA     | Mukherjee et al., 2004 |
|                          | 37            | Other food (various ingredients) | Canteen; homemade dish | Korea; Malawi | Ryu et al., 2011; Taulo et al., 2008T |
|                          | other         | Vegetables (lettuce, cabbage, carrot and radish sprout) | Manufacturer | Iran | Khandaghi et al., 2010 |
| *Klebsiella oxytoca*     | 4             | Grape                 | Local retail | Libya   | Ghenghesh et al., 2005 |
|                          | 5             | Orange                | Local retail | Libya   | Ghenghesh et al., 2005 |
|                          | 7             | Peach                 | Local retail | Libya   | Ghenghesh et al., 2005 |
|                          | 8             | Mango                 | Local retail | Libya   | Ghenghesh et al., 2005 |
|                          | 8             | Pineapple             | Local retail | Libya   | Ghenghesh et al., 2005 |
|                          | 16            | Basil                 | Local retail | USA     | Wetzel et al., 2010 |
|                          | 36            | Mixed salad           | Local retail | Germany | Weiss et al., 2005 |
| *Klebsiella pneumoniae*  | 7             | Peach                 | Local retail | Libya   | Ghenghesh et al., 2005 |
|                          | 8             | Mango                 | Local retail | Libya   | Ghenghesh et al., 2005 |
|                          | 8             | Pineapple             | Local retail | Libya   | Ghenghesh et al., 2005 |
|                          | 9             | Watermelon            | Local retail | Nigeria | Chukwu et al., 2010 |
|                          | 36            | Mixed salad           | Local retail | Germany | Weiss et al., 2005 |
| *Listeria monocytogenes* | 1             | Fruits                | n.s.       | Italy     | ECDC, 2008          |
|                          | 2             | Strawberries          | Local retail/retail distribution | Norway | Johanessen et al., 2002 |
| Pathogen               | FoNAO Category | Food item(s)               | Source(s)*          | Country          | Reference(s)                                                                 |
|------------------------|----------------|---------------------------|---------------------|------------------|------------------------------------------------------------------------------|
| **Listeria monocytogenes** | 11             | Tomatoes                  | Local retail, manufacturer supermarket, | Chile, Greece,马来西亚, Spain | Cordano and Jacquet, 2009; Kokkinakis et al., 2007; Ponniah et al., 2007; Ponniah et al., 2010; Ramirez Merida, 2009; |
|                        | 12             | Green peppers            | Local retail/manufacturer | Portugal         | Mena et al., 2004                                                          |
|                        | 12             | Pepper                   | Manufacturer        | Greece           | Kokkinakis et al., 2007                                                     |
|                        | 13             | Cucumber                 | Local retail, supermarket | Malaysia         | Ponniah et al., 2010                                                        |
|                        | 13             | Zucchini                 | Manufacturer        | Germany          | Pappelbaum et al., 2008                                                     |
|                        | 14             | Broad beans              | Supermarket         | Chile            | Cordano and Jacquet, 2009                                                   |
|                        | 14             | Corn                     | Manufacturer        | Germany          | Pappelbaum et al., 2008                                                     |
|                        | 14             | Green beans              | Supermarket         | Chile            | Cordano and Jacquet, 2009                                                   |
|                        | 14             | Green pea                | Manufacturer        | Germany          | Pappelbaum et al., 2008                                                     |
|                        | 14             | Kidney beans             | Supermarket         | Chile            | Cordano and Jacquet, 2009                                                   |
|                        | 14             | Peas                     | Local retail, manufacturer supermarket | Chile Portugal, | Cordano and Jacquet, 2009; Mena et al., 2004; |
|                        | 14             | String bean              | Manufacturer        | Germany          | Pappelbaum et al., 2008                                                     |
|                        | 14             | Sweet corn               | Supermarket         | Chile            | Cordano and Jacquet, 2009                                                   |
|                        | 14             | Winged bean (Psophocarpus tetragonolobus) | Local retail, supermarket | Malaysia         | Ponniah et al., 2010                                                        |
|                        | 14             | Yardlong bean (Vigna unguiculata) | Local retail, supermarket | Malaysia         | Ponniah et al., 2010                                                        |
|                        | 15             | Baby spinach             | Manufacturer        | Canada            | Ilic et al., 2008                                                          |
|                        | 15             | Cabbage                  | Local retail, manufacturer supermarket | Malaysia,USA     | Johnston et al., 2006, Ponniah et al., 2010, Frazak et al., 2002 |
|                        | 15             | Lettuce                  | Local retail, manufacturer, retail distribution | Norway          | Johanessen et al., 2002, Loncarevic et al., 2005 |
|                        | 15             | Salad                    | Local retail, manufacturer, n.s. | Czech Republic, Estonia, Hungary, Slovenia,Spain | ECDC, 2009                     |
| Pathogen            | FoNAO Category | Food item(s)          | Source(s)*               | Country                  | Reference(s)                                                                 |
|---------------------|----------------|-----------------------|--------------------------|--------------------------|-------------------------------------------------------------------------------|
| Listeria monocytogenes | 15             | Spinach               | Manufacturer, supermarket | Brazil, Chile, Germany, Spain | Cordano and Jacquet, 2009; Froder et al., 2007; Moreno et al., 2012; Pappelbaum et al., 2008; |
| 15                  | Vegetable (rucola, lettuce) | Manufacturer | Italy                      | De Giusti et al., 2010   |                                                                                      |
| 16                  | Coriander       | Supermarket           | Spain                     | Ramírez Merida 2009      |                                                                                      |
| 16                  | Indian pennywort (*Centella asiatica*) | Local retail, supermarket | Malaysia               | Ponniyah et al., 2010 |                                                                                      |
| 16                  | Parsley         | Local retail/supermarket | Mexico                   | Gomez-Govea et al., 2012 |                                                                                      |
| 16                  | Parsley (*Oenanther stolonifera*) | Local retail, supermarket | Malaysia               | Ponniyah et al., 2010 |                                                                                      |
| 16                  | Wild parsley (*Cosmos caudatus*) | Local retail | Malaysia                     | Ponniyah et al., 2010 |                                                                                      |
| 17                  | Cabbage         | Supermarket           | Brazil                    | Sant’Ana et al., 2012   |                                                                                      |
| 17                  | Collard greens  | Supermarket           | Brazil                    | Sant’Ana et al., 2012   |                                                                                      |
| 17                  | Edible leaves   | Local retail          | Spain                     | Badosa et al., 2008     |                                                                                      |
| 17                  | Escarole        | Supermarket           | Brazil                    | Sant’Ana et al., 2012   |                                                                                      |
| 17                  | Lettuce         | Manufacturer, supermarket | Costa Rica, Brazil, Spain | Abadias et al., 2008; Althaus et al., 2012; Monge et al., 2011; Sant’Ana et al., 2012 |                                                                                      |
| 17                  | Mixed lettuce   | Manufacturer          | Italy                     | De Giusti et al., 2010   |                                                                                      |
| 17                  | Mixed salads    | Local retail, supermarket | Spain                   | Abadias et al., 2008; Badosa et al., 2008 |                                                                                      |
| 17                  | Salad           | Local retail          | USA                       | Gombas et al., 2003     |                                                                                      |
| 17                  | Spinach         | Supermarket           | Brazil, Spain             | Moreno et al., 2012; Sant’Ana et al., 2012 |                                                                                  |
| 17                  | Watercress      | Supermarket           | Brazil                    | Sant’Ana et al., 2012   |                                                                                      |
| 19                  | Carrots         | Local retail, manufacturer, supermarket | Germany, India, Malaysia | Kamat et al., 2005; Pappelbaum et al., 2008; Ponniah et al., 2010 |                                                                                      |
| 21                  | Beetroot        | Supermarket           | Chile                     | Cordano and Jacquet, 2009 |                                                                                      |
| 21                  | Sweet potato    | Local retail, supermarket | Malaysia              | Ponniyah et al., 2010 |                                                                                      |
| 22                  | Asparagus       | Supermarket           | Chile                     | Cordano and Jacquet, 2009 |                                                                                      |
| Pathogen                      | FoNAO Category | Food item(s)         | Source(s) * | Country                   | Reference(s)                                                                 |
|-------------------------------|----------------|----------------------|-------------|---------------------------|------------------------------------------------------------------------------|
| *Listeria monocytogenes*      | 22             | Celery               | Supermarket | Chile, Korea              | Cordano and Jacquet, 2009; Cho et al., 2004                                  |
|                               | 23             | Broccoli             | Local retail, supermarket manufacturer | Chile, Germany, Portugal, Spain | Cordano and Jacquet, 2009; Mena et al., 2004; Moreno et al., 2012; Pappelbaum et al., 2008 |
|                               | 23             | Cauliflower          | Manufacturer, supermarket          | Chile, Germany          | Cordano and Jacquet, 2009; Pappelbaum et al., 2008                          |
|                               | 23             | Courgette            | Local retail/manufacturer          | Portugal                | Mena et al., 2004                                                            |
|                               | 29             | Boletus edulis       | Local retail/supermarket          | Spain                   | Venturini et al., 2011                                                      |
|                               | 29             | Calocybe gambosa     | Local retail/supermarket          | Spain                   | Venturini et al., 2011                                                      |
|                               | 29             | Hygrophorus limacinus| Local retail/supermarket          | Spain                   | Venturini et al., 2011                                                      |
|                               | 29             | Lactarius deliciousus| Local retail/supermarket          | Spain                   | Venturini et al., 2011                                                      |
|                               | 29             | Mushrooms            | Local retail, manufacturer supermarket, retail distribution | Chile, Germany, Korea, Norway, Spain | Cho et al., 2004; Cordano and Jacquet, 2009; Johanessen et al., 2002; Pappelbaum et al., 2008; Venturini et al., 2011 |
|                               | 29             | Tuber indicum        | Local retail/supermarket          | Spain                   | Venturini et al., 2011                                                      |
|                               | 30             | Seaweed              | Supermarket                        | Chile                   | Cordano and Jacquet, 2009                                                   |
|                               | 35             | Asazuke (Japanese light pickles) | Supermarket | Japan         | Maklon et al., 2010                                                        |
|                               | 35             | Green table olives   | n.s.                           | Italy                   | Caggia et al., 2004                                                         |
|                               | 36             | Mixed salads         | Supermarket                        | Chile                   | Cordano and Jacquet, 2009                                                   |
|                               | 36             | Salad                | Local retail, manufacturer, n.s., supermarket | Brazil, Estonia, Hungary, Ireland, Lithuania, United Kingdom, USA, Slovakia | ECDC, 2008; Sauders et al., 2009; Verdin et al., 2007                      |
| Pathogen          | FoNAO Category | Food item(s) | Source(s)* | Country           | Reference(s)                                                                 |
|-------------------|----------------|--------------|------------|-------------------|------------------------------------------------------------------------------|
| *Listeria monocytogenes* | 36             | Salad mix    | Supermarket | Brazil, Portugal   | Sant'Ana et al., 2012; Santos et al., 2012                                  |
|                   | 36             | Salad vegetables | Catering, local retail | United Kingdom   | Sagoo et al., 2003a                                                        |
|                   | 37             | Bean curd    | Local retail | China             | Zhou et al., 2006                                                          |
|                   | 37             | Deli salads  | Local retail | USA               | Gombas et al., 2003                                                         |
|                   |                | Other food   | Take-away   | Italy              | Latorre et al., 2007                                                        |
| 1/other           |                | Fruits and vegetables | Catering, local retail | Ireland, Portugal, Slovenia, Spain | Badosa et al., 2008; ECDC, 2008; ECDC, 2009                                 |
| 1/other           |                | Produce      | Local retail | USA               | Zhang et al., 2007                                                          |
| 1/other           |                | Vegetable or fruit salad | Local retail | Netherlands       | ECDC, 2009                                                                  |
| other             |                | Vegetable (products) | Manufacturer | Estonia           | ECDC, 2009                                                                  |
| other             |                | Vegetables   | Local retail, manufacturer, restaurant, supermarket, n.s. | Brazil China, Czech Republic, Germany Hungary Korea Slovakia Spain Switzerland-land Iran Vene-zuela | Aguado et al., 2004; Althaus et al., 2012; de Curtis et al., 2002; ECDC, 2008; ECDC, 2009; Jalali and Abedi 2008; Moreno et al., 2012; Pappelbaum et al., 2008 Sant’Ana et al., 2012; Thapa et al., 2008; Vitas et al., 2004; Zhou et al., 2006; |
| 4                 |                | Grape        | Local retail | Libya              | Ghenghesh et al., 2005                                                      |
| *Pseudomonas aeruginosa* | 5              | Orange       | Local retail, take-away | India; Libya       | Ghenghesh et al., 2005; Tambekar et al., 2009                                |
| 5                 |                | Sweet lemon (Citrus limetta) | Take-away | India              | Tambekar et al., 2009                                                       |
| 6                 |                | Apples       | Local retail, take-away | India, Libya       | Ghenghesh et al., 2005; Tambekar et al., 2009                                |
| 8                 |                | Pineapple    | Local retail, take-away | India; Nigeria    | Chukwu et al., 2010; Tambekar et al., 2009                                   |
| 8                 |                | Pomegranate  | Take-away    | India              | Tambekar et al., 2009                                                       |
### Pathogen: Pseudomonas aeruginosa

| Pathogen          | FoNAO Category | Food item(s)              | Source(s)* | Country          | Reference(s)       |
|-------------------|----------------|---------------------------|------------|------------------|--------------------|
| 11                | Tomatoes       | Local retail              |            | Saudi Arabia     | Hassan et al., 2011|
| 13                | Cucumber       | Local retail              |            | Saudi Arabia     | Hassan et al., 2011|
| 15                | Cabbage        | Local retail              |            | Saudi Arabia     | Hassan et al., 2011|
| 15                | Lettuce        | Local retail              |            | Saudi Arabia     | Hassan et al., 2011|
| 15                | Spinach        | Local retail              |            | Saudi Arabia     | Hassan et al., 2011|
| 16                | Basil          | Local retail              |            | USA              | Wetzel et al., 2010|
| 16                | Coriander      | Local retail              |            | Saudi Arabia     | Hassan et al., 2011|
| 16                | Parsley        | Local retail              |            | Saudi Arabia     | Hassan et al., 2011|
| 22                | Celery         | Local retail              |            | Saudi Arabia     | Hassan et al., 2011|
| 22                | Green onion    | Local retail              |            | Saudi Arabia     | Hassan et al., 2011|
| 23                | Cauliflower    | Local retail              |            | Saudi Arabia     | Hassan et al., 2011|
| 30                | Algae          | Take-away                 |            | Italy            | Catellani et al., 2010|
| 36                | Mixed salad    | Local retail              |            | Germany          | Weiss et al., 2005  |
| 36                | Salad          | Restaurant/take-away      |            | Nigeria          | Isara et al., 2010  |
| 37                | Taco-dressing (raw coriander onion mix) | Local retail |            | Mexico           | Estrada-Garcia et al., 2004 |

### Pathogens: Salmonella

| Pathogen          | FoNAO Category | Food item(s)              | Source(s)* | Country          | Reference(s)       |
|-------------------|----------------|---------------------------|------------|------------------|--------------------|
| Salmonella Agona  | 36              | Salad vegetables          | Local retail | United Kingdom   | Sagoo et al., 2003  |
| Salmonella Durban | 15              | Lettuce and arugula       | Supermarket | Brazil           | Sant’Ana et al., 2011|
| Salmonella enterica| 37             | Taco-dressing (boiled green chilli sauce) | Local retail | Mexico           | Estrada-Garcia et al., 2004 |
| 37                | Taco-dressing (raw coriander onion mix) | Local retail |            | Mexico           | Estrada-Garcia et al., 2004 |
| 37                | Taco-dressing (boiled green chilli sauce) | Local retail |            | Mexico           | Estrada-Garcia et al., 2004 |
| Salmonella Enteritidis| 37          | Taco-dressing (raw red chilli sauce) | Local retail | Mexico           | Estrada-Garcia et al., 2004 |
| other             | Vegetables     | Local retail              |            | Austria          | ECDC, 2008         |
| Salmonella Gustavia| 9              | Cantaloupe                | Manufacturer | USA              | Johnston et al., 2005 |
| Pathogen       | FoNAO Category | Food item(s)           | Source(s)* | Country     | Reference(s)          |
|---------------|----------------|------------------------|------------|-------------|-----------------------|
| *Salmonella*  | 1/-other       | Produce                | Manufacturer | USA         | Johnston et al., 2005 |
| Montevideo    | 36             | Salad vegetables       | Local retail | United Kingdom | Sagoo et al., 2003    |
| *Salmonella*  | 1              | Various                | Take-away   | India        | Lewis et al., 2006    |
| Newport       | 4              | Grape                  | Take-away   | India        | Lewis et al., 2006    |
|               | 5              | Fruit juice            | Take-away   | Nigeria       | Ukwo et al., 2011     |
|               | 5              | Orange                 | Take-away   | India        | Lewis et al., 2006    |
|               | 5              | Sweet lemon *(Citrus limetta)* | Take-away   | India        | Titarmare et al., 2009 |
|               | 7              | Drupes                 | Local retail | Spain        | Badosa et al., 2008   |
|               | 8              | Coconut products       | Local retail | Hungary       | ECDC, 2009            |
|               | 8              | Dragon fruit           | Local retail | Malaysia      | Pui et al., 2011      |
|               | 8              | Fruit juice            | Take-away   | Nigeria       | Ukwo et al., 2011     |
|               | 8              | Jackfruit              | Local retail | Malaysia      | Pui et al., 2011      |
|               | 8              | Mango                  | Take-away   | India        | Lewis et al., 2006    |
| *Salmonella*  | 8              | Papaya                 | Local retail, take-away | India, Malaysia | Mukhopadhyay et al., 2002; Pui et al., 2011 |
| spp.          | 8              | Paw-Paw (Asimina)      | Local retail | Nigeria       | Chukwu et al., 2010   |
|               | 8              | Persimmon fruit *(Diospyrus kaki)* | Local retail/retail distribution | Brazil | Rezende et al., 2009 |
|               | 8              | Pineapple              | Local retail, take-away | India, Nigeria | Chukwu et al., 2010; Lewis et al., 2006; Titarmare et al., 2009 |
|               | 8              | Sapodilla              | Local retail | Malaysia      | Pui et al., 2011      |
|               | 9              | Bitter melon           | Take-away   | India        | Titarmare et al., 2009 |
|               | 9              | Cantaloupe             | Manufacturer | Mexico       | Gallegos-Robles et al., 2008 |
|               | 9              | Honeydew               | Local retail | Malaysia      | Pui et al., 2011      |
|               | 9              | Watermelon             | Local retail | Malaysia, Nigeria | Chukwu et al., 2010; Pui et al., 2011 |
|               | 11             | Tomatoes               | Local retail/retail distribution | Canada | Arthur et al., 2007 |
## Pathogen | FoNAO Category | Food item(s) | Source(s)* | Country | Reference(s)
--- | --- | --- | --- | --- | ---
Salmonella spp. | 12 | Chile pepper | Manufacturer | Mexico | Gallegos-Robles et al., 2008
| 12 | Green peppers | Manufacturer | USA | Mukherjee et al., 2004
| 13 | Bottle gourd (Lagenaria siceraria) | Take-away | India | Tintarmare et al., 2009
| 13 | Cucumber | Take-away | India | Tintarmare et al., 2009
| 13 | Zucchini | Local retail | Mexico | Castro-Rosas et al., 2010
| 15 | Cabbage | Manufacturer | Mexico | Quiroz-Santiago et al., 2009
| 15 | Chicories | Supermarket | Brazil | Fröder et al., 2007
| 15 | Endive | n.s. | Netherlands | ECDC, 2008
| 15 | Lettuce | Local retail, manufacturer, retail distribution, supermarket | Brazil, Canada, Mexico; USA, Turkey | Arthur et al., 2007; Cetin et al., 2008, Fröder et al., 2007, Mukherjee et al., 2004, Quiroz-Santiago et al., 2009
| 15 | Mixed salads | Supermarket | Brazil | Fröder et al., 2007
| 15 | Purslane (Portulaca oleracea) | Manufacturer | Mexico | Quiroz-Santiago et al., 2009
| 15 | Romaine lettuce | Manufacturer | Mexico | Quiroz-Santiago et al., 2009
| 15 | Salad | Catering | Spain | ECDC, 2009
| 15 | Savoy spinach | Manufacturer | Canada | Ilic et al., 2008
| 15 | Spinach | Manufacturer | Canada, Mexico | Ilic et al., 2008, Quiroz-Santiago et al., 2009
| 15 | Vegetable (rucola, lettuce) | Manufacturer | Italy | De Giusti et al., 2010
| 15 | Watercress | Manufacturer, supermarket | Brazil, Mexico | Fröder et al., 2007; Quiroz-Santiago et al., 2009
| 16 | Basil | Local retail | United Kingdom | Elviss et al., 2009
| 16 | Chinese parsley | Manufacturer | Mexico | Quiroz-Santiago et al., 2009
| 16 | Cilantro | Manufacturer | Mexico | Quiroz-Santiago et al., 2009
| 16 | Coriander | Local retail | India, United Kingdom | Elviss et al., 2009; Singh et al., 2007
| 16 | Herbs | n.s. | Netherlands | ECDC, 2009

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| Pathogen          | FoNAO Category | Food item(s)                          | Source(s)* | Country      | Reference(s)                      |
|-------------------|----------------|---------------------------------------|------------|--------------|-----------------------------------|
| Salmonella spp.   | 16             | Kangkong (*Ipomoea aquatica*)         | Local retail | Malaysia     | Salleh et al., 2003               |
|                   | 16             | Kesum (*Polygonum minus*)             | Local retail | Malaysia     | Salleh et al., 2003               |
|                   | 16             | Korean Herbs                          | Local retail | Malaysia     | Salleh et al., 2003               |
|                   | 16             | Mint                                  | Local retail | India        | Singh et al., 2007                |
|                   | 16             | Mint                                  | Local retail | United Kingdom | Elviss et al., 2009 |
|                   | 16             | Other (rosemary, thyme, methi,       | Local retail | United Kingdom | Elviss et al., 2009 |
|                   |                | curry leaves, walleria)               |            |              |                                   |
|                   | 16             | Papaloquelite or Mexican cilantro    | Manufacturer | Mexico      | Quiroz-Santiago et al., 2009      |
|                   | 16             | Parsley                               | Local retail, manufacturer | Mexico; United Kingdom | Elviss et al., 2009; Quiroz- Santiago et al., 2009 |
|                   | 16             | Pegaga (*Centella asiatica*)         | Local retail | Malaysia     | Salleh et al., 2003               |
|                   | 16             | Selom (*Oenanthe stolonifera*)       | Local retail | Malaysia     | Salleh et al., 2003               |
|                   | 17             | Corn salad (*Valerianella locusta*)  | Supermarket | Spain        | Abadias et al., 2008             |
|                   | 17             | Lettuce                               | Supermarket, Take-away | Costa Rica, Spain, United Kingdom | Abadias et al., 2008; Meldrum et al., 2009; Monge et al., 2011 |
|                   | 17             | Mixed salads                          | Local retail, supermarket | Spain      | Abadias et al., 2008; Badosa et al., 2008 |
|                   | 17             | Spinach                               | Supermarket | Spain        | Abadias et al., 2008             |
|                   | 19             | Carrots                               | Local retail, take-away, manufacturer | India, USA | Endley et al., 2003; Mudgil et al., 2004; Singh et al., 2007; Titarmare et al., 2009 |
|                   | 19             | Fruit juice                           | Take-away   | Nigeria      | Ukwo et al., 2011                |
|                   | 20             | Potato                                | Manufacturer | Mexico      | Quiroz-Santiago et al., 2009      |
|                   | 21             | Beetroot                              | Manufacturer | Mexico      | Quiroz-Santiago et al., 2009      |
|                   | 21             | Ginger                                | Take-away   | India        | Titarmare et al., 2009           |
|                   | 21             | Radish                                | Local retail | India        | Singh et al., 2007               |
| Pathogen                      | FoNAO Category | Food item(s)                                     | Source(s)* | Country    | Reference(s) |
|-------------------------------|----------------|-------------------------------------------------|------------|------------|--------------|
| Salmonella spp.               | 22             | Bulbous vegetables (leek plants)                 | Supermarket | Germany    | Schwaiger et al., 2011 |
|                               | 22             | Celery                                          | Manufacturer | Mexico   | Quiroz-Santiago et al., 2009 |
|                               | 23             | Broccoli                                        | Manufacturer | Mexico   | Quiroz-Santiago et al., 2009 |
|                               | 23             | Cauliflower                                     | Manufacturer | Mexico   | Quiroz-Santiago et al., 2009 |
|                               | 37             | Confectionary products and pastes               | Manufacturer | Romania  | ECDC, 2009 |
|                               | 37             | Importet confectionary products and pastes      | Local retail | Slovakia | ECDC, 2009 |
|                               | 37             | Other food (various ingredients)                | Homemade dish | Malawi  | Taulo et al., 2008 |
|                               | 37             | Sauce and Dressings                             | Local retail | Lithuania | ECDC, 2009 |
|                               | 37             | Vegetables                                      | Homemade dish | Malawi  | Taulo et al., 2008 |
| Other                        | 38             | Raisins                                         | Local retail | India    | Sharma et al., 2008 |
| other                        | 1/-other        | Fruits and vegetables                            | Local retail | Spain    | Badosa et al., 2008 |
| other                        | 1/-other        | Fruits and vegetables                            | Local retail/retail distribution, manufacturer; n.s. | Belgium Canada Germany Luxembourg Sweden, USA | Arthur et al., 2007; ECDC, 2008; ECDC, 2009; Mukherjee et al., 2004 |
| other                        | other           | Vegetable (products)                            | n.s.        | Italy     | ECDC, 2009 |
|                               | other           | Vegetables                                      | Local retail, manufacturer, n.s. supermarket, | Mexico, Spain, Italy | Badosa et al., 2008; ECDC, 2008; ECDC, 2009; Miranda et al., 2009 Quiroz-Santiago et al., 2009 |
|                               | 36             | Salad vegetables                                 | Local retail | United Kingdom | Sagoo et al., 2003 |

| Salmonella spp.; Listeria monocytogenes | 5 | Orange | Take-away | India | Tambekar et al., 2009 |

| Salmonella Typhi | 5 | Sweet lemon (Citrus limetta) | Take-away | India | Tambekar et al., 2009 |
| Pathogen         | FoNAO Category | Food item(s)                  | Source(s)* | Country   | Reference(s) |
|------------------|----------------|------------------------------|------------|-----------|--------------|
| 8                |                | Dragon fruit, Jackfruit, Mango, Papaya | Local retail | Malaysia  | Pui et al., 2011 |
| 8                |                | Pineapple, Pomegranate       | Take-away  | India     | Tambekar et al., 2009 |
| 9                |                | Honeydew                     | Local retail | Malaysia  | Pui et al., 2011 |
| 9                |                | Watermelon                   | Local retail | Malaysia  | Pui et al., 2011 |
| 15               |                | Lettuce and arugula          | Supermarket | Brazil    | Sant’Ana et al., 2011 |
| 16               |                | Parsley                      | Local retail/supermarket | Mexico    | Gomez-Govea et al., 2012 |
| 36               |                | Salad                        | Restaurant/take-away | Nigeria   | Isara et al., 2010 |
| 8                |                | Dragon fruit                 | Local retail | Malaysia  | Pui et al., 2011 |
| *Salmonella* Typhimurium | 9             | Honeydew                     | Local retail | Malaysia  | Pui et al., 2011 |
|                  | 15             | Lettuce                      | Manufacturer | Netherlands | ECDC, 2008 |
|                  | 16             | Basil                        | Local retail | USA       | Wetzel et al., 2010 |
|                  | 36             | Salad                        | Restaurant/take-away | Nigeria   | Isara et al., 2010 |
| other            |                | Vegetables                   | n.s.       | Spain     | ECDC, 2008 |
|                  | 36             | Salad vegetables             | Local retail | United Kingdom | Sagoo et al., 2003 |
| *Salmonella* Umbilo            | 36             | Salad                        | Restaurant/take-away | Nigeria   | Isara et al., 2010 |
| *Shigella* sonnet | 1              | various                      | Take-away  | India     | Lewis et al., 2006 |
| *Shigella* spp. | 4              | Grape                        | Take-away  | India     | Lewis et al., 2006 |
|                  | 5              | Orange                       | Take-away  | India     | Lewis et al., 2006 |
|                  | 8              | Coconut slices               | Local retail | India    | Ghosh et al., 2007 |
|                  | 8              | Mango                        | Take-away  | India     | Lewis et al., 2006 |
|                  | 8              | Pineapple                    | Take-away  | India     | Lewis et al., 2006 |
|                  | 15             | Lettuce                      | Local retail | Saudi Arabia | Hassan et al., 2011 |
| Pathogen                      | FoNAO Category | Food item(s)       | Source(s)* | Country   | Reference(s)               |
|-------------------------------|----------------|--------------------|------------|-----------|----------------------------|
|                               | 15             | Spinach            | Local retail | Saudi Arabia | Hassan et al., 2011        |
|                               | 36             | Salad              | Local retail | India     | Ghosh et al., 2007         |
|                               | 37             | Coriander sauce    | Take-away   | India     | Ghosh et al., 2007         |
|                               | 1              | Fruits             | Supermarket | Korea     | Seo et al., 2010           |
|                               | 2              | Strawberries       | Local retail/retail distribution | Norway | Johanessen et al., 2002 |
|                               | 4              | Grape              | Local retail | Libya     | Ghenghesh et al., 2005    |
|                               | 5              | Kinnow mandarin    | Take-away   | India     | Muddil et al., 2004       |
|                               | 5              | Orange             | Local retail | Libya     | Ghenghesh et al., 2005    |
|                               | 5              | Sweet lemon (Citrus limetta) | Take-away | India     | Tambekar et al., 2009     |
|                               | 6              | Apples             | Local retail, take-away | Libya; India | Ghenghesh et al., 2005; Tambekar et al., 2009 |
|                               | 8              | Coconut slices     | Local retail | India     | Ghosh et al., 2007        |
|                               | 8              | Date               | Local retail | Saudi Arabia | Hamad et al., 2012    |
|                               | 8              | Mango              | Local retail | Libya     | Ghenghesh et al., 2005    |
|                               | 8              | Papaya             | Take-away   | India     | Mukhopadhyay et al., 2002 |
|                               | 8              | Paw-Paw (Asimina)  | Local retail | Nigeria   | Chukwu et al., 2010       |
|                               | 8              | Pineapple          | Local retail | Libya, Nigeria | Chukwu et al., 2010; Ghenghesh et al., 2005 |
|                               | 8              | Pineapple          | Take-away   | India     | Tambekar et al., 2009     |
|                               | 9              | Watermelon         | Local retail | Nigeria   | Chukwu et al., 2010       |
|                               | 10             | Fruit juice        | Take-away   | Korea     | Cho et al., 2011          |
|                               | 13             | Cucumber           | Take-away   | United Kingdom | Meldrum et al., 2009 |
|                               | 15             | Lettuce            | Local retail, manufacturer supermarket | Korea, Turkey | Erkan et al., 2008; Seo et al., 2010 |
|                               | 15             | Watercress         | Local retail/manufacturer | Turkey | Erkan et al., 2008 |
|                               | 16             | Parsley            | Local retail/manufacturer | Turkey | Erkan et al., 2008 |
|                               | 17             | Cabbage            | Take-away   | United Kingdom | Meldrum et al., 2009 |

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| Pathogen          | FoNAO Category | Food item(s)                  | Source(s)*                     | Country          | Reference(s)                      |
|-------------------|----------------|-------------------------------|--------------------------------|------------------|-----------------------------------|
| *Staphylococcus aureus* |                |                               |                                |                  |                                   |
| 17                |                | Lettuce                       | Take-away                      | United Kingdom   | Meldrum et al., 2009              |
| 19                |                | Carrots                       | Take-away                      | India            | Mudgil et al., 2004              |
| 22                |                | Green onion                   | Supermarket                    | Korea            | Seo et al., 2010                 |
| 29                |                | Mushrooms                     | Local retail/retail distribution | Norway           | Johannesssen et al., 2002        |
| 35                |                | Olives                        | Local retail/supermarket       | Portugal          | Pereira et al., 2008             |
| 36                |                | Mixed salads                  | Supermarket                    | Korea            | Seo et al., 2010                 |
| 36                |                | Mixed salads (cabbage, lettuce, tomato) | Take-away                      | United Kingdom   | Meldrum et al., 2009              |
| 36                |                | Salad                         | Local retail, restaurant, take-away | India, Nigeria    | Ghosh et al., 2007 Isara et al., 2010 |
| 37                |                | Coriander sauce               | Take-away                      | India            | Ghosh et al., 2007               |
| 37                |                | Other food (various ingredients) | Homemade dish, take-away       | Korea, Malawi    | Cho et al., 2011, Taulo et al., 2008 |
| 37                |                | Staple food                   | Local retail/supermarket       | Taiwan           | Wei et al., 2006                 |
| 37                |                | Vegetables                    | Homemade dish                  | Malawi           | Taulo et al., 2008               |
| 37                |                | Vegetarian food               | Local retail/supermarket       | Taiwan           | Wei et al., 2006                 |
| 1/-other          |                | Fruits and vegetables         | Supermarket                    | Korea            | Chung et al., 2010               |
| other             |                | Vegetables                    | Manufacturer, supermarket      | Korea, Taiwan    | Fang et al., 2003; Thapa et al., 2008 |
| 5                 |                | Orange                        | Take-away                      | Nigeria          | Ukwo et al., 2011                |
| *Vibrio cholerae* |                | Papaya                        | Take-away                      | India            | Mukhopadhyay et al., 2002         |
| 8                 |                | Pineapple                     | Take-away                      | India            | Ukwo et al., 2011                |
| 19                |                | Carrots                       | Take-away                      | Nigeria          | Ukwo et al., 2011                |
| 22                |                | Garlic                        | Take-away                      | Nigeria          | Ukwo et al., 2011                |
| 11                |                | Tomatoes                      | Local retail/supermarket       | Malaysia         | Tunung et al., 2010              |
| Pathogen                  | FoNAO Category | Food item(s)                  | Source(s)*                  | Country     | Reference(s)                  |
|--------------------------|----------------|-------------------------------|-----------------------------|-------------|-------------------------------|
| *Vibrio parahaemolyticus* | 13             | Cucumber                      | Local retail/supermarket    | Malaysia    | Tunung et al., 2010           |
|                          | 14             | Winged bean (*Psophocarpus tetragonolobus*) | Local retail/supermarket    | Malaysia    | Tunung et al., 2010           |
|                          | 14             | Yardlong bean (*Vigna unguiculata*) | Local retail/supermarket    | Malaysia    | Tunung et al., 2010           |
|                          | 15             | Cabbage                       | Local retail/supermarket    | Malaysia    | Tunung et al., 2010           |
|                          | 15             | Lettuce                       | Local retail/supermarket    | Malaysia    | Tunung et al., 2010           |
|                          | 16             | Indian pennywort (*Centella asiatica*) | Local retail/supermarket    | Malaysia    | Tunung et al., 2010           |
|                          | 16             | Parsley, Japanese (*Oenanthe stolonifera*) | Local retail/supermarket    | Malaysia    | Tunung et al., 2010           |
|                          | 16             | Wild cosmos (*Cosmos caudatus*) | Local retail/supermarket    | Malaysia    | Tunung et al., 2010           |
|                          | 19             | Carrots                       | Local retail/supermarket    | Malaysia    | Tunung et al., 2010           |
|                          | 21             | Sweet potato                  | Local retail/supermarket    | Malaysia    | Tunung et al., 2010           |
|                          | 17             | Cabbage                       | Supermarket                 | Korea       | Lee et al., 2004              |
| *Yersinia enterocolitica* | 17             | Chinese cabbage               | Supermarket                 | Korea       | Lee et al., 2004              |
|                          | 17             | Lettuce                       | Supermarket                 | Korea       | Lee et al., 2004              |
|                          | 17             | Spinach                       | Supermarket                 | Korea       | Lee et al., 2004              |
|                          | 17             | Water dropwort (*Oenanthe lachenalii*) | Supermarket                 | Korea       | Lee et al., 2004              |
|                          | 21             | Radish root                   | Supermarket                 | Korea       | Lee et al., 2004              |
|                          | 22             | Green onion                   | Supermarket                 | Korea       | Lee et al., 2004              |
|                          | 29             | Mushrooms                     | Supermarket                 | Korea       | Lee et al., 2004              |
|                          | 36             | Mixed salad                   | Local retail                | Germany     | Weiss et al., 2005            |
|                          | 15             | Lettuce                       | Local retail/retail distribution | Norway     | Johanessen et al., 2002      |
|                          | 29             | *Calocybe gambosa*            | Local retail/supermarket    | Spain       | Venturini et al., 2011        |
|                          | 29             | *Cantharellus cibarius*       | Local retail/supermarket    | Spain       | Venturini et al., 2011        |
|                          | 29             | *Craterellus cornucopioides*   | Local retail/supermarket    | Spain       | Venturini et al., 2011        |
### Table 13: Viruses identified in association with FoNAO with high water content, listed in alphabetical order. “Country” signifies the place where the food commodity was found in association with the biological contaminant (e.g. site of survey or screening).

| Pathogen      | FoNAO Category | Food item(s) | Source(s)a | Country                | Reference(s)         |
|---------------|----------------|--------------|------------|------------------------|----------------------|
| Norovirus     | 1              | Soft red fruits | n.s.       | Belgium, France        | Baert et al., 2011   |
|               | 15             | Leafy greens | n.s.       | Belgium; Canada France | Baert et al., 2011   |
|               | 1/other        | Produce      | n.s.       | Belgium                | Baert et al., 2011   |
| Rotavirus     | 11             | Tomatoes     | Manufacturer | South Africa         | van Zyl et al., 2006 |

*a n.s.= non specified*
### Table 14: Parasites identified in association with FoNAO with high water content, listed in alphabetical order. “Country” signifies the place where the food commodity was found in association with the biological contaminant (e.g. site of survey or screening).

| Pathogen          | FoNAO Category | Food item(s) | Source<sup>a</sup> | Country    | Reference(s)                      |
|-------------------|----------------|--------------|---------------------|------------|-----------------------------------|
| *Anquilostomidae* | 16             | Chives       | Manufacturer        | Venezuela  | Cazorla et al., 2009              |
|                   | other          | Vegetables   | Manufacturer        | Venezuela  | Cazorla et al., 2009              |
| *Ascaris lumbricoides* | 15             | Cress        | Local retail        | Iran       | Fallah et al., 2012               |
|                   | 15             | Lettuce      | Local retail, retail distribution | India, Turkey | Gupta et al., 2009; Kozan et al., 2004 |
|                   | 15             | Purslane     | Local retail        | Iran       | Fallah et al., 2012               |
|                   | 15             | Radish       | Local retail        | Iran       | Fallah et al., 2012               |
|                   | 15             | Spinach      | Retail distribution/local retail | India | Gupta et al., 2009               |
|                   | 16             | Basil        | Local retail        | Iran       | Fallah et al., 2012               |
|                   | 16             | Coriander    | Retail distribution/local retail | India | Gupta et al., 2009               |
|                   | 16             | Parsley      | Retail distribution/local retail | India | Gupta et al., 2009               |
|                   | 16             | Pudina (mentha) | Retail distribution/local retail | India | Gupta et al., 2009               |
|                   | 16             | Spearmint    | Local retail        | Iran       | Fallah et al., 2012               |
|                   | 22             | Celery       | Retail distribution/local retail | India | Gupta et al., 2009               |
|                   | 22             | Leek         | Local retail        | Iran       | Fallah et al., 2012               |
|                   | 22             | Scallion     | Local retail        | Iran       | Fallah et al., 2012               |
| *Ascaris spp.*    | 11             | Tomatoes     | Manufacturer        | Venezuela  | Cazorla et al., 2009              |
|                   | 12             | Pepper       | Manufacturer        | Venezuela  | Cazorla et al., 2009              |
|                   | 15             | Cabbage      | Manufacturer        | Venezuela  | Cazorla et al., 2009              |

<sup>a</sup> Source: Manufacturer, Local retail, Retail distribution/local retail.
| Pathogen                  | FoNAO Category | Food item(s) | Source* | Country       | Reference(s)                                      |
|---------------------------|----------------|--------------|---------|---------------|--------------------------------------------------|
|                           | 15             | Lettuce      | Manufacturer | Venezuela   | Cazorla et al., 2009                             |
|                           | 16             | Chives       | Manufacturer | Venezuela   | Cazorla et al., 2009                             |
|                           | 16             | Coriander    | Manufacturer | Venezuela   | Cazorla et al., 2009                             |
|                           | 22             | Celery       | Manufacturer | Venezuela   | Cazorla et al., 2009                             |
|                           | 22             | Garlic       | Manufacturer | Venezuela   | Cazorla et al., 2009                             |
|                           | 22             | Onion        | Manufacturer | Venezuela   | Cazorla et al., 2009                             |
|                           | other          | Vegetables   | Manufacturer | Venezuela   | Cazorla et al., 2009                             |
| Ascaris spp. (oocysts)    | 11             | Tomatoes     | Local retail, retail distribution | Libya      | Abougrain et al., 2010                           |
|                           | 12             | Garden egg (Solanum aethiopicum) | Local retail | Nigeria      | Abougrain et al., 2012                           |
|                           | 13             | Cucumber     | Local retail, retail distribution | Libya      | Abougrain et al., 2010                           |
|                           | 15             | Cress        | Local retail, retail distribution | Libya      | Abougrain et al., 2010                           |
|                           | 15             | Lettuce      | Local retail | Libya, Nigeria | Abougrain et al., 2010, Adamu et al., 2012       |
|                           | 15             | Lettuce      | Retail distribution | Libya      | Abougrain et al., 2010                           |
| Ancylostoma duodenale     | 15             | Lettuce      | Local retail, retail distribution | India, Nigeria | Adamu et al., 2012; Gupta et al., 2009          |
|                           | 15             | Spinach      | Local retail, retail distribution | India      | Gupta et al., 2009                              |
|                           | 16             | Coriander    | Local retail, retail distribution | India      | Gupta et al., 2009                              |
|                           | 16             | Parsley      | Local retail, retail distribution | India      | Gupta et al., 2009                              |
|                           | 16             | Pudina (mentha) | Local retail, retail distribution | India      | Gupta et al., 2009                              |
|                           | 22             | Celery       | Local retail, retail distribution | India      | Gupta et al., 2009                              |
| Blastocystis spp.         | 15             | Lettuce      | Manufacturer | Venezuela   | Cazorla et al., 2009                             |

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| Pathogen                  | FoNAO Category | Food item(s)          | Source*          | Country          | Reference(s)                      |
|--------------------------|----------------|-----------------------|------------------|------------------|-----------------------------------|
|                          | 16             | Chives                | Manufacturer     | Venezuela        | Cazorla et al., 2009              |
|                          | 4              | Blackberry            | Local retail     | Costa Rica       | Calvo et al., 2004                |
| Cryptosporidium spp.     | 15             | Cabbage               | Manufacturer     | Venezuela        | Cazorla et al., 2009              |
|                          | 15             | Lettuce               | Local retail, manufacturer | Costa Rica, Venezuela | Calvo et al., 2004; Cazorla et al., 2009 |
|                          | 15             | Spinach               | Local retail     | Canada           | Bohaychuk et al., 2009            |
|                          | 15             | Water spinach (Ipomoea aquatica) | Lake         | Vietnam, Denmark | Vuong et al., 2007                |
|                          | 16             | Amaranth leaves       | Local retail     | India            | Rai et al., 2008                  |
|                          | 22             | Celery                | Local retail, Manufacturer | Costa Rica, Venezuela | Calvo et al., 2004; Cazorla et al., 2009 |
|                          | 1/other        | Produce               | Local retail     | Canada           | Bohaychuk et al., 2009            |
|                          | other          | Vegetables            | Manufacturer     | Venezuela        | Cazorla et al., 2009              |
| Cyclospora cayetanensis  | 15             | Lettuce               | Local retail     | Costa Rica       | Calvo et al., 2004                |
| Cyclospora spp.          | 15             | Cabbage               | Manufacturer, valley | Nepal, USA, Venezuela | Cazorla et al., 2009; Sherchand and Cross 2002 |
|                          | 15             | Lettuce               | Local retail; manufacturer; valley | Canada, Nepal, USA, Venezuela | Cazorla et al., 2009; Sherchand and Cross 2002; Tram et al., 2008 |
|                          | 15             | Mustard leaves        | Valley           | Nepal, USA       | Sherchand and Cross 2002          |
|                          | 15             | Water spinach (Ipomoea aquatica) | Lake         | Vietnam, Denmark | Vuong et al., 2007                |
|                          | 15             | Water spinach (Ipomoea aquatica) | Lake         | Vietnam, Denmark | Vuong et al., 2007                |
|                          | 16             | Basil                 | Local retail/manufacturer | Vietnam, Canada | Tram et al., 2008                 |

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### Pathogen

| Pathogen             | FoNAO Category | Food item(s) | Source¹ | Country          | Reference(s)                  |
|----------------------|----------------|--------------|---------|------------------|-------------------------------|
| Dipylidium caninum   | 16             | Chives       | Manufacturer | Venezuela          | Cazorla et al., 2009          |
|                      | 16             | Coriander    | Local retail/manufacturer | Vietnam, Canada | Tram et al., 2008 |
|                      | 16             | Marjoram     | Local retail/manufacturer | Vietnam, Canada | Tram et al., 2008 |
|                      | 16             | Persicaria   | Local retail/manufacturer | Vietnam, Canada | Tram et al., 2008 |
|                      | 16             | Vietnamese mint | Local retail/manufacturer | Vietnam, Canada | Tram et al., 2008 |
|                      | 22             | Celery       | Manufacturer | Venezuela          | Cazorla et al., 2009          |
|                      |                | Vegetables   | Manufacturer | Venezuela          | Cazorla et al., 2009          |
| Eimeria spp. (oocysts) | 16             | Coriander    | Manufacturer | Venezuela          | Cazorla et al., 2009          |
|                      |                | Vegetables   | Manufacturer | Venezuela          | Cazorla et al., 2009          |
|                      |                | Local retail | Vietnam, Canada | Tram et al., 2008 |
| Entamoeba coli       | 11             | Tomatoes     | Local retail | Egypt, Yemen          | Hassan et al., 2012          |
|                      | 13             | Cucumber     | Local retail | Egypt, Yemen          | Hassan et al., 2012          |
|                      | 15             | Cress        | Local retail | Iran                | Fallah et al., 2012          |
|                      | 15             | Tarragon     | Local retail | Iran                | Fallah et al., 2012          |
|                      | 15             | Watercress   | Local retail | Iran                | Fallah et al., 2012          |
|                      | 16             | Basil        | Local retail | Egypt, Yemen          | Hassan et al., 2012          |
|                      | 16             | Coriander    | Local retail | Egypt, Iran, Yemen    | Fallah et al., 2012; Hassan et al., 2012 |
|                      | 16             | Dill         | Local retail | Iran                | Fallah et al., 2012          |
|                      | 16             | Parsley      | Local retail | Egypt, Iran, Yemen    | Fallah et al., 2012; Hassan et al., 2012 |

