Commercial complementary food in Germany: a market survey

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Abstract

Background: As consumption of commercial complementary food (CCF) during infancy and toddlerhood is common, the aim of the present study was to describe the current (2020) German market of CCF products targeted at infants and toddlers with a special focus on ingredients, macronutrients, and the practice of nutrient fortification.

Methods: Information on age declarations, ingredients, energy and nutrient contents, and nutrient fortification was obtained in a market survey by contacting the producers and searching manufacturers’ websites. Each product was assigned to one of thirteen product categories (menus, milk-cereal-meal, fruit-cereal-meal, oil, vegetables, meat, fish, fruits, cereals, snack foods, pouches, desserts, beverages). Descriptive statistics were used in order to give an overview of the available products.

Results: We identified 1057 CF products on the German market (infants’ CCF (< 12 months): n=829; toddlers’ CCF (> 12 months): n=228)). Highest protein content (% of energy content, %E) was found in meat products. In pouches, beverages, cereal fruit meals, and fruits, more than 50 % of energy came from total sugar. Highest median salt content was found in toddlers’ menus and desserts. Around one third of infants’ CCF products and one quarter of toddlers’ products were fortified with nutrients. Vitamin B1 (thiamin) was the most frequently fortified nutrient, followed by vitamin C, iron, calcium, and vitamin D. Apple was the type of fruit listed most often in products with fruits, whereas carrot was the most frequent vegetable among CCF with vegetables.

Conclusion: In particular the high sugar content of most CCFs currently available on the German market may promote unhealthy dietary habits. Parents need to be educated about the optimal selection of products.

Background

The introduction of complementary foods should not begin before 4 months and should not be delayed beyond 6 month (1, 2). While breast milk provides all the essential nutrients after birth, complementary foods are more variable in energy and nutrient content and have to be combined to meet nutrient requirements (3, 1). Furthermore, infants’ taste preferences continue to develop with long-lasting effects for later life (4–6).

Parents have to decide whether they self-prepare the infants’ meals from fresh foods or whether they use commercial complementary food (CCF) products. Both approaches have some advantages and disadvantages. In particular, home-made complementary food has the potential to provide a greater variety of flavors and textures, whereas food variety in CCF is reported to be lower (7).

In both commercial and home-made complementary food, the composition of ingredients is decisive for energy and nutrient contents. Some characteristics of CCF are required by law in the European Union. For example, maximum contents of sucrose or other sweetening foods were set, if these ingredients were
added to a product. Furthermore, upper limits for sodium content were set (8). Nevertheless, market surveys repeatedly show that additions of salt and sugars in CCF are common in Europe and other countries (9–12). Another distinction of home-made and CCF is the fortification with nutrients, which offers the possibility of supplementing possible nutrients at risk, in particular alpha-linolenic acid (ALA), docosahexaenoic acid (DHA), iron, iodine, vitamin D (13).

Consumption of CCF during infancy and toddlerhood is common in Germany and Europe (9, 14, 15). In the German DONALD study, only 20 % of complementary food was home made during infancy and toddlerhood, but 60 % was CCF and the remaining 20 % a combination of both (14). Hence, parents need to be confident that the CCF they feed their children meet the specific needs of this age group, but data on nutritional quality and composition of CCF is limited. A recent cross-sectional study described the nutritional adequacy of commercial complementary cereals on the German market (9). In this cross-sectional survey, a low high sugar content and low content of zinc, iron, iodine was demonstrated (9). However, cereals only make up a small part of the market for CCFs. The last complete market survey by CCF in Germany was conducted 20 years ago. At that time, there were more than 600 products on the market that had a high energy but low fat content. More than two thirds of the products were fortified, mostly with vitamin C (16). Hence, the aim of the present article was to describe the current market of CCF targeted at infants and toddlers in Germany with a special focus on ingredients, macronutrients, and the practice of nutrient fortification.