¹ Source: Manufacturer, Local retail/manufacturer

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| Pathogen       | FoNAO Category | Food item(s)     | Source   | Country          | Reference(s)         |
|---------------|----------------|-----------------|----------|------------------|----------------------|
|               | 16             | Spearmint       | Local retail | Iran             | Fallah et al., 2012 |
|               | 19             | Carrots         | Local retail | Egypt, Yemen    | Hassan et al., 2012 |
|               | 21             | Radish          | Local retail | Egypt, Iran, Yemen | Fallah et al., 2012; Hassan et al., 2012 |
|               | 22             | Celery          | Manufacturer | Venezuela      | Cazorla et al., 2009 |
|               | 22             | Leek            | Local retail | Iran            | Fallah et al., 2012 |
|               |                | Vegetables      | Manufacturer | Venezuela      | Cazorla et al., 2009 |
| Entamoeba histolytica | 12             | Chili fruits    | Local retail | India           | Rai et al., 2008    |
|               | 12             | Pepper          | Local retail | Egypt, Yemen    | Hassan et al., 2012 |
|               | 13             | Cucumber        | Local retail | Egypt, Yemen    | Hassan et al., 2012 |
|               | 15             | Cabbage         | Local retail | India           | Rai et al., 2008    |
|               | 16             | Coriander       | Local retail | Egypt, Yemen    | Hassan et al., 2012 |
|               | 21             | Amaranth roots  | Local retail | India           | Rai et al., 2008    |
|               | 21             | Radish          | Local retail | Egypt, Yemen    | Hassan et al., 2012 |
| Entamoeba histolytica/dispar | 15             | Cabbage         | Manufacturer | Venezuela      | Cazorla et al., 2009 |
|               |                | Vegetables      | Manufacturer | Venezuela      | Cazorla et al., 2009 |
| Entamoeba spp. | 12             | Chili fruits    | Local retail | India           | Rai et al., 2008    |
|               | 15             | Cabbage         | Local retail | India           | Rai et al., 2008    |
|               | 15             | Lettuce         | Local retail | India           | Rai et al., 2008    |
|               | 15             | Spinach leaves  | Local retail | India           | Rai et al., 2008    |
|               | 16             | Mint leaves     | Local retail | India           | Rai et al., 2008    |
| Pathogen                  | FoNAO Category | Food item(s)     | Source⁷          | Country          | Reference(s)                  |
|--------------------------|---------------|-----------------|-----------------|-----------------|------------------------------|
| Enterocytozoon bieneusi  | 19            | Carrots         | Local retail    | India            | Rai et al., 2008             |
|                          | 21            | Amaranth roots  | Local retail    | India            | Rai et al., 2008             |
|                          | 21            | Radish          | Local retail    | India            | Rai et al., 2008             |
| Giardia lamblia          | 3             | Raspberries     | n.s.            | Poland, USA      | Jedrzejewski et al., 2007    |
|                          | 15            | Curly lettuce   | n.s.            | Poland, USA      | Jedrzejewski et al., 2007    |
| Giardia spp.             | 11            | Tomatoes        | Local retail    | Egypt, Yemen     | Hassan et al., 2012          |
|                          | 12            | Pepper          | Local retail    | Egypt, Yemen     | Hassan et al., 2012          |
|                          | 13            | Cucumber        | Local retail    | Egypt, Yemen     | Hassan et al., 2012          |
|                          | 16            | Coriander       | Local retail    | Egypt, Yemen     | Hassan et al., 2012          |
|                          | 16            | Parsley         | Local retail    | Egypt, Yemen     | Hassan et al., 2012          |
|                          | 19            | Carrots         | Local retail    | Egypt, Yemen     | Hassan et al., 2012          |
|                          | 21            | Radish          | Local retail    | Egypt, Yemen     | Hassan et al., 2012          |
| Giardia spp.             | 12            | Chili fruits    | Local retail    | India            | Rai et al., 2008             |
|                          | 15            | Cabbage         | Local retail    | India            | Rai et al., 2008             |
|                          | 15            | Cress           | Local retail    | Iran             | Fallah et al., 2012          |
|                          | 15            | Lettuce         | Local retail    | India            | Rai et al., 2008             |
|                          | 15            | Purslane        | Local retail    | India            | Fallah et al., 2012          |
|                          | 15            | Spinach leaves  | Local retail    | India            | Rai et al., 2008             |
|                          | 15            | Water spinach (Ipomoea aquatica) | Lake | Vietnam, Denmark | Vuong et al., 2007 |
|                          | 15            | Water spinach (Ipomoea aquatica) | Lake | Vietnam, Denmark | Vuong et al., 2007 |
| Pathogen                        | FoNAO Category | Food item(s)       | Source       | Country     | Reference(s)                  |
|--------------------------------|----------------|--------------------|--------------|-------------|-------------------------------|
|                                |                | Basil              | Local retail | Iran        | Fallah et al., 2012           |
|                                |                | Mint leaves        | Local retail | India       | Rai et al., 2008              |
|                                |                | Spearmint          | Local retail | Iran        | Fallah et al., 2012           |
|                                |                | Carrots            | Local retail | India       | Rai et al., 2008              |
|                                |                | Amaranth roots     | Local retail | India       | Rai et al., 2008              |
|                                |                | Radish             | Local retail | India, Iran | Fallah et al., 2012; Rai et al., 2008 |
|                                |                | Leek               | Local retail | Iran        | Fallah et al., 2012           |
|                                |                | Scallion           | Local retail | Iran        | Fallah et al., 2012           |
| Giardia spp. (oocysts)         | 11             | Tomatoes           | Local retail | Libya       | Abougrain et al., 2010        |
|                                | 13             | Cucumber           | Local retail, retail distribution | Libya | Abougrain et al., 2010 |
|                                | 15             | Cress              | Local retail, retail distribution | Libya | Abougrain et al., 2010 |
|                                | 15             | Lettuce            | Local retail | Libya       | Abougrain et al., 2010        |
| Intestinal helminthes (Cestodes, Trematodes, Nematodes) | 15             | Cabbage            | Local retail | Kenia, Italy | Nyarango et al., 2008 |
|                                | 18             | Black night shade  | Local retail | Kenia, Italy | Nyarango et al., 2008 |
|                                | 18             | Kale               | Local retail | Kenia, Italy | Nyarango et al., 2008 |
|                                | 18             | Spider flower      | Local retail | Kenia, Italy | Nyarango et al., 2008 |
| Microsporidia                  | 15             | Lettuce            | Local retail | Costa Rica  | Calvo et al., 2004            |
|                                | 16             | Coriander          | Local retail | Costa Rica  | Calvo et al., 2004            |
| Microsporidia (spores)         | 1              | Berries            | n.s.         | Poland, USA | Jedrzejewski et al., 2007    |
|                                |                | Vegetables         | n.s.         | Poland, USA | Jedrzejewski et al., 2007    |

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| Pathogen                        | FoNAO Category | Food item(s) | Source* | Country | Reference(s)         |
|--------------------------------|----------------|--------------|---------|---------|----------------------|
| Strongyloides stercoralis      | 15             | Cabbage      | Local retail | Nigeria | Adamu et al., 2012   |
|                                | 19             | Carrots      | Local retail | Nigeria | Adamu et al., 2012   |
| Taenia spp.                    | 13             | Cucumber     | Retail distribution | Turkey | Kozan et al., 2004 |
|                                | 16             | Parsley      | Retail distribution | Turkey | Kozan et al., 2004 |
|                                | 19             | Carrots      | Retail distribution | Turkey | Kozan et al., 2004 |
|                                | 22             | Green onion  | Retail distribution | Turkey | Kozan et al., 2004 |
| Taenia/Echinococcus spp.       | 11             | Tomatoes     | Local retail | Libya   | Abougrain et al., 2010 |
|                                | 13             | Cucumber     | Local retail, retail distribution | Libya | Abougrain et al., 2010 |
|                                | 15             | Cress        | Local retail, retail distribution | Libya | Abougrain et al., 2010 |
|                                | 15             | Lettuce      | Local retail, retail distribution | Libya | Abougrain et al., 2010 |
| Taenia/Echinococcus spp. (oocysts) | 15         | Lettuce      | Local retail | Nigeria | Adamu et al., 2012   |
| Taeniid spp.                   | 15             | Cress        | Local retail | Iran    | Fallah et al., 2012 |
|                                | 16             | Basil        | Local retail | Iran    | Fallah et al., 2012 |
|                                | 16             | Coriander    | Local retail | Iran    | Fallah et al., 2012 |
|                                | 16             | Dill         | Local retail | Iran    | Fallah et al., 2012 |
|                                | 16             | Parsley      | Local retail | Iran    | Fallah et al., 2012 |
|                                | 16             | Spearmint    | Local retail | Iran    | Fallah et al., 2012 |
|                                | 16             | Tarragon     | Local retail | Iran    | Fallah et al., 2012 |
|                                | 21             | Radish       | Local retail | Iran    | Fallah et al., 2012 |
|                                | 22             | Leek         | Local retail | Iran    | Fallah et al., 2012 |

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| Pathogen     | FoNAO Category | Food item(s)      | Source¹               | Country | Reference(s)                  |
|-------------|----------------|-------------------|-----------------------|---------|------------------------------|
| *Toxocara canis* | 11  | Tomatoes          | Local retail          | Libya   | Abougain et al., 2010       |
|             | 13  | Cucumber          | Local retail, retail distribution | Libya   | Abougain et al., 2010       |
|             | 15  | Cress             | Local retail, retail distribution | Libya   | Abougain et al., 2010       |
|             | 15  | Lettuce           | Local retail, retail distribution | Libya   | Abougain et al., 2010       |
| *Toxocara cati* | 11  | Tomatoes          | Local retail, retail distribution | Libya   | Abougain et al., 2010       |
|             | 13  | Cucumber          | Local retail, retail distribution | Libya   | Abougain et al., 2010       |
|             | 15  | Cress             | Local retail, retail distribution | Libya   | Abougain et al., 2010       |
|             | 15  | Lettuce           | Local retail, retail distribution | Libya   | Abougain et al., 2010       |
| *Toxocara spp.* | 11  | Tomatoes          | Manufacturer          | Venezuela| Cazorla et al., 2009   |
|             | 15  | Cabbage           | Manufacturer          | Venezuela| Cazorla et al., 2009   |
|             | 15  | Cress             | Local retail          | Iran     | Fallah et al., 2012        |
|             | 15  | Lettuce           | Retail distribution   | Turkey   | Kozan et al., 2004         |
|             | 16  | Coriander         | Local retail          | Iran     | Fallah et al., 2012        |
|             | 16  | Parsley           | Retail distribution   | Turkey   | Kozan et al., 2004         |
|             | 21  | Radish            | Local retail          | Iran     | Fallah et al., 2012        |
|             | 22  | Leek              | Local retail          | Iran     | Fallah et al., 2012        |
|             | 22  | Scallion          | Local retail          | Iran     | Fallah et al., 2012        |
|             | other | Vegetables     | Manufacturer          | Venezuela| Cazorla et al., 2009   |
| *Toxoplasma gondii* | 15  | Lettuce           | Local retail, Garden  | Poland   | Lass et al., 2012          |
|             | 19  | Carrots           | Local retail, Garden  | Poland   | Lass et al., 2012          |

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### Pathogen

| Pathogen       | FoNAO Category | Food item(s)                  | Source       | Country    | Reference(s)          |
|----------------|----------------|------------------------------|--------------|------------|-----------------------|
| **Trichostrongylus spp.** |                |                               |              |            |                       |
| 21             | Radish         | Local retail                 | Poland       |            | Lass et al., 2012     |
| 15             | Purslane       | Local retail                 | Iran         |            | Fallah et al., 2012   |
| 15             | Tarragon       | Local retail                 | Iran         |            | Fallah et al., 2012   |
| 16             | Basil          | Local retail                 | Iran         |            | Fallah et al., 2012   |
| 16             | Parsley        | Local retail                 | Iran         |            | Fallah et al., 2012   |
| 16             | Spearmint      | Local retail                 | Iran         |            | Fallah et al., 2012   |
| 22             | Scallion       | Local retail                 | Iran         |            | Fallah et al., 2012   |
| **Trichuris spp.** |                |                               |              |            |                       |
| 12             | Garden egg (*Solanum aethiopicum*) | Local retail | Nigeria     |            | Adamu et al., 2012    |
| 13             | Cucumber       | Local retail                 | Nigeria      |            | Adamu et al., 2012    |
| 15             | Lettuce        | Local retail                 | Nigeria      |            | Adamu et al., 2012    |
| **Trichuris trichiura** |            |                               |              |            |                       |
| 15             | Spinach        | Retail distribution/local retail | India       |            | Gupta et al., 2009    |
| 16             | Coriander      | Retail distribution/local retail | India       |            | Gupta et al., 2009    |
| 16             | Pudina (mentha) | Retail distribution/local retail | India       |            | Gupta et al., 2009    |

* n.s. = non specified
Table 15: Prevalence of pathogenic bacteria, viruses, and parasites in association with FoNAO of high water content, EU countries. Pathogens are listed in alphabetical order.

| Pathogen                        | FoNAO Category | Food item(s)                        | Source | Processing /Comment | Prevalence | Country | Reference(s) |
|---------------------------------|----------------|-------------------------------------|--------|---------------------|------------|---------|--------------|
| **Pathogenic bacteria**         |                |                                     |        |                     |            |         |              |
| Aeromonas hydrophila            | 36             | Mixed salads (spinach, sprouts, cabbage, mushrooms, rocket, valerian or multi-salad packs) | Manufacturer | minimally processed | 21/26 (80%) | Greece  | Xanthopoulos et al., 2010 |
| **Bacillus cereus**             | 13             | Zucchini                            | Manufacturer | fresh               | 10/10 (100%) | France  | Guinebretiere et al., 2003 |
|                                 | 13             | Zucchini                            | Manufacturer | heat-treated; cooked | 2/10 (20%)  | France  | Guinebretiere et al., 2003 |
|                                 | 13             | Zucchini                            | Manufacturer | washed              | 10/10 (100%) | France  | Guinebretiere et al., 2003 |
|                                 | 36             | Salad mix (romaine lettuce, various spinach and mixed salads) | Supermarket | minimally processed  | 34/151 (23%) | Portugal | Santos et al., 2012 |
|                                 | 37             | Potato meal                         | Catering | processed           | 6/54 (11%)  | Italy   | Bonerba et al., 2010 |
|                                 | 10             | Fruit juice                         | Pharmacy | fresh               | 3/30 (10%)  | Poland  | Mostafa et al., 2002 |
| **Bacillus cereus group spp.**  | 12             | Paprika                             | Local retail | n.s.¹               | 1/20 (5%)   | Belgium | Samapundo et al., 2011 |
|                                 | 15             | Chinese cabbage                     | Local retail | n.s.               | 6/20 (30%)  | Belgium | Samapundo et al., 2011 |
|                                 | 19             | Carrots                             | Local retail | n.s.               | 8/20 (40%)  | Belgium | Samapundo et al., 2011 |
|                                 | 22             | Celery                              | Local retail | n.s.               | 7/20 (35%)  | Belgium | Samapundo et al., 2011 |
| **Bacillus cereus like organism** | 1              | Fruits                              | Local retail | fresh; ready to eat | 9/317 (3%)   | Denmark | Rosenquist et al., 2005 |
|                                 | 17             | Lettuce                             | Local retail | fresh; ready to eat | 3/131 (2%)   | Denmark | Rosenquist et al., 2005 |
|                                 | 11/13          | Cucumbers, Tomatoes                 | Local retail | fresh; ready to eat | 1/38 (3%)   | Denmark | Rosenquist et al., 2005 |
|                                 | other          | Other Vegetables                     | Local retail | fresh; ready to eat | 15/367 (4%)  | Denmark | Rosenquist et al., 2005 |
|                                 | other          | Vegetables                          | Local retail | heat-treated; ready to eat | 8/428 (2%)  | Denmark | Rosenquist et al., 2005 |
| **Clostridium botulinum**       | 14             | Green beans                         | Manufacturer | fresh               | 1/188 (0.5%) | France  | Sevenier et al., 2012 |
|                                 | 19             | Carrots                             | Manufacturer | fresh               | 1/128 (1%)   | France  | Sevenier et al., 2012 |
| Pathogen           | FoNAO Category | Food item(s) | Source | Processing /Comment     | Prevalence | Country     | Reference(s)      |
|--------------------|----------------|--------------|--------|-------------------------|------------|-------------|-------------------|
| *Cronobacter sakazakii* | 36             | Mixed salad  | Local retail | ready-to-eat            | 19/72 (26%) | Germany      | Weiss et al., 2005 |
|                    | 38             | Coconut      | Supermarket | heat-treated; dehydrated | 1/10 (10%)  | Czech Republic | Hochele et al., 2012 |
| *Cronobacter spp.*  | 15             | Leafy greens | Supermarket | fresh                   | 2/6 (33%)   | Ireland      | Molloy et al., 2009 |
|                    | 38             | Vegetables   | Manufacturer/local retail | heat-treated; dried | 2/47 (4%)   | Netherlands  | Kandhai et al., 2010 |
| other Vegetables    | n.s.           | n.s.         |         |                         | 5/12 (42%)  | Slovakia     | Turcovský et al., 2011 |
| *Enterobacter aerogenes* | 36             | Mixed salad  | Local retail | ready-to-eat            | 2/72 (3%)  | Germany      | Weiss et al., 2005 |
| *Enterobacter cloacae* | 36             | Mixed salad  | Local retail | ready-to-eat            | 16/72 (22%) | Germany      | Weiss et al., 2005 |
| *Escherichia coli (VTEC)* | 15             | Endive       | n.s.    | n.s.                    | 4/298 (1%)  | Netherlands  | ECDC, 2008        |
|                    | 15             | Mixed lettuce| n.s.    | n.s.                    | 1/172 (1%)  | Netherlands  | ECDC, 2008        |
| 36                 | Salad mix (romaine lettuce, various spinach and mixed salads) | Supermarket | minimally processed | 3/151 (2%) | Portugal     | Santos et al., 2012 |
| other Vegetables    | n.s.           | n.s.         |         |                         | 4/62 (6%)   | Spain        | ECDC, 2010        |
| other Vegetables    | n.s.           | n.s.         |         |                         | 1/18 (6%)   | n.s.         | ECDC, 2010        |
| other Vegetables    | n.s.           | n.s.         |         |                         | 2/23 (9%)   | Spain        | ECDC, 2008        |
| other Vegetables    | n.s.           | n.s.         |         |                         | 288/2 (1%)  | Belgium      | ECDC, 2010        |
| *Klebsiella oxytoca* | 36             | Mixed salad  | Local retail | ready-to-eat            | 3/72 (4%)   | Germany      | Weiss et al., 2005 |
| *Klebsiella pneumoniae* | 36             | Mixed salad  | Local retail | ready-to-eat            | 1/72 (1%)   | Germany      | Weiss et al., 2005 |
| *Listeria monocytogenes* | 1              | Fruits       | n.s.    | n.s.                    | 1/387 (0.3%) | Italy        | ECDC, 2008        |
|                    | 2              | Strawberries | Local retail/retail distribution | fresh      | 1/173 (0.6%) | Norway       | Johanessen et al., 2002 |
| 11                 | Tomatoes       | Manufacturer | fresh   |                         | 215/ (13%)  | Greece       | Kokkinakis et al., 2007 |
| Pathogen   | FoNAO Category | Food item(s)         | Source                     | Processing /Comment | Prevalence | Country  | Reference(s)                  |
|------------|----------------|----------------------|----------------------------|---------------------|------------|----------|-----------------------------|
| Listeria monocytogenes | 11             | Tomatoes             | Manufacturer               | fresh               | 10/15 (67%) | Greece   | Kokkinakis et al., 2007     |
|            | 11             | Tomatoes             | Supermarket                | fresh               | 24/96 (25%) | Spain    | Ramirez Merida 2009          |
|            | 12             | Green peppers       | Local retail/manufacturer  | frozen; pre-cut     | 7/31 (23%)  | Portugal | Mena et al., 2004           |
|            | 12             | Pepper               | Manufacturer               | fresh               | 3/15 (20%)  | Greece   | Kokkinakis et al., 2007     |
|            | 12             | Pepper               | Manufacturer               | fresh               | 5/15 (33%)  | Greece   | Kokkinakis et al., 2007     |
|            | 13             | Zucchini             | Manufacturer               | frozen              | 12/23 (52%) | Germany | Pappelbaum et al., 2008     |
|            | 14             | Corn                 | Manufacturer               | frozen              | 1/12 (8%)   | Germany | Pappelbaum et al., 2008     |
|            | 14             | Green pea            | Manufacturer               | frozen              | 22/110 (20%)| Germany | Pappelbaum et al., 2008     |
|            | 14             | Peas                 | Local retail/manufacturer  | frozen              | 4/27 (15%)  | Portugal | Mena et al., 2004           |
|            | 14             | String bean          | Manufacturer               | frozen              | 65/121 (54%)| Germany | Pappelbaum et al., 2008     |
|            | 15             | Lettuce              | Local retail/retail        | fresh               | 1/200 (1%)  | Norway   | Johanessen et al., 2002     |
|            | 15             | Lettuce              | Manufacturer               | fresh               | 2/179 (1%)  | Norway   | Loncarevic et al., 2005     |
|            | 15             | Salad                | Local retail               | ready to eat        | 24/503 (5%) | Hungary | ECDC, 2009                   |
|            | 15             | Salad                | Manufacturer               | ready to eat        | 6/198 (3%)  | Czech Republic | ECDC, 2009 |
|            | 15             | Salad                | Manufacturer               | ready to eat        | 4/256 (2%)  | Slovenia | ECDC, 2009                   |
|            | 15             | Salad                | n.s.                       | ready to eat        | 41/251 (16%)| Spain   | ECDC, 2009                   |
|            | 15             | Salad                | n.s.                       | ready to eat        | 2/43 (5%)   | Estonia  | ECDC, 2009                   |
|            | 15             | Salad                | n.s.                       | ready to eat        | 1/106 (1%)  | Estonia  | ECDC, 2009                   |
|            | 15             | Spinach              | Manufacturer               | frozen              | 10/15 (67%) | Germany | Pappelbaum et al., 2008     |
|            | 15             | Spinach              | Supermarket                | frozen; ready to eat| 2/16 (13%) | Spain   | Moreno et al., 2012         |
|            | 15             | Vegetable (rucola, lettuce) | Manufacturer | fresh | 1/265 (0.4%) | Italy  | De Giusti et al., 2010      |
|            | 16             | Coriander            | Supermarket                | fresh               | 35/96 (37%) | Spain   | Ramirez Merida 2009          |
| Pathogen | FoNAO Category | Food item(s) | Source\(^c\) | Processing /Comment | Prevalence | Country | Reference(s) |
|----------|----------------|--------------|--------------|---------------------|------------|---------|--------------|
| Listeria monocytogenes | 17 | Edible leaves | Local retail | fresh; packed, ready to eat | 2/42 (5%) | Spain | Badosa et al., 2008 |
| | 17 | Lettuce | Supermarket | pre-cut | 1/29 (3%) | Spain | Abadias et al., 2008 |
| | 17 | Mixed lettuce | Manufacturer | ready to eat | 2/699 (0.3%) | Italy | De Giusti et al., 2010 |
| | 17 | Mixed salads | Local retail | fresh; packed, ready to eat | 2/42 (5%) | Spain | Badosa et al., 2008 |
| | 17 | Mixed salads | Supermarket | pre-cut | 22/132 (17%) | Spain | Abadias et al., 2008 |
| | 17 | Spinach | Supermarket | fresh; ready to eat | 1/18 (6%) | Spain | Moreno et al., 2012 |
| | 19 | Carrots | Manufacturer | frozen | 19/43 (44%) | Germany | Pappelbaum et al., 2008 |
| | 23 | Broccoli | Local retail/manufacturer | frozen | 6/37 (16%) | Portugal | Mena et al., 2004 |
| | 23 | Broccoli | Manufacturer | frozen | 192/242 (79%) | Germany | Pappelbaum et al., 2008 |
| | 23 | Broccoli | Supermarket | fresh; ready to eat; pre-cut; packed | 2/16 (13%) | Spain | Moreno et al., 2012 |
| | 23 | Broccoli | Supermarket | frozen; ready to eat | 1/6 (17%) | Spain | Moreno et al., 2012 |
| | 23 | Cauliflower | Manufacturer | frozen | 259/419 (62%) | Germany | Pappelbaum et al., 2008 |
| | 23 | Courgette | Local retail/manufacturer | frozen; pre-cut | 18/106 (17%) | Portugal | Mena et al., 2004 |
| | 29 | Boletus edulis | Local retail/supermarket | fresh | 4/22 (18%) | Spain | Venturini et al., 2011 |
| | 29 | Calocybe gambosa | Local retail/supermarket | fresh | 8/20 (40%) | Spain | Venturini et al., 2011 |
| | 29 | Hygrophorus limacinus | Local retail/supermarket | fresh | 4/10 (40%) | Spain | Venturini et al., 2011 |
| | 29 | Lactarius deliciosus | Local retail/supermarket | fresh | 4/16 (25%) | Spain | Venturini et al., 2011 |
| | 29 | Mushrooms | Local retail/retail distribution | fresh | 1/156 (0.6%) | Norway | Johanessen et al., 2002 |
| Pathogen          | FoNAO Category | Food item(s)                          | Source\(^1\)              | Processing /Comment | Prevalence   | Country | Reference(s)   |
|-------------------|----------------|---------------------------------------|---------------------------|---------------------|--------------|---------|----------------|
| **Listeria**      | 29             | Mushrooms                             | Local retail/supermarket  | fresh               | 26/402 (6%)  | Spain   | Venturini et al., 2011 |
| monocytophages    | 29             | Mushrooms                             | Manufacturer             | frozen              | 81/340 (24%) | Germany | Pappelbaum et al., 2008 |
|                   | 29             | Tuber indicum                         | Local retail/supermarket  | fresh               | 6/6 (100%)   | Spain   | Venturini et al., 2011 |
|                   | 35             | Green table olives                    | n.s.                     | processed; biological samples | 12/34 (35%)  | Italy   | Caggia et al., 2004 |
|                   | 35             | Green table olives                    | n.s.                     | processed; commercial samples | 4/10 (40%)   | Italy   | Caggia et al., 2004 |
|                   | 35             | Green table olives                    | n.s.                     | processed; Spanish process | 10/25 (40%)  | Italy   | Caggia et al., 2004 |
|                   | 36             | Salad                                  | Local retail              | ready to eat        | 3/661 (0.5%) | Ireland | ECDC, 2008 |
|                   | 36             | Salad                                  | Local retail              | ready to eat        | 5/64 (8%)    | Estonia | ECDC, 2008 |
|                   | 36             | Salad                                  | Local retail              | ready to eat        | 4/55 (7%)    | Lithuania | ECDC, 2008 |
|                   | 36             | Salad                                  | Local retail              | ready to eat        | 3/335 (1%)   | United Kingdom | ECDC, 2008 |
|                   | 36             | Salad                                  | Manufacturer             | ready to eat        | 3/38 (8%)    | Estonia | ECDC, 2008 |
|                   | 36             | Salad                                  | n.s.                     | ready to eat        | 23/714 (3%)  | Slovakia | ECDC, 2008 |
|                   | 36             | Salad                                  | n.s.                     | ready to eat        | 15/497 (3%)  | Hungary | ECDC, 2008 |
|                   | 36             | Salad mix (romaine lettuce, various spinach and mixed salads) | Supermarket | minimally processed | 1/151 (0.7%) | Portugal | Santos et al., 2012 |
|                   | 36             | Salad vegetables                       | Catering/local retail    | ready to eat        | 88/2950 (3%) | United Kingdom | Sagoo et al., 2003 |
|                   | 36             | Salad vegetables                       | Local retail              | fresh; packed; ready to eat | 1/3852 (0.02%) | United Kingdom | Sagoo et al., 2003 |
|                   | 37             | Other food (various ingredients)      | Take-away                | heat-treated and non heat-treated | 7/433 (2%)  | Italy   | Latorre et al., 2007 |
|                   | 1/other         | Fruits and vegetables                 | Catering                 | pre-cut; ready to eat | 6/324 (2%)   | Portugal | ECDC, 2009 |

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### Pathogens

| Pathogen          | FoNAO Category | Food item(s)                        | Source | Processing /Comment | Prevalence | Country      | Reference(s) |
|-------------------|----------------|-------------------------------------|--------|---------------------|------------|--------------|---------------|
| *Listeria monocytogenes* | 1/other        | Fruits and vegetables               | Catering | pre-cut; ready to eat | 5/345 (1%) | Portugal     | ECDC, 2008    |
|                   | 1/other        | Fruits and vegetables               | Local retail | fresh              | 4/445 (1%) | Spain        | Badosa et al., 2008 |
|                   | 1/other        | Fruits and vegetables               | Local retail | n.s.               | 5/89 (6%)  | Ireland      | ECDC, 2008    |
|                   | 1/other        | Fruits and vegetables               | Local retail | pre-cut            | 1/47 (2%)  | Slovenia     | ECDC, 2008    |
|                   | 1/other        | Fruits and vegetables               | Local retail | pre-cut            | 1/58 (2%)  | Ireland      | ECDC, 2008    |
|                   | 1/other        | Produce                             | Local retail/retail distribution | fresh | 3/890 (0.3%) | Norway       | Johansson et al., 2002 |
|                   | 1/other        | Vegetable or fruit salat            | Local retail | n.s.               | 1/385 (0.3%) | Netherlands  | ECDC, 2009    |
| other             | Vegetable (products) | Manufacturer                   | n.s.               | 1/36 (3%)  | Estonia      | ECDC, 2009    |
| other             | Vegetables     | Local retail                        | fresh; not pre-cut | 1/84 (1%) | Czech Republic | ECDC, 2008    |
| other             | Vegetables     | Local retail                        | frozen; pre-cut   | 3/36 (8%)  | Czech Republic | ECDC, 2008    |
| other             | Vegetables     | Local retail                        | pre-cut           | 2/54 (4%)  | Hungary      | ECDC, 2008    |
| other             | Vegetables     | Local retail/manufacturer           | frozen           | 31/1750 (2%) | Spain        | Vitas et al., 2004 |
| other             | Vegetables     | Manufacturer                        | frozen           | 113/248 (46%) | Germany     | Pappelbaum et al., 2008 |
| other             | Vegetables     | Manufacturer                        | frozen           | 11/906 (1%) | Spain        | Aguado et al., 2004 |
| other             | Vegetables     | Manufacturer                        | n.s.             | 4/224 (2%)  | Czech Republic | ECDC, 2008    |
| other             | Vegetables     | n.s.                                | fresh; not pre-cut | 21/1 (5%)  | Czech Republic | ECDC, 2009    |
| other             | Vegetables     | n.s.                                | frozen; pre-cut  | 7/38 (18%) | Slovakia     | ECDC, 2008    |
| other             | Vegetables     | n.s.                                | frozen; pre-cut  | 2/170 (1%) | Hungary      | ECDC, 2009    |
| other             | Vegetables     | n.s.                                | n.s.             | 45/141 (32%) | Spain        | ECDC, 2008    |
| other             | Vegetables     | n.s.                                | pre-cut; ready to eat | 1/21 (5%)  | Hungary      | ECDC, 2009    |
| other             | Vegetables     | n.s.                                | ready to eat    | 8/61 (13%) | Spain        | ECDC, 2009    |
| Pathogen                        | FoNAO Category | Food item(s)                                                                 | Source   | Processing /Comment   | Prevalence | Country | Reference(s)        |
|--------------------------------|----------------|-----------------------------------------------------------------------------|----------|-----------------------|------------|---------|---------------------|
|                                | other          | Vegetables (tomatoes, celery, parsley, paprika, brussels sprouts)           | Manufacturer | frozen                | 17/73 (23%) | Germany | Pappelbaum et al., 2008 |
|                                | other          | Vegetables                                                                  | Supermarket | frozen; stir fry; ready to eat | 1/5 (20%)  | Spain   | Moreno et al., 2012  |
| Pseudomonas aeruginosa         | 30             | Algae                                                                       | Take-away | heat-treated; fried    | 1/16 (6%)   | Italy   | Catellani et al., 2010 |
|                                | 36             | Mixed salad                                                                 | Local retail | ready-to-eat          | 10/72 (14%) | Germany | Weiss et al., 2005   |
| Salmonella Durban              | 36             | Salad vegetables                                                            | Local retail | fresh; packed; ready to eat | 1/3852 (0.02%) | United Kingdom | Sagoo et al., 2003   |
| Salmonella Gustavia            | other          | Vegetables                                                                  | Local retail | n.s.                  | 1/29 (3%)   | Austria | ECDC, 2008           |
| Salmonella Newport             | 36             | Salad vegetables                                                            | Local retail | fresh; packed; ready to eat | 1/3852 (0.02%) | United Kingdom | Sagoo et al., 2003   |
| Salmonella spp.                | 7              | Drupes                                                                      | Local retail | fresh                 | 1/57 (2%)   | Spain   | Badosa et al., 2008  |
|                                | 8              | Coconut products                                                           | Local retail | n.s.                  | 1/71 (1%)   | Hungary | ECDC, 2009           |
|                                | 15             | Endive                                                                      | Local retail | n.s.                  | 1/298 (0.3%)| United Kingdom | ECDC, 2008           |
|                                | 15             | Salad                                                                       | Catering   | ready to eat          | 1/248 (0.8%)| Spain   | ECDC, 2009           |
|                                | 15             | Vegetable (rucola, lettuce)                                                | Manufacturer | fresh                 | 2/265 (0.8%)| Italy   | De Giusti et al., 2010 |
|                                | 16             | Basil                                                                       | Local retail | fresh; ready to eat  | 9/674 (1%)   | United Kingdom | Elviss et al., 2009 |
|                                | 16             | Coriander                                                                   | Local retail | fresh; ready to eat  | 3/733 (0.4%)| United Kingdom | Elviss et al., 2009 |
|                                | 16             | Herbs                                                                       | Local retail | n.s.                  | 32/410 (8%) | Netherlands | ECDC, 2009           |
|                                | 16             | Herbs                                                                       | Local retail | fresh                 | 14/766 (2%) | Netherlands | ECDC, 2009           |
|                                | 16             | Mint                                                                        | Local retail | fresh; ready to eat  | 1/397 (0.3%)| United Kingdom | Elviss et al., 2009 |
|                                | 16             | Other (rosemary, thyme, methi, curry leaves, walleria)                      | Local retail | fresh; ready to eat  | 3/487 (0.6%)| United Kingdom | Elviss et al., 2009 |
| Pathogen       | FoNAO Category | Food item(s)                           | Source\(^a\) | Processing /Comment | Prevalence | Country          | Reference(s)          |
|----------------|----------------|----------------------------------------|--------------|---------------------|------------|------------------|-----------------------|
| 16             |                | Parsley                                | Local retail | fresh; ready to eat | 2/774 (0.3%) | United Kingdom   | Elviss et al., 2009   |
| 17             |                | Corn salad (Valerianella locusta)      | Supermarket  | pre-cut             | 1/21 (5%)  | Spain            | Abadias et al., 2008  |
| 17             |                | Lettuce                                | Supermarket  | pre-cut             | 1/29 (3%)  | Spain            | Abadias et al., 2008  |
|                |                | Lettuce                                | Take-away    | ready to eat        | 1/454 (0.2%)| United Kingdom   | Meldrum et al., 2009  |
| 17             |                | Mixed salads                           | Local retail | fresh; packed, ready to eat | 1/42 (2%) | Spain            | Badosa et al., 2008   |
| 17             |                | Mixed salads                           | Supermarket  | pre-cut             | 1/132 (0.8%)| Spain            | Abadias et al., 2008  |
| 17             |                | Spinach                                | Supermarket  | pre-cut             | 1/10 (10%) | Spain            | Abadias et al., 2008  |
| 22             |                | Bulbous vegetables (leek plants)       | Supermarket  | fresh               | 1/1000 (0.1%)| Germany         | Schwaiger et al., 2011|
| 37             |                | Confectionary products and pastes      | Manufacturer | n.s.                | 1/23 (4%)  | Romania          | ECDC, 2009            |
| 37             |                | Importet confectionary products and pastes | Local retail | n.s.                | 6/25 (24%) | Slovakia         | ECDC, 2009            |
| 37             |                | Sauce and Dressings                    | Local retail | n.s.                | 1/5 (20%)  | Lithuania        | ECDC, 2009            |
| 1/other        |                | Fruits and vegetables                  | Local retail | fresh               | 3/445 (1%) | Spain            | Badosa et al., 2008   |
| 1/other        |                | Fruits and vegetables                  | Local retail | pre-cut; ready to eat| 1/403 (0.2%)| Sweden          | ECDC, 2008            |
| 1/other        |                | Fruits and vegetables                  | Manufacturer | pre-cut; ready to eat| 1/12 (8%)  | Belgium          | ECDC, 2008            |
| 1/other        |                | Fruits and vegetables                  | n.s.         | n.s.                | 1/643 (0.2%)| Germany         | ECDC, 2009            |
| 1/other        |                | Fruits and vegetables                  | n.s.         | pre-cut             | 1/60 (2%)  | Belgium          | ECDC, 2009            |
| 1/other        |                | Fruits and vegetables                  | n.s.         | pre-cut             | 1/711 (0.1%)| Germany         | ECDC, 2008            |
| 1/other        |                | Fruits and vegetables                  | n.s.         | pre-cut; ready to eat| 1/840 (0.1%)| Luxembourg      | ECDC, 2009            |
| other          |                | Vegetable (products)                   | n.s.         | n.s.                | 1/46 (2%)  | Italy            | ECDC, 2009            |
| other          |                | Vegetables                             | n.s.         | n.s.                | 7/1876 (0.4%)| Spain           | ECDC, 2008            |
| other          |                | Vegetables                             | Local retail | fresh               | 1/72 (1%)  | Spain            | Badosa et al., 2008   |

\(^a\) Source:
- Local retail
- Supermarket
- Take-away
- Manufacturer
- Manufacturer pre-cut; ready to eat
- Local retail pre-cut; ready to eat
- Local retail
- Local retail n.s.
- Manufacturer n.s.
- Manufacturer
- Manufacturer n.s.
- Local retail
- Manufacturer n.s.
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- Local retail

**Supporting publications 2013:EN-402**

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| Pathogen | FoNAO Category | Food item(s) | Source | Processing /Comment | Prevalence | Country | Reference(s) |
|----------|----------------|--------------|--------|---------------------|------------|---------|--------------|
| Salmonella spp.; Listeria monocytogenes | 36 | Salad vegetables | Local retail | fresh; packed; ready to eat | 6/3852 (0.2%) | United Kingdom | Sagoo et al., 2003 |
| Salmonella Typhimurium | 15 | Lettuce | Manufacturer | n.s. | 1/655 (0.2%) | Netherlands | ECDC, 2008 |
| Salmonella Umbilo | 36 | Salad vegetables | Local retail | fresh; packed; ready to eat | 3/3852 (0.1%) | United Kingdom | Sagoo et al., 2003 |
| Staphylococcus aureus | 2 | Strawberries | Local retail/retail distribution | fresh | 2/173 (1.2%) | Norway | Johanessen et al., 2002 |
| | 13 | Cucumber | Take-away | ready to eat | 3/67 (5%) | United Kingdom | Meldrum et al., 2009 |
| | 17 | Cabbage | Take-away | ready to eat | 2/123 (2%) | United Kingdom | Meldrum et al., 2009 |
| | 17 | Lettuce | Take-away | ready to eat | 5/454 (1%) | United Kingdom | Meldrum et al., 2009 |
| | 29 | Mushrooms | Local retail/retail distribution | fresh | 2/156 (1%) | Norway | Johanessen et al., 2002 |
| | 35 | Olives | Local retail/supermarket | not direct; packing brine | 4/35 (11%) | Portugal | Pereira et al., 2008 |
| | 36 | Mixed salads (cabbage, lettuce, tomato) | Take-away | ready to eat | 4/356 (1%) | United Kingdom | Meldrum et al., 2009 |
| Yersinia enterocolitica | 36 | Mixed salad | Local retail | ready-to-eat | 1/72 (1%) | Germany | Weiss et al., 2005 |
| | 15 | Lettuce | Local retail/retail distribution | fresh | 6/200 (3.0%) | Norway | Johanessen et al., 2002 |
| | 29 | Calocybe gambosa | Local retail/supermarket | fresh | 1/20 (5%) | Spain | Venturini et al., 2011 |
| | 29 | Craterellus cornucopioides | Local retail/supermarket | fresh | 1/24 (4%) | Spain | Venturini et al., 2011 |
| | 29 | Craterellus cornucopioides | Local retail/supermarket | fresh | 2/20 (10%) | Spain | Venturini et al., 2011 |
| Pathogen   | FoNAO Category | Food item(s)                                      | Source       | Processing /Comment | Prevalence | Country | Reference(s)            |
|------------|----------------|------------------------------------------------|--------------|---------------------|------------|---------|-------------------------|
|            | 29             | Mushrooms                                       | Local retail/supermarket | fresh             | 4/402 (1%) | Spain   | Venturini et al., 2011  |
|            | 36             | Mixed salads (spinach, sprouts, cabbage, mushrooms, rocket, valerian or multi-salad packs) | Manufacturer | minimally processed | 2/26 (8%)  | Greece  | Xanthopoulos et al., 2010 |
| **Viruses**|                |                                                 |              |                     |            |         |                         |
| Norovirus  | 1              | Soft red fruits                                 | n.s.         | n.s.                | 10/29 (35%)| Belgium | Baert et al., 2011      |
|           | 1              | Soft red fruits                                 | n.s.         | n.s.                | 10/150 (7%)| France  | Baert et al., 2011      |
|           | 15             | Leafy greens                                    | n.s.         | n.s.                | 6/6 (33%) | Belgium | Baert et al., 2011      |
|           | 15             | Leafy greens                                    | n.s.         | n.s.                | 3/6 (50%) | France  | Baert et al., 2011      |
|           | 1/-other        | Produce                                         | n.s.         | n.s.                | 10/18 (56%)| Belgium | Baert et al., 2011      |
| **Parasites**|              |                                                 |              |                     |            |         |                         |
| Toxoplasma gondii |            | Lettuce                                         | Local retail | n.s.                | 7/35 (20%)| Poland  | Lass et al., 2012       |
|            | 15             | Lettuce                                         | Garden       | n.s.                | 2/15 (13%)| Poland  | Lass et al., 2012       |
|            | 19             | Carrots                                         | Local retail | n.s.                | 4/27 (15%)| Poland  | Lass et al., 2012       |
|            | 19             | Carrots                                         | Garden       | n.s.                | 5/19 (26%)| Poland  | Lass et al., 2012       |
|            | 21             | Radish                                          | Local retail | n.s.                | 3/54 (6%) | Poland  | Lass et al., 2012       |

*a n.s. = non specified*
### Table 16: Prevalence of pathogenic bacteria and parasites in association with FoNAO of high water content, non-EU countries.

No detection rates were reported for viruses on/in FoNAO with high water content for non-EU countries.

| Pathogen                  | FoNAO Category | Food item(s)                        | Source* | Processing /Comment | Prevalence | Country | Reference(s) |
|---------------------------|----------------|-------------------------------------|---------|---------------------|------------|---------|--------------|
| **Pathogenic bacteria**   |                |                                     |         |                     |            |         |              |
| Bacillus cereus           | 16             | Parsley                             | Local/retail/supermarket | heat-treated; dehydrated | 1/15 (7%)  | Brazil  | Moreira et al., 2009 |
|                           | 20             | Potato                              | n.s.    | fresh               | 7/9 (78%)  | Argentina | Fangio et al., 2010 |
|                           | 22             | Onion                               | Local/retail/supermarket | heat-treated; dehydrated | 1/15 (8%)  | Brazil  | Moreira et al., 2009 |
|                           | 36             | Salad                               | Restaurant/take-away | processed            | 2/10 (20%) | Nigeria | Isara et al., 2010 |
|                           | 37             | Sunsik (grain, fruit and vegetables) | Local retail | ready-to-eat       | 39/93 (42%) | Korea  | Lee et al., 2011 |
|                           | 38             | Dehydrated potato flakes            | Supermarket | ready to eat       | 8/50 (16%) | New Zealand | Turner et al., 2006 |
|                           | 1/other        | Fruits and vegetables               | Supermarket | pre-cut             | 2/60 (3%)  | Korea  | Chung et al., 2010 |
|                           | 13/20          | Vegetables (butter nut squash, potato) | n.s. | fresh               | 11/23 (48%) | Argentina | Fangio et al., 2010 |
| other Vegetables          |                | Manufacturer                         | fresh    |                     | 3/58 (5%)  | Korea  | Thapa et al., 2008 |
| other Vegetables          |                | Manufacturer                         | fresh    |                     | 3/58 (5%)  | Korea  | Thapa et al., 2008 |
| other Vegetables          |                | Supermarket                          | ready to eat |                     | 19/45 (42%) | Taiwan | Fang et al., 2003 |
| Campylobacter coli        | 14             | Winged bean (Psophocarpus tetragonolobus) | Local/retail/supermarket | fresh       | 18/39 (46%) | Malaysia | Chai et al., 2007 |
|                           | 14             | Yardlong bean (Vigna unguiculata)   | Local/retail/supermarket | fresh       | 1/40 (3%)  | Malaysia | Chai et al., 2007 |
|                           | 15             | Water spinach                        | Local/retail/supermarket | fresh       | 17/39 (44%) | Malaysia | Chai et al., 2007 |
|                           | 16             | Coriander, Vietnamese (Polygonum minus) | Local/retail/supermarket | fresh       | 16/36 (44%) | Malaysia | Chai et al., 2007 |
|                           | 16             | Indian pennywort (Centella asiatica) | Local/retail/supermarket | fresh       | 19/37 (51%) | Malaysia | Chai et al., 2007 |
## Pathogen

| Pathogen | FoNAO Category | Food item(s) | Source / Comment | Prevalence | Country | Reference(s) |
|----------|----------------|--------------|------------------|------------|---------|--------------|
| *Campylobacter fetus* | 16 | Parsley, Japanese (Oenanthe stolonifera) | Local retail/supermarket | fresh | 19/39 (49%) | Malaysia | Chai et al., 2007 |
| | 16 | Wild cosmos (Cosmos caudatus) | Local retail/supermarket | fresh | 18/38 (47%) | Malaysia | Chai et al., 2007 |
| | 16 | Indian pennywort (Centella asiatica) | Local retail/supermarket | fresh | 1/37 (3%) | Malaysia | Chai et al., 2007 |
| | 16 | Wild cosmos (Cosmos caudatus) | Local retail/supermarket | fresh | 1/38 (3%) | Malaysia | Chai et al., 2007 |
| *Campylobacter jejuni* | 14 | Winged bean (Psophocarpus tetragonolobus) | Local retail/supermarket | fresh | 18/39 (46%) | Malaysia | Chai et al., 2007 |
| | 14 | Yardlong bean (Vigna unguiculata) | Local retail/supermarket | fresh | 1/40 (3%) | Malaysia | Chai et al., 2007 |
| | 15 | Cabbage | Manufacturer | fresh | 2/4 (50%) | Malaysia | Chai et al., 2009 |
| | 15 | Water spinach | Local retail/supermarket | fresh | 22/39 (56%) | Malaysia | Chai et al., 2007 |
| | 16 | Coriander, Vietnamese (Polygonum minus) | Local retail/supermarket | fresh | 17/36 (47%) | Malaysia | Chai et al., 2007 |
| | 16 | Coriander, Vietnamese (Polygonum minus) | Manufacturer | fresh | 1/8 (13%) | Malaysia | Chai et al., 2009 |
| | 16 | Indian pennywort (Centella asiatica) | Local retail/supermarket | fresh | 19/37 (51%) | Malaysia | Chai et al., 2007 |
| | 16 | Parsley, Japanese (Oenanthe stolonifera) | Local retail/supermarket | fresh | 20/39 (51%) | Malaysia | Chai et al., 2007 |
| | 16 | Wild cosmos (Cosmos caudatus) | Local retail/supermarket | fresh | 21/38 (55%) | Malaysia | Chai et al., 2007 |
| | 21 | Radish | Manufacturer | fresh | 1/6 (17%) | Malaysia | Chai et al., 2009 |
| *Clostridium perfringens* | 16 | Parsley | Local retail/supermarket | fresh | 6/50 (12%) | Mexico | Gomez-Govea et al., 2012 |
| *Cronobacter sakazakii* | 37 | Other food (various ingredients) | Canteen | processed | 2/77 (3%) | Korea | Ryu et al., 2011 |
| *Cronobacter spp.* | 1 | Fruits | Local retail/supermarket | n.s. | 3/41 (7%) | Korea | Lee et al., 2012 |
| Pathogen | FoNAO Category | Food item(s) | Source* | Processing /Comment | Prevalence | Country | Reference(s) |
|----------|----------------|--------------|---------|---------------------|------------|---------|--------------|
| Enterobacter aerogenes | 8 | Paw-Paw (Asimina) | Local retail | minimally processed | 1/50 (2%) | Nigeria | Chukwu et al., 2010 |
| Enterobacter cloacae | 9 | Watermelon | Local retail | minimally processed | 2/50 (4%) | Nigeria | Chukwu et al., 2010 |
| Escherichia coli (Enteroinvasive and Shiga-toxin producing) | 15 | Vegetable (lettuce, spinach) | Local retail | fresh | 1/12 (8%) | Colombia | Rugeles et al., 2010 |
| | 36 | Mixed salads (lettuce, avocado, water cress, wheat sprouts, tomato, cucumber, radish, carrot) | Restaurant | ready to eat | 2/15 (13%) | Mexico | Castro-Rosas et al., 2012 |
| Escherichia coli (Enteroinvasive) | 36 | Mixed salads (lettuce, avocado, water cress, wheat sprouts, tomato, cucumber, radish, carrot) | Restaurant | ready to eat | 2/15 (13%) | Mexico | Castro-Rosas et al., 2012 |
| | 17 | Lettuce | Manufacturer | ready to eat | 11/142 (8%) | Switzerland | Althaus et al., 2012 |
| Pathogen                          | FoNAO Category | Food item(s)                                                        | Source¹   | Processing /Comment | Prevalence | Country    | Reference(s)                   |
|----------------------------------|----------------|---------------------------------------------------------------------|-----------|---------------------|------------|------------|-------------------------------|
| Food of plant origin with high water content |                |                                                                    |           |                     |            |            |                               |
| (EPEC)                           | other          | Vegetables                                                          | Manufacturer | ready to eat        | 11/233 (5%) | Switzerland | Althaus et al., 2012            |
| Escherichia coli (ETEC)          |                | Salad mix (raw spinach, tomato, mushrooms)                          | Restaurant | fresh               | 1/25 (4%)  | Mexico     | Castro-Rosas et al., 2012       |
| Escherichia coli (STEC)          |                | Vegetable (lettuce, spinach)                                        | Local retail | fresh               | 1/12 (8%)  | Colombia   | Rugeles et al., 2010           |
|                                  |                | Lettuce                                                             | Manufacturer | ready to eat        | 1/142 (1%) | Switzerland | Althaus et al., 2012            |
|                                  |                | Mixed salads (lettuce, avocado, water cress, wheat sprouts, tomato, cucumber, radish, carrot) | Restaurant | ready to eat        | 2/15 (13%) | Mexico     | Castro-Rosas et al., 2012       |
|                                  |                | Salad mix (raw spinach, tomato, mushrooms)                          | Restaurant | ready to eat        | 1/25 (4%)  | Mexico     | Castro-Rosas et al., 2012       |
| Escherichia coli O157:H7 (EHEC)  |                | various                                                             | Take-away  | fruit juice          | 30/108 (28%) | India      | Lewis et al., 2006              |
|                                  |                | Green peppers                                                       | Manufacturer | organic production | 1/605 (0.2%) | USA        | Mukherjee et al., 2004         |
|                                  |                | Lettuce                                                             | Manufacturer | fresh               | 1/605 (0.2%) | USA        | Mukherjee et al., 2004         |
|                                  |                | Other food (various ingredients)                                    | Canteen    | processed           | 2/77 (3%)  | Korea      | Ryu et al., 2011                |
|                                  |                | Other food (various ingredients)                                    | Homemade dish | heat-treated        | 2/13 (15%) | Malawi     | Taulo et al., 2008             |
|                                  |                | Vegetables                                                          | Homemade dish | heat-treated; cooked | 4/28 (14%) | Malawi     | Taulo et al., 2008             |
| Klebsiella oxytoca               |                | Vegetables (lettuce, cabbage, carrot and radish sprout)             | Manufacturer | fresh               | 2/282 (0.4%) | Iran       | Khandaghi et al., 2010         |
|                                  |                | Grape                                                               | Local retail | fruit juice          | 2/30 (7%)  | Libya      | Genghes et al., 2005           |
|                                  |                | Orange                                                              | Local retail | fruit juice          | 2/19 (11%) | Libya      | Genghes et al., 2005           |
|                                  |                | Peach                                                               | Local retail | fruit juice          | 3/8 (38%)  | Libya      | Genghes et al., 2005           |
|                                  |                | Mango                                                               | Local retail | fruit juice          | 3/29 (10%) | Libya      | Genghes et al., 2005           |
|                                  |                | Pineapple                                                           | Local retail | fruit juice          | 5/24 (21%) | Libya      | Genghes et al., 2005           |
|                                  |                | Basil                                                               | Local retail | n.s.                | 1/29 (3%)  | USA        | Wetzel et al., 2010            |

¹ The term “Source” includes the manufacturer, restaurant, local retail, and homemade dish, among others.

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| Pathogen | FoNAO Category | Food item(s) | Source | Processing /Comment | Prevalence | Country | Reference(s) |
|----------|----------------|--------------|--------|---------------------|------------|---------|--------------|
| Klebsiella pneumoniae | 7 | Peach | Local retail | fruit juice | 2/8 (25%) | Libya | Ghenghesh et al., 2005 |
| | 8 | Mango | Local retail | fruit juice | 5/29 (17%) | Libya | Ghenghesh et al., 2005 |
| | 8 | Pineapple | Local retail | fruit juice | 6/24 (25%) | Libya | Ghenghesh et al., 2005 |
| | 9 | Watermelon | Local retail | minimally processed | 2/50 (4%) | Nigeria | Chukwu et al., 2010 |
| Listeria monocytogenes | 11 | Tomatoes | Local retail | fresh | 3/16 (19%) | Malaysia | Ponniah et al., 2010 |
| | 11 | Tomatoes | Supermarket | fresh | 5/16 (31%) | Malaysia | Ponniah et al., 2010 |
| | 11 | Tomatoes | Supermarket | minimally processed | 2/10 (20%) | Chile | Cordano and Jacquet, 2009 |
| | 13 | Cucumber | Local retail | fresh | 3/16 (19%) | Malaysia | Ponniah et al., 2010 |
| | 13 | Cucumber | Supermarket | fresh | 5/16 (31%) | Malaysia | Ponniah et al., 2010 |
| | 14 | Broad beans | Supermarket | frozen | 7/33 (21%) | Chile | Cordano and Jacquet, 2009 |
| | 14 | Broad beans | Supermarket | minimally processed | 1/20 (5%) | Chile | Cordano and Jacquet, 2009 |
| | 14 | Green beans | Supermarket | frozen | 18/37 (49%) | Chile | Cordano and Jacquet, 2009 |
| | 14 | Green beans | Supermarket | minimally processed | 1/3 (33%) | Chile | Cordano and Jacquet, 2009 |
| | 14 | Kidney beans | Supermarket | frozen | 6/20 (30%) | Chile | Cordano and Jacquet, 2009 |
| | 14 | Kidney beans | Supermarket | minimally processed | 1/6 (17%) | Chile | Cordano and Jacquet, 2009 |
| | 14 | Peas | Supermarket | frozen | 12/33 (36%) | Chile | Cordano and Jacquet, 2009 |
| | 14 | Sweet corn | Supermarket | frozen | 10/39 (26%) | Chile | Cordano and Jacquet, 2009 |
| | 14 | Sweet corn | Supermarket | minimally processed | 1/15 (7%) | Chile | Cordano and Jacquet, 2009 |
| | 14 | Winged bean (Psophocarpus tetragonolobus) | Local retail | fresh | 1/16 (6%) | Malaysia | Ponniah et al., 2010 |
| Pathogen | FoNAO Category | Food item(s) | Source¹ | Processing /Comment | Prevalence | Country | Reference(s) |
|----------|----------------|--------------|---------|---------------------|------------|---------|--------------|
|          | 14             | Winged bean (Psophocarpus tetragonolobus) | Supermarket | fresh               | 4/16 (25%) | Malaysia | Ponniah et al., 2010 |
|          | 14             | Yardlong bean (Vigna unguiculata) | Local retail | fresh               | 5/16 (31%) | Malaysia | Ponniah et al., 2010 |
|          | 14             | Yardlong bean (Vigna unguiculata) | Supermarket | fresh               | 5/16 (31%) | Malaysia | Ponniah et al., 2010 |
|          | 15             | Baby spinach | Manufacturer | minimally processed | 3/409 (0.7%) | Canada | Illic et al., 2008 |
|          | 15             | Cabbage | Local retail | fresh               | 3/16 (19%) | Malaysia | Ponniah et al., 2010 |
|          | 15             | Cabbage | Manufacturer | fresh               | 3/43 (7%) | USA | Johnston et al., 2006 |
|          | 15             | Cabbage | Manufacturer | fresh               | 26/855 (3%) | USA | Prazak et al., 2002 |
|          | 15             | Cabbage | Supermarket | fresh               | 5/16 (31%) | Malaysia | Ponniah et al., 2010 |
|          | 15             | Spinach | Supermarket | frozen              | 1/13 (8%) | Chile | Cordano and Jacquet, 2009 |
|          | 15             | Spinach | Supermarket | minimally processed | 1/12 (8%) | Brazil | Froder et al., 2007 |
|          | 16             | Indian pennywort (Centella asiatica) | Local retail | fresh               | 2/16 (13%) | Malaysia | Ponniah et al., 2010 |
|          | 16             | Indian pennywort (Centella asiatica) | Supermarket | fresh               | 3/16 (19%) | Malaysia | Ponniah et al., 2010 |
|          | 16             | Parsley | Local retail/supermarket | fresh | 1/50 (2%) | Mexico | Gomez-Govea et al., 2012 |
|          | 16             | Parsley (Oenanther stolonifera) | Supermarket | fresh               | 1/16 (6%) | Malaysia | Ponniah et al., 2010 |
|          | 16             | Parsley, Japanese (Oenanther stolonifera) | Local retail | fresh               | 8/17 (47%) | Malaysia | Ponniah et al., 2010 |
|          | 16             | Wild parsley (Cosmos caudatus) | Local retail | fresh               | 4/16 (25%) | Malaysia | Ponniah et al., 2010 |
|          | 17             | Cabbage | Supermarket | ready to eat        | 2/11 (18%) | Brazil | Sant'Ana et al., 2012 |
|          | 17             | Collard greens | Supermarket | ready to eat        | 1/24 (4%) | Brazil | Sant'Ana et al., 2012 |
| Pathogen       | FoNAO Category | Food item(s) | Source / Comment | Prevalence | Country   | Reference(s)               |
|---------------|----------------|--------------|------------------|------------|-----------|---------------------------|
| *Listeria monocytogenes* |               | Escarole     | Supermarket, ready to eat | 3/13 (23%) | Brazil    | Sant'Ana et al., 2012     |
| 17            |                | Lettuce      | Supermarket, ready to eat | 3/152 (2%)  | Brazil    | Sant'Ana et al., 2012     |
| 17            |                | Lettuce      | Supermarket, ready to eat | 1/30 (3%)   | Costa Rica | Monge et al., 2011        |
| 17            |                | Lettuce      | Manufacturer, ready to eat | 5/142 (4%)  | Switzerland | Althaus et al., 2012     |
| 17            |                | Salad        | Local retail, ready to eat; packed | 22/2966 (0.7%) | USA     | Gombas et al., 2003       |
| 17            |                | Spinach      | Supermarket, ready to eat | 1/11 (9%)   | Brazil    | Sant'Ana et al., 2012     |
| 17            |                | Watercress   | Supermarket, ready to eat | 1/18 (6%)   | Brazil    | Sant'Ana et al., 2012     |
| 17            |                | Carrots      | Local retail, fresh | 3/16 (19%)  | Costa Rica | Monge et al., 2011        |
| 17            |                | Carrots      | Local retail, minimally processed | 3/11 (27%) | Costa Rica | Monge et al., 2011        |
| 19            |                | Carrots      | Supermarket, fresh | 5/17 (30%)  | Malaysia  | Ponniah et al., 2010      |
| 19            |                | Carrots      | Supermarket, fresh | 5/17 (30%)  | Malaysia  | Ponniah et al., 2010      |
| 19            |                | Carrots      | Supermarket, minimally processed | 5/17 (30%) | Malaysia  | Ponniah et al., 2010      |
| 21            |                | Carrots      | Local retail, fresh | 4/16 (25%)  | Malaysia  | Ponniah et al., 2010      |
| 21            |                | Carrots      | Supermarket, fresh | 3/16 (19%)  | Malaysia  | Ponniah et al., 2010      |
| 21            |                | Carrots      | Supermarket, fresh | 3/16 (19%)  | Malaysia  | Ponniah et al., 2010      |
| 21            |                | Carrots      | Supermarket, minimally processed | 3/16 (19%) | Malaysia  | Ponniah et al., 2010      |
| 22            |                | Carrots      | Supermarket, frozen | 1/12 (8%)   | Chile     | Cordano and Jacquet, 2009 |
| 22            |                | Carrots      | Supermarket, minimally processed | 2/13 (15%) | Chile     | Cordano and Jacquet, 2009 |
| 22            |                | Carrots      | Supermarket, minimally processed | 1/37 (3%)  | Korea     | Cho et al., 2004          |
| 23            |                | Carrots      | Supermarket, frozen | 2/21 (10%)  | Chile     | Cordano and Jacquet, 2009 |
| 23            |                | Carrots      | Supermarket, minimally processed | 1/5 (20%)  | Chile     | Cordano and Jacquet, 2009 |
| 23            |                | Carrots      | Supermarket, frozen | 4/17 (24%)  | Chile     | Cordano and Jacquet, 2009 |
| 29            |                | Mushrooms    | Supermarket, frozen | 1/14 (7%)   | Chile     | Cordano and Jacquet, 2009 |
| Pathogen          | FoNAO Category | Food item(s)                                      | Source / Comment | Prevalence | Country | Reference(s)          |
|------------------|----------------|--------------------------------------------------|------------------|------------|---------|-----------------------|
| Listeria monocytogenes |                | Mushrooms                                        | Supermarket      | 1/46 (2%)  | Korea   | Cho et al., 2004      |
|                  |                | Seaweed                                          | Supermarket      | 3/6 (50%)  | Chile   | Cordano and Jacquet, 2009 |
|                  |                | Asazuke (Japanese light pickles)                 | Supermarket      | 12/108 (11%) | Japan   | Maklon et al., 2010   |
|                  |                | Mixed salads                                     | Supermarket      | 27/36 (43%) | Chile   | Cordano and Jacquet, 2009 |
|                  |                | Mixed salads                                     | Supermarket      | 9/87 (10%)  | Chile   | Cordano and Jacquet, 2009 |
|                  |                | Salad                                            | Local retail     | 1/13 (8%)   | USA     | Sauders et al., 2009  |
|                  |                | Salad                                            | Supermarket      | 7/52 (13%)  | Brazil  | Verdin et al., 2007   |
|                  |                | Salad mix (mixes of different varieties of     | Supermarket      | 2/214 (0.9%) | Brazil  | Sant’Ana et al., 2012 |
|                  |                | lettuce, watercress, chard, spinach, carrot,    |                  |            |         |                       |
|                  |                | arugula, chicory, escarole and tomato)          |                  |            |         |                       |
|                  |                | Bean curd                                        | Local retail     | 2/90 (1%)   | China   | Zhou et al., 2006     |
|                  |                | Deli salads                                      | Local retail     | 202/8549 (2%) | USA    | Gombas et al., 2003  |
| other            |                | Mix for sukiyaki (soup/stew type, a Japanese    | Supermarket      | 2/6 (33%)  | Brazil  | Sant’Ana et al., 2012 |
| other            |                | Vegetables                                       | Local retail     | 2/167 (2%)  | China   | Zhou et al., 2006     |
| other            |                | Vegetables                                       | Manufacturer     | 1/58 (2%)   | Korea   | Thapa et al., 2008    |
| other            |                | Vegetables                                       | Manufacturer/supermarket/restaurant | 7/617 (1%) | Iran   | Jalali and Abedi 2008 |
| other            |                | Vegetables                                       | n.s.             | 9/120 (8%)  | Venezuela | de Curtis et al., 2002 |
| other            |                | Vegetables                                       | Supermarket      | 1/18 (6%)   | Brazil  | Sant’Ana et al., 2012 |
| Pathogen       | FoNAO Category | Food item(s) | Source/Comment | Prevalence | Country | Reference(s) |
|----------------|----------------|--------------|----------------|------------|---------|--------------|
| *Pseudomonas aeruginosa* | other | Vegetables | Manufacturer, ready to eat | 5/233 (2%) | Switzerland | Althaus et al., 2012 |
| 4              | Grape          | Local retail | fruit juice | 2/30 (7%) | Libya | Ghenghesh et al., 2005 |
| 5              | Orange         | Local retail | fruit juice | 1/19 (5%) | Libya | Ghenghesh et al., 2005 |
| 5              | Orange         | Take-away    | fruit juice | 2/6 (33%) | India | Tambekar et al., 2009 |
| 5              | Sweet lemon (Citrus limetta) | Take-away | fruit juice | 6/17 (35%) | India | Tambekar et al., 2009 |
| 6              | Apples         | Local retail | fruit juice | 1/9 (11%) | Libya | Ghenghesh et al., 2005 |
| 6              | Apples         | Take-away    | fruit juice | 4/6 (67%) | India | Tambekar et al., 2009 |
| 8              | Pineapple      | Local retail | minimally processed | 2/50 (4%) | Nigeria | Chukwu et al., 2010 |
| 8              | Pineapple      | Take-away    | fruit juice | 5/16 (31%) | India | Tambekar et al., 2009 |
| 8              | Pomegranate    | Take-away    | fruit juice | 2/6 (33%) | India | Tambekar et al., 2009 |
| 11             | Tomatoes       | Local retail | fresh | 1/68 (1%) | Saudi Arabia | Hassan et al., 2011 |
| 13             | Cucumber       | Local retail | fresh | 1/68 (1%) | Saudi Arabia | Hassan et al., 2011 |
| 15             | Cabbage        | Local retail | fresh | 3/68 (4%) | Saudi Arabia | Hassan et al., 2011 |
| 15             | Lettuce        | Local retail | fresh | 2/68 (3%) | Saudi Arabia | Hassan et al., 2011 |
| 15             | Spinach        | Local retail | fresh | 6/68 (9%) | Saudi Arabia | Hassan et al., 2011 |
| 16             | Basil          | Local retail | n.s. | 1/29 (3%) | USA | Wetzel et al., 2010 |
| 16             | Coriander      | Local retail | fresh | 3/68 (4%) | Saudi Arabia | Hassan et al., 2011 |
| 16             | Parsley        | Local retail | fresh | 1/68 (1%) | Saudi Arabia | Hassan et al., 2011 |
| 22             | Celery         | Local retail | fresh | 3/68 (4%) | Saudi Arabia | Hassan et al., 2011 |
| 22             | Green onion    | Local retail | fresh | 2/68 (3%) | Saudi Arabia | Hassan et al., 2011 |
| Pathogen                | FoNAO Category | Food item(s)                               | Source*                  | Processing /Comment | Prevalence | Country   | Reference(s)                  |
|-------------------------|----------------|--------------------------------------------|--------------------------|---------------------|------------|-----------|--------------------------------|
| Salmonella Agona        | 36             | Salad                                      | Restaurant/take-away     | processed           | 1/3 (33%)  | Nigeria   | Isara et al., 2010            |
| Salmonella enterica     | 15             | Lettuce and arugula                        | Supermarket              | minimally processed | 1/512 (0.2%)| Brazil    | Sant’ Ana et al., 2011        |
| Salmonella Enteritidis  | 37             | Taco-dressing (boiled green chilli sauce)  | Local retail             | processed           | 1/26 (4%)  | Mexico    | Estrada-Garcia et al., 2004   |
| Salmonella Enteritidis  | 37             | Taco-dressing (raw coriander onion mix)    | Local retail             | processed           | 1/5 (20%)  | Mexico    | Estrada-Garcia et al., 2004   |
| Salmonella Montevideo   | 9              | Cantaloupe                                 | Manufacturer             | not direct; packing sheds of produce | 3/91 (3%) | USA       | Johnston et al., 2005         |
| Salmonella spp.         | 1              | various                                    | Take-away                | fruit juice         | 42/108 (39%)| India     | Lewis et al., 2006            |
|                         | 5              | Fruit juice                               | Take-away                | fruit juice         | 2/5 (40%)  | Nigeria   | Ukwo et al., 2011             |
|                         | 5              | Sweet lemon (Citrus limetta)               | Take-away                | fruit juice         | 5/10 (50%) | India     | Titarmare et al., 2009        |
|                         | 8              | Dragon fruit                              | Local retail             | pre-cut             | 15/20 (75%)| Malaysia  | Pui et al., 2011              |
|                         | 8              | Fruit juice                               | Take-away                | fruit juice         | 3/5 (60%)  | Nigeria   | Ukwo et al., 2011             |
|                         | 8              | Jackfruit                                 | Local retail             | pre-cut             | 2/20 (10%) | Malaysia  | Pui et al., 2011              |
|                         | 8              | Papaya                                    | Local retail             | pre-cut             | 6/20 (30%) | Malaysia  | Pui et al., 2011              |
|                         | 8              | Papaya                                    | Take-away                | pre-cut             | 1/30 (3%)  | India     | Mukhopadhyay et al., 2002     |
|                         | 8              | Paw-Paw (Asimina)                         | Local retail             | minimally processed | 3/50 (6%)  | Nigeria   | Chukwu et al., 2010           |
| Pathogen     | FoNAO Category | Food item(s)                          | Source /Comment      | Prevalence | Country  | Reference(s)       |
|--------------|----------------|---------------------------------------|----------------------|------------|-----------|-------------------|
| Salmonella   | 8              | Persimmon fruit (Diospyrus kaki)      | Local retail/retail distribution fresh | 5/582 (1%) | Brazil    | Rezende et al., 2009 |
|              | 8              | Pineapple                             | Local retail minimally processed fruit juice | 7/50 (14%) | Nigeria   | Chukwu et al., 2010 |
|              | 8              | Pineapple                             | Take-away pre-cut    | 5/10 (50%) | India     | Titarmare et al., 2009 |
|              | 8              | Sapodilla                             | Local retail         | 6/20 (30%) | Malaysia  | Pui et al., 2011   |
|              | 9              | Bitter melon                          | Take-away fruit juice | 1/3 (33%)  | India     | Titarmare et al., 2009 |
|              | 9              | Cantaloupe                            | Manufacturer fresh   | 12/55 (22%)| Mexico    | Gallegos-Robles et al., 2008 |
|              | 9              | Honeydew                              | Local retail pre-cut | 5/20 (25%) | Malaysia  | Pui et al., 2011   |
|              | 9              | Watermelon                            | Local retail pre-cut | 6/20 (30%) | Malaysia  | Pui et al., 2011   |
|              | 9              | Watermelon                            | Local retail minimally processed | 3/50 (6%)  | Nigeria   | Chukwu et al., 2010 |
|              | 11             | Tomatoes                              | Local retail/retail distribution fresh | 1/1183 (0.1%)| Canada    | Arthur et al., 2007 |
|              | 12             | Chile pepper                          | Manufacturer fresh   | 10/55 (18%)| Mexico    | Gallegos-Robles et al., 2008 |
|              | 12             | Green peppers                         | Manufacturer fresh   | 1/49 (2%)  | USA       | Mukherjee et al., 2004 |
|              | 13             | Bottle gourd (Lagenaria siceraria)    | Take-away fruit juice | 2/3 (67%)  | India     | Titarmare et al., 2009 |
|              | 13             | Cucumber                              | Take-away fruit juice | 2/3 (67%)  | India     | Titarmare et al., 2009 |
|              | 13             | Zucchini                              | Local retail whole and sliced | 10/100 (10%) | Mexico    | Castro-Rosas et al., 2010 |
|              | 15             | Cabbage                               | Manufacturer fresh   | 1/100 (1%) | Mexico    | Quiroz-Santiago et al., 2009 |
|              | 15             | Chicories                             | Supermarket minimally processed | 1/12 (8%)  | Brazil    | Froder et al., 2007 |
|              | 15             | Lettuce                               | Local retail/retail distribution fresh | 1/1183 (0.1%) | Canada    | Arthur et al., 2007 |
|              | 15             | Lettuce                               | Manufacturer fresh   | 1/49 (2%)  | USA       | Mukherjee et al., 2004 |
| Pathogen | Food of plant origin with high water content |
|----------|---------------------------------------------|
| Salmonella spp. | |

| FoNAO Category | Food item(s) | Source/Comment | Prevalence | Country | Reference(s) |
|----------------|--------------|----------------|------------|---------|--------------|
| 15             | Lettuce      | Supermarket    | minimally processed | 1/41 (2%) | Brazil        | Froder et al., 2007 |
| 15             | Lettuce      | Supermarket/take-away | fresh | 5/60 (8%) | Turkey        | Cetin et al., 2008 |
| 15             | Lettuce      | Manufacturer | fresh | 7/100 (7%) | Mexico | Quiroz-Santiago et al., 2009 |
| 15             | Mixed salads | Supermarket    | minimally processed | 1/21 (5%) | Brazil | Froder et al., 2007 |
| 15             | Purslane (Portulaca oleracea) | Manufacturer | fresh | 9/100 (9%) | Mexico | Quiroz-Santiago et al., 2009 |
| 15             | Romaine lettuce | Manufacturer | fresh | 3/100 (3%) | Mexico | Quiroz-Santiago et al., 2009 |
| 15             | Savoy spinach | Manufacturer | fresh | 1/1311 (0.1%) | Canada | Ilic et al., 2008 |
| 15             | Savoy spinach | Manufacturer | minimally processed | 4/1311 (0.3%) | Canada | Ilic et al., 2008 |
| 15             | Spinach      | Manufacturer | fresh | 7/100 (7%) | Mexico | Quiroz-Santiago et al., 2009 |
| 15             | Spinach      | Manufacturer | minimally processed | 5/1311 (0.4%) | Canada | Ilic et al., 2008 |
| 15             | Watercress   | Manufacturer | fresh | 7/100 (7%) | Mexico | Quiroz-Santiago et al., 2009 |
| 15             | Watercress   | Supermarket   | minimally processed | 1/13 (8%) | Brazil | Froder et al., 2007 |
| 16             | Chinese parsley | Manufacturer | fresh | 6/100 (6%) | Mexico | Quiroz-Santiago et al., 2009 |
| 16             | Cilantro     | Manufacturer | fresh | 11/100 (11%) | Mexico | Quiroz-Santiago et al., 2009 |
| 16             | Coriander    | Local retail  | fresh | 9/304 (3%) | India | Singh et al., 2007 |
| 16             | Kangkong (Ipomoea aquatica) | Local retail | not direct; rinses of vegetables | 8/25 (32%) | Malaysia | Salleh et al., 2003 |
| 16             | Kesum (Polygonum minus) | Local retail | not direct; rinses of vegetables | 8/18 (44%) | Malaysia | Salleh et al., 2003 |
| Pathogen                      | FoNAO Category | Food item(s)              | Source²     | Processing /Comment | Prevalence | Country | Reference(s)            |
|-------------------------------|----------------|---------------------------|-------------|---------------------|------------|---------|-------------------------|
| 16                            | 16             | Korean Herbs              | Local retail | not direct; rinses of vegetables | 40/112 (36%) | Malaysia | Salleh et al., 2003   |
| 16                            | 16             | Mint                      | Local retail | fresh               | 5/212 (2%)  | India    | Singh et al., 2007    |
| 16                            | 16             | Papaloquelite or Mexican cilantro | Manufacturer | fresh               | 9/100 (9%)  | Mexico   | Quiroz-Santiago et al., 2009 |
| 16                            | 16             | Parsley                   | Manufacturer | fresh               | 12/100 (12%) | Mexico   | Quiroz-Santiago et al., 2009 |
| 16                            | 16             | Pegaga (Centella asiatica) | Local retail | not direct; rinses of vegetables | 8/26 (31%)  | Malaysia | Salleh et al., 2003   |
| 16                            | 16             | Selom (Oenanthe stolonifera) | Local retail | not direct; rinses of vegetables | 16/43 (37%) | Malaysia | Salleh et al., 2003   |
| 17                            | 17             | Lettuce                   | Supermarket  | ready to eat        | 4/30 (13%)  | Costa Rica | Monge et al., 2011  |
| 19                            | 19             | Carrots                   | Local retail | fresh               | 11/258 (4%) | India    | Singh et al., 2007   |
| 19                            | 19             | Carrots                   | Manufacturer | fresh               | 3/75 (4%)   | USA      | Endley et al., 2003  |
| 19                            | 19             | Carrots                   | Take-away    | fruit juice         | 3/3 (100%)  | India    | Titarmare et al., 2009 |
| 19                            | 19             | Carrots                   | Take-away    | fruit juice         | 3/150 (2%)  | India    | Mudgil et al., 2004  |
| 19                            | 19             | Fruit juice               | Take-away    | fruit juice         | 3/5 (60%)   | Nigeria  | Ukwo et al., 2011   |
| 20                            | 20             | Potato                    | Manufacturer | fresh               | 1/100 (1%)  | Mexico   | Quiroz-Santiago et al., 2009 |
| 21                            | 21             | Beetroot                  | Manufacturer | fresh               | 4/100 (4%)  | Mexico   | Quiroz-Santiago et al., 2009 |
| 21                            | 21             | Ginger                    | Take-away    | fruit juice         | 1/3 (33%)   | India    | Titarmare et al., 2009 |
| 21                            | 21             | Radish                    | Local retail | fresh               | 10/200 (5%) | India    | Singh et al., 2007  |
| 22                            | 22             | Celery                    | Manufacturer | fresh               | 3/100 (3%)  | Mexico   | Quiroz-Santiago et al., 2009 |
| 23                            | 23             | Broccoli                  | Manufacturer | fresh               | 9/100 (9%)  | Mexico   | Quiroz-Santiago et al., 2009 |
| 23                            | 23             | Cauliflower               | Manufacturer | fresh               | 9/100 (9%)  | Mexico   | Quiroz-Santiago et al., 2009 |

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| Pathogen       | FoNAO Category | Food item(s) | Source / Comment | Prevalence | Country | Reference(s) |
|---------------|----------------|--------------|------------------|------------|---------|--------------|
| Salmonella Typhi |                |              |                  |            |         |              |
|                | 37             | Other food (various ingredients) | Homemade dish | heat-treated | 4/13 (31%) | Malawi | Taulo et al., 2008 |
|                | 37             | Vegetables   | Homemade dish | heat-treated; cooked | 5/28 (18%) | Malawi | Taulo et al., 2008 |
|                | 1/other        | Fruits and vegetables | Local retail/retail distribution | fresh | 2/1183 (0.2%) | Canada | Arthur et al., 2007 |
|                | 1/other        | Produce      | Manufacturer | fresh | 2/605 (0.3%) | USA | Mukherjee et al., 2004 |
|                | other          | Vegetables   | Local retail | fresh | 13/35 (37%) | Mexico | Miranda et al., 2009 |
|                | other          | Vegetables   | Local retail/supermarket | fresh | 17/78 (22%) | Mexico | Miranda et al., 2009 |
|                | other          | Vegetables   | Manufacturer | fresh | 98/1700 (6%) | Mexico | Quiroz-Santiago et al., 2009 |
|                | other          | Vegetables   | Supermarket | fresh | 4/43 (9%) | Mexico | Miranda et al., 2009 |
| 5              | Orange         | Take-away    | fruit juice | 1/6 (17%) | India | Tambekar et al., 2009 |
| 5              | Sweet lemon (Citrus limetta) | Take-away    | fruit juice | 2/17 (12%) | India | Tambekar et al., 2009 |
| 8              | Dragon fruit   | Local retail | pre-cut | 8/20 (40%) | Malaysia | Pui et al., 2011 |
| 8              | Jackfruit      | Local retail | pre-cut | 1/20 (5%) | Malaysia | Pui et al., 2011 |
| 8              | Mango          | Local retail | pre-cut | 1/20 (5%) | Malaysia | Pui et al., 2011 |
| 8              | Papaya         | Local retail | pre-cut | 3/20 (15%) | Malaysia | Pui et al., 2011 |
| 8              | Pineapple      | Take-away    | fruit juice | 5/16 (31%) | India | Tambekar et al., 2009 |
| 8              | Pomegranate    | Take-away    | fruit juice | 4/6 (67%) | India | Tambekar et al., 2009 |
| 9              | Honeydew       | Local retail | pre-cut | 3/20 (15%) | Malaysia | Pui et al., 2011 |
| 9              | Watermelon     | Local retail | pre-cut | 1/20 (5%) | Malaysia | Pui et al., 2011 |
| 15             | Lettuce and arugula | Supermarket | minimally processed | 3/512 (0.6%) | Brazil | Sant’Ana et al., 2011 |
| 16             | Parsley        | Local retail/supermarket | fresh | 1/50 (2%) | Mexico | Gomez-Govea et al., 2012 |
| 36             | Salad          | Restaurant/take-away | processed | 2/3 (67%) | Nigeria | Isara et al., 2010 |
| Salmonella     | 8              | Dragon fruit | Local retail | pre-cut | 5/20 (25%) | Malaysia | Pui et al., 2011 |

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| Pathogen          | FoNAO Category | Food item(s)         | Source /Comment          | Prevalence | Country | Reference(s)   |
|-------------------|----------------|----------------------|--------------------------|------------|---------|----------------|
| **Typhimurium**   | 9              | Honeydew             | Local retail, pre-cut    | 2/20 (10%) | Malaysia | Pui et al., 2011 |
|                   | 16             | Basil                | Local retail, n.s.       | 1/29 (3%)  | USA     | Wetzel et al., 2010 |
|                   | 36             | Salad                | Restaurant/take-away, processed | 6/7 (85%) | Nigeria | Isara et al., 2010 |
| **Shigella sonnei**| 36             | Salad                | Restaurant/take-away, processed | 1/3 (33%) | Nigeria | Isara et al., 2010 |
| **Shigella spp.** | 1              | various              | Take-away, fruit juice   | 18/108 (17%) | India   | Lewis et al., 2006 |
|                   | 8              | Coconut slices       | Local retail, fresh; street-vended | 23/150 (15%) | India   | Ghosh et al., 2007 |
|                   | 15             | Lettuce              | Local retail, fresh      | 1/68 (1%)  | Saudi Arabia | Hassan et al., 2011 |
|                   | 15             | Spinach              | Local retail, fresh      | 2/68 (3%)  | Saudi Arabia | Hassan et al., 2011 |
|                   | 36             | Salad                | Local retail, fresh; street-vended; ready to eat | 13/150 (9%) | India   | Ghosh et al., 2007 |
|                   | 37             | Coriander sauce      | Take-away, processed     | 10/150 (7%) | India   | Ghosh et al., 2007 |
| **Staphylococcus aureus** | 1          | Fruits               | Supermarket, minimally processed | 1/47 (2%)  | Korea   | Seo et al., 2010 |
|                   | 4              | Grape                | Local retail, fruit juice | 2/30 (7%)  | Libya   | Ghenghesh et al., 2005 |
|                   | 5              | Kinnow mandarin      | Take-away, fruit juice   | 18/150 (12%) | India   | Mudgil et al., 2004 |
|                   | 5              | Orange               | Local retail, fruit juice | 1/19 (5%)  | Libya   | Ghenghesh et al., 2005 |
|                   | 5              | Sweet lemon (Citrus limetta) | Take-away, fruit juice | 3/17 (18%) | India   | Tambekar et al., 2009 |
|                   | 6              | Apples               | Local retail, fruit juice | 1/9 (11%)  | Libya   | Ghenghesh et al., 2005 |
|                   | 6              | Apples               | Take-away, fruit juice   | 1/6 (17%)  | India   | Tambekar et al., 2009 |
|                   | 8              | Coconut slices       | Local retail, fresh; street-vended | 57/150 (38%) | India   | Ghosh et al., 2007 |
|                   | 8              | Date                 | Local retail, fresh      | 57/60 (95%) | Saudi Arabia | Hamad et al., 2012 |
|                   | 8              | Mango                | Local retail, fruit juice | 1/29 (3%)  | Libya   | Ghenghesh et al., 2005 |
|                   | 8              | Papaya               | Take-away, pre-cut       | 5/30 (17%) | India   | Mukhopadhyay et al., 2002 |
| Pathogen               | FoNAO Category | Food item(s)       | Source / Comment | Prevalence | Country | Reference(s) |
|-----------------------|----------------|-------------------|------------------|------------|---------|--------------|
| *Staphylococcus aureus* | 8              | Paw-Paw (Asimina) | Local retail     | 10/50 (20%) | Nigeria | Chukwu et al., 2010 |
|                       | 8              | Pineapple         | Local retail     | 2/24 (8%)   | Libya   | Ghenghesh et al., 2005 |
|                       | 8              | Pineapple         | Local retail     | 6/50 (12%)  | Nigeria | Chukwu et al., 2010 |
|                       | 8              | Pineapple         | Take-away        | 1/16 (6%)   | India   | Tambekar et al., 2009 |
|                       | 9              | Watermelon        | Local retail     | 13/50 (26%) | Nigeria | Chukwu et al., 2010 |
|                       | 10             | Fruit juice       | Take-away        | n.s.        | Korea   | Cho et al., 2011    |
|                       | 15             | Lettuce           | Local retail/manufacturer | 2/20 (13%) | Turkey  | Erkan et al., 2008 |
|                       | 15             | Lettuce           | Supermarket      | 3/30 (10%)  | Korea   | Seo et al., 2010    |
|                       | 15             | Watercress        | Local retail/manufacturer | 4/18 (22%) | Turkey  | Erkan et al., 2008 |
|                       | 16             | Parsley           | Local retail/manufacturer | 2/22 (9%)  | Turkey  | Erkan et al., 2008 |
|                       | 19             | Carrots           | Take-away        | 45/150 (30%) | India  | Mudgil et al., 2004 |
|                       | 22             | Green onion       | Supermarket      | 4/27 (15%)  | Korea   | Seo et al., 2010    |
|                       | 36             | Mixed salads      | Supermarket      | 13/129 (10%) | Korea  | Seo et al., 2010    |
|                       | 36             | Salad             | Local retail     | 99/150 (66%) | India  | Ghosh et al., 2007  |
|                       | 36             | Salad             | Restaurant/take-away | 12/21 (57%) | Nigeria | Isara et al., 2010  |
|                       | 37             | Coriander sauce   | Take-away        | 71/150 (47%) | India  | Ghosh et al., 2007  |
|                       | 37             | Other food (various ingredients) | Homemade dish | 5/13 (38%)  | Malawi | Taulo et al., 2008  |
|                       | 37             | Other food (various ingredients) | Take-away       | 29/288 (10%) | Korea  | Cho et al., 2011    |
| Pathogen                        | FoNAO Category | Food item(s)            | Source/Comment       | Prevalence       | Country  | Reference(s) |
|-------------------------------|----------------|-------------------------|----------------------|-----------------|----------|--------------|
|                               |                |                         |                      |                 |          |              |
|                               | 37             | Staple food             | Local retail/supermarket ready to eat | 12/33 (36%)    | Taiwan   | Wei et al., 2006 |
|                               | 37             | Vegetables              | Homemade dish heat-treated; cooked | 21/28 (75%)    | Malawi   | Taulo et al., 2008 |
|                               | 37             | Vegetarian food         | Local retail/supermarket ready to eat | 8/30 (27%)     | Taiwan   | Wei et al., 2006 |
|                               | 1/other        | Fruits and vegetables   | Supermarket pre-cut | 1/60 (2%)       | Korea    | Chung et al., 2010 |
|                               | other          | Vegetables              | Manufacturer fresh   | 2/58 (3%)       | Korea    | Thapa et al., 2008 |
|                               | other          | Vegetables              | Supermarket ready to eat | 6/45 (13%)     | Taiwan   | Fang et al., 2003 |
| **Vibrio cholerae**           | 5              | Orange                  | Take-away fruit juice | 3/5 (60%)      | Nigeria  | Ukwo et al., 2011 |
|                               | 8              | Papaya                  | Take-away pre-cut    | 1/30 (3%)       | India    | Mukhopadhyay et al., 2002 |
|                               | 8              | Pineapple               | Take-away fruit juice | 3/5 (60%)      | Nigeria  | Ukwo et al., 2011 |
|                               | 19             | Carrots                 | Take-away fruit juice | 3/5 (60%)      | Nigeria  | Ukwo et al., 2011 |
|                               | 22             | Garlic                  | Take-away fruit juice | 2/5 (40%)      | Nigeria  | Ukwo et al., 2011 |
| **Vibrio parahaemolyticus**   | 11             | Tomatoes                | Local retail/supermarket fresh | 7/38 (18%)     | Malaysia | Tunung et al., 2010 |
|                               | 13             | Cucumber                | Local retail/supermarket fresh | 5/28 (18%)     | Malaysia | Tunung et al., 2010 |
|                               | 14             | Winged bean (Psophocarpus tetragonolobus) | Local retail/supermarket fresh | 5/26 (19%)     | Malaysia | Tunung et al., 2010 |
|                               | 14             | Yardlong bean (Vigna unguiculata) | Local retail/supermarket fresh | 5/32 (16%)     | Malaysia | Tunung et al., 2010 |
|                               | 15             | Cabbage                 | Local retail/supermarket fresh | 8/30 (27%)     | Malaysia | Tunung et al., 2010 |
|                               | 15             | Lettuce                 | Local retail/supermarket fresh | 2/16 (13%)     | Malaysia | Tunung et al., 2010 |
|                               | 16             | Indian pennywort (Centella asiatica) | Local retail/supermarket fresh | 7/17 (41%)     | Malaysia | Tunung et al., 2010 |
|                               | 16             | Parsley, Japanese (Oenanthe stolonifera) | Local retail/supermarket fresh | 6/21 (29%)     | Malaysia | Tunung et al., 2010 |
| Pathogen | FoNAO Category | Food item(s) | Source / Comment | Prevalence | Country | Reference(s) |
|----------|----------------|--------------|------------------|------------|---------|--------------|
|          | 16             | Wild cosmos (Cosmos caudatus) | Local retail/supermarket | fresh | 3/8 (38%) | Malaysia | Tunung et al., 2010 |
|          | 19             | Carrots | Local retail/supermarket | fresh | 5/31 (16%) | Malaysia | Tunung et al., 2010 |
|          | 21             | Sweet potato | Local retail/supermarket | fresh | 4/29 (14%) | Malaysia | Tunung et al., 2010 |
| Yersinia enterocolitica | 17 | Cabbage | Supermarket | ready to eat | 2/65 (3%) | Korea | Lee et al., 2004 |
|          | 17             | Chinese cabbage | Supermarket | ready to eat | 2/55 (4%) | Korea | Lee et al., 2004 |
|          | 17             | Lettuce | Supermarket | ready to eat | 2/58 (3%) | Korea | Lee et al., 2004 |
|          | 17             | Spinach | Supermarket | ready to eat | 1/26 (4%) | Korea | Lee et al., 2004 |
|          | 17             | Water dropwort (Oenanthe lachenalii) | Supermarket | ready to eat | 4/40 (10%) | Korea | Lee et al., 2004 |
|          | 21             | Radish root | Supermarket | ready to eat | 1/32 (3%) | Korea | Lee et al., 2004 |
|          | 22             | Green onion | Supermarket | ready to eat | 1/51 (2%) | Korea | Lee et al., 2004 |
|          | 29             | Mushrooms | Supermarket | ready to eat | 2/105 (2%) | Korea | Lee et al., 2004 |
| Parasites |                |              |                  |            |         |              |
|          |                |              |                  |            |         |              |
| Ancylostoma duodenale | 15 | Lettuce | Local retail | fresh | 11/300 (4%) | Nigeria | Adamu et al., 2012 |
|          | 15             | Lettuce | Retail distribution/local retail | fresh | 3/32 (9%) | India | Gupta et al., 2009 |
|          | 15             | Spinach | Retail distribution/local retail | fresh | 2/30 (7%) | India | Gupta et al., 2009 |
|          | 16             | Coriander | Retail distribution/local retail | fresh | 1/20 (5%) | India | Gupta et al., 2009 |
|          | 16             | Parsley | Retail distribution/local retail | fresh | 1/30 (3%) | India | Gupta et al., 2009 |
|          | 16             | Pudina (mentha) | Retail distribution/local retail | fresh | 3/32 (9%) | India | Gupta et al., 2009 |
|          | 22             | Celery | Retail distribution/local retail | fresh | 1/28 (4%) | India | Gupta et al., 2009 |
| Anquilostómidos | 16 | Chives | Manufacturer | n.s. | 1/21 (5%) | Venezuela | Cazorla et al., 2009 |
## Food of plant origin with high water content

| Pathogen                        | FoNAO Category | Food item(s) | Source / Comment | Prevalence | Country | Reference(s) |
|---------------------------------|----------------|--------------|------------------|------------|---------|--------------|
| **Ascaris lumbricoides**        | 15             | Cress        | Local retail     | 9/30 (30%) | Iran    | Fallah et al., 2012 |
|                                 | 15             | Lettuce      | Retail distribution | 2/35 (6%) | Turkey | Kozan et al., 2004 |
|                                 | 15             | Lettuce      | Retail distribution/local retail | 14/32 (44%) | India | Gupta et al., 2009 |
|                                 | 15             | Purslane     | Local retail     | 1/22 (5%)  | Iran    | Fallah et al., 2012 |
|                                 | 15             | Radish       | Local retail     | 9/29 (31%) | Iran    | Fallah et al., 2012 |
|                                 | 15             | Spinach      | Retail distribution/local retail | 11/30 (37%) | India | Gupta et al., 2009 |
|                                 | 16             | Basil        | Local retail     | 14/31 (45%) | Iran    | Fallah et al., 2012 |
|                                 | 16             | Coriander    | Retail distribution/local retail | 7/20 (35%) | India | Gupta et al., 2009 |
|                                 | 16             | Parsley      | Retail distribution/local retail | 7/30 (23%) | India | Gupta et al., 2009 |
|                                 | 16             | Pudina (mentha) | Retail distribution/local retail | 16/32 (50%) | India | Gupta et al., 2009 |
|                                 | 16             | Spearmint    | Local retail     | 1/27 (4%)  | Iran    | Fallah et al., 2012 |
|                                 | 22             | Celery       | Retail distribution/local retail | 7/28 (25%) | India | Gupta et al., 2009 |
|                                 | 22             | Leek         | Local retail     | 7/27 (26%) | Iran    | Fallah et al., 2012 |
|                                 | 22             | Scallion     | Local retail     | 2/29 (7%)  | Iran    | Fallah et al., 2012 |
| **Ascaris spp.**                | 11             | Tomatoes     | Manufacturer     | 2/19 (11%) | Venezuela | Cazorla et al., 2009 |
|                                 | 12             | Pepper       | Manufacturer     | 1/4 (25%)  | Venezuela | Cazorla et al., 2009 |
|                                 | 15             | Cabbage      | Manufacturer     | 1/14 (7%)  | Venezuela | Cazorla et al., 2009 |
|                                 | 15             | Lettuce      | Manufacturer     | 2/18 (11%) | Venezuela | Cazorla et al., 2009 |
|                                 | 16             | Chives       | Manufacturer     | 2/21 (10%) | Venezuela | Cazorla et al., 2009 |
|                                 | 16             | Coriander    | Manufacturer     | 3/20 (15%) | Venezuela | Cazorla et al., 2009 |
|                                 | 22             | Celery       | Manufacturer     | 1/5 (20%)  | Venezuela | Cazorla et al., 2009 |
| Pathogen                  | FoNAO Category | Food item(s)        | Source / Comment | Prevalence | Country     | Reference(s)       |
|--------------------------|----------------|---------------------|------------------|------------|-------------|-------------------|
| Ascaris spp. (oocysts)   | 11             | Tomatoes            | Retail distribution | 4/28 (14%) | Libya       | Abougrain et al., 2010 |
|                          | 12             | Garden egg (Solanum aethiopicum) | Local retail | fresh | 2/200 (1%) | Nigeria | Adamu et al., 2012 |
|                          | 13             | Cucumber            | Local retail     | fresh | 20/28 (71%) | Libya | Abougrain et al., 2010 |
|                          | 15             | Cress               | Retail distribution | fresh | 7/8 (88%) | Libya | Abougrain et al., 2010 |
|                          | 15             | Lettuce             | Local retail     | fresh | 20/21 (95%) | Libya | Abougrain et al., 2010 |
|                          | 15             | Lettuce             | Local retail     | fresh | 6/6 (100%) | Libya | Abougrain et al., 2010 |
|                          | 15             | Lettuce             | Retail distribution | fresh | 21/21 (100%) | Libya | Abougrain et al., 2010 |
|                          | 15             | Cabbage             | Manufacturer     | n.s. | 1/14 (7%) | Venezuela | Cazorla et al., 2009 |
| Blastocystis spp.        | 15             | Lettuce             | Manufacturer     | n.s. | 2/14 (14%) | Venezuela | Cazorla et al., 2009 |
|                          | 16             | Chives              | Manufacturer     | n.s. | 3/18 (17%) | Venezuela | Cazorla et al., 2009 |
|                          |                | Vegetables          | Manufacturer     | n.s. | 1/127 (2%) | Venezuela | Cazorla et al., 2009 |
| Cryptosporidium spp.     | 4              | Blackberry          | Local retail     | n.s. | 3/50 (6%) | Costa Rica | Calvo et al., 2004 |
|                          | 15             | Cabbage             | Manufacturer     | n.s. | 2/14 (14%) | Venezuela | Cazorla et al., 2009 |
|                          | 15             | Lettuce             | Manufacturer     | n.s. | 3/18 (17%) | Venezuela | Cazorla et al., 2009 |
|                          | 15             | Lettuce             | Local retail     | n.s. | 7/50 (14%) | Costa Rica | Calvo et al., 2004 |
|                          | 15             | Spinach             | Local retail     | fresh | 1/59 (2%) | Canada | Bohaychuk et al., 2009 |
|                          | 15             | Water spinach (Ipomoea aquatica) | Lake | cultivation; with and without wastewater contact | 6/36 (17%) | Vietnam, Denmark | Vuong et al., 2007 |
|                          | 15             | Water spinach (Ipomoea aquatica) | Lake | cultivation; with wastewater contact | 4/18 (22%) | Vietnam, Denmark | Vuong et al., 2007 |
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| Pathogen | FoNAO Category | Food item(s) | Source / Comment | Prevalence | Country | Reference(s) |
|----------|----------------|--------------|------------------|------------|---------|--------------|
|          |                | Vietnamese mint | Local retail/manufacturer | 6/61 (10%) | Vietnam, Canada | Tram et al., 2008 |
|          | 22             | Celery | Manufacturer | 1/5 (20%) | Venezuela | Cazorla et al., 2009 |
|          | other          | Vegetables | Manufacturer | n.s. | Venezuela | Cazorla et al., 2009 |
| Dipyldium caninum | 16 | Coriander | Manufacturer | 1/20 (5%) | Venezuela | Cazorla et al., 2009 |
| Eimeria spp. (oocysts) | other | Vegetables | Local retail | ready to eat | 8/52 (15%) | Brazil | Pavon da Silvia et al., 2007 |
|          | 1              | Berries | n.s. | n.s. | Poland, USA | Jedrzejewski et al., 2007 |
| Entamoeba coli | 11          | Tomatoes | Local retail | fresh | 1/9 (11%) | Egypt, Yemen | Hassan et al., 2012 |
|          | 13             | Cucumber | Local retail | fresh | 4/13 (31%) | Egypt, Yemen | Hassan et al., 2012 |
|          | 15             | Cress | Local retail | fresh | 4/30 (13%) | Iran | Fallah et al., 2012 |
|          | 15             | Tarragon | Local retail | fresh | 1/24 (4%) | Iran | Fallah et al., 2012 |
|          | 15             | Watercress | Local retail | fresh | 1/11 (9%) | Egypt, Yemen | Hassan et al., 2012 |
|          | 16             | Basil | Local retail | fresh | 3/31 (10%) | Iran | Fallah et al., 2012 |
|          | 16             | Coriander | Local retail | fresh | 1/12 (8%) | Egypt, Yemen | Hassan et al., 2012 |
|          | 16             | Coriander | Local retail | fresh | 4/30 (13%) | Iran | Fallah et al., 2012 |
|          | 16             | Dill | Local retail | fresh | 5/27 (19%) | Iran | Fallah et al., 2012 |
|          | 16             | Parsley | Local retail | fresh | 1/10 (10%) | Egypt, Yemen | Hassan et al., 2012 |
|          | 16             | Parsley | Local retail | fresh | 2/28 (7%) | Iran | Fallah et al., 2012 |
|          | 16             | Spearmint | Local retail | fresh | 5/27 (19%) | Iran | Fallah et al., 2012 |
|          | 19             | Carrots | Local retail | fresh | 2/10 (20%) | Egypt, Yemen | Hassan et al., 2012 |
## Food of plant origin with high water content

| Pathogen                  | FoNAO Category | Food item(s) | Source / Comment | Prevalence | Country     | Reference(s) |
|---------------------------|----------------|--------------|------------------|------------|-------------|--------------|
| Entamoeba histolytica     | 21             | Radish       | Local retail     | 1/4 (25%)  | Egypt, Yemen| Hassan et al., 2012 |
|                           |                | Radish       | Local retail     | 2/29 (7%)  | Iran        | Fallah et al., 2012 |
|                           | 22             | Celery       | Manufacturer     | 1/5 (20%)  | Venezuela   | Cazorla et al., 2009 |
|                           |                | Leek         | Local retail     | 4/27 (15%) | Iran        | Fallah et al., 2012 |
|                           |                | other        | Vegetables       | 1/127 (1%) | Venezuela   | Cazorla et al., 2009 |
| Entamoeba histolytica/dispar | 12             | Pepper       | Local retail     | 3/13 (23%) | Egypt, Yemen| Hassan et al., 2012 |
|                           |                | Cucumber     | Local retail     | 2/13 (15%) | Egypt, Yemen| Hassan et al., 2012 |
|                           |                | Coriander    | Local retail     | 1/12 (8%)  | Egypt, Yemen| Hassan et al., 2012 |
| Entamoeba spp.            | 15             | Cabbage      | Manufacturer     | 1/14 (7%)  | Venezuela   | Cazorla et al., 2009 |
|                           |                | other        | Vegetables       | 1/127 (1%) | Venezuela   | Cazorla et al., 2009 |
| Entamoeba histolytica/dispar | 19             | Carrots      | Local retail     | n.d.       | India       | Rai et al., 2008 |
| Enterocytozoon bieneusi   | 3              | Raspberries  | n.s.             | 2/10 (20%) | Poland, USA | Jedrzejewski et al., 2007 |
|                           |                | Curly lettuce| n.s.             | 1/5 (20%)  | Poland, USA | Jedrzejewski et al., 2007 |
| Giardia lamblia           | 11             | Tomatoes     | Local retail     | 1/9 (11%)  | Egypt, Yemen| Hassan et al., 2012 |
|                           |                | Pepper       | Local retail     | 1/13 (8%)  | Egypt, Yemen| Hassan et al., 2012 |
|                           |                | Cucumber     | Local retail     | 1/13 (8%)  | Egypt, Yemen| Hassan et al., 2012 |
|                           |                | Coriander    | Local retail     | 1/12 (8%)  | Egypt, Yemen| Hassan et al., 2012 |