**Methods**

The survey started with the identification of relevant retailers, manufacturers and brands in April 2020 through visits to supermarkets and discounters in Bonn and websites. Then, the producers were contacted to obtain declared product information (May to July 2020). In case of no response, the necessary information was researched via the manufacturers’ websites (supplementary table 1).

Each product was assigned to one product category:

### Complete meals:

- Menus: offered in jars, declared as "baby menus" (for age group 5 to 7 months) and "junior menus" (for age group 8 to 12 months), composed of vegetables, starchy food (e.g., potatoes) and protein food (e.g., meat, fish), in part with added oil and/or fruit as ingredients, including soups and stews,
- Milk-cereal-meal: declared as “milk porridge”, “Porridge”, “Good Evening Porridge”, “Good Night Porridge”, composed of milk and cereals, in part combined with fruit, offered as ready-to-eat meal in jars or bottles (drink meals) or instant products for the preparation with water
- Fruit-cereal-meal: composed of fruit and cereals, often declared as „muesli“, available in jars

### Meal components:
- Oil
- Vegetables: Pureed vegetables in jars, in part mixed with potatoes or cereals, and oil
- Meat: Pureed meat, in part with starchy ingredients and/or added oil, offered in jars
- Fish: Pureed fish, in part with potatoes, offered in jars
- Fruits: Pureed fruits, in part mixed with dairy (e.g. yoghurt), cereal, or vegetables, offered in jars
- Cereals: instant flakes or popped cereals, in part mixed with dried fruit pieces, offered as instant products

**Snacks and beverages:**

- Snack foods: biscuits, waffles, rusk, or bars
- Pouches: pureed fruit partly mixed with vegetables, cereals or dairy, offered in compressed plastic bags with a spout and a screw cap, from which the contents can be sucked out
- Desserts: declared as desserts or pudding, offered in jars
- Beverages: juices from fruit or vegetables, in part mixed with water or tea, teas (instant, tea bags or ready-to-drink)

Complete meals (i.e. menus, milk-cereal-meals, and cereal-fruit-meals) correspond to the meals within the German complementary food guidelines (17, 1). The term complete meals means that they are intended as a complete, nutritionally adequate meal, without the need to add other ingredients (except water in the case of instant milk-cereal meals). Meal components (i.e., cereals, fruits, vegetables, meat, fish, and oil) can be used for the preparation of these meals. Snacks (i.e., pouches, snack foods, and desserts) do not correspond to the recommendations.

Data entry of the surveyed products were performed using Microsoft Excel (version 2016). The product characteristics included brand and product name of the manufacturer, age declaration, declared ingredients, energy and nutrient contents, and nutrient fortification. If sodium was declared instead of salt, the amount of salt was calculated. If nutrient contents were declared as “less than” (e.g., < 20 mg sodium), the threshold value was used instead (20 mg sodium). Products with added sweetening foods (i.e., sugar, syrup, honey, fruit concentrates, as well as fruit juice) according to the WHO-definition of free sugar (18), salt (i.e., iodized salt, sea salt, table salt), and added fat/oil were identified according to the ingredient list.

Products were stratified into infants’ CCF (declaration < 12 months) and toddlers’ CCF (declaration “after 12 months”, “after 1 year”, or “1-3 years”).

Descriptive statistics were performed with SAS ® procedures (version 9.2; Cary, NC, USA) and included frequencies and percentages for categorical variables and median and quartiles for continuous variables.
As this study does not include humans nor animals and refers only to freely available information, which is declared on the products, no ethical approval was necessary.

**Results**

**CCF products**

Overall, 1057 CCF products of 27 brands were identified (one to 210 products per brand), produced by 21 companies. Of these, 829 CCF products (78 %) were declared for infants, 228 (22 %) products were declared for toddlers (Table 1).