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### Pathogen

| Pathogen          | FoNAO Category | Food item(s)                  | Source¹   | Processing /Comment                                                                 | Prevalence   | Country       | Reference(s)          |
|-------------------|----------------|-------------------------------|-----------|-------------------------------------------------------------------------------------|--------------|---------------|-----------------------|
| Giardia spp.      | 15             | Cress                         | Local retail | fresh                                                                                   | 2/30 (7%)   | Iran          | Fallah et al., 2012  |
|                   | 15             | Purslane                      | Local retail | fresh                                                                                   | 3/22 (14%)  | Iran          | Fallah et al., 2012  |
|                   | 15             | Water spinach (Ipomoea aquatica) | Lake      | cultivation; with and without wastewater contact                                       | 20/36 (56%) | Vietnam, Denmark | Vuong et al., 2007 |
|                   | 15             | Water spinach (Ipomoea aquatica) | Lake      | cultivation; with wastewater contact                                                   | 12/18 (67%) | Vietnam, Denmark | Vuong et al., 2007 |
|                   | 15             | Water spinach (Ipomoea aquatica) | Lake      | cultivation; without wastewater contact                                                 | 8/18 (44%)  | Vietnam, Denmark | Vuong et al., 2007 |
|                   | 16             | Basil                         | Local retail | fresh                                                                                   | 4/31 (13%)  | Iran          | Fallah et al., 2012  |
|                   | 16             | Spearmint                     | Local retail | fresh                                                                                   | 6/27 (22%)  | India         | Rai et al., 2008     |
|                   | 19             | Carrots                       | Local retail | fresh                                                                                   | n.d.        | India         | Rai et al., 2008     |
|                   | 19             | Carrots                       | Local retail | fresh                                                                                   | n.d.        | India         | Rai et al., 2008     |
|                   | 21             | Radish                        | Local retail | fresh                                                                                   | 2/29 (10%)  | Iran          | Fallah et al., 2012  |
|                   | 22             | Leek                          | Local retail | fresh                                                                                   | 6/27 (22%)  | Iran          | Fallah et al., 2012  |
|                   | 22             | Scallion                      | Local retail | fresh                                                                                   | 1/29 (3%)   | Iran          | Fallah et al., 2012  |
| Giardia spp. (oocysts) | 11        | Tomatoes                      | Local retail | fresh                                                                                   | 1/28 (4%)   | Libya         | Abougrain et al., 2010 |
|                   | 13             | Cucumber                      | Local retail | fresh                                                                                   | 5/28 (18%)  | Libya         | Abougrain et al., 2010 |
|                   | 13             | Cucumber                      | Retail distribution | fresh                                                                                   | 2/8 (25%)   | Libya         | Abougrain et al., 2010 |
|                   | 15             | Cress                         | Local retail | fresh                                                                                   | 2/21 (10%)  | Libya         | Abougrain et al., 2010 |
|                   | 15             | Cress                         | Retail distribution | fresh                                                                                   | 1/6 (17%)   | Libya         | Abougrain et al., 2010 |
|                   | 15             | Lettuce                       | Local retail | fresh                                                                                   | 1/21 (5%)   | Libya         | Abougrain et al., 2010 |

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¹ Source details are not provided in the text. The table is a structured representation of the supporting data points.
| Pathogen | FoNAO Category | Food item(s) | Source / Comment | Prevalence | Country | Reference(s) |
|----------|----------------|--------------|-----------------|------------|---------|---------------|
| Intestinal helminths (Cestodes, Trematodes, Nematodes) | 15 | Cabbage | Local retail | n.s. | 12/21 (57%) | Kenia, Italy | Nyarango et al., 2008 |
| | 18 | Black night shade | Local retail | n.s. | 15/21 (71%) | Kenia, Italy | Nyarango et al., 2008 |
| | 18 | Kales | Local retail | n.s. | 11/21 (52%) | Kenia, Italy | Nyarango et al., 2008 |
| | 18 | Spider flower | Local retail | n.s. | 17/21 (81%) | Kenia, Italy | Nyarango et al., 2008 |
| Microsporidia | 15 | Lettuce | Local retail | n.s. | 16/50 (32%) | Costa Rica | Calvo et al., 2004 |
| | 16 | Coriander | Local retail | n.s. | 2/50 (4%) | Costa Rica | Calvo et al., 2004 |
| Microsporidia (spores) | 1 | Berries | n.s. | n.s. | 6/25 (24%) | Poland, USA | Jedrzejewski et al., 2007 |
| | | Vegetables | n.s. | n.s. | 2/35 (6%) | Poland, USA | Jedrzejewski et al., 2007 |
| Strongyloides stercoralis | 15 | Cabbage | Local retail | fresh | 5/250 (2%) | Nigeria | Adamu et al., 2012 |
| | 19 | Carrots | Local retail | fresh | 2/150 (1%) | Nigeria | Adamu et al., 2012 |
| Taenia spp. | 13 | Cucumber | Retail distribution | fresh | 1/16 (6%) | Turkey | Kozan et al., 2004 |
| | 16 | Parsley | Retail distribution | fresh | 4/44 (9%) | Turkey | Kozan et al., 2004 |
| | 19 | Carrots | Retail distribution | fresh | 1/40 (3%) | Turkey | Kozan et al., 2004 |
| | 22 | Green onion | Retail distribution | fresh | 1/15 (7%) | Turkey | Kozan et al., 2004 |
| Taenia/Echinococcus | 11 | Tomatoes | Local retail | fresh | 2/28 (7%) | Libya | Abougrain et al., 2010 |
| | 13 | Cucumber | Local retail | fresh | 7/28 (25%) | Libya | Abougrain et al., 2010 |
| | 13 | Cucumber | Retail distribution | fresh | 2/8 (25%) | Libya | Abougrain et al., 2010 |
| | 15 | Cress | Local retail | fresh | 6/21 (29%) | Libya | Abougrain et al., 2010 |
| | 15 | Cress | Retail distribution | fresh | 2/6 (33%) | Libya | Abougrain et al., 2010 |
| | 15 | Lettuce | Local retail | fresh | 7/21 (33%) | Libya | Abougrain et al., 2010 |
| | 15 | Lettuce | Retail distribution | fresh | 2/6 (33%) | Libya | Abougrain et al., 2010 |
| Taenia/Echinococcus spp. (oocysts) | 15 | Lettuce | Local retail | fresh | 6/300 (2%) | Nigeria | Adamu et al., 2012 |
| Taeniid spp. | 15 | Cress | Local retail | fresh | 5/30 (17%) | Iran | Fallah et al., 2012 |
| Pathogen       | FoNAO Category | Food item(s) | Source /Comment | Prevalence | Country | Reference(s) |
|----------------|----------------|--------------|-----------------|------------|---------|--------------|
| Toxocara canis | 11             | Tomatoes     | Local retail    | 1/28 (4%)  | Libya   | Abougrain et al., 2010 |
| 12             | Cucumber       | Local retail | fresh           | 2/28 (7%)  | Libya   | Abougrain et al., 2010 |
| 13             | Cucumber       | Retail distribution | fresh | 1/8 (13%)  | Libya   | Abougrain et al., 2010 |
| 15             | Cress          | Local retail | fresh           | 6/21 (29%) | Libya   | Abougrain et al., 2010 |
| 15             | Cress          | Retail distribution | fresh | 3/6 (50%)  | Libya   | Abougrain et al., 2010 |
| 15             | Lettuce        | Local retail | fresh           | 7/21 (33%) | Libya   | Abougrain et al., 2010 |
| 15             | Lettuce        | Retail distribution | fresh | 3/6 (50%)  | Libya   | Abougrain et al., 2010 |
| Toxocara cati  | 11             | Tomatoes     | Local retail    | 3/28 (11%) | Libya   | Abougrain et al., 2010 |
| 11             | Tomatoes       | Retail distribution | fresh | 1/8 (13%)  | Libya   | Abougrain et al., 2010 |
| 13             | Cucumber       | Local retail | fresh           | 4/28 (14%) | Libya   | Abougrain et al., 2010 |
| 13             | Cucumber       | Retail distribution | fresh | 1/8 (13%)  | Libya   | Abougrain et al., 2010 |
| 15             | Cress          | Local retail | fresh           | 10/21 (48%)| Libya   | Abougrain et al., 2010 |
| 15             | Cress          | Retail distribution | fresh | 1/6 (17%)  | Libya   | Abougrain et al., 2010 |
| 15             | Lettuce        | Local retail | fresh           | 9/21 (43%) | Libya   | Abougrain et al., 2010 |
| 15             | Lettuce        | Retail distribution | fresh | 4/6 (67%)  | Libya   | Abougrain et al., 2010 |
| Toxocara spp.  | 11             | Tomatoes     | Manufacturer    | n.s.       | Venezuela | Cazorla et al., 2009 |
| 15             | Cabbage        | Manufacturer | n.s.            | 1/14 (7%)  | Venezuela | Cazorla et al., 2009 |
| Pathogen         | FoNAO Category | Food item(s)          | Source / Comment | Prevalence | Country | Reference(s) |
|------------------|----------------|-----------------------|------------------|------------|---------|--------------|
|                  | 15             | Cress                 | Local retail     | 3/30 (10%) | Iran    | Fallah et al., 2012 |
|                  | 15             | Lettuce               | Retail distribution | 2/35 (6%)  | Turkey  | Kozan et al., 2004 |
|                  | 16             | Coriander             | Local retail     | 1/30 (3%)  | Iran    | Fallah et al., 2012 |
|                  | 16             | Parsley               | Retail distribution | 1/44 (2%)  | Turkey  | Kozan et al., 2004 |
|                  | 21             | Radish                | Local retail     | 2/29 (7%)  | Iran    | Fallah et al., 2012 |
|                  | 22             | Leek                  | Local retail     | 2/27 (7%)  | Iran    | Fallah et al., 2012 |
|                  | 22             | Scallion              | Local retail     | 2/29 (7%)  | Iran    | Fallah et al., 2012 |
|                  |                | other Vegetables      | Manufacturer     | 2/127 (2%) | Venezuela | Cazorla et al., 2009 |
| *Trichostrongylus* spp. | 15             | Purslane              | Local retail     | 4/22 (18%) | Iran    | Fallah et al., 2012 |
|                  | 15             | Tarragon              | Local retail     | 1/24 (4%)  | Iran    | Fallah et al., 2012 |
|                  | 16             | Basil                 | Local retail     | 1/31 (3%)  | Iran    | Fallah et al., 2012 |
|                  | 16             | Parsley               | Local retail     | 3/28 (11%) | Iran    | Fallah et al., 2012 |
|                  | 16             | Spearmint             | Local retail     | 3/27 (11%) | Iran    | Fallah et al., 2012 |
|                  | 22             | Scallion              | Local retail     | 1/29 (3%)  | Iran    | Fallah et al., 2012 |
| *Trichuris* spp. | 12             | Garden egg (Solanum aethiopicum) | Local retail | 2/200 (1%) | Nigeria | Adamu et al., 2012 |
|                  | 13             | Cucumber              | Local retail     | 3/130 (2%) | Nigeria | Adamu et al., 2012 |
|                  | 15             | Lettuce               | Local retail     | 4/300 (1%) | Nigeria | Adamu et al., 2012 |
| *Trichuris trichiura* | 15             | Spinach               | Retail distribution/local retail | 1/30 (3%) | India  | Gupta et al., 2009 |
|                  | 16             | Coriander             | Retail distribution/local retail | 1/20 (5%) | India  | Gupta et al., 2009 |
|                  | 16             | Pudina (mentha)       | Retail distribution/local retail | 1/32 (3%) | India  | Gupta et al., 2009 |

*n.s. = non specified*
Table 17: Growth, survival or reduction of pathogenic bacteria, viruses and parasites linked to FoNAO with high water content. AMA; active modified atmosphere, PMA; passive modified atmosphere, MAP; modified atmosphere packaging, EMA; equilibrium modified atmosphere, CA; controlled atmosphere, RH; relative humidity, OPP; oriented polypropylene, TCID50; tissue culture infectious dose.

| Pathogen               | Food item(s)            | FoNAO Category | Experimental conditions/treatment | Inoculation | Treatment time | Increase/ decrease | Reference(s)                  |
|------------------------|-------------------------|----------------|-----------------------------------|-------------|----------------|--------------------|-------------------------------|
| **Pathogenic bacteria**|                         |                |                                   |             |                |                    |                               |
| *Bacillus cereus*      | Spinach/blanched        | 15             | 35°C                              |             | 10 hrs         | +7.8 log cfu/g     | Bae et al., 2012             |
|                        | Carrot purée            | 37             | 16°C; pH (5.1)                    | app. 4.2 log cfu/g | 40 days         | app. +1.8 log cfu/g | Valero et al., 2003          |
|                        | Carrot purée            | 37             | 5°C; pH (5.1)                     | app. 4.2 log cfu/g | 70 days         | app. +0.3 log cfu/g | Valero et al., 2003          |
| *Campylobacter jejuni* | Iceberg salad/          | 15             | 7°C                               | app. 5.5 log cfu/g | 70 hrs         | app. -1.5 log cfu/g | Kärenlampi and Hänninen, 2004|
|                        | fresh cut               |                |                                   |             |                |                    |                               |
|                        | Iceberg salad/fresh cut | 15             | 21°C                              | app. 5.5 log cfu/g | 70 hrs         | app. -3.5 log cfu/g | Kärenlampi and Hänninen, 2004|
|                        | Strawberry              | 2              | 7°C                               | app.6.8 log cfu/g | 70 hrs         | app. -2.8 log cfu/g | Kärenlampi and Hänninen, 2004|
|                        | Strawberry              | 2              | 21°C                              | app. 6.8 log cfu/g | 5 hrs          | app. -2.8 log cfu/g | Kärenlampi and Hänninen, 2004|
|                        | Cantaloupe              | 9              | 7°C                               | app. 6.2 log cfu/g | 70 hrs         | app. -1 log cfu/g  | Kärenlampi and Hänninen, 2004|
|                        | Cantaloupe              | 9              | 21°C                              | app. 6.2 log cfu/g | 70 hrs         | app. -4.2 log cfu/g | Kärenlampi and Hänninen, 2004|
|                        | Cucumber                | 137°C          |                                   | app. 6 log cfu/g  | 70 hrs         | app. -1 log cfu/g  | Kärenlampi and Hänninen, 2004|
|                        | Cucumber                | 1321°C         |                                   | app. 6 log cfu/g  | 70 hrs         | app. -4 log cfu/g  | Kärenlampi and Hänninen, 2004|
|                        | Carrot/grated           | 19             | 7°C                               | app. 6.8 log cfu/g | 70 hrs         | app. -0.8 log cfu/g | Kärenlampi and Hänninen, 2004|
|                        | Carrot/grated           | 19             | 21°C                              | app. 6.8 log cfu/g | 70 hrs         | app. -4.8 log cfu/g | Kärenlampi and Hänninen, 2004|
| *Clostridium botulinum*| Mushroom/purée          | 29             | 15°C                              | 4 log cfu/ml    | app. 400 hrs    | app. +4.5 log cfu/ml| Braconnier et al., 2003      |
| Pathogen               | Food item(s)          | FoNAO Category | Experimental conditions/treatment | Inoculation | Treatment time | Increase/ decrease | Reference(s)               |
|-----------------------|-----------------------|----------------|-----------------------------------|-------------|----------------|--------------------|---------------------------|
| **Enterobacter sakazakii** | Fruits and vegetables/fresh cut | other 4°C | 2 to 3 log cfu/g | 6 days | no growth or gradual decrease* |                 | Kim and Beuchat, 2005 |
| Fruits and vegetables/fresh cut | other 4°C | 2 to 3 log cfu/g | 6 days | no growth or gradual decrease* |                 | Kim and Beuchat, 2005 |
| Watermelon             | 9                     | 25°C           | 2 to 3 log cfu/g | 48 hrs | app. +5.8 log cfu/g |                 | Kim and Beuchat, 2005 |
| Watermelon juice       | 9                     | 25°C           | 1 to 2 log cfu/ml | 36 hrs | app. +6.2 log cfu/ml |                 | Kim and Beuchat, 2005 |
| Apples                 | 6                     | 4°C            | 8.78 log cfu/produce | 28 days | -1.46 log cfu/produce |                 | Kim et al., 2006         |
| Apples                 | 6                     | 25°C           | 8.78 log cfu/produce | 28 days | -4.03 log cfu/produce |                 | Kim et al., 2006         |
| Cantaloupe             | 9                     | 4°C            | 8.45 log cfu/produce | 14 days | -1.44 log cfu/produce |                 | Kim et al., 2006         |
| Cantaloupe             | 9                     | 25°C           | 8.45 log cfu/produce | 8 days  | -3.9 log cfu/produce |                 | Kim et al., 2006         |
| Strawberries           | 2                     | 4°C            | 8.78 log cfu/produce | 14 days | -1.43 log cfu/produce |                 | Kim et al., 2006         |
| Strawberries           | 2                     | 25°C           | 8.78 log cfu/produce | 8 days  | -3.9 log cfu/produce |                 | Kim et al., 2006         |
| Lettuce                | 15                    | 4°C            | 8.85 log cfu/produce | 14 days | -0.82 log cfu/produce |                 | Kim et al., 2006         |
| Lettuce                | 15                    | 25°C           | 8.85 log cfu/produce | 8 days  | -0.45 log cfu/produce |                 | Kim et al., 2006         |
| Tomato                 | 11                    | 4°C            | 8.60 log cfu/produce | 28 days | -1.07 log cfu/produce |                 | Kim et al., 2006         |
| Tomato                 | 11                    | 25°C           | 8.60 log cfu/produce | 28 days | -1.45 log cfu/produce |                 | Kim et al., 2006         |
| Apples                 | 6                     | 10 μg/ml chlorine dioxide | 1 min | -3.38 log cfu/apple |                 | Kim et al., 2006 |
| Apples                 | 6                     | 10 μg/ml chlorine dioxide | 5 min | -3.77 log cfu/apple |                 | Kim et al., 2006 |
| Apples                 | 6                     | 40 μg/ml peroxyacetic acid-based sanitizer | 1 min | -4 log cfu/apple |                 | Kim et al., 2006 |
| Tomato                 | 11                    | 10 μg/ml chlorine | 5 min | -3.7 log cfu/tomato |                 | Kim et al., 2006 |
| Tomato                 | 11                    | 10 μg/ml chlorine dioxide | 5 min | -3.7 log cfu/tomato |                 | Kim et al., 2006 |
| Pathogen                  | Food item(s)          | FoNAO Category | Experimental conditions/treatment | Inoculation | Treatment time | Increase/ decrease | Reference(s)          |
|--------------------------|-----------------------|----------------|-----------------------------------|-------------|----------------|---------------------|-----------------------|
| Tomato                   |                       | 11             | 40 μg/ml peroxyacetic acid-based sanitizer | 5 min      | -3.7 log cfu/tomato | Kim et al., 2006    |
| Lettuce                  |                       | 15             | 40 μg/ml peroxyacetic acid-based sanitizer | 5 min      | -5.31 log cfu/tomato | Kim et al., 2006    |
| Infant rice cereal       |                       | 14             | 4, 12, 21 or 30°C; pH 4.29          | 72 hrs      | not detected (<1 CFU 10^6/ml) | Richards et al., 2005 |
| reconstituted with        |                       |                |                                    |             |                |                     |                       |
| apple juice              |                       |                |                                    |             |                |                     |                       |
| Infant rice cereal       |                       | 14             | 4°C                                 | 72 hrs      | not detected (<1 CFU 10^6/ml) | Richards et al., 2005 |
| reconstituted with        |                       |                |                                    |             |                |                     |                       |
| water                    |                       |                |                                    |             |                |                     |                       |
| Artichokes/minimally     |                       | 23             | 4°C; MAP                            | 16 days     | +1.5 log cfu/g  | Sanz et al., 2003  |
| processed                |                       |                |                                    |             |                |                     |                       |
| Endivie/fresh cut        |                       | 15             | 25°C; PMA                           | 3 days      | app. +1.8 log cfu/ml | Abadias et al., 2012 |
| Endivie/fresh cut        |                       | 15             | Air; 25°C                           | 3 days      | app. +0.7 log cfu/ml | Abadias et al., 2012 |
| Carrots/grated           |                       | 19             | 25°C; Air                           | 3 days      | app. +3.8 log cfu/ml | Abadias et al., 2012 |
| Pineapple                |                       | 8              | Air; 25°C                           | 3 days      | app. -1 log cfu/g | Abadias et al., 2012 |
| Melon                    |                       | 9              | Air; 25°C                           | 3 days      | app. +4 log cfu/g | Abadias et al., 2012 |
| Iceberg lettuce/shredded |                       | 15             | 4°C                                 | 14 days     | -1.39 log cfu/g  | Chang and Fang, 2007 |
| Iceberg lettuce/shredded |                       | 15             | 22°C                                | 3 days      | +2.71 log cfu/g  | Chang and Fang, 2007 |
| Iceberg lettuce/shredded |                       | 15             | treated with rice vinegar           | -           | -10^9 cfu/g      | Chang and Fang, 2007 |
|                          |                       |                | (5% (v/v) acetic acid) for 5 min at 25°C | -           |                |                     |                       |
| Iceberg lettuce/shredded |                       | 15             | treated with rice vinegar           | -           | -10^{27} cfu/g  | Chang and Fang, 2007 |
|                          |                       |                | (5% (v/v) acetic acid) for 5 min at 25°C | -           |                |                     |                       |

**Escherichia coli O157:H7 (EHEC)**
| Pathogen | Food item(s) | FoNAO Category | Experimental conditions/treatment | Inoculation | Treatment time | Increase/ decrease | Reference(s) |
|----------|--------------|----------------|-----------------------------------|-------------|----------------|-------------------|---------------|
| *Escherichia coli* O157:H7 (EHEC) | Spinach leaves | 15 | 25°C; 100% RH; distilled water as carrier medium for inoculum | 7 log cfu/leaf; decreased to 5.6 log cfu/leaf after air-drying leaves for 1 h | 120 hrs | +1.7 log cfu/leaf | Choi et al., 2011 |
| | Spinach leaves | 15 | 12°C; 100% RH; 0.1% peptone water as carrier medium for inoculum | 7 log cfu/leaf; decreased to 5.4 log cfu/leaf after air-drying leaves for 1 h | 72 hrs | +0.7 log cfu/leaf | Choi et al., 2011 |
| | Spinach leaves | 15 | 25°C; 100% RH; 0.1% peptone water as carrier medium for inoculum | 7 log cfu/leaf; decreased to 5.4 log cfu/leaf after air-drying leaves for 1 h | 24 hrs | +1.3 log cfu/leaf | Choi et al., 2011 |
| | Gabbage | 15 | 35°C; 80% RH | 3 log cfu/g | 24 hrs | +5 log cfu/g | Ding et al., 2012 |
| | Gabbage | 15 | 15°C; 60% RH | 3 log cfu/g | 96 hrs | +0.3 log cfu/g | Ding et al., 2012 |
| | Cranberry juice concentrate | 4 | 0°C; 18 to 46 °Brix (pH 2.2 to 2.5) | - | after a 24 hrs 5-log cfu reduction incubation | Enache and Chen, 2007 |
| | Cranberry juice concentrate | 4 | 0°C; 14 °Brix (pH 2.5) | - | after a 96 hrs 5-log cfu reduction incubation | Enache and Chen, 2007 |
| | Lettuce/minimally processed | 15 | 4°C; refrigerator | 6.54 log cfu/g | 7 days | -0.64 log cfu/g | Ergönül, 2011 |
| | Lettuce/minimally processed | 15 | 20°C; room temperature | 6.54 log cfu/g | 2 days | -0.17 log cfu/g | Ergönül, 2011 |
| | Lettuce/minimally processed | 15 | 20°C; room temperature | 6.54 log cfu/g | 7 days | +1.57 log cfu/g | Ergönül, 2011 |
| | Apples/fresh cut | 6 | 15°C; MAP; high CO₂ ≥ 15%, low O₂ < 1% | app. 3.8 log cfu/g | 15 days | app. -0.2 log cfu/g | Gunes and Hotchkiss, 2002 |
| | Apples/fresh cut | 6 | 15°C; air | app. 3.8 log cfu/g | 15 days | app. +1.1 log cfu/g | Gunes and Hotchkiss, 2002 |
| | Lettuce/phyllosphere/surface | 15 | 20°C; 70% RH; lettuce grown on sandy soil | 10⁷ cfu/g; Soil inoculation | 21 days | app. -4 log cfu/g | Ibekwe et al., 2009 |
| | Lettuce/phyllosphere/surface | 15 | 20°C; 70% RH; lettuce grown on clay soil | 10⁷ cfu/g; Soil inoculation | 21 days | app. -2.8 log cfu/g | Ibekwe et al., 2009 |
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| Pathogen                      | Food item(s) | FoNAO Category | Experimental conditions/treatment | Inoculation | Treatment time | Increase/ decrease | Reference(s) |
|-------------------------------|--------------|----------------|----------------------------------|-------------|----------------|-------------------|--------------|
| *Escherichia coli* O157:H7    | Leaf lettuce | 15             | Fields treated with contaminated manure composts or irrigation water | water: $10^5$ cfu/ml | 77 days after seedling planted | app. -$10^4$ cfu/ml | Islam et al., 2004a |
|                               | Leaf lettuce | 15             | Fields treated with contaminated manure composts or irrigation water | compost: $10^7$ cfu/g | 77 days after seedling planted | app. -$10^6$ cfu/g | Islam et al., 2004a |
|                               | Parsley      | 16             | Fields treated with contaminated manure composts or irrigation water | water: $10^5$ cfu/ml | 177 days after seedling planted | app. -$10^4$ cfu/ml | Islam et al., 2004a |
|                               | Parsley      | 16             | Fields treated with contaminated manure composts or irrigation water | compost: $10^7$ cfu/g | 177 days after seedling planted | app. -$10^4$ cfu/ml | Islam et al., 2004a |
|                               | Carrots      | 19             | Fields treated with contaminated manure compost | compost: $10^7$ cfu/g | 84 days after seedling planted | app. -$10^3$ cfu/g | Islam et al., 2004b |
|                               | Onion        | 22             | Fields treated with contaminated manure compost | compost: $10^7$ cfu/g | 64 days after seedling planted | app. -$10^3$ cfu/g | Islam et al., 2004b |
| Apples (Golden Delicious)     | 6            | 4°C            | 6 to 7 log cfu/g | 28 days | app. -1 log cfu/g | Janes et al., 2002 |
| Apples (Golden Delicious)     | 6            | 25°C           | 6 to 7 log cfu/g | 28 days | app. +0.2 log cfu/g | Janes et al., 2002 |
| Apples                        | 6            | 21°C; spray coated with waxes | 12 weeks | - 1.48 log cfu/apple | Kenney and Beuchat, 2002 |
| Apples                        | 6            | 21°C; spray coated with waxes | 12 weeks | - 1.48 log cfu/apple | Kenney and Beuchat, 2002 |
| Pathogen | Food item(s) | FoNAO Category | Experimental conditions/treatment | Inoculation | Treatment time | Increase/ decrease | Reference(s) |
|----------|--------------|----------------|-----------------------------------|-------------|----------------|-------------------|--------------|
| Escherichia coli O157:H7 (EHEC) | Apples | 6 | 4°C; pH 3.1; 0.05% chitosan | 20 days | enhanced survival of E. coli O157:H7 (2/5 days versus 1/3 days untreated) | Kisko et al., 2005 |
| | Lettuce | 15 | 50°C | 10 days | +1.7–2.3 log cfu/g | Li et al., 2002 |
| | Baby spinach/packaged | 15 | 12°C | app. 3.7 log cfu/g | 9 days | app. +2.5 log cfu/g | Luo et al., 2009 |
| | Baby spinach/packaged | 15 | 1°C | app. 3.7 log cfu/g | 10 days | app. -1.4 log cfu/g | Luo et al., 2009 |
| | Juice concentrates (apple) | 6 | -23°C | 10⁷ to 10⁸ cfu/g | 12 weeks | recoverable; app. overall survival 10⁷ cfu/g | Oyarzabal et al., 2003 |
| | Iceberg lettuce/shredded | 15 | AMA; 4°C | 5.59 log cfu/g | 10 days | -1.7 log cfu/g | Sharma et al., 2011 |
| | Iceberg lettuce/shredded | 15 | AMA; 15°C | 3.98 log cfu/g | 10 days | +3.98 log cfu/g | Sharma et al., 2011 |
| | Lettuce plants | 15 | single spray irrigation with farm water | 10⁷ cfu/ml | 30 days | 0 cfu/g | Solomon et al., 2003 |
| | Lettuce plants | 15 | intermittent spray irrigation with farm water | 10⁷ cfu/ml | 30 days | 5 log cfu/g | Solomon et al., 2003 |
| | Apples | 6 | 25°C; acid adapted inoculum; untreated | 4.1 log cfu/g | 5 days | +2.6 log cfu/g | Stopforth et al., 2004 |
| | Apples | 6 | 25°C; acid adapted inoculum; acetic acid | 3.8 log cfu/g | 5 days | +3.4 log cfu/g | Stopforth et al., 2004 |
| | Apples | 6 | 25°C; Nonadapted inoculum; untreated | 4.4 log cfu/g | 5 days | +2.5 log cfu/g | Stopforth et al., 2004 |
| | Apples | 6 | 25°C; Nonadapted inoculum; acetic acid | 4 log cfu/g | 5 days | +3.1 log cfu/g | Stopforth et al., 2004 |
| Pathogen                      | Food item(s) | FoNAO Category | Experimental conditions/treatment | Inoculation | Treatment time | Increase/ decrease | Reference(s) |
|------------------------------|--------------|----------------|-----------------------------------|-------------|----------------|-------------------|---------------|
|                              | Tomato       | 11             | 25°C; 60% RH; inoculated on wounds; laboratory-etched tomatoes | app. 5 log cfu/g | 14 days | app. +1.8 log cfu/g | Yuk et al., 2007 |
|                              | Orange juice | 5              | 7°C; with pulp | app. 5.5 log cfu/g | 4 days | app. -3.8 log cfu/g | Yuk et al., 2008 |
|                              | Orange juice | 5              | 7°C; without pulp | app. 5.5 log cfu/g | 240 min | app. -3.8 log cfu/g | Yuk et al., 2008 |
|                              | Orange juice | 5              | 7°C; without pulp; with calcium lactate | app. 3 log cfu/g | 160 min | -3 log cfu/g | Yuk et al., 2008 |
|                              | Mixed salad  | 36             | 4°C; conventional MAP (3 to 5 kPa of O₂ and 6 to 8 kPa of CO₂) | 2.64 log cfu/g | 10 days | +0.3 log cfu/g | Allende et al., 2002 |
|                              | Mixed salad  | 36             | 4°C; MAP; superatmospheric O₂; O₂ concentration of 95 kPa and a high-barrier film (plastic film) permeability for O₂ | 2.64 log cfu/g | 11 days | -0.4 log cfu/g | Allende et al., 2002 |
| *Listeria monocytogenes*     | Coleslaw/shredded/dry | 36 | 8°C; CA | app. 4.1 log cfu/g | 12 days | 0 cfu/g | Bourke and O’Beirne, 2004 |
|                              | Coleslaw/shredded/dry | 36 | 8°C; Air | app. 4.1 log cfu/g | 12 days | app. -0.1 log cfu/g | Bourke and O’Beirne, 2004 |
|                              | Coleslaw/shredded/dry | 36 | 3°C; OPP | app. 4.5 log cfu/g | 13 days | app. -0.3 log cfu/g | Bourke and O’Beirne, 2004 |
|                              | Coleslaw/shredded/dry | 36 | 3°C; Air (unsealed OPP packages) | app. 4.5 log cfu/g | 14 days | app. -2.5 log cfu/g | Bourke and O’Beirne, 2004 |
|                              | Coleslaw/shredded/dry | 36 | 8°C; PA (microperforated OPP films (PA-120, PA-160, PA-190 and PA-210)) | app. 4.5 log cfu/g | 15 days | app. -0.3 log cfu/g | Bourke and O’Beirne, 2004 |
|                              | Coleslaw/shredded/dry | 36 | 8°C; Air (unsealed OPP packages) | app. 4.5 log cfu/g | 16 days | app. -0.6 log cfu/g | Bourke and O’Beirne, 2004 |
### Food of plant origin with high water content

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| Pathogen                | Food item(s)     | FoNAO Category | Experimental conditions/treatment | Inoculation | Treatment time | Increase/ decrease | Reference(s)       |
|-------------------------|------------------|----------------|-----------------------------------|-------------|----------------|---------------------|---------------------|
| **Listeria monocytogenes** | Coleslaw        | 36             | 5°C                               | app. 3 log cfu/g | 14 days       | app. -0.8 log cfu/g | Burnett et al., 2005 |
|                         | Coleslaw        | 36             | 10°C                              | app. 3 log cfu/g | 14 days       | app. -2.4 log cfu/g | Burnett et al., 2005 |
|                         | Orange slices/minimally processed | 5             | 25°C; app. pH 3.5; acid adapted 5.7; 3hrs | 10⁷ CFU/g    | 6 days         | +2.42 log cfu/g     | Caggia et al., 2009 |
|                         | Orange juice    | 5              | 30°C; pH 2.6; acid adapted 5.7; 3hrs | 5 log cfu/g  | 6 hrs         | app. +4 log cfu/ml  | Caggia et al., 2009 |
|                         | Iceberg lettuce/shredded/ready-to-eat | 15            | 13°C; packaged; 4.65–6.2% CO2 and 2.1–4.3% O2 and a balance of N2 | app. 2.5 log cfu/g | 14 days       | app. +4.9 log cfu/g | Carrasco et al., 2008 |
|                         | Iceberg lettuce/shredded/ready-to-eat | 15            | 5°C; packaged; 4.65–6.2% CO2 and 2.1–4.3% O2 and a balance of N2 | app. 3.4 log cfu/g | 14 days       | app. +2.6 log cfu/g | Carrasco et al., 2008 |
|                         | Green leafy salads | 15            | 3°C                               | 168 hrs      | +0.43 log cfu/g | Crépet et al., 2009 |
|                         | Green leafy salads | 15            | 5°C                               | 96 hrs       | +0.03 log cfu/g | Crépet et al., 2009 |
|                         | Green leafy salads | 15            | 8°C                               | 120 hrs      | +0.73 log cfu/g | Crépet et al., 2009 |
|                         | Green leafy salads | 15            | 10°C                              | 96 hrs       | +1.25 log cfu/g | Crépet et al., 2009 |
|                         | Green leafy salads | 15            | 15°C                              | 96 hrs       | +1.77 log cfu/g | Crépet et al., 2009 |
|                         | Parsley         | 16             | Low relative humidity (47–69%); culturable | 10⁹ culturable Listeria monocytogenes/leaf | 15 days | app. -10⁻⁷ culturable cells/leaf | Dreux et al., 2007 |
|                         | Parsley         | 16             | Low relative humidity (47–69%); viable | 10⁹ viable cells of Listeria monocytogenes/leaf | 15 days | app. -10⁻⁸ viable cells/leaf | Dreux et al., 2007 |
|                         | Parsley         | 16             | 100% RH (changing from low (32–64%) to 100% RH) | 10⁹ culturable Listeria monocytogenes/leaf | 7 days | not detected* | Dreux et al., 2007 |
|                         | Parsley         | 16             | 100% RH (changing from low (32–64%) to 100% RH) | 10⁹ culturable Listeria monocytogenes/leaf | 7 days | app. -10⁻⁷ culturable cells/leaf | Dreux et al., 2007 |
| Pathogen                   | Food item(s)                  | FoNAO Category | Experimental conditions/treatment                                                                 | Inoculation                                      | Treatment time | Increase/ decrease | Reference(s)        |
|----------------------------|-------------------------------|----------------|--------------------------------------------------------------------------------------------------|-------------------------------------------------|----------------|--------------------|---------------------|
| Listeria monocytogenes     | Parsley                       | 16             | 100% RH (changing from low (32–64%) to 100% RH)                                                  | 10⁵ viable cells of Listeria monocytogenes/leaf | 7 days         | app. -1⁰ viable cells/leaf | Dreux et al., 2007  |
|                            | Cabagge/not shredded          | 15             | 5°C                                                                                             |                                                  | 28 days        | app. -1 Log cfu/cm² | Ells and Hansen, 2010 |
|                            | Cabagge/shredded              | 15             | 5°C                                                                                             |                                                  | 14 days        | app. +1.2 Log cfu/cm²| Ells and Hansen, 2010 |
|                            | Cranberry juice concentrate   | 4              | 0°C; 18 to 46 °Brix (pH 2.2 to 2.5)                                                               | after a 6 hrs incubation                        | 5-log cfu reduction | Enache and Chen, 2007 |
|                            | Cranberry juice concentrate   | 4              | 0°C; 14 °Brix (pH 2.5)                                                                            | after a 24 hrs incubation                      | 5-log cfu reduction | Enache and Chen, 2007 |
|                            | Strawberries/whole            | 2              | 24°C                                                                                             | 7.5 log cfu/berry                               | 1 hr drying period | -0.4 log cfu/berry  | Flessa et al., 2005  |
|                            | Strawberries/whole            | 2              | 24°C                                                                                             | 7.5 log cfu/berry                               | 48 hrs         | -1 log cfu/berry    | Flessa et al., 2005  |
|                            | Strawberries/whole            | 2              | 24°C                                                                                             | 5.6 log cfu/berry                               | 1 hr drying period | -1 log cfu/berry    | Flessa et al., 2005  |
|                            | Strawberries/whole            | 2              | 24°C                                                                                             | 5.6 log cfu/berry                               | 48 hrs         | -3.3 log cfu/berry  | Flessa et al., 2005  |
|                            | Strawberries/cut              | 2              | 24°C                                                                                             | 7.5 log cfu/berry                               | 48 hrs         | -0.5 log cfu/berry  | Flessa et al., 2005  |
|                            | Strawberries/cut              | 2              | 24°C                                                                                             | 5.6 log cfu/berry                               | 48 hrs         | 0 cfu/berry         | Flessa et al., 2005  |
|                            | Strawberries/whole            | 2              | 24°C                                                                                             | 5.6 log cfu/berry                               | 1 hr drying period | -0.7 log cfu/berry  | Flessa et al., 2005  |
|                            | Strawberries/whole            | 2              | 4°C                                                                                              | 7.7 log cfu/berry                               | 1 hr drying period | -1.5 log cfu/berry  | Flessa et al., 2005  |
|                            | Strawberries/whole            | 2              | 4°C                                                                                              | 5.9 log cfu/berry                               | 7 days         | -3 log cfu/berry    | Flessa et al., 2005  |
|                            | Strawberries/whole            | 2              | 4°C                                                                                              | 5.9 log cfu/berry                               | 7 days         | -2.7 log cfu/berry  | Flessa et al., 2005  |
|                            | Strawberries/whole            | 2              | 4°C                                                                                              | 5.2 log cfu/berry                               | 7 days         | -1 log cfu/berry    | Flessa et al., 2005  |
|                            | Strawberries/cut              | 2              | -20°C; without added sucrose                                                                   | 6.7 log cfu/25-g sample                         | 24 hrs         | -1 log cfu/25-g sample | Flessa et al., 2005  |
| Pathogen          | Food item(s)               | FoNAO Category | Experimental conditions/treatment | Inoculation | Treatment time | Increase/ decrease | Reference(s)         |
|-------------------|----------------------------|----------------|----------------------------------|-------------|----------------|-------------------|----------------------|
| *Listeria monocytogenes* | Strawberries/cut | 2               | -20°C; without added sucrose      | 6.7 log cfu/25-g sample | 28 days         | -1.2 log cfu/25-g sample | Flessa et al., 2005 |
|                   | Strawberries/cut | 2               | -20°C; without added sucrose      | 6.4 log cfu/25-g sample | 29 days         | 0 cfu/g            | Flessa et al., 2005 |
|                   | Lettuce/shredded  | 15              | 8°C; MAP                          | 10^5 cfu/g  | 10 days        | app +1 log cfu/g   | Francis and O’Beirne, 2005 |
|                   | Coleslaw mix      | 36              | 8°C; MAP                          | 10^5 cfu/g  | 10 days        | app. -2 log cfu/g  | Francis and O’Beirne, 2005 |
|                   | Dill pickles      | 35              | NaCl concentration 1.3% 3.8% or 7.6% | 5.4 to 5.6 log cfu/cm² on cucumber | 91 days        | app. -3.11 log cfu/cm² | Kim et al., 2005   |
|                   | Iceberg salad/fresh cut | 15         | 5°C                               | app. 3.5 log cfu/g      | 170 hrs        | app. +1 log cfu/g   | Koseki and Isobe, 2005 |
|                   | Iceberg salad/fresh cut | 15         | 25°C                              | app. 3.5 log cfu/g      | 170 hrs        | app. +1.6 log cfu/g | Koseki and Isobe, 2005 |
|                   | Iceberg salad/fresh cut | 15         | 5°C; no sanitizer                  | 5.61 log cfu/g          |                | -0.66 log cfu/g     | Koseki and Isobe, 2005 |
|                   | Iceberg salad/fresh cut | 15         | 5°C; treated with acidic electrolyzed water (AcEW) | 3.89 log cfu/g  | 5 min          | +1.69 log cfu/g     | Koseki and Isobe, 2005 |
|                   | Iceberg salad/fresh cut | 15         | 25°C; no sanitizer                  | 5.61 log cfu/g          |                | -0.43 log cfu/g     | Koseki and Isobe, 2005 |
|                   | Iceberg salad/fresh cut | 15         | 25°C; treated with acidic electrolyzed water (AcEW) | 3.89 log cfu/g  | 5 min          | +2.44 log cfu/g     | Koseki and Isobe, 2005 |
|                   | Lettuce leaves/cut iceberg | 15         | Inoculation; water treatment at 50°C without 20 mg/l chlorine; storage: 5°C | 3.5 log cfu/g | 18 days      | app. +2.4 log cfu/g | Li et al., 2002   |

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| Pathogen                  | Food item(s)               | FoNAO Category | Experimental conditions/treatment                                                                 | Inoculation   | Treatment time | Increase/ decrease | Reference(s) |
|--------------------------|-----------------------------|----------------|-----------------------------------------------------------------------------------------------|---------------|----------------|--------------------|---------------|
| *Listeria monocytogenes* | Lettuce leaves/cut iceberg  | 15             | Inoculation; water treatment at 50°C with 20 mg/l chlorine; storage: 5°C                       | app. 3.3 log cfu/g | 18 days        | app. +1.9 log cfu/g | Li et al., 2002 |
|                          | Lettuce leaves/cut iceberg  | 15             | Inoculation; water treatment at 20°C without 20 mg/l chlorine; storage: 5°C                   | app. 3.5 log cfu/g | 18 days        | app. +0.3 log cfu/g | Li et al., 2002 |
|                          | Lettuce leaves/cut iceberg  | 15             | Inoculation; water treatment at 50°C without 20 mg/l chlorine; storage: 15°C                 | app. 3.5 log cfu/g | 7 days         | app. +3.5 log cfu/g | Li et al., 2002 |
|                          | Lettuce leaves/cut iceberg  | 15             | Inoculation; water treatment at 20°C with 20 mg/l chlorine; storage: 20°C                    | app. 4.5 log cfu/g | 18 days        | app. +1.8 log cfu/g | Li et al., 2002 |
|                          | Lettuce leaves/cut iceberg  | 15             | Inoculation; water treatment at 50°C without 20 mg/l chlorine; storage: 5°C                  | app. 4.5 log cfu/g | 7 days         | app. +2.4 log cfu/g | Li et al., 2002 |
|                          | Soymilk products            | 14             | 22°C                                                                                     | high (3x10⁸ CFU/ml); low (3x10⁴ CFU/ml) | 4 days       | Survival and growth at both inoculation levels (tested via plate counts) | Liu and Lin 2008 |
|                          | Juice concentrates (pineapple) | 8             | -23°C                                                                                  | 10⁷ to 10⁸ cfu/g | 12 weeks      | recoverable; overall survival 10⁶ cfu/g | Oyarzabal et al., 2003 |
|                          | Melon pulp                  | 9              | 10°C                                                                                     | 2.5 log cfu/g  | 168 hrs       | app. +6.0 log cfu/g | Penteado and Leitao, 2004b |
|                          | Melon pulp                  | 9              | 20°C                                                                                     | 2.5 log cfu/g  | 48 hrs        | app. +6.5 log cfu/g | Penteado and Leitao, 2004b |
|                          | Melon pulp                  | 9              | 30°C                                                                                     | 2.5 log cfu/g  | 24 hrs        | app. +6.5 log cfu/g | Penteado and Leitao, 2004b |
### Food of plant origin with high water content

**Pathogen**  
**Listeria monocytogenes**

| Pathogen           | Food item(s)                          | FoNAO Category | Experimental conditions/treatment | Inoculation | Treatment time | Increase/ decrease | Reference(s)                      |
|--------------------|---------------------------------------|----------------|-----------------------------------|-------------|---------------|-------------------|-----------------------------------|
|                    | Watermelon pulp                       | 9              | 10°C                              | 2.5 log cfu/g | 168 hrs       | app. +3.5 log cfu/g | Penteado and Leitao, 2004b       |
|                    | Watermelon pulp                       | 9              | 20°C                              | 2.5 log cfu/g | 48 hrs        | app. +4.5 log cfu/g | Penteado and Leitao, 2004b       |
|                    | Watermelon pulp                       | 9              | 30°C                              | 2.5 log cfu/g | 24 hrs        | app. +6.5 log cfu/g | Penteado and Leitao, 2004b       |
|                    | Papaya pulp                           | 8              | 10°C                              | 2.5 log cfu/g | 168 hrs       | app. +2.0 log cfu/g | Penteado and Leitao, 2004b       |
|                    | Papaya pulp                           | 8              | 20°C                              | 2.5 log cfu/g | 48 hrs        | app. +1.5 log cfu/g | Penteado and Leitao, 2004b       |
|                    | Papaya pulp                           | 8              | 30°C                              | 2.5 log cfu/g | 24 hrs        | app. +5.0 log cfu/g | Penteado and Leitao, 2004b       |
|                    | Lettuce/ready to eat                  | 15             | 5°C; MAP                          | 10^1-10^2 CFU/g | final populations: 10^5-10^7 | Sant’Ana et al., 2012            |
|                    | Artichokes/minimally processed        | 23             | 4°C; MAP                          | 5.5 log cfu/g | 16 days       | app. -0.5 log cfu/g | Sanz et al., 2003                |
|                    | Coconut/fresh cut                     | 8              | Air; pH 6.0; 12°C; low inoculum (102 cfu/g) | low inoculum | 6 days        | +2.63 log cfu/g    | Sinigaglia et al., 2006          |
|                    | Coconut/fresh cut                     | 8              | 12°C; MAP; pH 6.0; low inoculum (10^2 cfu/g) | low inoculum | 10 days       | +4.35 log cfu/g    | Sinigaglia et al., 2006          |
|                    | Soy milk                              | 27             | 8°C                               | 10^7 cfu/ml | 31 days       | app. +10^2 cfu/ml  | Tipparaju et al., 2004           |
|                    | Persimmon fruit (Diospyros kaki)      | 8              | 10°C                              | app. 3 log cfu/g | 120 hrs       | app. +2 log cfu/g  | Uchima, 2008                    |
|                    | Persimmon fruit (Diospyros kaki)      | 8              | 30°C                              | app. 3 log cfu/g | 16 days       | app. +2.8 log cfu/g | Uchima, 2008                    |
|                    | Persimmon fruit (Diospyros kaki)      | 8              | 10°C                              | app. 2.8 log cfu/g | 220 hrs       | app. +3.7 log cfu/g | Uchima, 2008                    |
|                    | Persimmon fruit (Diospyros kaki)      | 8              | 30°C                              | app. 2.8 log cfu/g | 27 hrs        | app. +5.4 log cfu/g | Uchima, 2008                    |
| **Salmonella Enterica** | Lettuce/ready to eat                  | 15             | 5°C; MAP                          | 10^7-10^9 CFU/g | final populations: 10^7-10^9 | Sant’Ana et al., 2012            |
| **Salmonella Enteritidis** | Melon                                  | 9              | 10, 20 and 30 °C; pH 5.87          | 7.31, 1.69 and 0.69 hrs | maximum populations: 10^7-10^9 | Penteado and Leitao, 2004a       |
|                    | Watermelon                            | 9              | 10, 20 and 30 °C; pH 5.88          | 7.31, 1.69 and 0.69 hrs | maximum populations: 10^7-10^9 | Penteado and Leitao, 2004a       |
### Pathogen: Salmonella Enteritidis

| Food item(s)       | FoNAO Category | Experimental conditions/treatment | Inoculation | Treatment time | Increase/ decrease | Reference(s) |
|--------------------|----------------|-----------------------------------|-------------|----------------|--------------------|---------------|
| Cherry tomatoes    | 11             | 7°C; Air                          | 7 log cfu/tomato | 20 days | app. -4.5 log cfu/tomato | Das et al., 2006 |
| Cherry tomatoes    | 11             | 7°C; Air                          | 3 log cfu/tomato | 20 days | not detected<sup>a</sup> | Das et al., 2006 |
| Cherry tomatoes    | 11             | 22°C; Air                         | 7 log cfu/tomato | 10 days | app. -4 log cfu/tomato | Das et al., 2006 |
| Cherry tomatoes    | 11             | 22°C; Air                         | 3 log cfu/tomato | 10 days | not detected<sup>a</sup> | Das et al., 2006 |
| Cherry tomatoes    | 11             | 7°C; PMA 6% O<sub>2</sub> and 4% CO<sub>2</sub> | 7 log cfu/tomato | 20 days | app. -4.8 log cfu/tomato | Das et al., 2006 |
| Cherry tomatoes    | 11             | 7°C; PMA 6% O<sub>2</sub> and 4% CO<sub>2</sub> | 3 log cfu/tomato | 20 days | not detected<sup>a</sup> | Das et al., 2006 |
| Cherry tomatoes    | 11             | 22°C; PMA 6% O<sub>2</sub> and 4% CO<sub>2</sub> | 7 log cfu/tomato | 10 days | app. -4 log cfu/tomato | Das et al., 2006 |
| Cherry tomatoes    | 11             | 22°C; PMA 6% O<sub>2</sub> and 4% CO<sub>2</sub> | 3 log cfu/tomato | 10 days | not detected<sup>a</sup> | Das et al., 2006 |
| Cherry tomatoes    | 11             | 7°C; CA; CO<sub>2</sub> level was maintained at 5% | 7 log cfu/tomato | 20 days | app. -4.8 log cfu/tomato | Das et al., 2006 |
| Cherry tomatoes    | 11             | 7°C; CA; CO<sub>2</sub> level was maintained at 5% | 3 log cfu/tomato | 20 days | not detected<sup>a</sup> | Das et al., 2006 |
| Cherry tomatoes    | 11             | 22°C; CA; CO<sub>2</sub> level was 7 log cfu/tomato maintained at 5% | 3 log cfu/tomato | 10 days | app. -4 log cfu/tomato | Das et al., 2006 |
| Cherry tomatoes    | 11             | 22°C; CA; CO<sub>2</sub> level was 3 log cfu/tomato maintained at 5% | 3 log cfu/tomato | 10 days | not detected<sup>a</sup> | Das et al., 2006 |
| Persimmon (Diospyrus kaki)/peel | 8             | 10°C                              | app. 2 log cfu/g | 72 hrs | app. +2 log cfu/g | Rezende et al., 2009 |
| Persimmon (Diospyrus kaki)/peel | 8             | 30°C                              | app. 2 log cfu/g | 16 hrs | app. +4 log cfu/g | Rezende et al., 2009 |
| Persimmon (Diospyrus kaki)/pulp  | 8             | 10°C                              | app. 2.3 log cfu/g | 168 hrs | app. +1.7 log cfu/g | Rezende et al., 2009 |

<sup>a</sup> Not detected in all tests.

**Supporting publications 2013:EN-402**

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| Pathogen       | Food item(s)          | FoNAO Category | Experimental conditions/treatment | Inoculation       | Treatment time | Increase/ decrease | Reference(s)                  |
|---------------|-----------------------|----------------|-----------------------------------|-------------------|----------------|-------------------|-------------------------------|
| Persimmon     | (Diospyrus kaki)/pulp | 8              | 20°C                              | app. 2.3 log cfu/g| app. +5.2 log cfu/g | Rezende et al., 2009     |
| Persimmon     | (Diospyrus kaki)/pulp | 8              | 30°C                              | app. 2.3 log cfu/g| app. +6.7 log cfu/g | Rezende et al., 2009     |
| Carrots/grated|                        | 19             | 4°C; Air                          | app. 3.9 log cfu/g| 10 days        | app. -0.3 log cfu/g | Tassou and Boziaris 2002     |
| Carrots/grated|                        | 19             | 4°C; MA                           | app. 3.9 log cfu/g| 11 days        | app. -0.2 log cfu/g | Tassou and Boziaris 2002     |
| Carrots/grated|                        | 19             | 4°C; Air; inoculated with         | app. 3.9 log cfu/g| 11 days        | app. -0.4 log cfu/g | Tassou and Boziaris 2002     |
| Carrots/grated|                        | 19             | 4°C; MA; inoculated with          | app. 3.9 log cfu/g| 9 days         | app. -0.5 log cfu/g | Tassou and Boziaris 2002     |
| Carrots/grated|                        | 19             | 4°C; MA; inoculated with          | app. 6 log cfu/g  | 7 days         | app. +0.2 log cfu/g | Tassou and Boziaris 2002     |
| Carrots/grated|                        | 19             | 4°C; MA; inoculated with          | app. 6 log cfu/g  | 7 days         | app. +0.5 log cfu/g | Tassou and Boziaris 2002     |
| Salmonella Poona | Cantaloupe          | 9              | 4°C; 0.05% Tween 80 in            | 8.58 log cfu      | 14 days        | -1.11 log cfu     | Beuchat and Scouten, 2004    |
| Salmonella Poona | Cantaloupe          | 9              | 21°C; 0.05% Tween 80 in           | 8.27 log cfu      | 14 days        | -1.14 log cfu     | Beuchat and Scouten, 2004    |
| Cantaloupe    |                       | 9              | 21°C; 0.05% Tween 80 in           | 8.55 log cfu      | 15 days        | -0.33 log cfu     | Beuchat and Scouten, 2004    |
### Pathogen

- **Salmonella Salford**
  - Food item(s): Passionfruit/fruit with inedible skins
  - FoNAO Category: 8
  - Experimental conditions/treatment: 10°C
  - Inoculation: 0.6 log cfu/cm²
  - Treatment time: 6 days
  - Increase/ decrease: +3.4 log cfu/cm² (survival: 4 cfu/cm²; 4 xE; E = detected by enrichment)
  - Reference(s): Behrsing et al., 2003

- **Salmonella Salford**
  - Food item(s): Banana/fruit with inedible skins
  - FoNAO Category: 8
  - Experimental conditions/treatment: 18°C
  - Inoculation: 1.78 log cfu/cm²
  - Treatment time: 13 days
  - Increase/ decrease: -0.15 log cfu/cm²
  - Reference(s): Behrsing et al., 2003

- **Salmonella Salford**
  - Food item(s): Cantaloupe(rock melon)/fruit with inedible skins
  - FoNAO Category: 9
  - Experimental conditions/treatment: 8°C for 1 day and then 5 days at 8°C
  - Inoculation: 2.08 log cfu/cm²
  - Treatment time: 7 days
  - Increase/ decrease: -0.3 log cfu/cm²
  - Reference(s): Behrsing et al., 2003

- **Salmonella Salford**
  - Food item(s): Honeydew melon/fruit with inedible skins
  - FoNAO Category: 9
  - Experimental conditions/treatment: 12°C for 1 day and then 5 days at 8°C
  - Inoculation: 1.92 log cfu/cm²
  - Treatment time: 6 days
  - Increase/ decrease: +2.08 log cfu/cm² (survival: 4 cfu/cm²; 4 xE; E = detected by enrichment)
  - Reference(s): Behrsing et al., 2003

- **Salmonella spp.**
  - Food item(s): Tomatoes/fresh
  - FoNAO Category: 11
  - Experimental conditions/treatment: 30°C; 80% RH
  - Inoculation: 5.1 log cfu/g
  - Treatment time: 28 days
  - Increase/ decrease: -3 log cfu/g
  - Reference(s): Allen et al., 2005

- **Salmonella spp.**
  - Food item(s): Tomatoes/fresh
  - FoNAO Category: 11
  - Experimental conditions/treatment: 20°C; 60% RH
  - Inoculation: 4.6 log cfu/g
  - Treatment time: 28 days
  - Increase/ decrease: -3.1 log cfu/g
  - Reference(s): Allen et al., 2005

- **Salmonella spp.**
  - Food item(s): Tomatoes/fresh
  - FoNAO Category: 11
  - Experimental conditions/treatment: 20°C; 90% RH
  - Inoculation: 4.6 log cfu/g
  - Treatment time: 28 days
  - Increase/ decrease: -3.2 log cfu/g
  - Reference(s): Allen et al., 2005

- **Salmonella spp.**
  - Food item(s): Tomatoes/raw/round/pulp
  - FoNAO Category: 11
  - Experimental conditions/treatment: 21°C
  - Inoculation: 0.08 log cfu/g
  - Treatment time: 14 days
  - Increase/ decrease: app. +8.12 log cfu/g
  - Reference(s): Beuchat and Mann, 2008

- **Salmonella spp.**
  - Food item(s): Tomatoes/raw/round/pulp
  - FoNAO Category: 11
  - Experimental conditions/treatment: 4°C
  - Inoculation: 0 cfu/g
  - Treatment time: 10 days
  - Increase/ decrease: 0 cfu/g
  - Reference(s): Beuchat and Mann, 2008

- **Salmonella spp.**
  - Food item(s): Cranberry juice concentrate
  - FoNAO Category: 4
  - Experimental conditions/treatment: 0°C; 18 to 46 °Brix (pH 2.2 to 2.5)
  - Inoculation: after a 6 hrs incubation
  - Increase/ decrease: 5-log cfu reduction
  - Reference(s): Enache and Chen, 2007

- **Salmonella spp.**
  - Food item(s): Cranberry juice concentrate
  - FoNAO Category: 4
  - Experimental conditions/treatment: 0°C; 14 °Brix (pH 2.5)
  - Inoculation: after a 24 hrs incubation
  - Increase/ decrease: 5-log cfu reduction
  - Reference(s): Enache and Chen, 2007

- **Salmonella spp.**
  - Food item(s): Tomatoes
  - FoNAO Category: 11
  - Experimental conditions/treatment: 20°C; 70% RH
  - Inoculation: 7.72 log cfu/g
  - Treatment time: 14 days
  - Increase/ decrease: app. -4.92 log cfu/g
  - Reference(s): Guo et al., 2002

- **Salmonella spp.**
  - Food item(s): Tomatoes
  - FoNAO Category: 11
  - Experimental conditions/treatment: tomatoes placed on inoculated soil
  - Inoculation: app. 5 log cfu/g
  - Treatment time: 10 days
  - Increase/ decrease: app. +2 log cfu/g
  - Reference(s): Guo et al., 2002

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| Pathogen          | Food item(s)                  | FoNAO Category | Experimental conditions/treatment | Inoculation | Treatment time | Increase/ decrease | Reference(s)  |
|-------------------|-------------------------------|----------------|-----------------------------------|-------------|---------------|-------------------|---------------|
| Salmonella spp.   | Juice concentrates (apple)    | 6              | -23°C                             | 10⁴ to 10⁶ cfu/g | 12 weeks       | recoverable; app. overall survival 10² cfu/g | Oyarzabal et al., 2003 |
|                   | Green tomatoes/mature          | 11             | 20°C; Air; 100% RH                | 7.6 x 10⁶ cfu | 6 days        | app. -3.56 x 10⁶ cfu | Rathinasabapathi, 2004 |
|                   | Green tomatoes/mature          | 11             | 20°C; Ethylene (100 ppm); 100% RH | 7.6 x 10⁶ cfu | 6 days        | app. -3.56 x 10⁶ cfu | Rathinasabapathi, 2004 |
|                   | Green tomatoes                | 11             | 15°C; 75% RH; Serovar on tomatoes | app. 3.09 log cfu/g | 7 days       | app. -0.75 log cfu/g | Shi et al., 2007 |
|                   | Green tomatoes                | 11             | 15°C; 95% RH; Serovar on tomatoes | app. 3.09 log cfu/g | 7 days       | app. +1.97 log cfu/g | Shi et al., 2007 |
|                   | Green tomatoes                | 11             | 25°C; 95% RH; Serovar within tomatoes | app. 3.09 log cfu/g | 7 days       | app. +3.5 log cfu/g | Shi et al., 2007 |
|                   | Mixed melon/fresh cut         | 9              | 22°C; fresh cut; before refrigeration | app. 2.2 log cfu/g | 5 hrs        | app. +1.3 log cfu/g | Ukuku and Sapers, 2007 |
|                   | Mixed melon/fresh cut         | 9              | 10°C                              | app. 2 log cfu/g | 9 days       | app. +2 log cfu/g | Ukuku and Sapers, 2007 |
|                   | Mixed melon/fresh cut         | 9              | 10°C                              | app. 2 log cfu/g | 15 days      | 0 cfu/g           | Ukuku and Sapers, 2007 |
|                   | Mixed melon/fresh cut         | 9              | 22°C                              | app. 2 log cfu/g | 3 days       | app. +2.3 log cfu/g | Ukuku and Sapers, 2007 |
|                   | Tomato                        | 11             | 25°C; 60% RH; inoculated on smooth surface; laboratory-etched tomatoes | app. 5 log cfu/g | 14 days       | not detected        | Yuk et al., 2007 |
|                   | Tomato                        | 11             | 25°C; 60% RH; inoculated on smooth surface; pilot plant-etched tomatoes | app. 6 log cfu/g | 14 days       | not detected        | Yuk et al., 2007 |
### Pathogen

- **Tomato**
  - **Food item(s):** Tomato
  - **FoNAO Category:** 11
  - **Experimental conditions/treatment:** 25°C; 60%; inoculated on app. 6 log cfu/g etched marks of tomatoes; pilot plant-etched tomatoes
  - **Inoculation:** 7 days
  - **Treatment time:** 7 days
  - **Increase/ decrease:** app. -3 log cfu/g
  - **Reference(s):** Yuk et al., 2007

- **Salmonella Typhimurium**
  - **Iceberg lettuce/shredded**
    - **Food item(s):** Iceberg lettuce/shredded
    - **FoNAO Category:** 15
    - **Experimental conditions/treatment:** 4°C
    - **Inoculation:** 6.4 log cfu/g
    - **Treatment time:** 14 days
    - **Increase/ decrease:** -1.1 log cfu/g
    - **Reference(s):** Chang and Fang, 2007
  - **Iceberg lettuce/shredded**
    - **Food item(s):** Iceberg lettuce/shredded
    - **FoNAO Category:** 15
    - **Experimental conditions/treatment:** 22°C
    - **Inoculation:** 6.4 log cfu/g
    - **Treatment time:** 3 days
    - **Increase/ decrease:** +2.86 log cfu/g
    - **Reference(s):** Chang and Fang, 2007
  - **Lettuce/minimally processed**
    - **Food item(s):** Lettuce/minimally processed
    - **FoNAO Category:** 15
    - **Experimental conditions/treatment:** 4°C
    - **Inoculation:** 6.3 log cfu/g
    - **Treatment time:** 5 days
    - **Increase/ decrease:** -1.23 log cfu/g
    - **Reference(s):** Ergönül, 2011
  - **Lettuce/minimally processed**
    - **Food item(s):** Lettuce/minimally processed
    - **FoNAO Category:** 15
    - **Experimental conditions/treatment:** 4°C
    - **Inoculation:** 6.3 log cfu/g
    - **Treatment time:** 7 days
    - **Increase/ decrease:** -1.07 log cfu/g
    - **Reference(s):** Ergönül, 2011
  - **Lettuce/minimally processed**
    - **Food item(s):** Lettuce/minimally processed
    - **FoNAO Category:** 15
    - **Experimental conditions/treatment:** 20°C
    - **Inoculation:** 6.3 log cfu/g
    - **Treatment time:** 5 days
    - **Increase/ decrease:** +0.88 log cfu/g
    - **Reference(s):** Ergönül, 2011
  - **Lettuce/minimally processed**
    - **Food item(s):** Lettuce/minimally processed
    - **FoNAO Category:** 15
    - **Experimental conditions/treatment:** 20°C
    - **Inoculation:** 6.3 log cfu/g
    - **Treatment time:** 7 days
    - **Increase/ decrease:** +0.04 log cfu/g
    - **Reference(s):** Ergönül, 2011
  - **Romaine lettuce leaves**
    - **Food item(s):** Romaine lettuce leaves
    - **FoNAO Category:** 15
    - **Experimental conditions/treatment:** Air; 8°C
    - **Inoculation:** 5.4 log cfu/g
    - **Treatment time:** 7 days
    - **Increase/ decrease:** app. -2 log cfu/g
    - **Reference(s):** Horev et al., 2012
  - **Romaine lettuce leaves**
    - **Food item(s):** Romaine lettuce leaves
    - **FoNAO Category:** 15
    - **Experimental conditions/treatment:** 8°C; PMA
    - **Inoculation:** 5.4 log cfu/g
    - **Treatment time:** 7 days
    - **Increase/ decrease:** app. -1.8 log cfu/g
    - **Reference(s):** Horev et al., 2012
  - **Romaine lettuce leaves**
    - **Food item(s):** Romaine lettuce leaves
    - **FoNAO Category:** 15
    - **Experimental conditions/treatment:** AMA; 8°C
    - **Inoculation:** 5.4 log cfu/g
    - **Treatment time:** 7 days
    - **Increase/ decrease:** app. -0.3 log cfu/g
    - **Reference(s):** Horev et al., 2012
  - **Parsley leaves**
    - **Food item(s):** Parsley leaves
    - **FoNAO Category:** 17
    - **Experimental conditions/treatment:** Spray irrigation during morning hours
    - **Inoculation:** 8.5 log cfu/ml
    - **Treatment time:** 48 hrs
    - **Increase/ decrease:** -3 log cfu/ml
    - **Reference(s):** Kisluk and Yaron, 2012
  - **Parsley leaves**
    - **Food item(s):** Parsley leaves
    - **FoNAO Category:** 17
    - **Experimental conditions/treatment:** Spray irrigation during morning hours
    - **Inoculation:** 8.5 log cfu/ml
    - **Treatment time:** 48 hrs
    - **Increase/ decrease:** -3 log cfu/ml
    - **Reference(s):** Kisluk and Yaron, 2012
  - **Parsley**
    - **Food item(s):** Parsley
    - **FoNAO Category:** 16
    - **Experimental conditions/treatment:** 1600 ppm chlorine
    - **Inoculation:** -3 log cfu/g
    - **Reference(s):** Lapidot et al., 2006
  - **Parsley**
    - **Food item(s):** Parsley
    - **FoNAO Category:** 16
    - **Experimental conditions/treatment:** 4°C; rinsing with water
    - **Inoculation:** -1 log cfu/g
    - **Reference(s):** Lapidot et al., 2006
  - **Parsley**
    - **Food item(s):** Parsley
    - **FoNAO Category:** 16
    - **Experimental conditions/treatment:** 4°C; rinsing with chlorine (100 mg/L)
    - **Inoculation:** -1.7 log cfu/g
    - **Reference(s):** Lapidot et al., 2006
  - **Parsley**
    - **Food item(s):** Parsley
    - **FoNAO Category:** 16
    - **Experimental conditions/treatment:** 4°C; rinsing with water
    - **Inoculation:** -0.3 log cfu/g
    - **Reference(s):** Lapidot et al., 2006

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| Pathogen          | Food item(s)         | FoNAO Category | Experimental conditions/treatment | Inoculation | Treatment time | Increase/ decrease | Reference(s)                  |
|------------------|----------------------|----------------|-----------------------------------|-------------|----------------|-------------------|-------------------------------|
|                  | Parsley              | 16             | 4°C; rinsing with chlorine (100 mg/L) | 7 days      | -1.4 log cfu/g |                   | Lapidot et al., 2006         |
|                  | Jalapeno extracts    | 1              | 37°C; OD measurements following inoculation | 4 hrs   | growth rates significantly higher than in other produce extracts | Nutt et al., 2003 |
|                  | Broccoli and lettuce extracts | 1 | 37°C; OD measurements following inoculation | 5 hrs | significantly higher OD600 values | Nutt et al., 2003 |
|                  | Cantaloupe           | 9              | Air; 3.7°C                        | 8.2 log cfu/melon | 200 hrs | -4.7 log cfu/fruit | Salgado et al., 2009 |
|                  | Cantaloupe           | 9              | AMA; 3.7°C                        | 8.2 log cfu/melon | 200 hrs | -4.3 log cfu/fruit | Salgado et al., 2009 |
| *Salmonella Saintpaul* | Jalapeno peppers/flesh | 12           | 4°C                              | app. 3.3 log cfu/g | 6 weeks | app. -2.5 log cfu/g | Liao et al., 2010 |
|                  | Jalapeno peppers/flesh | 12           | 4°C                              | app. 3.3 log cfu/g | 8 weeks | app. -2 log cfu/g | Liao et al., 2010 |
| *Shigella boydii* | Bean salad           | 36             | 4°C                              | 10^7 cfu/g | 5 days | app. -10^7 cfu/g | Agle et al., 2005 |
|                  | Bean salad           | 36             | 23°C                             | 10^7 cfu/g | 1 day | app. +10^3 cfu/g | Agle et al., 2005 |
|                  | Bean salad           | 36             | 23°C                             | 10^7 cfu/g | 1 day | app. -10^3 cfu/g | Agle et al., 2005 |
| *Shigella flexneri* | Mixed lettuce/minimally processed | 17 | 12°C; EMA                        | app. 6 log cfu/g | 7 days | app. +0.3 log cfu/g | Bagamboula et al., 2002 |
|                  | Mixed lettuce/minimally processed | 17 | 6°C; EMA                        | app. 6 log cfu/g | 7 days | app. +0.2 log cfu/g | Bagamboula et al., 2002 |
|                  | Carrots/grated/minimally processed | 19 | 12°C; EMA                        | app. 5.5 log cfu/g | 7 days | app. -1 log cfu/g | Bagamboula et al., 2002 |
|                  | Carrots/grated/minimally processed | 19 | 6°C; EMA                        | app. 5.5 log cfu/g | 7 days | app. -3.5 log cfu/g | Bagamboula et al., 2002 |
|                  | Bell peppers/chopped/minimally processed | 12 | 12°C; EMA                        | app. 4.5 log cfu/g | 7 days | app. -0.5 log cfu/g | Bagamboula et al., 2002 |
| Pathogen               | Food item(s)                          | FoNAO Category | Experimental conditions/treatment | Inoculation | Treatment time | Increase/ decrease | Reference(s)          |
|------------------------|---------------------------------------|----------------|-----------------------------------|-------------|----------------|---------------------|------------------------|
|                        | Bell peppers/chopped/minimally processed | 12              | 6°C; EMA                           | app. 4.5 log cfu/g | 7 days          | app. -1.2 log cfu/g | Bagamboula et al., 2002 |
| *Shigella sonnei*      | Mixed lettuce/minimally processed    | 17              | 12°C; EMA                          | app. 5.8 log cfu/g | 7 days          | app. +0.2 log cfu/g | Bagamboula et al., 2002 |
|                        | Mixed lettuce/minimally processed    | 17              | 6°C; EMA                           | app. 5.8 log cfu/g | 7 days          | app. -0.9 log cfu/g | Bagamboula et al., 2002 |
|                        | Carrots/grated/minimally processed   | 19              | 12°C; EMA                          | app. 5.5 log cfu/g | 7 days          | app. -1.5 log cfu/g | Bagamboula et al., 2002 |
|                        | Carrots/grated/minimally processed   | 19              | 6°C; EMA                           | app. 5.5 log cfu/g | 7 days          | app. -3.5 log cfu/g | Bagamboula et al., 2002 |
|                        | Bell peppers/chopped/minimally processed | 12              | 12°C; EMA                          | app. 4.5 log cfu/g | 7 days          | app. -2.5 log cfu/g | Bagamboula et al., 2002 |
|                        | Bell peppers/chopped/minimally processed | 12              | 6°C; EMA                           | app. 4.5 log cfu/g | 7 days          | app. -1.6 log cfu/g | Bagamboula et al., 2002 |
|                        | Tomato/smooth/surfaces               | 11              | 8°C                                | app. 6 log cfu/g | 28 days         | not detected^a     | Warren et al., 2007    |
|                        | Potato salad                          | 11              | 13°C; 85% RH                       | app. 6 log cfu/g | 2 days          | not detected^a     | Warren et al., 2007    |
| *Yersinia enterocolitica* | Orange juice                         | 5               | 4°C; pH 3.9                        | 6.8 log cfu/ml | 72 hrs          | -1.7 log cfu/ml    | Abdela et al., 2011    |
|                        | Orange juice                          | 5               | 4°C; pH 7; NaOH                    | 6.8 log cfu/ml | 3 hrs           | -0.3 log cfu/ml    | Abdela et al., 2011    |
|                        | Orange juice                          | 5               | 4°C; pH 7; NaOH                    | 6.8 log cfu/ml | 168 hrs         | 0 log cfu/ml       | Abdela et al., 2011    |
| *Yersinia pseudotuberculosis* | Orange juice                         | 5               | 4°C; pH 3.9                        | 7 log cfu/ml  | 168 hrs         | -3.3 log cfu/ml    | Abdela et al., 2011    |
|                        | Orange juice                          | 5               | 4°C; pH 7; NaOH                    | 7 log cfu/ml  | 24 hrs          | -0.8 log cfu/ml    | Abdela et al., 2011    |
|                        | Orange juice                          | 5               | 4°C; pH 7; NaOH                    | 7 log cfu/ml  | 168 hrs         | -0.1 log cfu/ml    | Abdela et al., 2011    |
| Pathogen                                         | Food item(s)          | FoNAO Category | Experimental conditions/treatment | Inoculation                  | Treatment time | Increase/ decrease | Reference(s)              |
|------------------------------------------------|-----------------------|----------------|-----------------------------------|------------------------------|----------------|--------------------|--------------------------|
| Viruses                                         |                       |                |                                   |                              |                |                    |                          |
| Hepatitis A                                     | Lettuce/fresh         | 15             | 4°C; not washed                   | 4.48 log tissue culture      | 9 days         | -2.02 TCID50/ml    | Croci et al., 2002      |
|                                                 | vegetable/eaten raw   |                |                                   | infectious dose (TCID50)/ml  |                |                    |                          |
|                                                 | Lettuce/fresh         | 15             | 4°C; washed                       | 4.38 log tissue culture      | 9 days         | -1.97 TCID50/ml    | Croci et al., 2002      |
|                                                 | vegetable/eaten raw   |                |                                   | infectious dose (TCID50)/ml  |                |                    |                          |
|                                                 | Fennel/fresh          | 22             | 4°C; not washed                   | 4.32 log tissue culture      | 7 days         | -3.32 TCID50/ml    | Croci et al., 2002      |
|                                                 | vegetable/eaten raw   |                |                                   | infectious dose (TCID50)/ml  |                |                    |                          |
|                                                 | Fennel/fresh          | 22             | 4°C; washed                       | 4.37 log tissue culture      | 4 days         | -1.81 TCID50/ml    | Croci et al., 2002      |
|                                                 | vegetable/eaten raw   |                |                                   | infectious dose (TCID50)/ml  |                |                    |                          |
| Norovirus (MS2 Bacteriophage as surrogate)      | Carrots/fresh         | 19             | 4°C                               | app. 7 log pfu/g             | 87 days        | app. -1.7 log pfu/g| Dawson et al., 2005    |
|                                                 | produce               |                |                                   |                              |                |                    |                          |
|                                                 | Cabbage/fresh         | 15             | 8°C                               | app. 7 log pfu/g             | 95 days        | app. -1.3 log pfu/g| Dawson et al., 2005    |
|                                                 | produce               |                |                                   |                              |                |                    |                          |
|                                                 | Carrots/fresh         | 19             | 2°C                               | app. 7 log pfu/g             | 43 days        | app. -3 log pfu/g  | Dawson et al., 2005    |
|                                                 | produce               |                |                                   |                              |                |                    |                          |
|                                                 | Orange                | 5              | 4°C; refrigeration                 | 6 log PFU/ml                 | 21 days        | 0 cfu              | Horm and D’Souza, 2011  |
|                                                 |                      |                |                                   |                              |                |                    |                          |
|                                                 | Pomegranate juice     | 8              | 4°C; refrigeration                 | 6 log PFU/ml                 | 21 days        | -1.4 log cfu       | Horm and D’Souza, 2011  |
| Human norovirus (feline calicivirus FCV-F9 as surrogate) | Orange                | 5              | 4°C; refrigeration                 | app. 6 log pfu/g             | 14 days        | -6 log pfu/g       | Horm and D’Souza, 2011  |
|                                                 |                      |                |                                   |                              |                |                    |                          |
|                                                 | Pomegranate juice     | 8              | 4°C; refrigeration                 | app. 6 log pfu/g             | 14 days        | -6 log pfu/g       | Horm and D’Souza, 2011  |
|                                                 |                      |                |                                   |                              |                |                    |                          |
|                                                 | Orange juice          | 5              | 4°C                               | app. 6 log pfu/g             | 14 days        | not detected"      | Horm and D’Souza, 2011  |
## Pathogen

| Pathogen                                      | Food item(s)                | FoNAO Category | Experimental conditions/treatment | Inoculation | Treatment time | Increase/ decrease | Reference(s)       |
|-----------------------------------------------|-----------------------------|----------------|----------------------------------|-------------|----------------|--------------------|---------------------|
| Norovirus (murine norovirus MNV-1 as surrogate) | Orange juice and pomegranate juice/blends | 8; 5           | 4°C                              | app. 5.5 log pfu/g | 1 day           | not detected*     | Horm and D’Souza, 2011 |
|                                               | Pomegranate juice           | 8              | 4°C                              | app. 5.5 log pfu/g | 21 days        | not detected*    | Horm and D’Souza, 2011 |
| Norovirus (feline calicivirus as surrogate)   | Orange                      | 5              | 4°C; refrigeration                | 5 log pfu/ml | 7 days         | complete reduction* | Horm and D’Souza, 2011 |
|                                               | Pomegranate juice           | 8              | 4°C; refrigeration                | 5 log pfu/ml | 7 days         | complete reduction* | Horm and D’Souza, 2011 |
| Rotavirus (SA11)                              | Pineapple juice/fresh       | 8              | 28°C; pH 3.60 ± 0.06             | 3 hrs       |                | 98% decline       | Leong et al., 2008  |
|                                               | Papaya juice/fresh          | 8              | 28°C; pH 5.13 ± 0.06             | 3 hrs       |                | no increase/decrease* | Leong et al., 2008  |
|                                               | Honeydew melon juice/fresh  | 9              | 28°C; pH 6.30 ± 0.21             | 3 hrs       |                | no increase/decrease* | Leong et al., 2008  |
| Hepatitis A                                   | Spinach                     | 15             | 5.4 ± 1.2 °C; moisture and gas-permeable packages | 4 weeks     | app. 1 log pfu/leaf (survival 5%) | Shieh et al., 2009 |
|                                               | Onion                       | 22             | 3°C; cold storage                | 3.26 log pfu/onion | 29 days     | -1.17 log pfu/onion | Sun et al., 2012   |
|                                               | Onion                       | 22             | 10.3°C - 23.4°C                  | 4.57 log pfu/onion | 16 days     | -1.15 log pfu/onion | Sun et al., 2012   |
|                                               | Lettuce/fresh vegetable/eaten raw | 15           | 4°C; not washed                  | 4.48 log tissue culture infectious dose (TCID50)/ml | 9 days     | -2.02 TCID50/ml     | Croci et al., 2002  |

* no quantitative data reported

Supporting publications 2013:EN-402

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Table 18: Colonisation behaviour of pathogenic bacteria, linked to FoNAO with high water content.

| Pathogen | FoNAO Category | Food item(s) | Attachment* | Biofilm Formation* | Internalisation* | Details\(^b\) | Reference(s) |
|----------|---------------|--------------|-------------|-------------------|-----------------|------------|--------------|
| *Bacillus cereus* (six different strains) | 15 | Cabbage | yes | yes | n.d. | increasing attachment strength between 1 and 24 h, biofilm formed at 10°C after 24 h | Elhariry, 2011 |
| 15 | Lettuce | yes | yes | n.d. | increasing attachment strength between 1 and 24 h, biofilm formed at 10°C after 24 h | Elhariry, 2011 |
| *Escherichia coli* O157:H7 | 5 | Oranges | n.d. | n.d. | yes | NR | Eblen et al., 2004 |
| 6 | Apple | n.d. | n.d. | yes | NR | Fatemi et al., 2006 |
| 6 | Apple | yes | n.d. | n.d. | NR | Hassan and Frank, 2004 |
| 7 | Peaches and plums | yes | yes, exopolysaccharide | n.d. | visibly attached after 30 s and 1 h | Collignon and Korsten, 2010 |
| 15 | Lettuce | n.d. | n.d. | yes | NR | Dinu and Bach, 2011 |
| 15 | Lettuce leaves (lettuce/spinach) | n.d. | n.d. | yes | internalisation in leaves | Erickson et al., 2010a |
| 15 | Leafy green vegetables | n.d. | n.d. | yes | internalisation via plant roots in the field is rare and when it occurs, O157:H7 does not persist 7 days later | Erickson et al., 2010b |
| 15 | Lettuce | yes | n.d. | n.d. | NR | Hassan and Frank, 2004 |
| 15 | Growing spinach leaves | n.d. | n.d. | no | NR | Hora et al., 2005 |
| 15 | Lettuce (Romaine) | yes | yes | n.d. | curli expressed at 20 and 37°C | Kim and Harrison, 2009 |
| 15 | Spinach | yes | n.d. | no | no conclusive evidence for natural entry into the plant interior | Mitra et al., 2009 |
| 15 | Cabbage | n.d | n.d. | yes | dependent on time of manure application (tropical field conditions) | Ongeng et al., 2011 |
| 15 | Cabbage | yes | yes | n.d. | produce surface did not affect bacterial attachment | Patel and Ravishakar, 2011 |
## Food of plant origin with high water content

### Pathogen

| Pathogen                  | FoNAO Category | Food item(s)      | Attachment | Biofilm Formation | Internalisation | Details                                      | Reference(s) |
|---------------------------|----------------|-------------------|------------|-------------------|-----------------|----------------------------------------------|--------------|
| **Listeria monocytogenes**| 7              | Peaches and plums | yes        | yes, exopolysaccharide | n.d.            | Immediate attachment                          | Collignon and Korsten, 2010 |
|                           | 20             | Potato            | yes        | n.d.              | n.d.            | NR                                            | Garrood et al., 2004   |
|                           | 21             | Radish            | yes        | n.d.              | n.d.            | Attachment at temperature-dependent rate      | Gorski et al., 2003   |
| **Listeria spp. including Listeria monocytogenes** | 15             | Cabbage           | yes        | yes               | n.d.            | attachment strength dependent on temperature | Ells and Hansen, 2006 |
| **Salmonella enterica**   | 11             | Tomatoes          | yes        | n.d.              | yes             | active colonisation of phyllosphere and fruit, preferentially via trichomes; colonisation dependent on tomato cultivar | Barak et al., 2011   |
|                           | 11             | Tomatoes          | yes        | n.d.              | n.d.            | attachment via cellulose                       | Shaw et al., 2011     |
| **Salmonella enterica serovars** | 15             | Cabbage           | yes        | yes, varied with strain | n.d.            | attachment strength: cabbage < iceberg lettuce < romaine lettuce | Patel and Sharma, 2010 |
|                           | 15             | Lettuce           | yes        | yes, varied with strain | n.d.            | attachment strength: cabbage < iceberg lettuce < romaine lettuce | Patel and Sharma, 2010 |
| **Salmonella Enteritidis**| 5              | Oranges           | n.d.       | n.d.              | yes             | internalisation frequency into the stem end segment (83%) was higher than into the middle side (19%) or blossom end (9%) | Eblen et al., 2004   |
|                           | 8              | Mango             | n.d.       | n.d.              | yes             |                                               | Penteado et al., 2004 |
| Pathogen               | FoNAO Category | Food item(s)                  | Attachment\(^a\) | Biofilm Formation\(^a\) | Internalisation\(^a\) | Details\(^b\)                                                                 | Reference(s)                                                                 |
|-----------------------|----------------|-------------------------------|------------------|-------------------------|-----------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| *Salmonella Montevideo* | 11             | Tomatoes, Tomatillo           | yes              | n.d.                    | n.d.                  | attached within 90 min                                                    | Iturriaga et al., 2003                                                        |
|                       | 11             | Tomatoes                      | yes              | yes                     | n.d.                  | growth enforced by high temperature and humidity                          | Iturriaga et al., 2007                                                        |
|                       | 11             | Tomatoes                      | n.d.             | n.d.                    | no                    | NR                                                                          | Miles et al., 2009                                                           |
| *Salmonella spp.*     | 8              | Mango                         | yes              | n.d.                    | yes                   | microorganism source: Water for hydrothermal treatment; active internalisation in intact fruit | Branquinho Bordini et al., 2007                                               |
|                       | 9              | Cantaloupe                    | yes              | n.d.                    | n.d.                  | no reduction by different washing methods                                  | Ukuku and Fett, 2006                                                          |
| *Salmonella Typhi*    | 8              | Guava                         | yes              | yes                     | n.d.                  | attachment potential increased with contact time                          | Tang et al., 2012                                                            |
|                       | 8              | Mango                         | yes              | yes                     | n.d.                  | attachment potential increased with contact time                          | Tang et al., 2012                                                            |
|                       | 13             | Cucumber                      | yes              | yes                     | n.d.                  | attachment potential increased with contact time                          | Tang et al., 2012                                                            |
| *Salmonella Typhimurium* | n.s.         | Vegetables                    | yes              | n.d.                    | n.d.                  | must be metabolically active to ensure attachment                          | Saggers et al., 2008                                                         |
|                       | 15/16          | Leafy green vegetables and fresh herbs | n.d.             | n.d.                    | yes                   | level of internalisation largely varies among plants and within the same crop | Golberg et al., 2011                                                         |
|                       | 7              | Peaches and plums             | yes              | yes, exopolysaccharide  | n.d.                  | Immediate attachment                                                       | Collignon and Korsten, 2010                                                   |
|                       | 8              | Mango                         | n.d.             | n.d.                    | yes                   | pulp entered by vascular elements and lenticels                            | Soto et al., 2007                                                            |
|                       | 11             | Tomatoes                      | yes              | n.d.                    | yes                   | active internalisation via tomato leaves                                    | Gu et al., 2011                                                              |
|                       | 15             | Lettuce                       | n.d.             | n.d.                    | yes                   | internalisation in leaves, not roots; increased internalisation due to extreme weather events (drought, storm) at high inocula | Ge et al., 2012 (incl. Corrigendum)                                           |
| Pathogen     | FoNAO Category | Food item(s)       | Attachment | Biofilm Formation | Internalisation | Details                                                                                           | Reference(s) |
|--------------|----------------|--------------------|------------|-------------------|----------------|-----------------------------------------------------------------------------------------------|--------------|
| Staphylococcus aureus | 7              | Peaches and plums  | yes        | yes, exopolysaccharide | n.d.           | visibly attached after 30 s and 1 h                                                             | Collignon and Korsten, 2010 |
|              |                |                    |            |                   |                |                                                                                                |              |
|              | 15             | Leafy green vegetables | n.d.      | yes                | n.d.           | osmoregulated periplasmic glucans play crucial role in growth and biofilm formation             | Liu et al., 2009 |
|              |                |                    |            |                   |                |                                                                                                |              |
|              |                | Cabbage            | n.d.       | n.d.              | yes            | dependent on time of manure application (tropical field conditions)                            | Ongeng et al., 2011 |
|              |                | Green onion        | n.d.       | n.d.              | yes            | internalisation in leaves and roots; increased internalisation due to extreme weather events (drought, storm) at high inocula | Ge et al., 2012 (incl. Corrigendum) |

*n.d. = not determined; NR= not reported
Table 19: Treatments for mitigating contamination of pathogenic bacteria, viruses and parasites linked to FoNAO with high water content. AA; Ascorbic Acid, CA; Citric Acid, LA; Lactic Acid.

| Pathogen                     | Food item(s) | FoNAO Category | Treatment | Treatment characterisation | Conditions (concentrations)\(^a\) | Treatment time\(^a\) | Reduction Effect | Reference(s)         |
|------------------------------|--------------|----------------|-----------|---------------------------|-----------------------------------|----------------------|-------------------|---------------------|
| **Bacteria**                 |              |                |           |                           |                                    |                      |                   |                     |
| Bacillus cereus              | Mango pulp   | 8              | Bovicin HC5 | Chemical                  | Bacteriocin concentration 100 AU ml\(^{-1}\); pH 4.0; 30°C | 24 h                 | 7 log units       | de Carvalho et al., 2007 |
|                             | Mango pulp   | 8              | Nisin      | Chemical                  | Bacteriocin concentration 100 AU ml\(^{-1}\); pH 4.0; 30°C | 24 h                 | 7 log units       | de Carvalho et al., 2007 |
|                             | Green olive  | 35             | Fermentation | Physical                  | heat shock (85°C for 10 min) and inoculation with Lactobacillus plantarum | n.s.                 | Rate of inactivation: - 2.21 log CFU/day | Panagou et al., 2008 |
| Escherichia coli            | Green leaf lettuce | 15          | Ozone    | Chemical                  | 2 mg/l, 10°C, different incubation time for bacteria (6 h, 12 h, 48 h) | 2 min                 | 99.9% (6 h incubation) | Olmez and Temur, 2010 |
|                             | Green leaf lettuce | 15          | Chlorine | Chemical                  | 100 mg/l, 10°C, different incubation time for bacteria (6 h, 12 h, 48 h) | 2 min                 | 99.9% (6 h incubation) | Olmez and Temur, 2010 |
|                             | Green leaf lettuce | 15          | Organic acid mixture | Chemical | 0.25 g/100g CA + 0.50 g/100g AA, 10°C (6 h, 12 h, 48 h) | 2 min                 | 99.9% (6 h incubation) | Olmez and Temur, 2010 |
| Escherichia coli O157:H7 (EHEC) | Lettuce    | 15            | Epiphytic bacteria | Biological | Co-inoculation of Enterobacteria 3 days asburiae and Escherichia coli O157:H7 (1:1) | 26-fold reduction | Cooley et al., 2006 |
| Carrot/pomegranate juice blend juices | 19/8      | Pomegranate juice | Biological | 40% pomegranate juice blend with carrot juices | n.s. | 2 log reduction | Ibrahim et al., 2011 |
| Apple/pomegranate juice blend juices | 6/9      | Pomegranate juice | Biological | 40% pomegranate juice blend with apple juices | n.s. | 2 log reduction | Ibrahim et al., 2011 |
| Baby romaine lettuce      | 15          | Bacteriophage cocktail (BEC8) + transcinnamaldehyde | Biological + Chemical | 10\(^8\) PFU/leaf; 0.5% | 10 min | no survivors\(^a\) | Viazis et al., 2011 |
| Pathogen | Food item(s) | FoNAO Category | Treatment | Treatment characterisation | Conditions (concentrations)\(^a\) | Treatment time\(^a\) | Reduction Effect | Reference(s) |
|----------|--------------|----------------|-----------|--------------------------|---------------------------------|----------------|----------------|--------------|
| *Escherichia coli* O157:H7 (EHEC) | Baby spinach | 15 | Bacteriophage cocktail (BEC8) + transcinnamaldehyde | Biological + Chemical | 10⁶ PFU/leaf; 0.5% | 10 min | no survivors\(^a\) | Viazis et al., 2011 |
| | Shredded carrots | 19 | Sodium Hypochlorite (SH) and Acidified Sodium Chlorite (ASC) | Chemical | SH 200 mg/L; ASC 100 mg/L | n.s. | 2 log reduction | Allende et al., 2007 |
| | Shredded carrots | 19 | Acidified Sodium Chlorite (ASC) | Chemical | ASC 1000 mg/L; 5°C | 14 days | no growth\(^a\) | Allende et al., 2007 |
| | Apple | 6 | Chlorine | Chemical | 2000 ppm active chlorine solution; 21°C (nonpunctured apple) | 2 min | 0.98 log CFU/cm² of surface | Burnett and Beuchat, 2002 |
| | Cantaloupe | 9 | Lactic acid combined with a surfactant | Chemical | 35°C, LA (1.5%) + Tergitol (0.3%) | 10 min | reduction up to 7.0 log CFU/cm² | Materon, 2003 |
| | Minimally processed artichokes | 23 | Chlorine | Chemical | 50 ppm | 5 min | 0.4 log CFU/g | Sanz et al., 2003 |
| | Minimally processed artichokes | 23 | Ascorbic acid + citric acid | Chemical | 0.02% CA and 0.2% AA | n.s. | 0.8 log CFU/g | Sanz et al., 2003 |
| | Apple cider | 6 | Glycerol monolaurate + eating | Chemical + Physical | 0.02% Glycerol monolaurate; 50°C (5 min) | 15 min | 5.0 log CFU/ml | Annamalai et al., 2003 |
| | Ready to eat iceberg lettuce | 15 | Chlorinated water + temperature | Chemical + Physical | 100 mg/l total chlorine; 47°C | 3 min | 2 log CFU/g | Delaquis et al., 2002 |
| | Orange juice | 5 | Ozone + mild heating | Chemical + Physical | Ozone: 0.9 g/h; 50°C | 75 min | undetectable (reduction ~5 log CFU/ml) | Williams et al., 2004 |
| Pathogen                  | Food item(s)                                      | FoNAO Category | Treatment | Treatment characterisation | Conditions (concentrations)¹ | Treatment time² | Reduction Effect | Reference(s)       |
|--------------------------|--------------------------------------------------|----------------|-----------|---------------------------|------------------------------|-----------------|------------------|-------------------|
| Apple cider              | 6 Ozone + mild heating                           | Chemical + Physical | Ozone: 0.9 g/h; 50°C | 45 min | undetectable (reduction ~ 5 log CPU/ml) | Williams et al., 2004 |
| Tomato juice             | 11 High pressure                                | Physical       | 4 times at 300 Mpa for in total 40 min; room temperature | total of 40 min | max. inactivation² | Bari et al., 2007 |
| Orange juice             | 5 Dynamic high pressure                         | Physical       | 200 MPa after 5 and 3 passes at 25°C | n.s. | 5 log CFU/ml | Tahiri et al., 2006 |
| *Listeria innocua*       | Unpasteurized and pasteurized apple juice        | Chemical       | 500 ppm potassium sorbate; pH 3.3; 30°C | 4-8 h | app. 5 log CFU/ml | Corte et al., 2004 |
|                          | Unpasteurized and pasteurized apple juice        | Chemical       | 3000 ppm vanillin; pH 3.3 or 3.8; 30°C | 4-8 h | app. 5 log CFU/ml | Corte et al., 2004 |
| *Listeria innocua*       | Processed orange juice                          | Chemical       | 1100 ppm vanillin; 57°C | 2.2 min | 6.5 log reduction | Char et al., 2009 |
| (surrogate for *Listeria*| Processed orange juice                          | Chemical       | 0 ppm vanillin; 57°C | 8 min | 6.3 log reduction | Char et al., 2009 |
|                          | Processed orange juice                          | Chemical       | 700 ppm vanillin; 61°C | 2.3 min | 7 log reduction | Char et al., 2009 |
|                          | Processed orange juice                          | Chemical       | 0 ppm vanillin; 61°C | 1.8 min | 7 log reduction | Char et al., 2009 |
| *Listeria monocytogenes* | Lettuce                                          | Chemical       | nisin–coagulin cocktail (1:1); 4°C | 48 h | 1.5 log units | Allende et al., 2007 |
|                          | Tomatoes                                         | Chemical       | chlorine 200 ppm; 72 h attachment time | 1 min | 2.26 log CFU | Ijabadeniyi et al., 2011 |
|                          | Spinach                                          | Chemical       | chlorine 200 ppm; 30 min attachment time | 1 min | 3.01 log CFU | Ijabadeniyi et al., 2011 |
|                          | Ready to eat iceberg lettuce                     | Chemical + Physical | 100 mg/l total chlorine; 4 or 47°C | 3 min | 1 log CFU/g | Delaquis et al., 2002 |
|                          | Apple slices                                     | Physical       | Cesium-137 gamma radiation source: 1.6 kGy | n.s. | 99.9% | Fan et al., 2005 |
|                          | Spinach                                          | Chemical       | 1 g/l; 7 days storage 4°C | 10 min | 3.5 log CFU/cm² | Engels et al., 2012 |

¹ Conditions (concentrations) may include concentrations, temperatures, and other relevant factors.
² Treatment time refers to the duration of the treatment.
³ Reduction Effect: The reduction in bacterial counts typically expressed in log units.