Complete meals made up more than one third of infant CCF (39.6 %, Table 1). Among complete meals, more than half were menus (Table 1). Most menus were made with meat (n=98, 54.5 % of menus), followed by vegetarian menus (n=50, 27.7 %) and fish-menus (n=17, 9.4 %). Fifteen menus (8.3 %) were declared as ‘soups’ (data not shown).

Milk-cereals-meals were offered as instant products to be prepared with water (n=49, 57.6 % of milk-cereal-meals) or as ready to eat meals in jars (n=30, 35.3 %). Six products (7.1 %) were offered as drink-meals (data not shown).

Cereal-fruit-meals accounted for around 20 % of complete meals (Table 1).

Among meal components, fruit products accounted for around half of the products (Table 1). The majority of fruit products were made from pure fruits, either single fruits (n=20, 14.6 % of fruit products) or a mix of fruit types (n=89, 65.0 %). Some fruit products were mixed with dairy (n=25, 18.2 % of fruit products) or vegetables (n=3, 2.2 %) (data not shown).

Among vegetable products, single vegetables (n=21, 33.3 %) or mixtures from different types of vegetables (n=19, 30.2 %) accounted for one third of the products. Some vegetables were mixed with potatoes (n=18, 28.6 %) or fruits (n=5, 7.9 %) (data not shown).

Infant cereals accounted for around 10 % of infants’ CCF products. Meat, oil, and fish were the meal components with the lowest number of products (Table 1).

The majority of snacks were pouches, followed by snack foods and desserts (Table 1).

Among pouches, three products were made only from vegetables (2.7 %), the other pouches were prepared from fruits (n=42, 37.8%) or mixtures of fruits with dairy (n=9, 8.1 %), vegetables (n=22, 19.8 %) or cereals (n=35, 31.8 %) (data not shown).

Of beverages (Table 1), around two thirds were teas or mixtures from juice and water or tea (n=33, 61.1 %), 21 products (38.9 %) were pure juices (data not shown).
The majority of infant CCF was declared for younger ages (“after 4 months”/“from the age of 5 months”), only 13% of infant CCF was declared as “from the 10th to 12th months” (Table 1).

Snack foods (n=77, 33.8%) were the predominant category among toddlers’ CCF, followed by pouches (n=60, 26.3%), menus (n=40, 17.5%) and beverages (n=26, 11.4%). Six products (2.6%) were categorized as desserts. Toddlers’ cereals (referred to as mueslis, n=12, 5.3%), noodles (n=2, 0.9%) and sauces (n=5, 2.2%) accounted for less than 10% of toddlers’ CCF, respectively. Of toddlers’ menus, six products (15.0%) were vegetarian menus and three products were prepared with fish (7.5%) (data not shown).

Table 1

Product categories and declared age of infants’ commercial complementary foods, results of a 2020 market survey in Germany
| Product category | Total | After 4th month/from the age of 5 months | After 6th/7th month | After 8th/9th month | After 10th/12th month |
|------------------|-------|------------------------------------------|---------------------|-------------------|----------------------|
|                  | N (%) | N (%) | N (%) | N (%) | N (%) |
| Complete Meals (n=328) |       |       |       |       |       |
| Menus            | 180 (21.7) | 38 (21.1) | 21 (11.7) | 65 (36.1) | 56 (31.1) |
| Milk-Cereal-Meals | 85 (10.3) | 25 (29.4) | 41 (48.2) | 10 (11.8) | 9 (10.6) |
| Cereal-Fruit-Meals | 63 (7.6) | 19 (30.2) | 28 (44.4) | 11 (17.5) | 5 (7.9) |
| Meal Components (n=288) |       |       |       |       |       |
| Fruit            | 137 (16.5) | 93 (78.9) | 22 (16.1) | 6 (4.4) | 16 (11.7) |
| Cereals          | 68 (8.2) | 38 (55.9) | 20 (29.4) | 4 (5.9) | 6 (8.8) |
| Vegetables       | 63 (7.6) | 53 (84.1) | 10 (15.9) | - | - |
| Meat             | 12 (1.4) | 10 (83.3) | 2 (16.7) | - | - |
| Fish             | 2 (0.2) | 1 (50) | 1 (50) | - | - |
| Oil              | 6 (0.7) | 6 (100) | - | - | - |
| Snacks (n=159)   |       |       |       |       |       |
| Pouches          | 111 (13.4) | 12 (10.8) | 78 (70.3) | 14 (12.6) | 7 (6.3) |
| Snack foods      | 43 (5.2) | - | 8 (18.6) | 32 (74.4) | 3 (7.0) |
| Desserts         | 5 (0.6) | - | 1 (20.0) | - | 4 (80.0) |
| Beverages (n=54) |       |       |       |       |       |
| Tea, water, juices | 54 (6.5) | 45 (83.3) | 6 (11.1) | 1 (1.9) | 2 (3.7) |
| Total            | 829 | 340 (41.0) | 238 (28.7) | 143 (17.3) | 108 (13.0) |
1 Percentage of all products