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### Pathogen: Listeria monocytogenes

| Pathogen          | Food item(s) | FoNAO Category | Treatment | Treatment characterisation | Conditions (concentrations)a | Treatment timea | Reduction Effect | Reference(s)            |
|-------------------|--------------|----------------|-----------|----------------------------|-----------------------------|----------------|------------------|------------------------|
| Lettuce           | 15 Gallotannin | Chemical       | 1 g/l; 7 days storage 4°C | 10 min | app. 2 log CFU/cm² | Engels et al., 2012 |
| Green leaf lettuce | 15 Ozone     | Chemical       | 2 mg/l, 10°C, different incubation time for bacteria (6 h, 12 h, 48 h) | 2 min | 99.9% (6h incubation) | Olmez and Temur, 2010 |
| Green leaf lettuce | 15 Chlorine  | Chemical       | 100 mg/l, 10°C, different incubation time for bacteria (6 h, 12 h, 48 h) | 2 min | 99.9% (6h incubation) | Olmez and Temur, 2010 |
| Green leaf lettuce | 15 Organic acid mixture | Chemical | 0.25 g/100 g CA + 0.50 g/100 g AA, 10°C (6 h, 12 h, 48 h) | 2 min | 99.9% (6h incubation) | Olmez and Temur, 2010 |
| Minimally processed artichokes | 23 Chlorine | Chemical | 50 ppm | 5 min | 0.9 log CFU/g | Sanz et al., 2003 |
| Minimally processed artichokes | 23 Ascorbic acid + citric acid | Chemical | 0.02% CA and 0.2% AA | n.s. | 1.6 log CFU/g | Sanz et al., 2003 |
| Carrots/Lettuce | 19 or 15 Washing | Physical | n.s. | n.s. | slight reductionb | Martino et al., 2008 |
| Endive            | 15 Irradiation | Physical | gamma radiation: 0.6 kGy; flushed bags with air (5% CO₂, 5% O₂, 90% N₂ and 10% CO₂, 10% O₂, 80% N₂; 4°C) | n.s. | 3.09 log CFU/g | Niemira et al., 2005 |
| Cherry tomatoes   | 11 Irradiation, gamma | Physical | 1.25 kGy, 21+/− 2°C | n.s. | complete eliminationb | Todoriki et al., 2009 |

**Salmonella (Typhimurium, Montevideo, Javiana)**

| Pathogen          | Food item(s) | FoNAO Category | Treatment | Treatment characterisation | Conditions (concentrations)a | Treatment timea | Reduction Effect | Reference(s)            |
|-------------------|--------------|----------------|-----------|----------------------------|-----------------------------|----------------|------------------|------------------------|
| Whole Green Onions | 22 Irradiation, gamma | Physical | Various | n.s. | D-value of 0.32 kGy | Murugesan et al., 2011 |
| Concentrated orange juice | 5 Freezing + irradiation | Physical | -20°C; Cesium-137 gamma radiation source: 2.0 kGy | n.s. | 1.95 log CFU/ml | Niemira et al., 2003 |
| Concentrated orange juice | 5 Freezing + irradiation | Physical | -20°C; Cesium-137 gamma radiation source: 2.0 kGy | n.s. | 1.98 log CFU/ml | Niemira et al., 2003 |
| Pathogen      | Food item(s)       | FoNAO Category | Treatment | Treatment characterisation | Conditions (concentrations) | Treatment time | Reduction Effect | Reference(s)              |
|---------------|--------------------|----------------|-----------|----------------------------|-----------------------------|----------------|-----------------|------------------------|
| *Salmonella*  |                    |                |           |                            |                             |                |                 |                        |
| Enteritidis   | Cherry tomatoes    | 11             | Ozone     | Chemical                   | 20 mg/L                     | 20 min         | not detectable | Das et al., 2006     |
|               | Cherry tomatoes    | 11             | Ozone     | Chemical                   | 10 mg/L                     | 20 min         | not detectable | Das et al., 2006     |
|               | Cherry tomatoes    | 11             | Ozone     | Chemical                   | 5 mg/L (1 h after inoculation) | 20 min     | app. -4 log     | Das et al., 2006     |
|               | Cherry tomatoes    | 11             | Ozone     | Chemical                   | 5 mg/L (4 h after inoculation) | 20 min     | app. -2.5 log   | Das et al., 2006     |
| Enteritidis   | Concentrated orange juice | 5            | Freezing + irradiation | Physical                  | -20°C; Cesium-137 gamma radiation source: 2.0 kGy | n.s.        | 2.12 log CFU/ml | Niemira et al., 2003 |
| Enteritidis   | Concentrated orange juice | 5            | Freezing + irradiation | Physical                  | -20°C; Cesium-137 gamma radiation source: 2.0 kGy | n.s.        | 1.81 log CFU/ml | Niemira et al., 2003 |
| Javiana       | Tomatoes           | 11             | Biocontrol with Enterobacter asбурiae JX1 | Biological                | 6 log CFU/ml      | n.s.        | suppressing effect | Ye et al., 2009 |
| Montevideo    | Tomatoes           | 11             | Chlorine  | Chemical                   | 200 and 1000 mg/L, pH 6.5 | 5 min         | 4.5 - 5.0 log    | Iturriaga and Escartín et al., 2010 |
| *Salmonella*  | Carrot juice       | 19             | Lactic acid + copper | Chemical                  | 2% LA; 50 ppm copper       | 12 h          | reduction from 2.5x10^7 to 2.8x10^2 | Ibrahim et al., 2008 |
| Enteritidis   | Cantaloupe         | 9              | Hydrogen peroxide | Chemical                  | 5%; 70°C                    | 60 sec         | 3.8 log CFU/cm²  | Ukuku et al., 2004   |
|               | Orange juice       | 5              | Ozone + mild heating | Chemical + Physical       | Ozone: 0.9 g/h; 50°C        | 15 min         | undetectable    | Williams et al., 2004 |
|               | Apple cider        | 6              | Ozone + mild heating | Chemical + Physical       | Ozone: 0.9 g/h; 50°C        | 15 min         | complete elimination | Williams et al., 2004 |
|               | Cantaloupe         | 9              | Hot water  | Physical                   | 97°C                        | 60 sec         | 3.3 log CFU/cm²  | Ukuku et al., 2004   |
|               | Orange juice       | 5              | Sonication + high osmotic pressure storage | Physical                  | 50 ± 0.2 W, 20 kHz (range: 5.9-34.1 min); 650 g TSS/kg (24-82 h) | n.s. | approx. 5 log CFU/ml | Wong et al., 2012   |
| Stanley       | Concentrated orange juice | 5            | Freezing + irradiation | Physical                  | freezing + gamma radiation 2.0 freezing for 1 h |  | 2.17 log CFU/ml | Niemira et al., 2003 |
|               | Concentrated orange juice | 5            | Freezing + irradiation | Physical                  | freezing + nonirradiated    | 14 days        | 1.2 log CFU/ml  | Niemira et al., 2003  |
| Pathogen                          | Food item(s)            | FoNAO Category | Treatment                          | Treatment characterisation | Conditions (concentrations) | Treatment time | Reduction Effect | Reference(s)       |
|----------------------------------|-------------------------|----------------|------------------------------------|----------------------------|----------------------------|----------------|-----------------|-------------------|
| **Salmonella Stanley H0588**     | Concentrated orange juice | 5              | Freezing + irradiation             | Physical                   | freezing + gamma radiation 2.0 kGy | 14 days        | 3.3 log CFU/ml   | Niemira et al., 2003 |
| **Salmonella Typhimurium 14028** | Concentrated orange juice | 5              | Freezing + irradiation             | Physical                   | -20°C; Cesium-137 gamma radiation source: 2.0 kGy | n.s.           | 2.17 log CFU/ml  | Niemira et al., 2003 |
| **Salmonella Typhimurium**       | Concentrated orange juice | 5              | Freezing + irradiation             | Physical                   | freezing + gamma radiation 2.0 kGy | 1 h            | 1.29 log CFU/ml  | Niemira et al., 2003 |
| **Staphylococcus aureus**        | Vegetables              | Other          | Lactobacillus plantarum           | Biological                 | different inoculum sizes; storage at 4°C, 8°C and 12°C | 7 days         | inhibition at all tested temperatures | Scolari et al., 2004 |
| **Pesto**                        |                         |                |                                    | Chemical                   | AS-48 (15 µg/ml) + hydrocinnamic acid (5mM) | 24 h           | to 0 log CFU/g   | Grande et al., 2007 |
| **Napoletana sauce**             |                         |                |                                    | Chemical                   | AS-48 (15 µg/ml) + hydrocinnamic acid (5mM) | 24 h           | complete elimination | Grande et al., 2007 |
| **Green sauce**                  |                         |                |                                    | Chemical                   | AS-48 (15 µg/ml) + Carvacrol (31.5mM) | 8 h            | complete elimination | Grande et al., 2007 |
| **Yersinia enterocolitica**      | Laboratory prepared orange juice | 5              | Organic acid mixture               | Chemical                   | AA, LA, CA (Combination of two acids); 25°C | 20 min         | 3.06-4.07 log units/ml | Lucero-Estrada et al., 2010 |
| **Yersinia enterocolitica**      | Commercial prepared orange juice | 5              | Organic acid mixture               | Chemical                   | AA, LA, CA (Combination of two acids); 25°C | 10 min         | complete elimination | Lucero-Estrada et al., 2010 |
| **Parasites & Viruses**          |                         |                |                                    |                           |                                           |                |                 |                   |
| **Cryptosporidium parvum**       | Purple grape juice 4    |                | Hydrogen peroxide                  | Chemical                   | 0.03%                                     | ≥ 2 h          | > 99.9 %        | Kniel et al., 2003 |
| **White grape juice**            |                         |                | Hydrogen peroxide                  | Chemical                   | 0.03%                                     | ≥ 2 h          | > 99.9 %        | Kniel et al., 2003 |
| **Orange juice**                 |                         |                | Hydrogen peroxide                  | Chemical                   | 0.03%                                     | ≥ 2 h          | > 99.9 %        | Kniel et al., 2003 |
| **Apple cider**                  |                         |                | Hydrogen peroxide                  | Chemical                   | 0.03%                                     | ≥ 2 h          | > 99.0 %        | Kniel et al., 2003 |

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| Pathogen                                  | Food item(s)       | FoNAO Category | Treatment | Treatment characterisation | Conditions (concentrations) | Treatment time | Reduction Effect | Reference(s)               |
|------------------------------------------|--------------------|----------------|-----------|----------------------------|-----------------------------|----------------|-----------------|--------------------------|
| Murine norovirus 1 (surrogate for human noroviruses) | Spinach            | 15             | Blanching | Physical                   | 80°C                        | 1 min          | 2.44 log PFU reduction | Baert et al., 2008     |
|                                          |                    |                |           |                            |                             |                |                 |                          |
|                                          | Deep frozen onions and spinach | 22/15 | Peracetic acid (PAA) | Chemical | 20 ppm of PAA in demineralized water (pH 4.13) and in potable water (pH 7.70) | 5 min | 2.88 log PFU reduction | Baert et al., 2008 |
|                                          | Deep frozen onions and spinach | 22/15 | Washing       | Physical                  | n.s.                        |                 | 1 log PFU reduction | Baert et al., 2008 |

*a n.s.= not specified, b no quantitative data reported*
### Table 20: Outbreaks of disease caused by pathogenic bacteria, viruses, and parasites linked to FoNAO with high water content, EU countries.

| Pathogen                  | Food item                  | FoNAO category | Details (vehicle, source) | Country | Year | Number of cases | Number of hospitalisations | Number of deaths | Reference(s) |
|---------------------------|-----------------------------|----------------|---------------------------|---------|------|----------------|---------------------------|-----------------|--------------|
| **Pathogenic bacteria**   |                             |                |                           |         |      |                |                           |                 |              |
| *Bacillus cereus*         | Vegetables and juices and other products thereof | other | NR | France | 2009 | 2 | n.s. | 0 | ECDC, 2009 |
| Chinese cabbage           | 15 | farm (primary production) | Finland | 2010 | 2 | 0 | 0 | ECDC, 2010 |
| Salad                     | 36 | buffet | Germany | 2009 | 102 | 0 | 0 | ECDC, 2009 |
| Salad                     | 36 | NR | Finland | 2010 | 2 | 0 | 0 | ECDC, 2010 |
| Tomatoes                  | 37 | soup | Netherlands | 2009 | 12 | n.s. | n.s. | ECDC, 2009 |
| Canned food products      | 37 | NR | France | 2010 | 62 | 0 | 0 | ECDC, 2010 |
| **Clostridium botulinum** | Vegetables and juices and other products thereof | other | NR | France | 2010 | 5 | 4 | 1 | ECDC, 2010 |
| Green olives              | 35 | paste | France | 2011 | 9 | 9 | n.s. | Pingeon et al., 2011 |
| **Clostridium perfringens** | Vegetables and juices and other products thereof | other | NR | France | 2009 | 100 | 0 | 0 | ECDC, 2009 |
| Peas                      | 37 | soup | Netherlands | 2009 | 4 | n.s. | n.s. | ECDC, 2009 |
| Pathogen | Food item | FoNAO category | Details (vehicle, source) | Country | Year | Number of cases | Number of hospitalisations | Number of deaths | Reference(s) |
|----------|-----------|----------------|--------------------------|---------|------|----------------|--------------------------|----------------|-------------|
| Tomatoes | 37        | sauce, Pizza sauce | Netherlands | 2009 | 3 | n.s. | n.s. | ECDC, 2009 |
| Vegetables and juices and other products thereof | 37 | soup with crème | Belgium | 2009 | 19 | 0 | 0 | ECDC, 2009 |
| Clostridium spp. | Vegetables and juices and other products thereof | 37 | |  |  |  |  |  |  |
| Escherichia coli O157 | Lettuce | 15 | NR | Netherlands, Iceland | 2007 | 50 | 20 | n.s. | Friesema et al., 2008 |
| Lettuce (Iceberg) | 15 | locally produced | Sweden | 2005 | 120 | n.s. | n.s. | Söderström et al., 2005 |
| Escherichia coli O157:VT2 | Lettuce | 15 | NR | Sweden | 2005 | 135 | 11 | 0 | Söderström et al., 2008 |
| Lettuce (Iceberg) | 15 | locally produced | Switzerland | 2005 | 120 | n.s. | n.s. | Pakalniskiene et al., 2009 |
| Basil | 15 | fresh, pasta salad | Denmark | 2006 | 217 | n.s. | n.s. | Gajraj et al., 2012 |
| Lettuce (Iceberg) | 15 | NR | United Kingdom | 2003 | 145 | 0 | n.s. | Mertens et al., 2012 |
| Vegetable pasta salad | 2 | with curd cheese | Germany | 2009 | 26 | 2 | 0 | ECDC, 2009 |
| Salad | 36 | NR | United Kingdom | 2009 | 81 | 5 | n.s. | Severi et al., 2012 |
| Potatoes | 37 | with boiled codfish | Portugal | 2009 | 30 | 30 | 0 | ECDC, 2009 |

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| Pathogen                  | Food item                   | FoNAO category | Details (vehicle, source) | Country        | Year | Number of cases | Number of hospitalisations | Number of deaths | Reference(s)            |
|--------------------------|-----------------------------|----------------|---------------------------|----------------|------|-----------------|---------------------------|-----------------|------------------------|
| *Salmonella Enteritidis* | Chips and Salad             | 37             | NR                        | United Kingdom | 2005 | 85              | 17                        | n.s.            | Giraudon et al., 2009  |
| *Salmonella Napoli*      | Rucola                      | 15             | NR                        | Sweden         | 2009 | 5               | 0                         | 0               | ECDC, 2009              |
| *Salmonella Newport*     | Lettuce                     | 15             | NR                        | Northern Ireland | 2004 | 130             | 25                        | 0               | Irvine et al., 2009     |
| *Salmonella Newport, Salmonella Reading* | Lettuce (Iceberg) | 15             | NR                        | Finland        | 2008 | 108             | 15                        | 2               | Lienemann et al., 2011 |
| *Salmonella Panama*      | Fruit Juice                 | 1              | fresh                     | Netherlands    | 2008 | 33              | 10                        | 0               | Noel et al., 2010       |
| *Salmonella Paratyphi B var. Java* | Mixed lettuce leaves | 17             | NR                        | United Kingdom | 2010 | 130             | 16                        | 0               | ECDC, 2010              |
| *Salmonella Senftenberg* | Basil                       | 16             | fresh                     | United Kingdom | 2007 | 30              | 3                         | n.s.            | Pezzoli et al., 2007    |
| *Salmonella spp.*        | Vegetables and juices and other products thereof | other | NR                        | France         | 2010 | 2               | 2                         | 0               | ECDC, 2010              |
| *Salmonella Typhimurium* | Vegetables and juices and other products thereof | other | NR                        | France         | 2010 | 5               | 1                         | 0               | ECDC, 2010              |
| *Salmonella Typhimurium DT104B* | Lettuce (Iceberg) | 15             | from Spain                | Finland        | 2005 | 60              | n.s.                      | n.s.            | Takkinen et al., 2005   |
| *Shigella dysenteriae*   | Sugarsnaps                  | 14             | NR                        | Sweden         | 2009 | 35              | 0                         | 0               | ECDC, 2009; Löfdahl et al., 2009 |
| *Shigella flexneri*      | Fruit, berries and juices and other products thereof | l/other | NR                        | Poland         | 2010 | 2               | 1                         | 0               | ECDC, 2010              |
| Pathogen                       | Food item         | FoNAO category | Details (vehicle, source) | Country  | Year | Number of cases | Number of hospitalisations | Number of deaths | Reference(s)                                      |
|-------------------------------|-------------------|----------------|---------------------------|----------|------|-----------------|---------------------------|----------------|-------------------------------------------------|
| *Shigella sonnei*             | Sugar peas        | 14 NR          |                           | Denmark  | 2009 | 10              | 0                         | 0              | ECDC, 2009; Müller et al., 2009                 |
|                               | Salad             | 36 NR          |                           | Austria  | 2008 | 53              | 1 n.s.                    |                | Kuo et al., 2009                                |
|                               | Potatoes          | 37 with sauce  |                           | Spain    | 2005 | 196             | 9                         | 0              | Castell Monsalve et al., 2008                  |
| *Staphylococcus aureus*       | Beans             | 14 frozen      |                           | Belgium  | 2009 | 14              | 0                         | 0              | ECDC, 2009                                      |
|                               | Vegetables and    | 36 potato salad with onion |               | Slovakia | 2009 | 17              | 0                         | 0              | ECDC, 2009                                      |
|                               | juices and other  |               |                           |          |      |                 |                           |                |                                                 |
|                               | products thereof  |               |                           |          |      |                 |                           |                |                                                 |
| *Staphylococcus enterotoxins* | Vegetables        | other with chicken |                       | Portugal | 2009 | 40              | n.s.                      | 0              | ECDC, 2009                                      |
| unknown bacterial agents      | Beans             | 14 dried       |                           | Denmark  | 2010 | 105             | 0                         | 0              | ECDC, 2010                                      |
|                               | White beans       | 14 dried       |                           | Denmark  | 2010 | 16              | 0                         | 0              | ECDC, 2010                                      |
|                               | Beetroot          | 21 raw         |                           | Finland  | 2010 | 43              | 0                         | 0              | ECDC, 2010                                      |
|                               | Beetroot          | 21 raw         |                           | Finland  | 2010 | 36              | 0                         | 0              | ECDC, 2010                                      |
|                               | Beetroot          | 21 raw         |                           | Finland  | 2010 | 18              | 0                         | 0              | ECDC, 2010                                      |
|                               | Beetroot          | 21 raw         |                           | Finland  | 2010 | 14              | 0                         | 0              | ECDC, 2010                                      |
|                               | Beetroot          | 21 raw         |                           | Finland  | 2010 | 13              | 0                         | 0              | ECDC, 2010                                      |
|                               | Beetroot          | 21 raw         |                           | Finland  | 2010 | 10              | 0                         | 0              | ECDC, 2010                                      |
|                               | Beetroot          | 21 raw         |                           | Finland  | 2010 | 8               | 0                         | 0              | ECDC, 2010                                      |
| *Yersinia pseudotuberculosis* | Carrots           | 19 grated      |                           | Finland  | 2003 | 111             | 9 n.s.                    |                | Jalava et al., 2006                             |
| O:1                           | Carrots           | 19 grated      |                           | Finland  | 2006 | 104             | 2 n.s.                    |                | Rimhanen-Finne et al., 2009                     |
| **Viruses**                   |                   |                |                           |          |      |                 |                           |                |                                                 |
| Hepatitis A virus             | Tomatoes          | 38 semidried   |                           | France   | 2010 | 59              | 28                        | 0              | Gallot et al., 2011; Couturier, 2011            |
| Pathogen          | Food item          | FoNAO category | Details (vehicle, source) | Country       | Year | Number of cases | Number of hospitalisations | Number of deaths | Reference(s)                          |
|-------------------|--------------------|----------------|---------------------------|---------------|------|-----------------|----------------------------|-----------------|---------------------------------------|
|                   | Tomatoes           | 38             | semidried                 | Netherlands   | 2010 | 13              | 0                          | 0               | ECDC, 2010; Pettrignani et al., 2010  |
|                   | Tomatoes           | 38             | semidried                 | United Kingdom| 2011 | 7               | 4                          | 0               | Carvalho et al., 2012                 |
|                   | Vegetables and     | other          | NR                        | Finland       | 2006 | 400             | 0                          | n.s.            | Makary et al., 2009                  |
| Norovirus         | salads             |                |                           |               |      |                 |                            |                 |                                       |
|                   | Vegetables and     | other          | NR                        | Poland        | 2009 | 13              | 0                          | 0               | ECDC, 2009                            |
|                   | juices and other   |                |                           |               |      |                 |                            |                 |                                       |
|                   | juices and other   |                |                           |               |      |                 |                            |                 |                                       |
|                   | products thereof   |                |                           |               |      |                 |                            |                 |                                       |
|                   | Juice              | 1/other         | NR                        | Germany,      | 2009 | 38              | 6                          | 0               | Visser et al., 2010                  |
|                   |                   |                |                           | Netherlands   |      |                 |                            |                 |                                       |
|                   | Vegetables and     | other          | mixed cooked legumes      | Germany       | 2010 | 40              | 0                          | 0               | ECDC, 2010                            |
|                   | juices and other   |                |                           |               |      |                 |                            |                 |                                       |
|                   | juices and other   |                |                           |               |      |                 |                            |                 |                                       |
|                   | products thereof   |                |                           |               |      |                 |                            |                 |                                       |
| Fruits            | 1                  | NR             | Denmark                   | 2009 | 8              | 0                          | 0               | ECDC, 2009                            |
|                   | Strawberries       | 2              | farm (primary production) | Sweden        | 2010 | 7               | 0                          | 0               | ECDC, 2010                            |
|                   | Strawberries       | 2              | frozen                    | Germany       | 2012 | 11000           | n.s.                      | n.s.            | RKI, online                           |
|                   | Raspberries or     | 2/3            | frozen                    | Finland       | 2009 | 11              | 0                          | 0               | ECDC, 2009                            |
|                   | strawberries       |                |                           |               |      |                 |                            |                 |                                       |
|                   | Raspberries        | 3              | frozen                    | Denmark       | 2005 | 1043            | 23                        | n.s.            | Korsager et al., 2005                |
|                   | Raspberries        | 3              | frozen                    | France        | 2005 | 75              | 0                          | 0               | Cotterelle et al., 2005              |
|                   | Raspberries        | 3              | frozen                    | Finland       | 2009 | 210             | 0                          | 0               | ECDC, 2009                            |
|                   | Raspberries        | 3              | frozen, in dessert sauce  | Finland       | 2009 | 32              | 0                          | 0               | ECDC, 2009                            |

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| Pathogen     | Food item           | FoNAO category | Details (vehicle, source) | Country | Year | Number of cases | Number of hospitalisations | Number of deaths | Reference(s) |
|--------------|---------------------|----------------|--------------------------|---------|------|----------------|--------------------------|----------------|--------------|
| Norovirus    | Raspberries        | 3              | frozen, in layer cake    | Finland | 2009 | 205            | 3                        | 0              | ECDC, 2009   |
|              | Raspberries        | 3              | frozen, mixed with curd cheese | Finland | 2009 | 622            | 0                        | 0              | ECDC, 2009   |
|              | Raspberries        | 3              | mixed in curd cheese     | Finland | 2009 | 13             | 0                        | 0              | ECDC, 2009   |
|              | Raspberries        | 3              | NR                       | Sweden  | 2009 | 130            | 0                        | 0              | ECDC, 2009   |
|              | Raspberries        | 3              | farm (primary production)| Sweden  | 2010 | 21             | 0                        | 0              | ECDC, 2010   |
|              | Raspberries        | 3              | farm (primary production)| Sweden  | 2010 | 8              | 0                        | 0              | ECDC, 2010   |
|              | Raspberries        | 3              | frozen                   | Denmark | 2010 | 60             | 0                        | 0              | ECDC, 2010   |
|              | Raspberries        | 3              | frozen, from a farm      | Finland | 2010 | 90             | 0                        | 0              | ECDC, 2010   |
|              | Raspberries        | 3              | frozen, from a farm      | Finland | 2010 | 43             | 0                        | 0              | ECDC, 2010   |
|              | Raspberries        | 3              | frozen, imported from Serbia| Denmark | 2010 | 30             | 0                        | 0              | ECDC, 2010   |
|              | Raspberries        | 3              | NR                       | Denmark | 2010 | 5              | 1                        | 0              | ECDC, 2010   |
|              | Blackberries       | 4              | frozen                   | Germany | 2005 | 241            | 0                        | n.s.           | Fell et al., 2007 |
|              | Coleslaw, green Salad | 15           | NR                      | United Kingdom | 2007 | 60             | 0                        | n.s.           | Vivancos et al., 2009 |
| Pathogen         | Food item   | FoNAO category | Details (vehicle, source)⁴ | Country    | Year | Number of cases | Number of hospitalisations⁴ | Number of deaths⁵ | Reference(s)                           |
|-----------------|-------------|----------------|----------------------------|------------|------|----------------|----------------------------|-----------------|--------------------------------------|
| Norovirus       | Lettuce     | 15             | NR                         | Finland    | 2009 | 77             | 0                          | 0               | ECDC, 2009                            |
|                 | Lettuce (Lollo Bionda) | 15         | from France                | Denmark    | 2010 | 409            | 1                          | 0               | ECDC, 2010; Ethelberg et al., 2010    |
|                 | Lettuce (Romaine) | 15          | from Germany               | Denmark    | 2010 | 14             | 0                          | 0               | ECDC, 2010                            |
|                 | Salad       | 17             | NR                         | Austria    | 2006 | 172            | 10                         | 0               | Schmid et al., 2007                   |
|                 | Mixed salad | 17             | NR                         | United Kingdom | 2007 | 36             | n.s.                       | n.s.            | Showell et al., 2007                  |
|                 | Salad       | 17             | NR                         | Germany    | 2009 | 101            | 4                          | n.s.            | Wadl et al., 2010                     |
|                 | Carrots     | 19             | NR                         | Belgium    | 2009 | 2              | 0                          | 0               | ECDC, 2009                            |
|                 | Onion       | 22             | raw, chopped in a salad    | Finland    | 2009 | 52             | 0                          | 0               | ECDC, 2009                            |
|                 | Mixed vegetable salad | 36          | NR                         | United Kingdom | 2010 | 20             | 0                          | 0               | ECDC, 2010                            |
|                 | Potatoes    | 37             | cooked, peeled             | Germany    | 2010 | 41             | 0                          | 0               | ECDC, 2010                            |
| Parasites       | Cryptosporidium hominis | 12 or 19  | grated carrots, whole carrots in water, pepper in water | Denmark | 2005 | 99             | n.s.                       | n.s.            | Ethelberg et al., 2009               |
|                 | Cryptosporidium parvum | 16         | fresh                      | Sweden     | 2008 | 21             | 3                          | n.s.            | Insulander et al., 2008              |
| Pathogen                        | Food item       | FoNAO category | Details (vehicle, source) | Country | Year | Number of cases | Number of hospitalisations | Number of deaths | Reference(s) |
|--------------------------------|------------------|----------------|---------------------------|---------|------|-----------------|---------------------------|-----------------|--------------|
| *Cyclospora cayetanensis*      | Sugar snap peas  | 14             | from Guatemala            | Sweden  | 2009 | 14              | 1                         | n.s.            | Insulander et al., 2010 |
| *Enterocytozoon bieneusi*      | Cucumber         | 13             | in sandwiches and as salad| Sweden  | 2009 | 135             | n.s.                      | n.s.            | Decraene et al., 2012   |
| *Fasciola hepatica*            | Watercress       | 15             | raw                       | France  | 2002 | 18              | n.s.                      | n.s.            | Mailles et al., 2006   |

NR = not reported  
N.s. = not specified
Table 21: Outbreaks of disease caused by pathogenic bacteria, viruses, and parasites linked to FoNAO with high water content, non-EU countries.

| Pathogen                  | Food item 1 | FoNAO category | Details (vehicle, source) | Country    | Year | Number of cases | Number of hospital | Number of deaths | Reference(s)                                                                 |
|----------------------------|-------------|----------------|---------------------------|------------|------|-----------------|--------------------|------------------|-----------------------------------------------------------------------------|
| *Campylobacter jejuni*     | Peas        | 14             | raw                       | USA        | 2008 | 98              | 5                  | 0                | Gardner et al., 2011 (with erratum: Gardner et al., 2012)                  |
| *Clostridium botulinum*    | Green beans | 37             | home-canned               | USA        | 2009 | 3               | 3                  | n.s.             | Date et al., 2011                                                         |
|                            | Carrots     | 37             | Juice, pasteurised        | USA, Canada| 2006 | 6               | 6                  | n.s.             | Sheth et al., 2008; Relevé épidémiologique hebdomadaire, 2006              |
|                            | Asparagus   | 37             | home-canned               | USA        | 2009 | 3               | 3                  | n.s.             | Date et al., 2011                                                         |
|                            | Tomatoes    | 37             | tinned fish in tomato sauce| USA        | 2002 | 2               | 2                  | 2                | Frean et al., 2004                                                        |
|                            | Carrots and green beans | 37 | home-canned | USA | 2008 | 6 | 6 | n.s. | Date et al., 2011 |
| *Escherichia coli* O145    | Lettuce (Romaine) | 15   | shredded                  | Multi-state outbreak USA (5 states) | 2010 | 33 | 12 | 0 | CDC, 2010 |
| *Escherichia coli* O157    | Lettuce     | 15             | most likely shredded lettuce (restaurant) | Multi-state outbreak USA (5 states) | 2006 | 71 | 53 | n.s. | CDC, 2006 |
| *Escherichia coli* O157:H7 | Peperoni    | 37             | pizza                      | Multi-state outbreak USA (10 states) | 2007 | 20 | 8 | 0 | CDC, 2007 |
|                            | Lettuce (Iceberg) | 15   | NR                        | USA        | 2006 | 77 | 51 | 0 | Sodha et al., 2011 |
|                            | Lettuce (Romaine) | 15 | NR | Multi-state outbreak USA (10 states) | 2011 | 60 | 30 | 0 | CDC, 2011 |
| Pathogen                                      | Food item   | FoNAO category | Details (vehicle, source) | Country                        | Year | Number of cases | Number of hospital | Number of deaths | Reference(s)                                                                 |
|----------------------------------------------|-------------|----------------|--------------------------|-------------------------------|------|-----------------|--------------------|------------------|-----------------------------------------------------------------------------|
| Spinach                                      | Fresh       | 15             | Multi state outbreak USA (26 states) | 2006                          | 199  | 102             | 3                  |                  | CDC, 2006; Charatan 2006, Grant 2008, Wendel et al., 2009, MMWR, 2006      |
| Escherichia coli O169:H41                    | Cabbage     | 15             | USA                      | 2003                          | 35   | n.s.            | n.s.               |                  | Devasia et al., 2003                                                        |
| Escherichia coli O6:H16                       | Celery, cabbage | 35           | "Kimuchi"                | Japan                         | 2005 | 401             | n.s.               | n.s.             | Kimura et al., 2006                                                        |
| non-O157 Shiga toxin producing Escherichia coli (O111) / Cryptosporidium parvum | Apple       | 6              | cider, unpasteurized     | USA                           | 2004 | 213             | 6                  | 0                | Schaffzin et al., 2012; Vojdani et al., 2008                               |
| Listeria monocytogenes                       | Cantaloupe melon | 9             | whole, grown at Jensen Farms' production fields in Granada, Colorado | Multi-state outbreak USA (28 states) | 2011 | 147             | 143                | 33               | CDC, 2011; MMWR, 2011                                                       |
| Salmonella Agona                             | Papaya      | 8              | whole, fresh, imported from Mexico | Multi-state outbreak USA (25 states) | 2011 | 106             | 10                 | 0                | CDC, 2011                                                               |
| Salmonella Braenderup                        | Mangoes     | 8              | NR                       | Multi-state outbreak USA (15 states) | 2012 | 121             | 25                 | 0                | CDC, 2012                                                               |
| Tomatoes                                     | NR          | 11             | Multi-state outbreak USA (16 states) | 2004                          | 125  | n.s.            | 0                  |                  | Gupta et al., 2007                                                       |
| Salmonella group E                            | Potatoes    | 37             | mashed                   | Singapore                      | 2007 | 55              | n.s.               | n.s.             | Lee et al., 2009                                                          |
| Pathogen              | Food item          | FoNAO category | Details (vehicle, source) | Country | Year | Number of cases | Number of hospital | Number of deaths | Reference(s)                      |
|-----------------------|--------------------|----------------|---------------------------|---------|------|-----------------|-------------------|-----------------|-----------------------------------|
| *Salmonella Javiana*  | Tomatoes           | 11             | sliced                    | USA     | 2002 | 82              | 3                 | 0               | Srikantiah et al., 2005; MMWR, 2002 |
|                       | Salad              | 17             | NR                        | USA     | 2003 | 641             | n.s.              | n.s.            | Elward et al., 2006               |
| *Salmonella Litchfield* | Papaya             | 8              | NR                        | Australia | 2006-2007 | 26 | n.s.              | n.s.              | Gibbs et al., 2009              |
|                       | Cantaloupe melon   | 9              | from Honduras             | Multi-state outbreak USA (16 states) | 2008 | 51              | 16                | 0               | CDC, 2008                        |
|                       | Fruit salad        | 10             | NR                        | USA     | 2007 | 30              | n.s.              | n.s.            | MMWR, 2008a                     |
| *Salmonella Newport*  | Tomatoes           | 11             | NR                        | Multi-state outbreak USA (16 states) | 2005 | 72              | 8                 | 0               | Greene et al., 2008              |
| *Salmonella Oranienburg* | Fruit salad      | 10             | NR                        | USA, Canada | 2006 | 41              | 7                 | 0               | MMWR, 2007                       |
| *Salmonella Panama*   | Cantaloupe melon   | 9              | single farm in Guatemala  | Multi-state outbreak USA (10 states) | 2011 | 20              | 3                 | 0               | CDC, 2011                        |
| *Salmonella Saintpaul* | Orange            | 5              | Fresh orange juice (unpasteurised) | USA     | 2005 | 5               | 0                 | 0               | Jain et al., 2009                |
|                       | Cantaloupe melon   | 9              | NR                        | Australia | 2006 | 232             | 9                 | n.s.            | Munnoch et al., 2009             |
|                       | Jalapeño peppers, serrano peppers, tomatoes | 11 or 12 | from Mexico               | Multi-state outbreak USA (43 states), Canada | 2008 | 1442             | 286               | 2               | Behravesh et al., 2011, CDC, 2008; Mody et al., 2011; Taylor et al., 2010 |
| *Salmonella Thompson* | Rucola lettuce or mixed salad | 15       | NR                        | Norway   | 2004 | 21              | n.s.              | n.s.            | Nygård et al., 2008              |
| Pathogen                              | Food item          | FoNAO category | Details (vehicle, source) | Country                  | Year  | Number of cases | Number of hospital | Number of deaths | Reference(s)          |
|--------------------------------------|--------------------|----------------|---------------------------|--------------------------|-------|-----------------|--------------------|------------------|----------------------|
| **Salmonella Typhi**                 | Mamey Fruit Pulp  | 37             | frozen milkshake or smoothie | Multi-state outbreak USA (2 states) | 2010  | 9               | 7                  | 0                | CDC, 2010            |
| **Salmonella Typhimurium**           | Orange             | 5              | juice, unpasteurized      | USA                      | 2005  | 152             | 89                 | 0                | Jain et al., 2009    |
| **Salmonella Typhimurium**           | Cantaloupe melon   | 9              | from Indiana              | Multi-state outbreak USA (24 states) | 2012  | 261             | 94                 | 3                | CDC, 2012 (last updated 10-10-2012) |
| **Salmonella Typhimurium and Salmonella St. Paul** | Watermelon         | 9              | NR                        | New Zealand              | 2009  | 19              | 5                  | 0                | McCallum et al., 2010 |
| **Salmonella Typhimurium, Salmonella Schwarzgrund** | Tomatoes           | 11             | Multi state outbreak USA (21 states), Canada | 2006                      | 185              | 22              | 0                  |                  | CDC, 2006; Behravesh et al., 2012 |
| **Salmonella Typhimurium and Salmonella St. Paul** | Orange             | 5              | juice, unpasteurized      | USA                      | 2005  | 152             | n.s.               | n.s.             | Vojdani et al., 2008 |
| **Salmonella Typhimurium**           | Potatoes           | 36             | salad                     | USA                      | 2009  | 9               | n.s.               | n.s.             | MMWR, 2010          |
| **Shigella sonnei**                  | Sugar peas         | 14             | NR                        | Norway                   | 2009  | 23              | 3                  | 0                | ECDC, 2009          |
| **Shigella sonnei**                  | Basil              | 16             | fresh                     | Norway                   | 2011  | 46              | n.s.               | n.s.             | Guzman-Herrador et al., 2011 |
| **Shigella sonnei**                  | Carrots            | 19             | raw                       | USA (flights from Hawaii)| 2004  | 163             | 9                  | n.s.             | Gaynor et al., 2009  |
| **Staphylococcus aureus**            | Potatoes           | 36             | salad                     | Switzerland              | 2010  | 27              | 27                 | 0                | ECDC, 2010          |
| **Staphylococcus aureus**            | Potatoes           | 36             | salad                     | Switzerland              | 2009  | 30              | 0                  | 0                | ECDC, 2009          |
| **Staphylococcus aureus**            | Potatoes           | 37             | soup, with raw milk       | Switzerland              | 2009  | 39              | 0                  | 0                | ECDC, 2009          |
| Pathogen                        | Food item     | FoNAO category | Details (vehicle, source) | Country  | Year       | Number of cases | Number of hospital | Number of deaths | Reference(s)                              |
|--------------------------------|---------------|----------------|---------------------------|----------|------------|-----------------|-------------------|-----------------|-------------------------------------------|
| *Vibrio cholerae* O1 Ogawa     | Vegetables    | other          | raw                       | Zambia   | 2003-2004  | 2529            | n.s.              | 128             | MMWR, 2004a                              |
| *Yersinia enterocolitica*      | Salad         | 17             | NR                        | Norway   | 2011       | 21              | n.s.              | n.s.            | MacDonald et al., 2012                   |
| **Viruses**                    |               |                |                            |          |            |                 |                   |                 |                                           |
| Hepatitis A virus              | Blueberries   | 4              | raw                       | New Zealand | 2002      | 81              | 18               | 1               | Calder et al., 2003                      |
|                               | Orange        | 5              | Juice, unpasteurized      | Egypt    | 2004       | 351             | 127              | 0               | Frank et al., 2007                       |
|                               | Coleslaw      | 15             | NR                        | Australia | 2003      | 21              | n.s.              | n.s.            | Munnoch et al., 2004                     |
|                               | Green onion   | 22             | NR                        | USA      | 2003       | 601             | 124              | 3               | Wheeler et al., 2005;                   |
|                               | Tomatoes      | 38             | semidried                 | Australia | 2009      | 562             | 0                | 1               | Wand and Moran 2004, MMWR, 2003           |
| Nipah virus                    | Date palm sap | 8              | raw                       | Bangladesh | 2008    | 10              | n.s.              | 9               | Rahman et al., 2012                     |
| Norovirus                      | Lettuce (Lotto) | 15           | farm (primary production) | Norway   | 2010       | 157             | 0                | 0               | ECDC, 2010                               |
|                               | Mixed salad   | 15             | NR                        | Norway   | 2010       | 38              | 0                | 0               | ECDC, 2010                               |
| Radish                        | NR            |                |                            | Korea    | 2008       | 117             | n.s.              | n.s.            | Yu et al., 2010                           |
| Parasites                      | Apple         | 6              | cider, unpasteurized      | USA      | 2003       | 144             | n.s.              | n.s.            | Vojdani et al., 2008                     |
| Cryptosporidium parvum         | Raspberries   | 3              | juice                      | Guatemala | 2003      | 7               | n.s.              | n.s.            | Puente et al., 2006                      |
| Cyclospora cayetanensis        | Snow Peas     | 14             | raw, from Guatemala        | USA      | 2004       | 96              | n.s.              | n.s.            | Heilpern et al., 2005; MMWR, 2004b       |
|                               | Basil         | 16             | fresh                     | Canada   | 2005       | 142             | 7                | 0               | Milord et al., 2012                      |
Food of plant origin with high water content

| Pathogen               | Food item       | FoNAO category | Details (vehicle, source) | Country    | Year | Number of cases | Number of hospital | Number of deaths | Reference(s)                  |
|------------------------|-----------------|----------------|---------------------------|------------|------|-----------------|--------------------|------------------|-----------------------------|
| *Trichostrongylus* spp. | Vegetables      | other          | sheep manure used as organic fertilizer | New Zealand | 2008 | 3               | n.s.               | n.s.             | Wall et al., 2011          |
| *Trypanosoma cruzi*    | Guava juice     | NR             |                          | Venezuela  | 2007 | 103             | 0                  | 1                | Alarcón de Noya et al., 2010 |
|                        | Sugar cane juice| NR             |                          | Brazil     | 2005 | 24              | n.s.               | 3                | Steindel et al., 2008       |

*NR = not reported  
^n.s. = not specified
### B. Appendix Specific to Thematic Area B

**Table 22:** Categories and items of FoNAO with high water content as reported in association with bacteria. Food items that have been implicated in outbreaks with the ten highest numbers of outbreak cases, hospitalisations, and/or deaths (see Table 30) are highlighted. “Country/ies” signifies the place where the food commodity was found in association with the biological contaminant (e.g. site of survey or screening).

| FoNAO Category | Food item | Pathogen(s) | Country/ies | Reference(s) |
|----------------|-----------|-------------|-------------|--------------|
| **1 Fruits (not specified)** | Fruits | *Listeria monocytogenes, Salmonella spp.*, *Escherichia coli O157:H7 (EHEC)*, *Shigella spp.*, *Cronobacter spp.*, *Bacillus cereus* like organism*, *Staphylococcus aureus* | Italy, India, Korea, Switzerland, Denmark | ECDC, 2008; Lewis et al., 2006; Lee et al., 2012; Althaus et al., 2012; Rosenquist et al., 2005; Seo et al., 2010 |
| **2 Strawberries** | Strawberries | *Listeria monocytogenes, Staphylococcus aureus* | Norway | Johanessen et al., 2002 |
| **4 Other berries** | Grape | *Escherichia coli O157:H7 (EHEC)*, *Klebsiella oxytoca*, *Pseudomonas aeruginosa*, *Salmonella spp.*, *Shigella spp.*, *Staphylococcus aureus* | India, Libya | Lewis et al., 2006; Ghenghesh et al., 2005 |
| **5 Citrus fruit** | Citrus fruit juice | *Salmonella spp.* | Nigeria | Ukwo et al., 2011 |
| | Kinnon mandarin | *Staphylococcus aureus* | India | Mudgil et al., 2004 |
| | Orange | *Escherichia coli O157:H7 (EHEC)*, *Klebsiella oxytoca*, *Pseudomonas aeruginosa*, *Salmonella spp.*, *Salmonella Typhi*, *Shigella spp.*, *Staphylococcus aureus*, *Vibrio cholerae* | India, Libya, Nigeria | Lewis et al., 2006; Ghenghesh et al., 2005; Tambekar et al., 2009; Ukwo et al., 2011 |
| | Sweet lemon (*Citrus limetta*) | *Pseudomonas aeruginosa*, *Salmonella spp.*, *Salmonella Typhi*, *Staphylococcus aureus* | India | Tambekar et al., 2009; Titarmare et al., 2009 |
| **6 Apples and related fruit** | Apples | *Pseudomonas aeruginosa*, *Staphylococcus aureus* | Libya, India | Ghenghesh et al., 2005; Tambekar et al., 2009 |
| **7 Stone fruit** | Drupes | *Salmonella spp.* | Spain | Badosa et al., 2008 |
| | Peach | *Klebsiella oxytoca*, *Klebsiella pneumoniae* | Libya | Ghenghesh et al., 2005 |
| FoNAO Category | Food item | Pathogen(s) | Country(ies) | Reference(s) |
|---------------|-----------|-------------|--------------|--------------|
| 8 Tropical fruit | Coconut products | *Salmonella* spp., *Shigella* spp., *Staphylococcus aureus* | Hungary, India | ECDC, 2009; Ghosh et al., 2007 |
|   | Date | *Staphylococcus aureus* | Saudi Arabia | Hamad et al., 2012 |
|   | Dragon fruit | *Salmonella* spp., *Salmonella Typhi*, *Salmonella Typhimurium* | Malaysia | Pui et al., 2011 |
|   | Fruit juice | *Salmonella* spp. | Nigeria | Ukwo et al., 2011 |
|   | Jackfruit | *Salmonella* spp., *Salmonella Typhi* | Malaysia | Pui et al., 2011 |
|   | Mango | *Escherichia coli* O157:H7 (EHEC), *Salmonella* spp., *Salmonella Typhi*, *Shigella* spp., *Klebsiella oxytoca*, *Klebsiella pneumoniae*, *Staphylococcus aureus* | India, Malaysia, Libya | Lewis et al., 2006; Pui et al., 2011; Ghenghesh et al., 2005 |
| 9 Melons | Bitter melon | *Salmonella* spp. | India | Titarmare et al., 2009 |
|   | Cantaloupe | *Salmonella* Montevideo, *Salmonella* spp. | USA, Mexico | Johnston et al., 2005; Gallegos-Robles et al., 2008 |
|   | Honeydew | *Salmonella* spp., *Salmonella Typhi*, *Salmonella Typhimurium* | Malaysia | Pui et al., 2011 |
|   | Watermelon | *Enterobacter aerogenes*, *Klebsiella pneumoniae*, *Salmonella* spp., *Salmonella Typhi*, *Staphylococcus aureus* | Malaysia | Chukwu et al., 2010; Pui et al., 2011 |
| 10 Fruit mixes | Fruit juice | *Staphylococcus aureus* | Korea | Cho et al., 2011 |
|   | Fruit juice | *Bacillus cereus* | Poland | Mostafa et al., 2002 |
| 11 Tomatoes | Tomatoes | *Listeria monocytogenes*, *Pseudomonas aeruginosa*, *Salmonella* spp., *Staphylococcus aureus*, *Vibrio parahaemolyticus* | Greece, Malaysia, Chile, Spain, Saudi Arabia, Canada | Kokkinakis et al., 2007; Ponniah et al., 2010; Cordano and Jacquet, 2009; Ramirez Merida 2009; Hassan et al., 2011; Arthur et al., 2007; Tunung et al., 2010 |
| 12 Peppers, and aubergines | Chile pepper | *Salmonella* spp. | Mexico | Gallegos-Robles et al., 2008 |
|   | Green peppers | *Escherichia coli* O157:H7 (EHEC), *Listeria monocytogenes*, *Salmonella* spp. | USA, Portugal | Mukherjee et al., 2004; Mena et al., 2004 |
|   | Paprika | *Bacillus cereus* group spp. | Belgium | Samapundo et al., 2011 |
| FoNAO Category                  | Food item                        | Pathogen(s)                                                                 | Country/ies                     | Reference(s)                                                                 |
|--------------------------------|----------------------------------|------------------------------------------------------------------------------|---------------------------------|------------------------------------------------------------------------------|
|                                | Pepper                           | *Listeria monocytogenes*                                                     | Greece                          | Kokkinakis et al., 2007                                                      |
| **13 Gourds and squashes**     | Bottle gourd (Lagenaria siceraria) | *Salmonella* spp.                                                            | India                           | Titarmare et al., 2009                                                      |
|                                | Cucumber                         | *Listeria monocytogenes, Pseudomonas aeruginosa, Salmonella* spp., *Staphylococcus aureus, Vibrio parahaemolyticus* | Malaysia, Saudi Arabia, India    | Ponniah et al., 2010; Hassan et al., 2011; Titarmare et al., 2009; Tunung et al., 2010 |
|                                | Zucchini                         | *Bacillus cereus, Listeria monocytogenes, Salmonella* spp.                    | France, Germany, Mexico         | Guinebretiere et al., 2003; Pappelbaum et al., 2008; Castro-Rosas et al., 2010 |
| **14 Fresh pods, legumes and grains** | Broad beans                    | *Listeria monocytogenes*                                                     | Chile                           | Cordano and Jacquet, 2009                                                   |
| **15 Leafy greens eaten raw as salads** | Baby spinach                   | *Listeria monocytogenes*                                                     | Canada                          | Ilic et al., 2008                                                           |
|                                | Cabbage                          | *Campylobacter jejuni, Listeria monocytogenes, Pseudomonas aeruginosa, Salmonella* spp., *Vibrio parahaemolyticus* | Malaysia, USA, Saudi Arabia, Mexico | Chai et al., 2009; Ponniah et al., 2010; Johnston et al., 2006; Prazak et al., 2002; Hassan et al., 2011; Quiroz-Santiago et al., 2009; Tunung et al., 2010 |
|                                | Chicories                        | *Salmonella* spp.                                                            | Brazil                          | Froder et al., 2007                                                        |
|                                | Chinese cabbage                  | *Bacillus cereus* group spp.                                                 | Belgium                         | Samapundo et al., 2011                                                     |
|                                | Endive                           | *Escherichia coli* (VTEC), *Salmonella* spp.                                | Netherlands                      | ECDC, 2008                                                                  |
|                                | Leafy greens                     | *Cronobacter* spp.                                                           | Ireland                         | Molloy et al., 2009                                                         |

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| FoNAO Category | Food item | Pathogen(s) | Country/ies | Reference(s) |
|---------------|-----------|-------------|-------------|--------------|
| Lettuce       | *Aeromonas caviae, Aeromonas hydrophila, Aeromonas sobria, Escherichia coli O157:H7 (EHEC), Pseudomonas aeruginosa, Salmonella spp., Salmonella Typhimurium, Shigella spp., Staphylococcus aureus, Vibrio parahaemolyticus, Listeria monocytogenes, Yersinia enterocolitica* | Brazil, USA, Saudi Arabia, Canada, Turkey, Brazil, Netherlands, Korea, Malaysia, Norway, Mexico | Castilho et al., 2009; Mukherjee et al., 2004; Hassan et al., 2011; Arthur et al., 2007; Cetin et al., 2008; Froder et al., 2007; Mukherjee et al., 2004; ECDC, 2008; Erkan et al., 2008; Seo et al., 2010; Tunung et al., 2010; Loncarevic et al., 2005; Johanessen et al., 2002; Quiroz-Santiago et al., 2009 |
| Lettuce and arugula | *Salmonella Enterica, Salmonella Typhi* | Brazil | Sant’Ana et al., 2011 |
| Mixed lettuce | *Escherichia coli (VTEC)* | Netherlands | ECDC, 2008 |
| Mixed salads | *Salmonella spp.* | Brazil | Froder et al., 2007 |
| Purslane (Portulaca oleracea) | *Salmonella spp.* | Mexico | Quiroz-Santiago et al., 2009 |
| Romaine lettuce | *Salmonella spp.* | Mexico | Quiroz-Santiago et al., 2009 |
| Salad | *Listeria monocytogenes, Salmonella spp.* | Spain, Hungary, Estonia, Czech Republic, Slovenia | ECDC, 2009 |
| Savoy spinach | *Salmonella spp.* | Canada | Ilic et al., 2008 |
| Spinach | *Listeria monocytogenes, Pseudomonas aeruginosa, Salmonella spp., Shigella spp.* | Chile, Brazil, Spain, Germany, Saudi Arabia, Canada, Mexico | Cordano and Jacquet, 2009; Froder et al., 2007; Moreno et al., 2012; Pappelbaum et al., 2008; Hassan et al., 2011; Ilic et al., 2008; Quiroz-Santiago et al., 2009 |
| Vegetable (lettuce, spinach) | *Escherichia coli (Enteroaggregative), Escherichia coli (STEC)* | Colombia | Rugeles et al., 2010 |
| FoNAO Category                | Food item                                      | Pathogen(s)                                           | Country/ies                      | Reference(s)                                                                 |
|------------------------------|-----------------------------------------------|-------------------------------------------------------|----------------------------------|-------------------------------------------------------------------------------|
|                              | Vegetable (rucola, lettuce)                   | *Listeria monocytogenes, Salmonella spp.*             | Italy                            | De Giusti et al., 2010                                                        |
|                              | Water spinach                                 | *Campylobacter coli, Campylobacter jejuni*            | Malaysia                         | Chai et al., 2007                                                             |
|                              | Watercress                                    | *Salmonella spp., Staphylococcus aureus*              | Brazil, Mexico, Turkey           | Froder et al., 2007; Quiroz-Santiago et al., 2009; Erkan et al., 2008        |
| 16 Fresh herbs               | Basil                                         | *Enterobacter cloacae, Klebsiella oxytoca, Pseudomonas aeruginosa, Salmonella spp., Salmonella Typhimurium* | USA, United Kingdom              | Wetzel et al., 2010; Elviss et al., 2009                                      |
|                              | Chinese parsley                               | *Salmonella spp.*                                     | Mexico                           | Quiroz-Santiago et al., 2009                                                  |
|                              | Cilantro                                      | *Salmonella spp.*                                     | Mexico                           | Quiroz-Santiago et al., 2009                                                  |
|                              | Coriander                                     | *Pseudomonas aeruginosa, Salmonella spp., Listeria monocytogenes* | Saudi Arabia, United Kingdom, India, Spain | Hassan et al., 2011; Elviss et al., 2009; Singh et al., 2007; Ramirez Merida 2009 |
|                              | Coriander, Vietnamese (Polygonum minus)       | *Campylobacter coli, Campylobacter jejuni*            | Malaysia                         | Chai et al., 2007; Chai et al., 2009                                          |
|                              | Herbs                                         | *Salmonella spp.*                                     | Netherlands                      | ECDC, 2009                                                                    |
|                              | Indian pennywort (Centella asiatica)          | *Campylobacter coli, Campylobacter fetus, Campylobacter jejuni, Listeria monocytogenes, Vibrio parahaemolyticus* | Malaysia                         | Chai et al., 2007; Ponniyah et al., 2010; Tunung et al., 2010                |
|                              | Japanese parsley (Oenanther stolonifera)      | *Listeria monocytogenes*                              | Malaysia                         | Ponniyah et al., 2010                                                         |
|                              | Kangkong (Ipomoea aquatica)                   | *Salmonella spp.*                                     | Malaysia                         | Salleh et al., 2003                                                           |
|                              | Kesum (Polygonum minus)                       | *Salmonella spp.*                                     | Malaysia                         | Salleh et al., 2003                                                           |
|                              | Korean Herbs                                  | *Salmonella spp.*                                     | Malaysia                         | Salleh et al., 2003                                                           |
|                              | Mint                                          | *Salmonella spp.*                                     | United Kingdom, India            | Elviss et al., 2009; Singh et al., 2007                                       |

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| FoNAO Category | Food item | Pathogen(s) | Country/ies | Reference(s) |
|----------------|-----------|-------------|-------------|--------------|
| Other (rosemary, thyme, methi, curry leaves, walleria) | Salmonella spp. | United Kingdom | Elviss et al., 2009 |
| Papaloquelite or Mexican cilantro | Salmonella spp. | Mexico | Quiroz-Santiago et al., 2009 |
| Parsley | Bacillus cereus, Clostridium perfringens, Listeria monocytogenes, Pseudomonas aeruginosa, Salmonella spp., Salmonella Typhi, Staphylococcus aureus | Brazil, Mexico, Saudi Arabia, United Kingdom, Turkey | Moreira et al., 2009; Gomez-Govea et al., 2012; Hassan et al., 2011; Elviss et al., 2009; Quiroz-Santiago et al., 2009; Erkan et al., 2008 |
| Parsley, Japanese (Oenanthe stolonifera) | Campylobacter coli, Campylobacter jejuni, Vibrio parahaemolyticus | Malaysia | Chai et al., 2007; Tunung et al., 2010 |
| Pegaga (Centella asiatica) | Salmonella spp. | Malaysia | Salleh et al., 2003 |
| Selom (Oenanthe stolonifera) | Salmonella spp. | Malaysia | Salleh et al., 2003 |
| Wild cosmos (Cosmos caudatus) | Campylobacter coli, Campylobacter fetus, Campylobacter jejuni, Vibrio parahaemolyticus | Malaysia | Chai et al., 2007; Tunung et al., 2010 |
| Wild parsley (Cosmos caudatus) | Listeria monocytogenes | Malaysia | Ponniah et al., 2010 |
| 17 Mixed fresh-cut salad leaves | Cabbage | Listeria monocytogenes, Salmonella spp., Staphylococcus aureus, Yersinia enterocolitica | Brazil, United Kingdom, Korea | Sant’Ana et al., 2012; Meldrum et al., 2009; Lee et al., 2004 |
| | Chinese cabbage | Yersinia enterocolitica | Korea | Lee et al., 2004 |
| | Collard greens | Listeria monocytogenes | Brazil | Sant’Ana et al., 2012 |
| | Corn salad (Valerianella locusta) | Salmonella spp. | Spain | Abadias et al., 2008 |
| | Edible leaves | Listeria monocytogenes | Spain | Badosa et al., 2008 |
| | Escarole | Listeria monocytogenes | Brazil | Sant’Ana et al., 2012 |
| FoNAO Category       | Food item          | Pathogen(s)                                                                 | Country/ies                  | Reference(s)                                      |
|---------------------|--------------------|-----------------------------------------------------------------------------|------------------------------|---------------------------------------------------|
|                     | Lettuce            | *Bacillus cereus* like organism, *Listeria monocytogenes*, *Salmonella* spp., *Staphylococcus aureus*, *Yersinia enterocolitica*, *Cronobacter* spp., *Escherichia coli* (EPEC), *Escherichia coli* (STEC) | Denmark, Spain, Costa Rica, Brazil, United Kingdom, Korea, Switzerland | Rosenquist et al., 2005; Abadias et al., 2008; Monge et al., 2011; Sant'Ana et al., 2012; Meldrum et al., 2009; Lee et al., 2004; Althaus et al., 2012 |
|                     | Mixed lettuce      | *Listeria monocytogenes*                                                    | Italy                        | De Giusti et al., 2010                             |
|                     | Mixed salads       | *Listeria monocytogenes, Salmonella* spp.                                   | Spain                        | Abadias et al., 2008; Badosa et al., 2008          |
|                     | Salad              | *Cronobacter* spp., *Listeria monocytogenes*                               | Korea, USA                   | Lee et al., 2012; Gombas et al., 2003              |
|                     | Spinach            | *Listeria monocytogenes, Salmonella* spp., *Yersinia enterocolitica*        | Spain, Brazil, Korea         | Moreno et al., 2012; Sant'Ana et al., 2012; Abadias et al., 2008; Lee et al., 2004 |
|                     | Water dropwort     | *Yersinia enterocolitica*                                                   | Korea                        | Lee et al., 2004                                  |
|                     | Watercress         | *Listeria monocytogenes*                                                    | Brazil                       | Sant'Ana et al., 2012                             |
| 19 Carrots          | Carrots            | *Bacillus cereus* group spp., *Clostridium botulinum*, *Listeria monocytogenes, Salmonella* spp., *Staphylococcus aureus*, *Vibrio cholerae*, *Vibrio parahaemolyticus* | Belgium, France, Germany, Malaysia, India, USA, Nigeria | Samapundo et al., 2011; Sevenier et al., 2012; Pappelbaum et al., 2008; Ponniiah et al., 2010; Kamat et al., 2005; Titarmare et al., 2009; Endley et al., 2003; Singh et al., 2007; Mudgil et al., 2004; Ukwo et al., 2011; Tunung et al., 2010 |
|                     | Fruit juice        | *Salmonella* spp.                                                           | Nigeria                      | Ukwo et al., 2011                                 |
| 20 Potatoes         | Potato             | *Salmonella* spp., *Bacillus cereus*                                      | Mexico, Argentina            | Quiroz-Santiago et al., 2009; Fangio et al., 2010 |
| FoNAO Category                                      | Food item               | Pathogen(s)                              | Country/ies        | Reference(s)                                      |
|-----------------------------------------------------|-------------------------|------------------------------------------|--------------------|---------------------------------------------------|
| 21 Other root and tuberous vegetables               | Beetroot                | *Listeria monocytogenes, Salmonella spp.*| Chile, Mexico      | Cordano and Jacquet, 2009; Quiroz-Santiago et al., 2009 |
|                                                     | Ginger                  | *Salmonella spp.*                        | India              | Titarmare et al., 2009                            |
|                                                     | Radish                  | *Campylobacter jejuni, Salmonella spp.*  | Malaysia, India    | Chai et al., 2009; Singh et al., 2007             |
|                                                     | Radish root             | *Yersinia enterocolitica*                | Korea              | Lee et al., 2004                                 |
|                                                     | Root vegetables         | *Cronobacter spp.*                       | Korea              | Kim et al., 2011b                                 |
|                                                     | Sweet potato            | *Listeria monocytogenes, Vibrio parahaemolyticus* | Malaysia | Ponniash et al., 2010; Tunung et al., 2010 |
| 22 Bulb and stem vegetables                         | Asparagus               | *Listeria monocytogenes*                 | Chile              | Cordano and Jacquet, 2009                         |
|                                                     | Bulbous vegetables      | *Salmonella spp.*                        | Germany            | Schwaiger et al., 2011                           |
|                                                     | Celery                  | *Bacillus cereus group spp., Listeria monocytogenes, Pseudomonas aeruginosa, Salmonella spp.* | Belgium, Chile, Korea, Saudi Arabia, Mexico | Samapundo et al., 2011; Cordano and Jacquet, 2009; Cho et al., 2004; Hassan et al., 2011; Quiroz-Santiago et al., 2009 |
|                                                     | Garlic                  | *Vibrio cholerae*                        | Nigeria            | Ukwo et al., 2011                                |
|                                                     | Green onion             | *Pseudomonas aeruginosa, Staphylococcus aureus, Yersinia enterocolitica* | Saudi Arabia, Korea | Hassan et al., 2011; Seo et al., 2010; Lee et al., 2004 |
|                                                     | Onion                   | *Bacillus cereus, Salmonella spp., Staphylococcus aureus* | Brazil, United Kingdom | Moreira et al., 2009 |
|                                                     | White asparagus         | *Clostridium perfringens, Clostridium septicum* | Spain              | Valero et al., 2006                              |
| 23 Flowers and flower buds                          | Broccoli                | *Listeria monocytogenes, Salmonella spp.*| Germany, Portugal, Chile, Spain, Mexico | Pappelbaum et al., 2008; Mena et al., 2004; Cordano and Jacquet, 2009; Moreno et al., 2012; Quiroz-Santiago et al., 2009 |
| FoNAO Category | Food item | Pathogen(s) | Country/ies | Reference(s) |
|---------------|-----------|-------------|-------------|--------------|
| 29 Mushrooms, fungi and yeasts | Cauliflower | Listeria monocytogenes, Pseudomonas aeruginosa, Salmonella spp. | Germany, Chile, Saudi Arabia, Mexico | Pappelbaum et al., 2008; Cordano and Jacquet, 2009; Hassan et al., 2011; Quiroz-Santiago et al., 2009 |
| | Courgette | Listeria monocytogenes | Portugal | Mena et al., 2004 |
| | Boletus edulis | Listeria monocytogenes | Spain | Venturini et al., 2011 |
| | Calocybe gambosa | Listeria monocytogenes, Yersinia enterocolitica | Spain | Venturini et al., 2011 |
| | Cantharellus cibarius | Yersinia enterocolitica | Spain | Venturini et al., 2011 |
| | Craterellus cornucopioides | Yersinia enterocolitica | Spain | Venturini et al., 2011 |
| | Hygrophorus limacinus | Listeria monocytogenes | Spain | Venturini et al., 2011 |
| | Lactarius deliciosus | Listeria monocytogenes | Spain | Venturini et al., 2011 |
| | Mushrooms | Listeria monocytogenes, Staphylococcus aureus, Yersinia enterocolitica | Norway, Germany, Spain, Chile, Korea | Johanessen et al., 2002; Pappelbaum et al., 2008; Venturini et al., 2011; Cordano and Jacquet, 2009; Cho et al., 2004; Lee et al., 2004 |
| | Tuber indicum | Listeria monocytogenes | Spain | Venturini et al., 2011 |
| 30 Sea vegetables | Algae | Pseudomonas aeruginosa | Italy | Catellani et al., 2010 |
| | Seaweed | Cronobacter spp., Listeria monocytogenes | Korea, Chile | Lee et al., 2012; Cordano and Jacquet, 2009 |
| 35 Fermented, salted, or acidified vegetables or fruit | Asazuke (Japanese light pickles) | Listeria monocytogenes | Japan | Maklon et al., 2010 |
| | Green table olives | Listeria monocytogenes | Italy | Caggia et al., 2004 |
| | Olives | Staphylococcus aureus | Portugal | Pereira et al., 2008 |
| 36 Mixed salads | Mixed salads (cabbage, lettuce, tomato) | Staphylococcus aureus | United Kingdom | Meldrum et al., 2009 |
| FoNAO Category | Food item | Pathogen(s) | Country/ies | Reference(s) |
|----------------|-----------|-------------|-------------|--------------|
| Mixed salads   | *Cronobacter sakazakii*, *Enterobacter aerogenes*, *Enterobacter cloacae*, *Klebsiella oxytoca*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Yersinia enterocolitica*, *Listeria monocytogenes*, *Staphylococcus aureus* | Germany, Chile, Korea | Weiss et al., 2005; Cordano and Jacquet, 2009; Seo et al., 2010 |
| Mixed salads (lettuce, avocado, water cress, wheat sprouts, tomato, cucumber, radish, carrot) | *Escherichia coli* (Enteroinvasive and Shiga-toxin producing), *Escherichia coli* (Enteroinvasive), *Escherichia coli* (STEC) | Mexico | Castro-Rosas et al., 2012 |
| Mixed salads (spinach, sprouts, cabbage, mushrooms, rocket, valerian or multi-salad packs) | *Yersinia enterocolitica*, *Aeromonas hydrophila* | Greece | Xanthopoulos et al., 2010 |
| Salad          | *Bacillus cereus* | Nigeria | Isara et al., 2010 |
| Salad          | *Listeria monocytogenes*, *Pseudomonas aeruginosa*, *Salmonella Typhi*, *Salmonella Typhimurium*, *Shigella sonnei*, *Shigella spp.*, *Staphylococcus aureus* | Ireland, Brazil, Estonia, Lithuania, Slovakia, Hungary, USA, United Kingdom, Nigeria, India | ECDC, 2008; Verdin et al., 2007; Sauders et al., 2009; Isara et al., 2010; Ghosh et al., 2007 |
| Salad mix (mixes of different varieties of lettuce, watercress, chard, spinach, carrot, arugula, chicory, escarole and tomato) | *Listeria monocytogenes* | Brazil | Sant’Ana et al., 2012 |
| Salad mix (raw spinach, tomato, mushrooms) | *Escherichia coli* (ETEC), *Escherichia coli* (STEC) | Mexico | Castro-Rosas et al., 2012 |
| FoNAO Category | Food item | Pathogen(s) | Country/ies | Reference(s) |
|----------------|-----------|-------------|-------------|--------------|
| Salad mix (romaine lettuce, various spinach and mixed salads) | *Bacillus cereus, Escherichia coli (VTEC), Listeria monocytogenes* | Portugal | Santos et al., 2012 |
| Salad vegetables | *Listeria monocytogenes, Salmonella Durban, Salmonella Newport, Salmonella spp., Salmonella Umbilo* | United Kingdom | Sagoo et al., 2003 |
| 37 Other processed products, sauces and dressings, purées, soup, and pastes (including canned and bottled products) | Bean curd | *Listeria monocytogenes* | China | Zhou et al., 2006 |
|  | Confectionery products and pastes | *Salmonella spp.* | Romania | ECDC, 2009 |
|  | Coriander sauce | *Shigella spp., Staphylococcus aureus* | India | Ghosh et al., 2007 |
|  | Deli salads | *Listeria monocytogenes* | USA | Gombas et al., 2003 |
|  | Imported confectionery products and pastes | *Salmonella spp.* | Slovakia | ECDC, 2009 |
|  | Other food (various ingredients) | *Cronobacter sakazakii, Escherichia coli O157:H7 (EHEC), Listeria monocytogenes, Salmonella spp., Staphylococcus aureus* | Korea, Malawi, Italy | Ryu et al., 2011; Taulo et al., 2008; Latorre et al., 2007; Cho et al., 2011 |
|  | Potato meal | *Bacillus cereus* | Italy | Bonerba et al., 2010 |
|  | Sauce and Dressings | *Salmonella spp.* | Lithuania | ECDC, 2009 |
|  | Staple food | *Staphylococcus aureus* | Taiwan | Wei et al., 2006 |
|  | Sunsik (grain, fruit and vegetables) | *Bacillus cereus* | Korea | Lee et al., 2011 |
|  | Taco-dressing (boiled green chilli sauce) | *Salmonella Enterica, Salmonella Enteritidis* | Mexico | Estrada- Garcia et al., 2004 |
|  | Taco-dressing (raw coriander onion mix) | *Salmonella Agona, Salmonella Enterica* | Mexico | Estrada- Garcia et al., 2004 |
|  | Taco-dressing (raw red chilli sauce) | *Salmonella Enteritidis* | Mexico | Estrada- Garcia et al., 2004 |
|  | Vegetables | *Escherichia coli O157:H7 (EHEC), Salmonella spp., Staphylococcus aureus* | Malawi | Taulo et al., 2008 |
|  | Vegetarian food | *Staphylococcus aureus* | Taiwan | Wei et al., 2006 |
| FoNAO Category | Food item | Pathogen(s) | Country/ies | Reference(s) |
|----------------|-----------|-------------|-------------|--------------|
| 38 Dehydrated vegetables and fruit | Coconut | Cronobacter sakazakii | Czech Republic | Hochel et al., 2012 |
| | Dehydrated potato flakes | Bacillus cereus | New Zealand | Turner et al., 2006 |
| | Raisins | Salmonella spp. | India | Sharma et al., 2008 |
| | Vegetables | Cronobacter spp. | Netherlands | Kandhai et al., 2010 |
| 1/other Fruits (not specified)/n.s. | Fruits and vegetables | Bacillus cereus, Cronobacter spp., Listeria monocytogenes, Salmonella spp., Staphylococcus aureus | Korea, Ireland, Slovenia, Portugal, Spain, Sweden, Germany, Canada, Luxembourg, Belgium | Chung et al., 2010; Kim et al., 2011b; ECDC, 2008; ECDC, 2009; Badosa et al., 2008; Arthur et al., 2007; Badosa et al., 2008; Chung et al., 2010 |
| | Produce | Listeria monocytogenes, Salmonella Montevideo, Salmonella spp. | USA, Norway | Zhang et al., 2007; Johnston et al., 2005; Johanessen et al., 2002; Mukherjee et al., 2004 |
| | Vegetable or fruit salat | Listeria monocytogenes | Netherlands | ECDC, 2009 |
| 11/13 Tomatoes/Gourds and squashes | Cucumbers, Tomatoes | Bacillus cereus like organism | Denmark | Rosenquist et al., 2005 |
| 13/20 Potatoes/Gourds and squashes | Vegetables (butter nut squash, potato) | Bacillus cereus | Argentina | Fangio et al., 2010 |
| n.s. | Other Vegetables | Bacillus cereus like organism | Denmark | Rosenquist et al., 2005 |
| | Vegetable (products) | Listeria monocytogenes, Salmonella spp. | Estonia, Italy | ECDC, 2009 |
| | Vegetables | Bacillus cereus | Taiwan, Korea | Fang et al., 2003; Thapa et al., 2008 |
| FoNAO Category     | Food item                                      | Pathogen(s)                                                                 | Country/ies                  | Reference(s)                     |
|--------------------|-----------------------------------------------|------------------------------------------------------------------------------|-----------------------------|----------------------------------|
| Vegetables         | **Cronobacter spp., Escherichia coli (VTEC), Listeria monocytogenes, Salmonella Typhimurium, Staphylococcus aureus**, Bacillus cereus like organism², *Escherichia coli (EPEC)*, *Escherichia coli (STEC)* | Korea, Slovakia, Spain, n.s., Belgium, Germany, Czech Republic, Venezuela, Hungary, China, Iran, Brazil, Austria, Mexico, Taiwan, Korea, Denmark, Switzerland, Italy | Lee et al., 2012; Chon et al., 2012; Turcovský et al., 2011; ECDC, 2010; ECDC, 2008; Pappelbaum et al., 2008; ECDC, 2009; de Curtis et al., 2002; Thapa et al., 2008; Vitas et al., 2004; Zhou et al., 2006; Jalali and Abedi 2008; Aguado et al., 2004; Sant'Ana et al., 2012; Moreno et al., 2012; Miranda et al., 2009; Quiroz-Santiago et al., 2009; Fang et al., 2003; Rosenquist et al., 2005; Althaus et al., 2012; Badosa et al., 2008 |
| Vegetables (lettuce, cabbage, carrot and radish sprout) | *Escherichia coli O157:H7 (EHEC)* | Iran | Khandaghi et al., 2010 |
| Vegetables (soy bean, yam, potato) | **Cronobacter spp.** | Korea | Kim et al., 2008 |
| Vegetables (tomatoes, celery, parsley, paprika, brussels sprouts) | **Listeria monocytogenes** | Germany | Pappelbaum et al., 2008 |
| Mix for sukiyaki (soup/stew type, a Japanese dish) | **Listeria monocytogenes** | Brazil | Sant'Ana et al., 2012 |
| Vegetable (products) | **Listeria monocytogenes, Salmonella spp.** | Estonia, Italy | ECDC, 2009 |
| Vegetables | **Bacillus cereus** | Taiwan, Korea | Fang et al., 2003; Thapa et al., 2008 |

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| FoNAO Category   | Food item                                              | Pathogen(s)                                                                 | Country/ies                                                                 | Reference(s)                                                                 |
|------------------|--------------------------------------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------|
| Vegetables       | *Cronobacter* spp., *Escherichia coli* (VTEC), *Listeria monocytogenes*, *Salmonella* Gustavia, *Salmonella* spp., *Salmonella* Typhimurium, *Staphylococcus* aureus, *Bacillus cereus* like organism, *Escherichia coli* (EPEC), *Escherichia coli* (STEC) | Korea, Slovakia, Spain, n.s., Belgium, Germany, Czech Republic, Venezuela, Hungary, China, Iran, Brazil, Austria, Mexico, Taiwan, Korea, Denmark, Switzerland, Italy | Lee et al., 2012; Chon et al., 2012; Turcovský et al., 2011; ECDC, 2010; ECDC, 2008; Pappelbaum et al., 2008; ECDC, 2009; de Curtis et al., 2002; Thapa et al., 2008; Vitas et al., 2004; Zhou et al., 2006; Jalali and Abedi 2008; A guado et al., 2004; Sant’Ana et al., 2012; Moreno et al., 2012; Miranda et al., 2009; Quiroz-Santiago et al., 2009; Fang et al., 2003; Rosenquist et al., 2005; Althaus et al., 2012; Bad osa et al., 2008 |
| Vegetables (lettuce, cabbage, carrot and radish sprout) | *Escherichia coli* O157:H7 (EHEC)                        | Korea, Slovakia, Spain, n.s., Belgium, Germany, Czech Republic, Venezuela, Hungary, China, Iran, Brazil, Austria, Mexico, Taiwan, Korea, Denmark, Switzerland, Italy | Khandaghi et al., 2010 |
| Vegetables (soy bean, yam, potato) | *Cronobacter* spp.                                     | Korea, Slovakia, Spain, n.s., Belgium, Germany, Czech Republic, Venezuela, Hungary, China, Iran, Brazil, Austria, Mexico, Taiwan, Korea, Denmark, Switzerland, Italy | Kim et al., 2008 |
| Vegetables (tomatoes, celery, parsley, paprika, brussels sprouts) | *Listeria monocytogenes*                                | Korea, Slovakia, Spain, n.s., Belgium, Germany, Czech Republic, Venezuela, Hungary, China, Iran, Brazil, Austria, Mexico, Taiwan, Korea, Denmark, Switzerland, Italy | Pappelbaum et al., 2008 |
| Mix for sukiyaki (soup/stew type, a Japanese dish) | *Listeria monocytogenes*                                | Brazil, Slovakia, Spain, n.s., Belgium, Germany, Czech Republic, Venezuela, Hungary, China, Iran, Brazil, Austria, Mexico, Taiwan, Korea, Denmark, Switzerland, Italy | Sant’Ana et al., 2012 |
| Vegetable (products) | *Listeria monocytogenes*, *Salmonella* spp.            | Estonia, Italy, Slovakia, Spain, n.s., Belgium, Germany, Czech Republic, Venezuela, Hungary, China, Iran, Brazil, Austria, Mexico, Taiwan, Korea, Denmark, Switzerland, Italy | ECDC, 2009 |
| Vegetables       | *Bacillus cereus*                                      | Taiwan, Korea, Slovakia, Spain, n.s., Belgium, Germany, Czech Republic, Venezuela, Hungary, China, Iran, Brazil, Austria, Mexico, Taiwan, Korea, Denmark, Switzerland, Italy | Fang et al., 2003; Thapa et al., 2008 |
Table 23: Categories and items of FoNAO with high water content as reported in association with viruses. Food items that have been implicated in outbreaks with the ten highest numbers of outbreak cases, hospitalisations, and/or deaths (see Table 30) are highlighted below. “Country/ies” signifies the place where the food commodity was found in association with the biological contaminant (e.g. site of survey or screening).

| FoNAO Category | Food item                        | Pathogen(s) | Country/ies            | Reference(s) |
|----------------|----------------------------------|-------------|------------------------|--------------|
| 1              | Fruits (not specified)           | Soft red fruits | Norovirus             | Belgium, France | Baert et al., 2011 |
| 11             | Tomatoes                         | Tomatoes    | Rotavirus              | South Africa | van Zyl et al., 2006 |
| 15             | Leafy greens eaten raw as salads | Leafy greens | Norovirus              | Canada, Belgium, France | Baert et al., 2011 |
| 1/other        | Fruit (non specified)/n.s.       | Produce     | Norovirus              | Belgium      | Baert et al., 2011 |
Table 24: Categories and items of FoNAO with high water content as reported in association with parasites. Food items that have been implicated in outbreaks with the ten highest numbers of outbreak cases, hospitalisations, and/or deaths (see Table 30) are highlighted below. “Country/ies” signifies the place where the food commodity was found in association with the biological contaminant (e.g. site of survey or screening).

| FoNAO Category                     | Food item          | Pathogen(s)                                                                 | Country/ies                          | Reference(s)                  |
|------------------------------------|--------------------|-----------------------------------------------------------------------------|--------------------------------------|-------------------------------|
| 1 Fruit (non specified)            | Berries           | *Encephalitozoon intestinalis*, *Microsporidia* (spores)                     | Poland, USA                          | Jedrzejewski et al., 2007    |
| 3 Raspberries                      | Raspberries       | *Enterocytozoon bieneusi*                                                   | Poland, USA                          | Jedrzejewski et al., 2007    |
| 4 Other berries                    | Blackberry        | *Cryptosporidium* spp.                                                      | Costa Rica                           | Calvo et al., 2004          |
| 11 Tomatoes                        | Tomatoes          | *Giardia* spp. (*oocysts*), *Toxocara canis*, *Taenia/Echinococcus*, *Ascaris* spp., *Toxocara cati*, *Giardia lamblia*, *Entamoeba coli*, *Ascaris* spp. (*oocysts*), *Toxocara* spp. | Libya, Venezuela, Egypt, Yemen     | Abougrain et al., 2010; Cazorla et al., 2009; Hassan et al., 2012 |
| 12 Peppers, and aubergines         | Chili fruits       | *Giardia* spp., *Entamoeba* spp., *Entamoeba histolytica*                   | India                                | Rai et al., 2008            |
|                                   | Garden egg (Solanum aethiopicum) | *Ascaris* spp. (*oocysts*), *Trichuris* spp.                                | Nigeria                              | Adamu et al., 2012          |
|                                   | Pepper            | *Giardia* lamblia, *Entamoeba histolytica*, *Ascaris* spp.                  | Egypt, Yemen, Venezuela              | Hassan et al., 2012; Cazorla et al., 2009 |
| 13 Gourds and squashes             | Cucumber          | *Trichuris* spp., *Taenia* spp., *Toxocara canis*, *Giardia lamblia*, *Toxocara cati*, *Entamoeba histolytica*, *Giardia* spp. (*oocysts*), *Taenia/Echinococcus*, *Entamoeba coli*, *Ascaris* spp. (*oocysts*) | Nigeria, Turkey, Libya, Egypt, Yemen | Adamu et al., 2012; Kozan et al., 2004; Abougrain et al., 2010; Hassan et al., 2012 |
| 15 Leafy greens eaten raw as salads | Cabbage           | *Strongyloides stercoralis*, *Toxocara* spp., *Entamoeba histolytica/dispar*, *Cryptosporidium* spp., *Cyclospora* spp., *Intestinal helminthes*, *Giardia* spp., *Entamoeba* spp., *Ascaris* spp. | Nigeria, Venezuela, Kenya, Italy, Nepal, USA, India | Adamu et al., 2012; Cazorla et al., 2009; Nyarango et al., 2008; Shericand and Cross 2002; Rai et al., 2008 |
| FoNAO Category | Food item | Pathogen(s) | Country/ies | Reference(s) |
|----------------|-----------|-------------|-------------|---------------|
| Cress          | Giardia spp., Toxocara spp., Entamoeba coli, Taeniid spp., Ascaris lumbricoide, Giardia spp. (oocysts), Taenia/Echinococcus, Toxocara canis, Toxocara cati, Ascaris spp. (oocysts) | Iran, Libya | Fallah et al., 2012; Abougrain et al., 2010 |
| Curly lettuce  | Entercytozoon bieneusi | Poland, Libya | Jedrzejewski et al., 2007 |
| Lettuce        | Ascaris spp. (oocysts), Trichuris spp., Taenia/Echinococcus spp. (oocysts), Ancylostomatidae, Microsporidia, Cyclospora cayetanensis, Ascaris lumbricoides, Toxocara spp., Cyclospora spp., Giardia spp. (oocysts), Toxoplasma gondii, Blastocystis spp., Crypto sporidium spp., Taenia/Echinococcus, Toxocara canis, Toxocara cati, Giardia spp., Entamoeba spp., Ascaris spp. | Nigeria, Costa Rica, Turkey, India, Vietnam, Canada, Libya, Poland, Venezuela, Nepal, USA | Adamu et al., 2012; Calvo et al., 2004; Kozan et al., 2004; Gupta et al., 2009; Tram et al., 2008; Abougrain et al., 2010; Lass et al., 2012; Cazorla et al., 2009; Sherchand and Cross 2002; Rai et al., 2008 |
| Mustard leaves | Cyclospora spp. | Nepal, USA | Sherchand and Cross 2002 |
| Purslane       | Ascaris lumbricoide, Giardia spp., Trichostrongylus spp. | Iran | Fallah et al., 2012 |
| Radish         | Ascaris lumbricoide, Toxocara spp., Entamoeba coli, Giardia spp., Taeniid spp., Toxoplasma gondii, Giardia lamblia, Entamoeba histolytica, Entamoeba spp. | Iran, Poland, Egypt, Yemen, India | Fallah et al., 2012; Lass et al., 2012; Hassan et al., 2012; Rai et al., 2008 |
| Spinach        | Crypto sporidium spp., Trichuris trichiura, Ancylostomatidae, Ascaris lumbricoides | Canada, India | Bohaychuk et al., 2009; Gupta et al., 2009 |
| Spinach leaves | Giardia spp., Entamoeba spp. | India | Rai et al., 2008 |
| Tarragon       | Entamoeba spp., Trichostrongylus spp., Taeniid spp. | Iran | Fallah et al., 2012 |
| FoNAO Category | Food item | Pathogen(s) | Country/ies | Reference(s) |
|----------------|-----------|-------------|-------------|---------------|
| Water spinach (Ipomoea aquatica) | Cyclospora spp., Cryptosporidium spp., Giardia spp. | Vietnam, Denmark | Vuong et al., 2007 |
| Watercress | Entamoeba coli | Egypt, Yemen | Hassan et al., 2012 |
| 16 Fresh herbs | Amaranth leaves | Cryptosporidium spp. | India | Rai et al., 2008 |
| | Basil | Trichostrongylus spp., Entamoeba coli, Cyclospora spp., Giardia spp., Taeniid spp., Ascaris lumbricoides | Iran, Vietnam, Canada | Fallah et al., 2012; Tram et al., 2008 |
| | Chives | Anquilostomídeos, Blastocystis spp., Ascaris spp., Cyclospora spp. | Venezuela | Cazorla et al., 2009 |
| | Coriander | Ancylostomatidae, Trichuris trichiura, Giardia lambia, Entamoeba coli, Entamoeba histolytica, Toxocara spp., Cyclospora spp., Taeniid spp., Ascaris lumbricoides, Dipylidium caninum, Microsporidia, Ascaris spp. | India, Egypt, Yemen, Iran, Vietnam, Canada, Venezuela, Costa Rica | Gupta et al., 2009; Hassan et al., 2012; Fallah et al., 2012; Tram et al., 2008; Cazorla et al., 2009; Calvo et al., 2004 |
| | Dill | Taeniid spp., Entamoeba coli | Iran | Fallah et al., 2012 |
| | Marjoram | Cyclospora spp. | Vietnam, Canada | Tram et al., 2008 |
| | Mint leaves | Giardia spp., Entamoeba spp. | India | Rai et al., 2008 |
| | Parsley | Toxocara spp., Entamoeba coli, Ancylostomatidae, Taenia spp., Giardia lambia, Trichostrongylus spp., Ascaris lumbricoides, Taeniid spp. | Turkey, Iran, India, Egypt, Yemen | Kozan et al., 2004; Fallah et al., 2012; Gupta et al., 2009; Hassan et al., 2012 |
| | Persicaria | Cyclospora spp. | Vietnam, Canada | Tram et al., 2008 |
| | Pudina (mentha) | Trichuris trichiura, Ancylostomatidae, Ascaris lumbricoides | India | Gupta et al., 2009 |
| | Spearmint | Ascaris lumbricoides, Taeniid spp., Trichostrongylus spp., Entamoeba coli, Giardia spp. | Iran | Fallah et al., 2012 |
| FoNAO Category         | Food item              | Pathogen(s)                                      | Country/ies          | Reference(s)                  |
|------------------------|------------------------|--------------------------------------------------|----------------------|--------------------------------|
| Vietnamese mint        | Cyclospora spp.        | Vietnam, Canada                                  | Tram et al., 2008    |
| 18 Other leaves        | Black night shade      | Intestinal helminthes                            | Kenia, Italy         | Nyarango et al., 2008          |
|                        | Kales                  | Intestinal helminthes                            | Kenia, Italy         | Nyarango et al., 2008          |
|                        | Spider flower          | Intestinal helminthes                            | Kenia, Italy         | Nyarango et al., 2008          |
| 19 Carrots             | Carrots                | *Toxoplasma gondii*, *Strongyloides stercoralis*,*Giardia lambia*,*Entamoeba coli*, *Giardia spp.*, *Entamoeba spp.* | Poland, Nigeria, Turkey, Egypt, Yemen, India | Lass et al., 2012; Adamu et al., 2012; Kozan et al., 2004; Hassan et al., 2012; Rai et al., 2008 |
| 21 Other root and tuberous vegetables | Amaranth roots  | *Giardia spp.*, *Entamoeba spp.*, *Entamoeba histolytica* | India                | Rai et al., 2008               |
| 22 Bulb and stem vegetables | Celery                | *Ancylostomatidae*, *Ascaris lumbricoides*, *Cryptosporidium spp.*, *Cyclospora spp.*, *Ascaris spp.*, *Entamoeba coli* | India, Costa Rica, Venezuela | Gupta et al., 2009; Calvo et al., 2004; Cazorla et al., 2009 |
|                        | Garlic                 | *Ascaris spp.*                                   | Venezuela            | Cazorla et al., 2009           |
|                        | Green onion            | *Taenia spp.*                                    | Turkey               | Kozan et al., 2004             |
|                        | Leek                   | *Toxocara spp.*, *Taeniid spp.*, *Entamoeba coli*,*Giardia spp.*, *Ascaris lumbricoides* | Iran                 | Fallah et al., 2012            |
|                        | Onion                  | *Ascaris spp.*                                   | Venezuela            | Cazorla et al., 2009           |
|                        | Scallion               | *Giardia spp.*, *Trichostrongylus spp.*, *Ascaris lumbricoides*,*Toxocara spp.* | Iran                 | Fallah et al., 2012            |
| I/other                | Produce                | *Cryptosporidium*                                 | Canada               | Bohaychuk et al., 2009         |

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| FoNAO Category | Food item | Pathogen(s) | Country/ies | Reference(s) |
|----------------|-----------|-------------|-------------|--------------|
| other/n.s.     | Vegetables| *Anquilostomídeos, Dipylidium caninum, Toxocara spp.*, *Cryptosporidium spp., Cyclospora spp., Entamoeba coli, Entamoeba histolytica/dispar, Blastocystis spp., Microsporidia (spores), Eimeria spp. (oocysts), Ascaris spp.* | Venezuela, Poland, USA, Brazil | Cazorla et al., 2009; Jedrzejewski et al., 2007; Pavan da Silvia et al., 2007 |
Table 25: Critical points in specific primary production procedures reported for the food items highlighted in tables 22-24, which have been most often documented in association with biological hazards

| FoNAO Category | Food item | Critical point/Hazard source(s) | Corrective action(s) | Reference |
|----------------|-----------|--------------------------------|----------------------|-----------|
| Strawberries/Raspberries /Other berries | Berries | Irrigation | NA | Bower et al., 2003 |
| | | Soil/Plant | NA | Bower et al., 2003 |
| | | Compost/Manure/Sewage sludge application | NA | Bower et al., 2003 |
| | | Animals (e.g., birds, insects, rodents) | NA | Bower et al., 2003 |
| | | Contact with humans | NA | Bower et al., 2003 |
| | | Equipment | NA | Bower et al., 2003 |
| Fruit and berry fruit crops | | Ground preparation/Fertiliser and compost application | certified manures, biosolids and fertilizers | Faulkner et al., 2001 |
| | | Planting/Worker hygiene | ensuring proper worker hygiene | Faulkner et al., 2001 |
| | | Planting/incorrect fertiliser application | certification, instructions | Faulkner et al., 2001 |
| | | Planting/irrigation | water sanitation | Faulkner et al., 2001 |
| | | Planting/contaminated soils | time between manure, biosolids, natural fertiliser | Faulkner et al., 2001 |
| | | Growing/Irrigation | water sanitation | Faulkner et al., 2001 |
| Fruit and berry fruit crops/Strawberries | | Harvesting/ Sorting (field) | ensuring proper worker hygiene; equipment and container sanitation; field management | Faulkner et al., 2001; FDA, 2011 |
| Strawberries | | Grading/Packing (field) | ensuring proper worker hygiene; water sanitation | FDA, 2011 |
| Citrus fruit | Orange | Harvesting | ensuring proper worker hygiene | FDA, 2008 |
| Tropical fruit | Mango | Environment | NA | Strawn et al., 2011 |
| | | Irrigation | water sanitation | Strawn et al., 2011 |
| | | Animals (e.g., birds, insects, rodents) | NA | Strawn et al., 2011 |
| | | Compost/Manure/Sewage sludge application | NA | Strawn et al., 2011 |
| FoNAO Category | Food item               | Critical point/Hazard source(s)                      | Corrective action(s)
|----------------|-------------------------|-----------------------------------------------------|-------------------------------------------------|
|                | Papaya                  | Environment                                         | NA                                               | Strawn et al., 2011                              |
|                |                         | Irrigation                                           | water sanitation                                 | Strawn et al., 2011                              |
|                |                         | Animals (e.g., birds, insects, rodents)              | NA                                               | Strawn et al., 2011                              |
|                |                         | Compost/Manure/Sewage sludge application             | NA                                               | Strawn et al., 2011                              |
|                |                         |                                                     |                                                  |                                                 |
| Melons         | 9                       | Cantaloupe                                           | Irrigation                                       | water sanitation                                 | FAO, 2008                                        |
|                |                         |                                                     | Harvesting                                       | NA                                               | FDA, 2008                                        |
|                |                         |                                                     | Sorting (field)                                  | NA                                               | FDA, 2008                                        |
|                |                         |                                                     | Packing (field)                                  | ensuring proper worker hygiene                   | FDA, 2008                                        |
|                |                         |                                                     | Transport to retail (cooled)                     | NA                                               | FDA, 2008                                        |
| Tomatoes       | 11                      | Tomatoes (open field)                                | Field management                                 | selection of field location; environmental assessment; assessment of adjacent land use | FDA, 2008                                        |
|                |                         |                                                     | Animals (e.g., birds, insects, rodents)          | animal exclusion (domestic) and measures to minimize wildlife presence | FDA, 2008                                        |
|                |                         |                                                     | Irrigation                                       | water sanitation                                 | FDA, 2008                                        |
|                |                         |                                                     | Contact with humans                              | written policies, employee training, sanitary facilities, health, designated drinking/eating/smoking areas | FDA, 2008                                        |
|                |                         |                                                     | Crop production practices (e.g., fertilizer, manure, pesticides) | assessment of risk of all production inputs | FDA, 2008; FDA, 2011                             |
|                |                         |                                                     | Equipment and containers                         | sanitation and cleaning                           | FDA, 2008; FDA, 2011                             |
|                |                         |                                                     | Sanitation and cleaning                          |                                                   | FDA, 2008                                        |
|                |                         |                                                     | Debris removal                                    | removal of e.g. dirt                              | FDA, 2008; FDA, 2011                             |
|                |                         |                                                     | Exclusion from harvest                            | intrusion                                        | FDA, 2008                                        |
|                |                         |                                                     | Sorting (field)                                   | removal of damaged, soft or decayed fruits       | FDA, 2008; FDA, 2011                             |

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| FoNAO Category | Food item          | Critical point/Hazard source(s)                      | Corrective action(s)* | Reference                |
|----------------|--------------------|------------------------------------------------------|-----------------------|--------------------------|
|                | Tomatoes (greenhouse) | Planting preparation/ incorrect fertiliser application | certification, instructions | Faulkner et al., 2001 |
|                |                    | Planting/Worker hygiene                              | ensuring proper worker hygiene | Faulkner et al., 2001 |
|                |                    | Planting/Soil/growing medium                         | NA                    | Faulkner et al., 2001   |
|                |                    | Growing/Irrigation                                   | water sanitation       | Faulkner et al., 2001   |
|                |                    | Growing/incorrect fertiliser application             | NA                    | Faulkner et al., 2001   |
|                |                    | Harvesting                                           | ensuring proper worker hygiene | Faulkner et al., 2001   |
|                | Tomatoes (mature green) | Harvesting                                           | Field, equipment and container sanitation | FDA, 2011 |
|                |                    | Waxing                                               | Equipment sanitation   | FDA, 2011 |
| Peppers and aubergines | Peppers             | Harvesting                                           | NA                    | FDA, 2008   |
|                |                    | Placing in field bins/boxes                          | equipment sanitation   | FDA, 2008   |
|                |                    | Transport to packinghouse                            | NA                    | FDA, 2008   |
| Gourds and squashes | Cucumber            | Harvesting                                           | ensuring proper worker hygiene | FDA, 2011 |
|                |                    | Hand harvest                                         | elimination defective fruit; fruit into clean plastic trays or buckets | FDA, 2011 |
|                |                    | Field management                                     | NA                    | FDA, 2011   |
|                |                    | Irrigation                                           | water sanitation       | FDA, 2011   |
|                |                    | Equipment and containers                             | sanitation and cleaning | FDA, 2011   |
|                |                    | Debris removal                                       | removal of e.g. dirt   | FDA, 2011   |
|                |                    | Sorting (field)                                      | NA                    | FDA, 2011   |
|                |                    | Placing in field bins/boxes                          | equipment sanitation   | FDA, 2011   |
|                |                    | Transport to packinghouse                            | NA                    | FDA, 2011   |
|                |                    | Harvesting                                           | ensuring proper worker hygiene | Mahovic et al. 2002 |
|                |                    | Irrigation                                           | water sanitation       | Mahovic et al. 2002 |
|                |                    | Pesticide mixing                                     | water sanitation       | Mahovic et al. 2002 |
| FoNAO Category                      | Food item                  | Critical point/Hazard source(s)                                      | Corrective action(s)*                  | Reference                                      |
|------------------------------------|----------------------------|---------------------------------------------------------------------|----------------------------------------|------------------------------------------------|
| Animals (e.g., birds, insects, rodents) | Any animal materials (waste, excrement etc.) should be removed from the field if possible (and practical); worker hygiene; Animal exclusion | Mahovic et al. 2002                                   |                                                       |
| Compost/Manure/Sewage sludge application | Mahovic et al. 2002 | Sorting (field) removal of damaged, soft or decayed fruits | Hurst et al., 2010                        |                                                |
| Leafy greens eaten raw as salad 15 | Lettuce, Spinach          | Ground preparation/Fertiliser and compost application certified manures, biosolids and fertilizers | Faulkner et al., 2001                      |                                                |
|                                  | Planting/Worker hygiene    | ensuring proper worker hygiene                                    | Faulkner et al., 2001                      |                                                |
|                                  | Planting/incorrect fertiliser application | certification, instructions                                      | Faulkner et al., 2001                      |                                                |
|                                  | Planting/irrigation        | water sanitation                                                   | Faulkner et al., 2001                      |                                                |
|                                  | Planting/contaminated soils | time between manure, biosolids, natural fertiliser | Faulkner et al., 2001                      |                                                |
|                                  | Harvesting                | ensuring proper worker hygiene                                    | Faulkner et al., 2001; FDA, 2011               |                                                |
|                                  | Irrigation                | water sanitation                                                   | Leafy green industry members (IFPA, PMA, UFFVA, WGA), 2006; FDA, 2011 |                                                |
|                                  | Harvesting (machine harvest/hand harvest) | avoiding cross contamination                                      | Leafy green industry members (IFPA, PMA, UFFVA, WGA), 2006 |                                                |
|                                  | Equipment                 | sanitation and cleaning                                             | Leafy green industry members (IFPA, PMA, UFFVA, WGA), 2006; FDA, 2011 |                                                |
|                                  | Environment               | control measures                                                   | Leafy green industry members (IFPA, PMA, UFFVA, WGA), 2006 |                                                |

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| FoNAO Category | Food item      | Critical point/Hazard source(s) | Corrective action(s)* | Reference                          |
|---------------|---------------|---------------------------------|----------------------|-----------------------------------|
|               |               | Soil amendment                  | NA                   | University of Georgia, Center for Food Safety |
|               |               | Irrigation                      | NA                   | University of Georgia, Center for Food Safety |
|               |               | Contact with humans             | NA                   | University of Georgia, Center for Food Safety |
|               |               | Animals (e.g., birds, insects, rodents) | NA | University of Georgia, Center for Food Safety |
|               |               | Equipment and containers        | NA                   | University of Georgia, Center for Food Safety |
|               |               | Adjacent Land Use               | NA                   | University of Georgia, Center for Food Safety |
|               |               | Cut, trim, sort, size, wrap, palletize (field) | ensuring proper worker hygiene; equipment and container sanitation | FDA, 2011 |
|               |               | Transport to packinghouse       | equipment sanitation | FDA, 2011 |
| Carrots       | 19            | Carrots                         | NA                   | FDA, 2008 |
|               |               | Harvesting                      | NA                   | FDA, 2008 |
|               |               | Shoot removal                   | NA                   | FDA, 2008 |
|               |               | Transport to packinghouse       | NA                   | FDA, 2008 |
| Potatoes      | 20            | Potato                          | Ground preparation/Fertiliser and compost application | NA | Faulkner et al., 2001 |
|               |               | Cultivation                     | NA                   | Faulkner et al., 2001 |
|               |               | Planting/fertiliser/compost/biosolids application | NA | Faulkner et al., 2001 |
|               |               | Planting/irrigation             | water sanitation     | Faulkner et al., 2001 |
|               |               | Growing/Irrigation              | water sanitation     | Faulkner et al., 2001 |
|               |               | Harvesting                      | ensuring proper worker hygiene | Faulkner et al., 2001 |
|               |               | Transport to packinghouse       | protection against dust, dirt, bird droppings, rodents | Faulkner et al., 2001 |
| Bulb and stem vegetables | 22 | Green onion | Ground preparation/Fertiliser and compost application | certified manures, biosolids and fertilizers | Faulkner et al., 2001 |