2 Percentage of the respective product category

Table 2

Declared energy and nutrient contents per 100 g of commercial complementary food products for infants and toddlers, results of a 2020 market survey in Germany

1
| Product category | Energy (kcal) | Protein (g) | Fat (g) | Saturated fatty acids (g) | Carbohydrates (g) | Total sugar (g) | Salt (mg) |
|------------------|--------------|-------------|---------|--------------------------|-------------------|----------------|----------|
| Infants          |              |             |         |                          |                   |                |          |
| Complete meals   |              |             |         |                          |                   |                |          |
| Menus (n=180)    | 66 (61;70)   | 2.5 (22.2; 2.8) | 2.4 (1.9; 2.8) | 0.5 (0.4; 0.7) | 7.7 (7.0; 8.7) | 2.1 (1.6; 2.5) | 0.08 (0.05; 0.03) |
| Milk-cereal-meals (n=85) | 92 (76;103) | 3.0 (2.6; 3.5) | 2.5 (2.2; 2.9) | 0.9 (0.7; 1.1) | 14.0 (11.0; 16.1) | 6.3 (4.8; 7.3) | 0.08 (0.07; 0.09) |
| Fruit-Cereal-meals (n=63) | 66 (60; 72) | 1.0 (0.8; 1.1) | 0.4 (0.3; 0.6) | 0.1 (0.0; 0.2) | 13.6 (11.9; 15.0) | 9.6 (7.6; 10.8) | 0.03 (0.01; 0.05) |
| Meal components  |              |             |         |                          |                   |                |          |
| Fruits (n=137)   | 57 (52; 62)  | 0.5 (0.4; 0.7) | 0.2 (0.1; 0.5) | 0.0 (0.0; 0.2) | 11.8 (11.1; 13.0) | 10.1 (9.1; 10.8) | 0.05 (0.01; 0.05) |
| Cereals (n=68)   | 376 (363; 388) | 11.0 (9.3; 12.5) | 3.2 (2.1; 4.5) | 0.7 (0.5; 0.9) | 70.0 (6.9; 78.1) | 1.5 (0.8; 5.7) | 0.01 (0.01; 0.03) |
| Vegetables (n=63) | 41 (31; 54)  | 0.9 (0.7; 1.2) | 1.2 (0.2; 1.8) | 0.1 (0.0; 0.2) | 6.5 (5.0; 7.5) | 2.6 (2.0; 3.8) | 0.05 (0.02; 0.08) |
| Meat (n=12)      | 102 (90; 108) | 8.1 (7.8; 8.9) | 4.6 (3.1; 5.8) | 1.7 (1.0; 2.1) | 6.0 (4.7; 6.4) | 0.0 (0.0; 0.2) | 0.07 (0.04; 0.08) |
| Pouches (n=111)  | 63 (54; 72)  | 0.8 (0.6; 1.1) | 0.5 (0.3; 0.6) | 0.1 (0.1; 0.2) | 12.0 (11.0; 14.0) | 9.9 (8.1; 12.0) | 0.01 (0.01; 0.05) |

Table 2
(continued)
| Product category | Energy (kcal) | Protein (g) | Fett (g) | SFA (g) | Carbohydrates (g) | Total sugar (g) | Salt (mg) |
|------------------|--------------|-------------|---------|---------|------------------|-----------------|----------|
| **Snacks**       |              |             |         |         |                  |                 |          |
| Snack foods      | 390          | 8.0         | 4.4     | 0.8     | 76.0             | 7.5             | 0.03     |
| (n=43)           | (370; 429)   | (6.9; 10.0) | (0.9; 11.0) | (0.2; 1.5) | (70.0; 82.0) | (2.7; 13.0) | (0.01; 0.05) |
| Desserts         | 84           | 3.5         | 2.7     | 1.2     | 12.4             | 8.4             | 0.13     |
| (n=5)            | (82; 84)     | (3.0; 3.6)  | (1.7; 3.1) | (1.1; 1.7) | (11.8; 13.1) | (8.4; 8.6) | (0.10; 0.13) |
| **Beverages**    |              |             |         |         |                  |                 |          |
| Beverages ³      | 30           | 0.2         | 0.1     | 0.0     | 6.5              | 6.2             | 0.05     |
| (n=44)           | (20; 47)     | (0.0; 0.5)  | (0.0; 0.2) | (0.0; 0.0) | (4.8; 10.9) | (4.4; 9.8) | (0.01; 0.05) |
| **Toddler**      |              |             |         |         |                  |                 |          |
| Menu             | 70           | 2.6         | 2.4     | 0.5     | 8.8              | 1.6             | 0.43     |
| (n=40)           | (67; 75)     | (2.5; 2.9)  | (2.3; 2.6) | (0.4; 0.8) | (8.2; 9.8) | (1.4; 1.9) | (0.36; 0.48) |
| Cereals          | 370          | 11.1        | 5.6     | 1.0     | 63.1             | 8.5             | 0.01     |
| (n=12)           | (35; 377)    | (10.5; 12.2) | (3.8; 5.9) | (0.7; 1.2) | (90.7; 67.7) | (6.3; 10.8) | (0.01; 0.05) |
| Pouches          | 59           | 0.6         | 0.4     | 0.0     | 12.0             | 10.8            | 0.05     |
| (n=60)           | (55; 64)     | (0.4; 0.8)  | (0.2; 0.5) | (0.0; 0.2) | (11.3; 12.9) | (10.1; 11.5) | (0.01; 0.05) |
| Snack foods      | 383          | 5.7         | 8.6     | 2.0     | 69.0             | 28.8            | 0.05     |
| (n=77)           | (366; 416)   | (4.4; 7.6)  | (6.6; 13.7) | (0.9; 3.6) | (64.8; 72.0) | (12.1; 41.0) | (0.03; 0.15) |
| Desserts         | 84           | 3.2         | 2.3     | 1.7 (1.2; 2.2) | 12.4       | 8.4             | 0.12     |
| (n=6)            | (82; 90)     | (3.1; 3.6)  | (1.7; 3.3) | (11.7; 13.3) | (7.4; 8.6) | (0.08; 0.15) |
| Beverages ²      | 18           | 0.0         | 0.1     | 0.0     | 3.8              | 3.5             | 0.05     |
| (n=25)           | (16; 21)     | (0.0; 0.1)  | (0.0; 0.0) | (3.5; 4.5) | (3.1; 4.2) | (0.05; 0.05) |

Values are median (Quartile 1, Quartile 3), SFA=saturated fatty acids
1 due to the small number of products, product categories oil and fish were not shown

2 content of the dry product

3 Excluding instant teas and bagged teas, missing values for salt content in beverages: n=3 (infant products) and n= 6 (toddler products)