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| FoNAO Category | Food item                    | Critical point/Hazard source(s)                                                                 | Corrective action(s)a           | Reference                     |
|---------------|------------------------------|------------------------------------------------------------------------------------------------|---------------------------------|-------------------------------|
|               | Planting/incorrect fertiliser application | certification, instructions                                                              | Faulkner et al., 2001; FDA, 2011 |
|               | Planting/irrigation          | water sanitation                                                                      | Faulkner et al., 2001; FDA, 2011 |
|               | Planting/contaminated soils  | time between manure, biosolids, natural fertiliser                                | Faulkner et al., 2001            |
|               | Growing/Irrigation           | water sanitation                                                                      | Faulkner et al., 2001; FDA, 2011 |
|               | Harvesting                   | ensuring proper worker hygiene                                                        | Faulkner et al., 2001; FDA, 2011 |
|               | Transport to packinghouse    | vehicle cleaning and inspection                                                       | Faulkner et al., 2001; FDA, 2011 |
|               | Sorting (field)              | NA                                                                                  | FDA, 2011                        |
|               | Packing (field)              | ensuring proper worker hygiene                                                        | FDA, 2011                        |

*a NA not applicable*
### Table 26: Critical points in specific processing procedures (post-harvest) reported for the food items highlighted in Tables 22-24, which have been most often documented in association with biological hazards

| FoNAO Category | Food item | Critical points/Contamination Sources /Vectors for contamination | Corrective action(s) | Reference(s) |
|----------------|-----------|---------------------------------------------------------------|---------------------|--------------|
| Strawberries/Raspberries/Other berries | Berries | Process water/ice | NR | Bower et al., 2003 |
| | | Dust | NR | Bower et al., 2003 |
| | | Crates soiled with dirt and manure | NR | Bower et al., 2003 |
| | | Animals (rodents, insects, birds) | NR | Bower et al., 2003 |
| | | Contact with humans | NR | Bower et al., 2003 |
| | | Equipment | NR | Bower et al., 2003 |
| | | Packing | NR | Bower et al., 2003 |
| | | Transport to retail | temperature control; truck sanitation | Bower et al., 2003; FDA, 2011 |
| | | Storage | NR | Bower et al., 2003 |
| | | Distribution | NR | Bower et al., 2003 |
| Fruit and berry fruit crops | Storage | facility inspection before use | Faulkner et al., 2001 |
| | | Post-harvest-treatment/incorrect agrichemical application | certification, instructions | Faulkner et al., 2001 |
| | | Post-harvest-treatment/contaminated water | water sanitation | Faulkner et al., 2001 |
| | | Storage | facility inspection before use | Faulkner et al., 2001 |
| | | Grading/Packing/Workers hygiene | sanitation and cleaning | Faulkner et al., 2001; FDA, 2011 |
| Strawberries | Cooling | temperature control | FDA, 2011 |
| | Loading | truck sanitation; equipment sanitation | FDA, 2011 |
| Citrus fruit | Orange juice | Fresh-cut operations/new technologies | determination the impact on food safety when evaluating new technologies | Leafy green industry members (IFPA, PMA, UFFVA, WGA), 2006 |
| | | Transport to retail | truck sanitation | Leafy green industry members (IFPA, PMA, UFFVA, WGA), 2006 |
| | | Storage | establishment of GMPs | Leafy green industry members (IFPA, PMA, UFFVA, WGA), 2006 |
| FoNAO Category | Food item | Critical points/Contamination Sources /Vectors for contamination | Corrective action(s)* | Reference(s) |
|----------------|-----------|---------------------------------------------------------------|-----------------------|--------------|
| Receipt of raw materials | visual inspection or automatic separator equipment; rejection of faulty fruits | Kourtis and Arvanitoyannis, 2001; HACCP Europa, online |
| Cold storage (fruit) | equipment/container sanitation | FDA, 2008; Houska et al., 2007 |
| Sorting/selecting/sizing (fruit) | ensuring proper worker hygiene | FDA, 2008 |
| Washing | re-washing of fruit batch | HACCP Europa, online; FDA, 2008; Houska et al., 2007 |
| Pasteurisation/Sterilization | re-pasteurisation of batch | Kourtis and Arvanitoyannis, 2001; HACCP Europa, online |
| High pressure processing | 500 MPa for 10 min | Houska et al., 2007 |
| Tropical fruit | Mango | Filling/packaging | NR | FDA, 2008 |
| Cooling | equipment sanitation; temperature control | Kourtis and Arvanitoyannis, 2001; HACCP Europa, online |
| Aseptic filling/bulk storage | rejection of faulty material | Kourtis and Arvanitoyannis, 2001; HACCP Europa, online |
| Storage (whole fruit) | > 12°C to prevent chilling injury | Strawn et al., 2011 |
| Washing | potable (warm/hot) water | Strawn et al., 2011 |
| Peeling/grating/cutting/slicing | cutting in pathogen-free environment | Strawn et al., 2011 |
| Contact with humans | ensuring proper worker hygiene | Strawn et al., 2011 |
| Cold storage (cut fruit) | NR | Strawn et al., 2011 |
| Storage (whole fruit) | > 12°C to prevent chilling injury | Strawn et al., 2011 |
| Washing | potable (warm/hot) water | Strawn et al., 2011 |
| Papaya | Cantaloupe | Peeling/grating/cutting/slicing | cutting in pathogen-free environment | Strawn et al., 2011 |
| Contact with humans | ensuring proper worker hygiene | Strawn et al., 2011 |
| Cold storage (cut fruit) | NR | Strawn et al., 2011 |
| Dry or wet dump | ensuring proper worker hygiene, equipment sanitation | FDA, 2008; PMA, 2005 |
| Melons | Cantaloupe | Peeling/grating/cutting/slicing | cutting in pathogen-free environment | Strawn et al., 2011 |
| Contact with humans | ensuring proper worker hygiene | Strawn et al., 2011 |
| Cold storage (cut fruit) | NR | Strawn et al., 2011 |
| Dry or wet dump | ensuring proper worker hygiene, equipment sanitation | FDA, 2008; PMA, 2005 |
| FoNAO Category | Food item | Critical points/Contamination Sources /Vectors for contamination | Corrective action(s)* | Reference(s) |
|----------------|-----------|---------------------------------------------------------------|-----------------------|--------------|
|                |           | Brushing                                                      | equipment sanitation; avoiding cross contamination | FDA, 2008; FAO, 2008; PMA, 2005 |
|                |           | Washing                                                       | water sanitation       | FAO, 2008    |
|                |           | Sorting/selecting/sizing                                     | ensuring proper worker hygiene, equipment sanitation | FDA, 2008    |
|                |           | Hydrocooling                                                 | water sanitation       | FDA, 2012; FAO, 2008 |
|                |           | Waxing                                                       | ensuring proper worker hygiene, equipment sanitation | FDA, 2008    |
| Tomatoes       | 11 Tomatoes | Packing/palletizing                                          | NR                    | FDA, 2008    |
|                | 11 Tomatoes | Transport to retail                                           | NR                    | FDA, 2008    |
| 38 Semidried tomatoes |           | Hand hygiene (most critical point in preventing viral contamination | NR                    | FAO, 2011    |
| 11 Tomatoes (greenhouse) |       | Transport to retail                                           | truck sanitation      | Faulkner et al., 2001 |
|                |           | Washing                                                      | water sanitation       | Faulkner et al., 2001; FDA, 2011 |
|                |           | Storage                                                      | facility inspection before use | Faulkner et al., 2001 |
|                |           | Grading/Packing/Workers hygiene                               | sanitation and cleaning | Faulkner et al., 2001 |
| 11 Tomatoes (catering) |       | Washing                                                      | Implementation of HACCP; GAP, GMP positive effect on product quality. | Kokkinakis and Fragkiadakis, 2007 |
| 11 Tomatoes (packaging house) |       | Dry or wet dump                                               | water quality mainteNRance in the packing house dump tank, including control of chlorine, pH and temperature; | Rushing et al., 1996 (only abstract) |
|                |           | Equipment and containers                                     | NR                    | Rushing et al., 1996 (only abstract) |
|                |           | Monitoring of hand-sorting procedures on the packing line     | NR                    | Rushing et al., 1996 (only abstract) |
| 11 Tomatoes (mature green) |       | Sorting/selecting/sizing                                     | equipment sanitation; ensuring proper worker hygiene | FDA, 2011    |
|                |           | Waxing                                                       | equipment sanitation; water sanitation | FDA, 2011    |

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| FoNAO Category | Food item          | Critical points/Contamination Sources /Vectors for contamination | Corrective action(s)* | Reference(s) |
|----------------|-------------------|------------------------------------------------------------------|-----------------------|--------------|
| Peppers and aubergines | 12 Peppers       | Hydrocooling: water sanitation                                   | FDA, 2008             |
|                 |                   | Peeling/grating/cutting/slicing: ensuring proper worker hygiene, equipment and container sanitation | FDA, 2011             |
|                 |                   | Bagging: ensuring proper worker hygiene, equipment sanitation     | FDA, 2008             |
|                 |                   | Dry or wet dump: equipment sanitation                             | FDA, 2008             |
|                 |                   | Brushing/washing/waxing: equipment and water sanitation           | FDA, 2008             |
| Gourds and squashes | 13 Cucumber         | Cooking: cooking until required interNRI temperature is reached | NMPED (New Mexico Public Education Department), online |
|                 |                   | Cooling (after cooking): cooling below 21°C in 2 h and below 5°C in 4 h | NMPED (New Mexico Public Education Department), online |
|                 |                   | Washing: water sanitation                                        | FDA, 2011             |
|                 |                   | Waxing: ensuring proper worker hygiene; equipment sanitation      | FDA, 2011             |
|                 |                   | Sorting/selecting/sizing: ensuring proper worker hygiene; equipment sanitation | FDA, 2011             |
|                 |                   | Packing/palletizing: ensuring proper worker hygiene; equipment and container sanitation | FDA, 2011             |
|                 |                   | Cooling: temperature control                                     | FDA, 2011             |
|                 |                   | Transport to retail: truck sanitation                             | FDA, 2011             |
|                 |                   | Cooling: temperature control                                     | Mahovic et al., 2002  |
|                 |                   | Storage room/truck trailers: Sanitation                           | Mahovic et al., 2002  |
|                 |                   | Reefer (a refrigerated vehicle): truck sanitation                 | Mahovic et al., 2002  |
| FoNAO Category | Food item          | Critical points/Contamination Sources /Vectors for contamination | Corrective action(s)* | Reference(s)                  |
|---------------|-------------------|---------------------------------------------------------------|-----------------------|-------------------------------|
| Leafy greens eaten raw as salad | 15 Lettuce, Spinach | Transport to retail | truck sanitation | Faulkner et al., 2001; FDA, 2011 |
|                |                   | Washing | water sanitation | Faulkner et al., 2001         |
|                |                   | Storage | facility inspection before use | Faulkner et al., 2001 |
|                |                   | Grading/Packing/Workers hygiene | sanitation and cleaning | Faulkner et al., 2001; FDA, 2011 |
|                |                   | Cooling | temperature control | Leafy green industry members (IFPA, PMA, UFFVA, WGA), 2006 |
|                |                   | Laundry | water sanitation | Leafy green industry members (IFPA, PMA, UFFVA, WGA), 2006 |
|                |                   | Re-use of field containers | appropriate equipment | Leafy green industry members (IFPA, PMA, UFFVA, WGA), 2006 |
|                |                   | Bulk Bin Modified Atmosphere Process | follow SOPs | Leafy green industry members (IFPA, PMA, UFFVA, WGA), 2006 |
|                |                   | Condition and sanitation of transportation vehicles | appropriate equipment | Leafy green industry members (IFPA, PMA, UFFVA, WGA), 2006 |
|                |                   | Contact with humans | ensuring proper worker hygiene | Leafy green industry members (IFPA, PMA, UFFVA, WGA), 2006 |
|                |                   | Top ice | water sanitation | FDA, 2011 |
| Carrots       | 19 Carrots        | Packing/palletizing | ensuring proper worker hygiene, equipment and container sanitation | FDA, 2008 |
|                |                   | Storage (whole fruit)/cooling/transport | truck sanitation | FDA, 2008 |
|                |                   | Cooling (pre-cut fruit) | NR | FAO, 2008 |
| FoNAO Category | Food item | Critical points/Contamination Sources /Vectors for contamination | Corrective action(s)\(^a\) | Reference(s) |
|----------------|-----------|---------------------------------------------------------------|-----------------------------|--------------|
| Sorting        | Potatoes  | Sorting ensuring proper worker hygiene, equipment sanitation  | FDA, 2008                   |              |
|                | 20 Potato salad | Sorting ensuring proper worker hygiene | FDA, 2008 |              |
|                |           | Packing/palletizing ensuring proper worker hygiene, equipment and container sanitation | FDA, 2008 |              |
|                |           | Transport to retail truck sanitation | FDA, 2008 |              |
|                |           | Washing water sanitation | Faulkner et al., 2001 |              |
|                |           | Storage (raw vegetable) protection against dust, dirt, bird droppings, rodents | Faulkner et al., 2001 |              |
|                |           | Packing/grading ensuring proper worker hygiene | Faulkner et al., 2001 |              |
|                | Bulb and stem vegetables | 22 Onions | Post-harvest-treatment/incorrect agrichemical application certification, instructions | Faulkner et al., 2001 |              |
|                |           | Post-harvest-treatment/contaminated water water sanitation | Faulkner et al., 2001 |              |
|                |           | Storage facility inspection before use; shaded | Faulkner et al., 2001; FDA, 2011 |              |
|                |           | Grading/Packing/Workers hygiene sanitation and cleaning | Faulkner et al., 2001 |              |
|                |           | Transport to retail truck sanitation | Faulkner et al., 2001; FDA, 2011 |              |
|                |           | Cooling temperature control | FDA, 2011 |              |

\(^a\)NR not reported
Table 27: Examples of Guidelines and Standards to improve food quality reported for selected food items listed in tables 27-32.

| Food Item          | FoNAO Category | Guideline documents/Regulations/Reports                                                                 | Organisation                              | Country/region\(^a\) | Reference                  |
|--------------------|----------------|--------------------------------------------------------------------------------------------------------|-------------------------------------------|----------------------|-----------------------------|
| Fruits and Vegetables | 1/other       | Code of hygienic practice for fresh fruits and vegetables. CAC/RCP 53-2003. Adopted 2003. Revision 2010 (new Annex III for Fresh Leafy Vegetables). | CAC (Codex Alimentarius Commission), 2003, online. | NA                   | CAC, 2003, online            |
|                    |                | Improving the quality and safety of fresh fruits and vegetables: a practical approach; Manual for Trainers | FAO (Food and Agriculture Organisation)   | USA                  | FAO, 2004, online           |
|                    |                | Guidance for Industry: Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables | FDA (U.S. Food and Drug Administration)   | USA                  | FDA, online(b)              |
|                    |                | Improving the Safety and Quality of Fresh Fruits and Vegetables: A Training Manual for Trainers            | JIFSAN (Joint Institute of Food Safety and Nutrition) | USA                  | JIFSAN, 2010, online        |
| Tomatoes           | 11             | Guidance for Industry: Guide to Minimize Microbial Food Safety Hazards of Tomatoes; Draft Guidance     | FDA (Food and Drug Administration)        | USA                  | FDA, online(d)              |
| Leafy greens       | 15             | Guidance for Industry: Guide to Minimize Microbial Food Safety Hazards of Leafy greens; Draft Guidance | FDA (U.S. Food and Drug Administration)   | USA                  | FDA, online(c)              |
| n.s.               | n.s.           | Good Agriculture Practices                                                                               | FAO (Food and Agriculture Organisation)   | USA                  | FAO, online                |
| n.s.               | n.s.           | Control points and compliance criteria integrated farm assurance                                          | GlobalGAP                                 | NA                   | GlobalGAP, 2007             |

\(^a\) NA not applicable
Table 28: Trade volumes of FoNAO with high water content imported from third countries into EU-27 from 2002 to 2011.

| Product description (EUROSTAT) | 2002       | 2003       | 2004       | 2005       | 2006       | 2007       | 2008       | 2009       | 2010       | 2011       |
|-------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| fresh strawberries, strawberries (uncooked, cooked, frozen) | 847,333    | 1,295,087  | 1,272,200  | 1,275,238  | 1,151,447  | 1,647,123  | 1,767,241  | 1,424,799  | 1,501,306  | 1,768,662  |
| fresh raspberries, raspberries (uncooked, cooked, frozen)     | 943,681    | 804,274    | 795,464    | 859,653    | 934,500    | 750,383    | 803,907    | 898,558    | 1,059,579  |
| fresh table grapes, black currants, red currants, white currants, gooseberries, cowberries, foxberries, mulberries, loganberries | 4,268,040  | 4,593,901  | 5,071,469  | 5,985,786  | 6,529,666  | 6,647,212  | 7,046,470  | 6,650,838  | 6,227,526  | 5,781,452  |
| sanguines, navels, sweet oranges, clementines, mandarins, monreales, tangerines, mandarins, satsuma, tangelos, ortanigués, lemons, limes, grapefruit | 17,615,377 | 18,875,265 | 18,090,615 | 21,811,192 | 20,448,752 | 22,007,124 | 20,459,556 | 21,976,227 | 19,249,881 |
| apples, pears, quinces                                      | 8,962,603  | 9,855,000  | 11,313,226 | 13,310,789 | 14,112,713 | 12,566,702 | 11,666,805 | 10,717,310 | 8,720,383  | 8,592,182  |
| apricots, sour cherries, peaches, nectarines, plums         | 1,200,384  | 1,681,014  | 1,828,563  | 1,793,643  | 1,703,981  | 1,977,368  | 1,801,943  | 1,735,337  | 1,426,206  | 1,536,177  |
| coconut, plantains, bananas, figs, pineapples, avocados, guavas, mangoes, papayas, kiwifruit, persimmons, durians, tamarind, cashew, apples, lychees, jackfruit, passionsfruit, guavas, mangosteen | 50,633,478 | 53,572,989 | 54,239,759 | 55,220,437 | 55,220,437 | 56,110,728 | 56,014,392 | 69,174,868 | 64,705,086 | 64,883,036 |
| watermelon, melon                                            | 3,028,521  | 3,696,701  | 3,787,130  | 4,373,245  | 5,027,829  | 5,494,613  | 5,760,489  | 5,068,083  | 5,313,136  | 5,317,189  |
| tomatoes                                                     | 2,808,858  | 2,919,236  | 2,892,845  | 3,550,782  | 3,551,303  | 4,709,234  | 4,730,473  | 5,429,303  | 4,977,549  | 4,605,226  |
| aubergines, sweet pepper                                     | 893,320    | 875,777    | 1,165,594  | 1,594,241  | 1,636,084  | 2,099,808  | 2,266,125  | 2,333,322  | 2,217,952  | 2,290,234  |
| cucumbers, gherkins, courgettes, pumpkins                   | 467,402    | 559,169    | 593,526    | 613,484    | 812,648    | 906,511    | 889,765    | 1,005,943  | 844,773    | 780,954    |
| peas, beans, leguminous vegetables, chickpeas, azuki beans, kidney beans, bambara beans, cow peas, horse beans, lentils, pigeon peas | 14,980,734 | 12,336,102 | 19,088,822 | 22,452,111 | 20,224,789 | 13,100,427 | 12,227,566 | 12,361,204 | 12,878,178 | 12,873,685 |
| cabbage lettuce, lettuce, chicory, spinach, salad vegetables | 70,505     | 116,469    | 69,976     | 213,509    | 188,936    | 221,745    | 238,282    | 200,811    | 237,174    | 216,667    |
| carrots                                                      | 215,266    | 415,657    | 278,123    | 404,569    | 473,754    | 619,030    | 660,537    | 1,170,341  | 935,750    | 840,228    |
| Product description (EUROSTAT) | 2002   | 2003   | 2004   | 2005   | 2006   | 2007   | 2008   | 2009   | 2010   | 2011   |
|---------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| potatoes                        | 3,829,773 | 4,031,415 | 5,882,893 | 6,033,633 | 5,490,073 | 6,231,863 | 5,225,552 | 4,564,727 | 4,218,668 | 3,958,928 |
| horse-radish, salad beetroot, salsify, celeriac, celery, yam, manioc, arrowroot, salep | 101,734 | 89,343 | 84,662 | 88,102 | 123,563 | 96,506 | 101,789 | 100,417 | 88,694 | 111,682 |
| onion, shallots, garlic, asparagus, celery, fennel | 4,326,138 | 4,595,547 | 4,398,042 | 3,558,577 | 4,335,631 | 5,934,061 | 5,281,043 | 4,104,101 | 4,439,968 | 4,785,591 |
| cauliflower, broccoli, artichokes | 45,817 | 73,514 | 91,814 | 158,048 | 218,663 | 201,700 | 180,521 | 272,020 | 240,114 | 240,596 |
| edible mushrooms, agaricus, truffles, chanterelles | 90,307 | 125,388 | 161,782 | 153,542 | 151,868 | 125,773 | 153,495 | 149,952 | 122,591 | 132,445 |

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**C. APPENDIX SPECIFIC TO THEMATIC AREA C**

Table 29: Major outcomes of European consumption studies relating to FoNAO regarding consumption rates, consumer groups, and regional effects.

| Food Item(s)   | Age-Class          | Method                | No. of surveyed participants | Scope of the study                                      | Outcome 1 (consumption rate) | Outcome 2* (observed differences between groups) | Outcome 3* (observed differences between countries/environments) | Research project | Country/countries                                       | Reference         |
|----------------|--------------------|-----------------------|------------------------------|--------------------------------------------------------|-------------------------------|-----------------------------------------------|---------------------------------------------------------------|------------------|--------------------------------------------------------|-------------------|
| Apple          | Adults (50-70 yrs) | Fruit-frequency       | 4271                         | Apple and peach consumption frequency                  | Highest consumption Poland (55 % > 5 times/wk) and Italy (39.3 % 3-5 times/wk); lowest consumption Netherland and Spain | Differences between gender (females higher consumption) and age groups | Differences between countries                               | ISAFRUIT         | Germany, Poland, Switzerland, France, Netherland, Italy, Spain | Konopacka et al. 2010 |
| Peach          | Adults (50-70 yrs) | Fruit-frequency       | 499                          | Apple and peach consumption frequency                  | Highest consumption France (48 % > 3.5 times/wk, 40 % > 5 times/wk); lowest consumption Germany | Differences between gender (females higher consumption) and age groups | Differences between countries                               | ISAFRUIT         | Germany, Poland, Spain, France, Italy                    | Konopacka et al. 2010 |
| Fruit and soft drinks | Adolescents (11, 13, 15 yrs) | standardised question. | 114 558 | Health behaviour in school aged children | 33 % consume fruit daily; 26 % consume soft drinks daily | Girls and younger pupils consume fruit more often and soft drinks less often | Differences between schools, countries, regions, and family material wealth | HBSSC            | 28 European countries or regions                        | Vereecken et al. 2005a |
| Fruit, vegetables and soft drinks | Adolescents (11, 13, 15 yrs) | standardised question. | 162 305 | Health behaviour in school aged children | Fruit consumption 2.8-5 /wk; vegetables 2.4-5.5/wk, soft drinks 2.5-5/ wk | NR | Differences between countries | HBSSC            | 35 Countries (Europe, Israel, N-America)                 | Vereecken et al. 2005b |
| Fruit and vegetables | -                  | standardised question. | 13 305 | Factors related to fruit and vegetable intake | 43.5 % consume fruit daily; 46.1 % consume vegetables daily | Gender differences | Differences between countries | ProChildren Project | Austria, Belgium, Denmark, Iceland, Netherland, Nor-way, Portugal, Spain, Sweden | Brug et al. 2008 |
| Food Item(s)         | Age-Class     | Method                   | No. of surveyed participants | Scope of the study                                      | Outcome 1 (consumption rate) | Outcome 2* (observed differences between groups) | Outcome 3* (observed differences between countries/environments) | Research project          | Country/ countries | Reference          |
|---------------------|---------------|--------------------------|-----------------------------|--------------------------------------------------------|-------------------------------|-----------------------------------------------|---------------------------------------------------------------|---------------------------|-------------------|--------------------|
| Fruit and vegetables | Adolescents   | 24 hours recall          | 1489                        | Effect of fruit and vegetable promotion                | Total fruit and vegetable intake 221-256 g/d | NR                                            | NR                                           | ProChildren Project     | Norway, Nether-land, Spain | Velde et al. 2008 |
| Fruit and vegetables | Adolescents (11 yrs) | Food frequency question.; 24 hrs recall | 1919                        | Influence of school environment on fruit and vegetable intake | 40 % consume > 200 g fruit/d; 25% consume > 130 g vegetables/d; 64 % consume fruit almost daily; 46.9 % consume vegetables almost daily | NR                                            | NR                                           | ProChildren Project     | Denmark            | Krolner et al. 2009 |
| Fruit and vegetables | Adolescents (11-13 yrs) | Food frequency question.; 24 hrs recall | 1601                        | Influence of parenting styles on fruit and vegetable consumption | 155 g/d fruits and 88 g/d vegetable consumption | NR                                            | NR                                           | ProChildren Project     | Portugal           | Franchini et al. 2011 |
| Fruit and vegetables | Adolescents (9-11 yrs) | 24 hours recall          | 1612                        | Impact of school fruit tuck shops and school food policies on fruit and vegetable consumption | 0.69-0.74 portions/d | NR                                            | NR                                           | -                         | U.K.               | Moore and Tapper 2008 |

*NR=not reported
### D. APPENDIX SPECIFIC TO THEMATIC AREA D

**Table 30:** FoNAO (high water content) item/pathogen combinations with highest numbers of outbreak cases, EU countries. Collective cases from multiple outbreaks are indicated in **bold.**

| Rank | Food item                          | FoNAO Category | Pathogen                          | Country                                      | Year       | Cases | Hospitalisations | Deaths<sup>b</sup> | Reference(s)                          |
|------|-----------------------------------|----------------|-----------------------------------|----------------------------------------------|------------|-------|-----------------|-------------------|----------------------------------------|
| **1** | Lettuce (unspec., mixed and Iceberg) | 15, 17          | *Salmonella* spp.                 | Finland, Northern Ireland, United Kingdom, Sweden | 2003-2010 | 578   | 56              | 2                 | Takkinen et al., 2005; Irvine et al., 2009; ECDC, 2010; Lienemann et al., 2011; Gajraj et al., 2012 |
| **2** | Lettuce (unspec., Romaine and Iceberg; whole and shredded) | 15              | *E. coli* O157, O157:H7 and O157:VT2 | Iceland, Netherlands, Sweden                  | 2005-2007 | 305   | 31              | 0 and n.s. | Friesema et al., 2008; Söderström et al., 2005; Söderström et al., 2008 |
| **3** | Basil (fresh)                      | 16              | *Salmonella* spp. (plus *E. coli* O92:H- and O153:H2 in one case) | Denmark, United Kingdom                        | 2006-2007 | 247   | 3               | n.s.              | Pezzoli et al., 2007; Pakalniskiene et al., 2009; Pezzoli et al., 2008 |
| **4** | Carrots (grated)                   | 19              | *Yersinia pseudotuberculosis* O:1 | Finland                                        | 2003, 2006 | 215   | 11              | n.s.              | Jalava et al., 2006; Rimhanen-Finne et al., 2009 |
| **6** | Mung beans                         | 14              | *Salmonella* Bareilly, *Salmonella* Virchow | Sweden                                            | 2006 | 115   | n.s. | n.s. | de Jong et al., 2007 |
| **7** | Sugarsnaps                         | 14              | *Shigella dysenteria*             | Sweden                                          | 2009 | 35    | 0               | 0                 | ECDC, 2009 |
| **8** | Fresh fruit juice                  | 1               | *Salmonella* Panama              | Netherlands                                     | 2008 | 33    | 10              | 0                 | Noel et al., 2010 |
| **9** | Beans                              | 14              | *Staphylococcus aureus*          | Belgium                                         | 2009 | 14    | 0               | 0                 | ECDC, 2009 |
| **10** | Sugar peas                         | 14              | *Shigella sonnei*                | Denmark                                         | 2009 | 10    | 0               | 0                 | Pingeon et al., 2009 |
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### Viruses

| Rank | Food item                      | FooNAO Category | Pathogen   | Country                  | Year             | Cases | Hospitalisations<sup>b</sup> | Deaths<sup>b</sup> | Reference(s)                                                                 |
|------|--------------------------------|-----------------|------------|--------------------------|------------------|-------|----------------------------|-------------------|-----------------------------------------------------------------------------|
| 1    | Strawberries                    | 2               | Norovirus  | Germany, Sweden          | 2010, 2012       | 11007 | 0/n.s.                     | 0/n.s.            | ECDC, 2010; RKI, online                                                    |
| 2    | Raspberries                     | 3               | Norovirus  | Denmark, Finland, Sweden | 2005-2010        | 2587  | 23                         | 0/n.s.            | ECDC, 2009; ECDC 2010; Korsager et al., 2005; Cottereau et al., 2005    |
| 3    | Lettuce, green salad            | 15              | Norovirus  | Denmark, Finland, U.K.   | 2007, 2009, 2010 | 560   | 1/n.s.                     | 0/n.s.            | ECDC, 2009; ECDC, 2010; Ethelberg et al., 2010; Vivancos et al., 2009 |
| 4    | Salad (mixed fresh-cut leaves)  | 17              | Norovirus  | Germany, Austria         | 2006-2009        | 273   | 14                         | 0/n.s.            | Schmid et al., 2007; Wadl et al., 2010                                   |
| 5    | Blackberries                    | 4               | Norovirus  | Germany                  | 2005             | 241   | 0                          | n.s.              | Fell et al., 2007                                                          |
| 6    | Tomatoes (semidried)            | 38              | Hepatitis A virus | France, United Kingdom, Netherlands | 2009-2011    | 79    | 32                         | 0                 | Carvalho et al., 2012; Couturier, 2011; ECDC, 2010; Gallot et al., 2011; Petignani et al., 2010 |
| 7    | Onion (raw)                     | 22              | Norovirus  | Finland                  | 2009             | 52    | 0                          | 0                 | ECDC, 2009                                                                 |
| 8    | Strawberries or raspberries     | 2/3             | Norovirus  | Finland                  | 2009             | 11    | 0                          | 0                 | ECDC, 2009                                                                 |
| 9    | Fruits                          | 1               | Norovirus  | Denmark                  | 2009             | 8     | 0                          | 0                 | ECDC, 2009                                                                 |
| 10   | Carrots                         | 19              | Norovirus  | Belgium                  | 2009             | 2     | 0                          | 0                 | ECDC, 2009                                                                 |

### Parasites

| Rank | Food item                        | FooNAO Category | Pathogen                | Country          | Year  | Cases | Hospitalisations<sup>b</sup> | Deaths<sup>b</sup> | Reference(s)                  |
|------|-----------------------------------|-----------------|-------------------------|------------------|-------|-------|----------------------------|-------------------|-------------------------------|
| 1    | Cucumber (in sandwiches, salads)  | 13              | *Enterocytozoon bieneusi* | Sweden           | 2009  | 135   | n.s.                     | n.s.              | Decraene et al., 2012         |
| Rank | Food item | FoNAO Category | Pathogen | Country | Year | Cases | Hospitalisations\(^b\) | Deaths\(^b\) | Reference(s) |
|------|-----------|----------------|----------|---------|------|-------|-------------------------|-------------|--------------|
| 2    | Carrot or red peppers (grated carrots, whole carrots in water, pepper in water) | 12 or 19 | *Cryptosporidium hominis* | Denmark | 2005 | 99 | n.s. | n.s. | Ethelberg et al., 2009 |
| 3    | Parsley (fresh) | 16 | *Cryptosporidium parvum* | Sweden | 2008 | 21 | 3 | n.s. | Insulander et al., 2008 |
| 4    | Watercress (fresh) | 15 | *Fasciola hepatica* | France | 2002 | 18 | n.s. | n.s. | Mailles et al., 2006 |
| 5    | Sugar snap peas (from Guatemala) | 14 | *Cyclospora cayetanensis* | Sweden | 2009 | 14 | 1 | n.s. | Insulander et al., 2010 |

* Outbreaks traced back to the consumption of highly processed food items (containing FoNAO mixed with other ingredients of animal origin, e.g. meat, milk or egg products) were not included in the ranking.

\(^b\) n.s.= non specified.
Table 31: FoNAO (high water content) item/pathogen combinations causing outbreaks with highest numbers of hospitalisation, EU countries. Collective cases from multiple outbreaks are indicated in bold.

| Rank | Food item | FoNAO Category | Pathogen | Country | Year | Cases | Hospitalisation | Deaths | Reference(s) |
|------|------------|----------------|----------|---------|------|-------|-----------------|--------|---------------|
|      | **Bacterial pathogens** |                  |          |         |      |       |                 |        |               |
| 1    | Lettuce (unspecified, mixed and Iceberg) | 15, 17 | *Salmonella* spp. | Finland, Northern Ireland, United Kingdom, Sweden | 2003-2010 | 578 | 56 | 2 | Takkenen et al., 2005; Irvine et al., 2009; ECDC, 2010; Lienemann et al., 2011; Gajraj et al., 2012 |
| 2    | Lettuce (unspecified, Romaine and Iceberg; whole and shredded) | 15 | *E. coli* O157, O157:H7 and O157:VT2 | Iceland, Netherlands, Sweden | 2005-2007 | 305 | 31 | 0 and n.s. | Friesema et al., 2008; Söderström et al., 2005; Söderström et al., 2008 |
| 3    | Carrots (grated) | 19 | *Yersinia pseudotuberculosis* O:1 | Finland | 2003, 2006 | 215 | 11 | n.s. | Jalava et al., 2006; Rimhanen-Finne et al., 2009 |
| 4    | Fresh fruit juice | 1 | *Salmonella* Panama | Netherlands | 2008 | 33 | 10 | 0 | Noel et al., 2010 |
| 5    | Green olives | 35 | *Clostridium botulinum* | France | 2011 | 9 | 9 | n.s. | Pingeon et al., 2006 |
| 6    | Basil (fresh) | 16 | *Salmonella* spp. (plus *E. coli* O92:H- and O153:H2 in one case) | Denmark, United Kingdom | 2006-2007 | 247 | 3 | n.s. | Pakalniskiene et al., 2009; Pezzoli et al., 2007; Pezzoli et al., 2008 |
|      | **Viruses** |                  |          |         |      |       |                 |        |               |
| 1    | Tomatoes (semidried) | 38 | *Hepatitis A* virus | France, United Kingdom, Netherlands | 2009-2011 | 79 | 32 | 0 | ECDC, 2010; Carvalho et al., 2012; Couturier, 2011; Gallot et al., 2011; Petigniani et al., 2010 |
| 2    | Raspberries | 3 | *Norovirus* | Denmark, Finland, Sweden | 2005-2010 | 2587 | 23 | 0/n.s. | ECDC, 2009; ECDC 2010; Korsager et al., 2005; Cotterelle et al., 2005 |
| 3    | Salad (mixed fresh-cut leaves) | 17 | *Norovirus* | Germany, Austria | 2006-2009 | 273 | 14 | 0/n.s. | Schmid et al., 2007; Wadl et al., 2010 |
Table 32: FoNAO (high water content) item/pathogen combinations causing outbreaks\(^a\) where cases of death have been reported, EU countries. Collective cases from multiple outbreaks are indicated in **bold**.

| Rank | Food item               | FoNAO Category | Pathogen                  | Country                  | Year | Cases | Hospitalisation | Deaths\(^b\) | Reference(s)                                      |
|------|-------------------------|----------------|---------------------------|--------------------------|------|-------|----------------|-------------|--------------------------------------------------|
| 1    | Iceberg lettuce         | 15             | *Salmonella* Newport, *Salmonella* Reading | Finland                  | 2008 | 108   | 15            | 2           | Lienemann et al., 2011                            |
| 2    | Sugar snap peas         | 14             | *Cyclospora* cayetanensis | Sweden                   | 2009 | 14    | 1             | n.s.        | Insulander et al., 2010                           |
| 3    | Parsley                 | 16             | *Cryptosporidium* parvum  | Sweden                   | 2008 | 21    | 3             | n.s.        | Insulander et al., 2008                           |

\(^a\) Outbreaks traced back to the consumption of highly processed food items (containing FoNAO mixed with other ingredients of animal origin, e.g. meat, milk or egg products) were not included in the ranking.

\(^b\) n.s. = non specified
Table 33: FoNAO (high water content) item/pathogen combinations with highest numbers of outbreak cases, non EU countries. Collective cases from multiple outbreaks are indicated in bold.

| Rank | Food item | FoNAO Categoryb | Pathogen | Country | Year       | Cases | Hospitalisationsc | Deathsd | Reference(s)                      |
|------|------------|-----------------|----------|---------|------------|-------|------------------|----------|----------------------------------|
| 1    | Vegetables (raw) | other | Vibrio cholerae O1 Ogawa | Zambia | 2003-2004 | 2529  | n.s.             | 128      | MMWR, 2004a                      |
| 2    | Jalapeño peppers, serrano peppers, tomatoes (from Mexico) | 12    | Salmonella Saintpaul | Multi-state outbreak USA (43 states), Canada | 2008 | 1442             | 286      | 2                                 |
| 3    | Salad (mixed, rucola and unspecified) | 15, 17 | Salmonella spp. | Norway, USA | 2003-2004 | 662   | n.s.             | n.s.     | Elward et al., 2006; Nygard et al., 2008 |
| 4    | Cantaloupe melon | 9      | Salmonella spp. | Australia; Multi-state outbreaks USA (24, 16 and 10 states) | 2006-2012 | 564   | 122              | 2 and n.s. | CDC, 2008; CDC, 2011; CDC, 2012 (last update 10-10-2012); Munnoch et al., 2009 |
| 5    | Tomatoes | 11    | Salmonella spp. | Canada, Multi-state outbreak USA (21 states), USA | 2002-2006 | 464   | 33               | 0        | Behravesh et al., 2012; CDC, 2006; Greene et al., 2008; Gupta et al., 2007; Srikantiah et al., 2005 |
| 6    | Celery, cabbage (“Kimuchi”) | 35    | E. coli O6:H16 | Japan | 2005    | 401   | n.s.             | n.s.     | Kimura et al., 2006             |
| 7    | Lettuce (unspecified, Romaine and Iceberg; whole and shredded) | 15    | E. coli O157, O157:H7 and O145 | Iceland, Netherlands, Multi-state outbreaks USA (10, 5 and 5 states), USA | 2005-2011 | 291   | 166              | 0 and n.s. | CDC, 2006; CDC, 2010; CDC, 2011; 2008; Friesema et al., 2008; Sodha et al., 2011 |
| Rank | Food item | FoNAO Category | Pathogen | Country       | Year | Cases | Hospitalisations | Deaths | Reference(s)                          |
|------|-----------|----------------|----------|---------------|------|-------|------------------|--------|---------------------------------------|
| 8    | Apple (cider, unpasteurised) | 6              | non-O157 Shiga toxin producing E. coli (O111) | USA  | 2004 | 213   | 6                | 0      | Schaffzin et al. 2012; Vojdani et al. 2008 |
| 9    | Spinach (fresh) | 15             | E. coli O157:H7 | Multi state outbreak USA (26 states) | 2006 | 199   | 102              | 3      | CDC, 2006; Charatan 2006, Grant 2008, Wendel et al., 2009, MMWR, 2006 |
| 10   | Carrots (raw) | 19             | Shigella sonnei | USA (flights from Hawaii) | 2004 | 163   | 9                | n.s.   | Gaynor et al. 2009                    |
|      | **Viruses** |                |          |               |      |       |                  |        |                                       |
| 1    | Green onion | 22             | Hepatitis A virus | USA | 2003 | 601   | 124             | 3      | Wheeler et al. 2005; Wand and Moran 2004; MMWR 2003, 52 (47), 1155-1157 |
| 2    | Tomatoes (semidried) | 38             | Hepatitis A virus | Australia | 2009 | 562   | 0                | 1      | Donnan et al. 2012                    |
| 3    | Orange juice | 5              | Hepatitis A virus | Egypt   | 2004 | 351   | 127             | 0      | Frank et al., 2007                    |
| 4    | Lettuce (Lotto; primary production) | 15            | Calicivirus norovirus (Norwalk-like virus) | Norway | 2010 | 157   | 0                | 0      | ECDC, 2010                            |
| 5    | Radish (dried salad) | 38             | Norovirus | Korea | 2008 | 117   | n.s.           | n.s.   | Yu et al. 2010                        |
| 6    | Blueberries (raw) | 4              | Hepatitis A virus | New Zealand | 2002 | 81    | 18             | 1      | Calder et al. 2003                   |
| 7    | Mixed salad* | 15             | Calicivirus norovirus (Norwalk-like virus) | Norway | 2010 | 38    | 0                | 0      | ECDC, 2010                            |
| 8    | Coleslaw | 15             | Hepatitis A virus | Australia | 2003 | 21    | n.s.           | n.s.   | Munnoch et al. 2004                  |
| 9    | Date palm sap (raw) | n.a.         | Nipah virus | Bangladesh | 2008 | 10    | n.s.           | 9      | Rahman et al. 2012                   |

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| Rank | Food item                        | FoNAO Category | Pathogen                | Country      | Year | Cases | Hospitalisations | Deaths | Reference(s)                      |
|------|----------------------------------|----------------|-------------------------|--------------|------|-------|------------------|--------|-----------------------------------|
| 1    | Apple (cider, unpasteurised)     | 6              | Cryptosporidium parvum  | USA          | 2003 | 144   | n.s.             | n.s.   | Vojdani et al. 2008               |
| 2    | Basil (fresh)                    | 16             | Cyclospora cayetanensis | Canada       | 2005 | 142   | 7                | 0      | Milord et al. 2012                |
| 3    | Guava juice                      | 8              | Trypanosoma cruzi       | Venezuela    | 2007 | 103   | 0                | 1      | Alarcón de Noya et al. 2010       |
| 4    | Snow Peas (raw, from Guatemala)  | 14             | Cyclospora cayetanensis | USA          | 2004 | 96    | n.s.             | n.s.   | Heilpern et al. 2005; MMWR 2004, 53 (37), 876-878 |
| 5    | Sugar cane juice                 | n.a.           | Trypanosoma cruzi       | Brazil       | 2005 | 24    | n.s.             | 3      | Steindel et al. 2008              |
| 6    | Raspberries (juice)              | 3              | Cyclospora cayetanensis | Guatemala    | 2003 | 7     | n.s.             | n.s.   | Puente et al. 2006                |

* Outbreaks traced back to the consumption of highly processed food items (containing FoNAO mixed with other ingredients of animal origin, e.g. meat, milk or egg products) were not included in the ranking.

b n.a.= not applicable
c n.s.= not specified
d Not further specified, supposedly fresh cut salad leaves
e reported as international outbreak in EU and non-EU states; data cannot be separated.
Table 34: FoNAO (high water content) item/pathogen combinations causing outbreaks with highest numbers of hospitalisation, non EU countries. Collective cases from multiple outbreaks are indicated in **bold**.

| Rank | Food item | FoNAO Category | pathogen | Country | Year | Cases | Hospital. | Deaths<sup>b</sup> | Reference(s) |
|------|-----------|----------------|----------|---------|------|-------|-----------|----------------|--------------|
| **Bacterial pathogens** | | | | | | | | | |
| 1 | Jalapeño peppers, serrano peppers, tomatoes (from Mexico) | 12 | *Salmonella* Saintpaul | Multi-state outbreak USA (43 states), Canada | 2008 | 1442 | 286 | 2 | CDC, 2008; MMWR 2008, 57 (34) 929-934, Behravesh et al., 2011, Mody et al., 2011 |
| 2 | Lettuce (unspecified, Romaine and Iceberg; whole and shredded) | 15 | *E. coli* O157, O157:H7 and O145 | Iceland, Netherlands, Multi-state outbreaks USA (10, 5 and 5 states), USA * | 2005-2011 | 291 | 166 | 0 and n.s. | CDC, 2006; CDC, 2010; CDC, 2011; 2008; Friesema et al., 22008; Sodha et al., 2011 |
| 3 | Cantaloupe melon (whole) | 9 | *Listeria monocytogenes* | Multi-state outbreak USA (28 states) | 2011 | 147 | 143 | 33 | CDC, 2011; MMWR 2011, 60 (39) 1357-1358 |
| 4 | Cantaloupe melon | 9 | *Salmonella* spp. | Australia; Multi-state outbreaks USA (24, 16 and 10 states) | 2006-2012 | 564 | 122 | 0 and n.s. | CDC, 2008; CDC, 2011; CDC, 2012 (last update 10-10-2012); Munnoch et al., 2009 |
| 5 | Spinach (fresh) | 15 | *E. coli* O157:H7 | Multi state outbreak USA (26 states) | 2006 | 199 | 102 | 3 | CDC, 2006; Charatan 2006, Grant 2008, Wendel et al., 2009, MMWR 2006, 55 (38), 1045-1046 |
| 6 | Orange juice | 5 | *Salmonella* spp. | USA | 2005 | 157 | 89 | 0 | Jain et al., 2009; Vojdani et al., 2008 |
| 7 | Tomatoes | 11 | *Salmonella* spp. | Canada, Multi state outbreak USA (21 states), USA | 2002-2006 | 464 | 33 | 0 | Behravesh et al., 2012; CDC, 2006; Greene et al., 2008; Gupta et al., 2007; Srikantiah et al., 2005 |
| 8 | Mangoes | 8 | *Salmonella* Braenderup | Multi-state outbreak USA (15 states) | 2012 | 121 | 25 | 0 | CDC, 2012 (last updated 10-10-2012) |
| 9 | Carrots (raw) | 19 | *Shigella sonnei* | USA (flights from Hawaii) | 2004 | 163 | 9 | n.s. | Gaynor et al. 2009 |
| Rank | Food item       | FoNAO Category | pathogen                  | Country                | Year | Cases | Hospital. | Deaths<sup>b</sup> | Reference(s) |
|------|-----------------|----------------|---------------------------|------------------------|------|-------|-----------|-------------------|--------------|
| 10   | Papaya          | 8              | *Salmonella Agona*        | USA (25 states)        | 2011 | 106   | 10        | 0                 | CDC, 2011    |
|      |                 |                |                           |                        |      |       |           |                   |              |
| **Viruses** |                |                |                           |                        |      |       |           |                   |              |
| 1    | Orange juice    | 5              | Hepatitis A virus         | Egypt                  | 2004 | 351   | 127       | 0                 | Frank et al., 2007 |
| 2    | Green onion     | 22             | Hepatitis A virus         | USA                    | 2003 | 601   | 124       | 3                 | Wheeler et al. 2005; Wand and Moran 2004; MMWR 2003, 52 (47), 1155-1157 |
| 3    | Blueberries (raw) | 4              | Hepatitis A virus         | New Zealand            | 2002 | 81    | 18        | 1                 | Calder et al. 2003 |
| **Parasites** |                |                |                           |                        |      |       |           |                   |              |
| 1    | Basil (fresh)   | 16             | *Cyclospora cayetanensis* | Canada                 | 2005 | 142   | 7         | 0                 | Milord et al., 2012 |

<sup>a</sup> Outbreaks traced back to the consumption of highly processed food items (containing FoNAO mixed with other ingredients of animal origin, e.g. meat, milk or egg products) were not included in the ranking.

<sup>b</sup> n.s. = not specified
Table 35: FoNAO (high water content) item/pathogen combinations causing outbreaks\(^a\) where cases of death have been reported, non EU countries. Collective cases from multiple outbreaks are indicated in **bold**.

| Rank | Food item | FoNAO Category\(^b\) | pathogen | Country | Year | Cases | Hospital.\(^c\) | Deaths | Reference(s) |
|------|-----------|----------------------|----------|---------|------|-------|----------------|--------|---------------|
| **Bacterial pathogens** | | | | | | | | | |
| 1 | Vegetables (raw) | other | *Vibrio cholerae* O1 Ogawa | Zambia | 2003-2004 | 2529 | n.s. | 128 | MMWR, 2004a |
| 2 | Cantaloupe melon (whole) | 9 | *Listeria monocytogenes* | Multi-state outbreak USA (28 states) | 2011 | 147 | 143 | 33 | CDC, 2011; MMWR, 2011 |
| 3 | Spinach (fresh) | 15 | *E. coli* O157:H7 | Multi-state outbreak USA (26 states) | 2006 | 199 | 102 | 3 | CDC, 2006; Charatan 2006; Grant 2008; Wendel et al. 2009; MMWR, 2006 |
| 4 | Cantaloupe melon (whole; from Indiana) | 9 | *Salmonella Typhimurium* | Multi-state outbreak USA (24 states) | 2012 | 261 | 94 | 3 | CDC, 2012 (last updated 10-10-2012) |
| 5 | Jalapeño peppers, serrano peppers, tomatoes | 11 or 12 | *Salmonella Saintpaul* | Multi-state outbreak USA (43 states), Canada | 2008 | 1442 | 286 | 2 | CDC, 2008; MMWR, 2008; Behravesh et al. 2011; Mody et al. 2011 |
| **Viruses** | | | | | | | | | |
| 1 | Date palm sap (raw) | n.a. | *Nipah virus* | Bangladesh | 2008 | 10 | n.s. | 9 | Rahman et al. 2012 |
| 2 | Green onion | 22 | *Hepatitis A virus* | USA | 2003 | 601 | 124 | 3 | Wheeler et al. 2005; Wand and Moran 2004; MMWR, 2003 |
| 3 | Blueberries (raw) | 4 | *Hepatitis A virus* | New Zealand | 2002 | 81 | 18 | 1 | Calder et al. 2003 |
| 4 | Tomatoes (semidried) | 38 | *Hepatitis A virus* | Australia | 2009 | 562 | 0 | 1 | Donnan et al. 2012 |
| **Parasites** | | | | | | | | | |
| 1 | Sugar cane juice | n.a. | *Trypanosoma cruzi* | Brazil | 20005 | 24 | n.s. | 3 | Steindel et al. 2008 |
| 2 | Guava juice | 8 | *Trypanosoma cruzi* | Venezuela | 2007 | 103 | 0 | 1 | Alarcón de Noya et al. 2010 |

\(^a\) Outbreaks traced back to the consumption of highly processed food items (containing FoNAO mixed with other ingredients of animal origin, e.g. meat, milk or egg products) were not included in the ranking.

\(^b\) n.a. = not applicable

\(^c\) n.s. = not specified