Energy and Nutrient Contents

Energy content was highest in infants’ or toddlers’ snack foods. Highest protein content was found in cereals. Maximum fat content was found in toddlers’ snack foods and cereals. Saturated fatty acids exceeded 1.5 g/100 g only in meat products, and in toddlers’ snack foods and desserts. Snack foods and cereals, both for infants and toddlers, had the highest carbohydrate contents (> 60 g/100 g). Total sugar content was around 10 g/100 g in fruit-cereal-meals, fruits, and pouches, and nearly 30 g/100 g in toddlers’ snack foods. Except toddlers’ menus and desserts, salt content was < 0.9 g/100 g (Table 2).

Expressed as % of energy, highest protein content was found in meat products, followed by menus for infants and toddlers and toddlers’ desserts. Carbohydrate content was lowest in meat (20.6%). In all other product groups carbohydrates provided between around 50 % and 90 % of energy content. In meat products, cereals and toddlers’ menus, contribution of sugar to energy content was less than 10 %. More than 50 %E sugar was found in pouches, beverages, cereal fruit meals, and fruits (Figure 1).

Fortification

Around one third of infants’ CCF products and one quarter of toddlers’ products were fortified with nutrients. Highest fortification prevalence among infants’ CCF was found in cereals, milk-cereal-menus, snack foods and beverages. In toddlers’ CCF, cereals was the category with the highest prevalence of fortification, followed by snack foods and pouches. Vitamin B1 (thiamin) was the most frequently fortified nutrient, followed by vitamin C, iron, calcium, and vitamin D (Table 3).

Table 3

Nutrient fortification in commercial complementary foods (CCF), results of a 2020 market survey in Germany
| Product category         | Total N (%) | Vitamin B1 N (%) | Vitamin C N (%) | Iron N (%) | Calcium N (%) | Vitamin D N (%) | Iodine N (%) |
|--------------------------|-------------|------------------|-----------------|------------|---------------|----------------|-------------|
| Infants' CCF (829)      | 264 (31.9)  | 185 (22.3)       | 91 (11.0)       | 63 (7.6)   | 61 (7.4)      | 59 (7.1)       | 32 (3.9)    |
| Menus (180)             | 22 (12.2)   | -                | -               | 22 (12.2)  | -             | -              | -           |
| Milk-cereal-meal (85)   | 79 (92.9)   | 77 (90.6)        | 33 (38.8)       | 36 (42.4)  | 57 (67.1)     | 57 (67.1)      | 32 (37.7)   |
| Cereal fruit meal (63)  | 11 (17.5)   | 7 (11.1)         | 5 (7.9)         | -          | -             | -              | -           |
| Fruits (137)            | 25 (18.3)   | 4 (2.9)          | 22 (16.1)       | -          | 4 (2.9)       | -              | -           |
| Cereals (68)            | 68 (100.0)  | 68 (100.0)       | 1 (1.5)         | 1 (1.5)    | -             | 1 (1.5)        | -           |
| Vegetables              | 2 (1.8)     | -                | 1 (1.6)         | 2 (3.2)    | -             | -              | -           |
| Pouches                 | 2 (1.8)     | -                | 2 (1.8)         | -          | -             | -              | -           |
| Snack foods (43)        | 28 (67.4)   | 28 (65.1)        | -               | -          | -             | -              | -           |
| Desserts                | 1 (20 %)    | 1 (20-0)         | 1               | -          | -             | 1 (20.0)       | -           |
| Beverages (54)          | 26 (48.2)   | -                | 26 (48.2)       | 2 (3.7)    | -             | -              | -           |
| Toddlers' CCF (228)     | 53 (23.3)   | 30 (13.2)        | 16 (7.0)        | 9 (4.0)    | 2 (0.9)       | -              | -           |
| Menus (23)              | 3 (13.0)    | -                | -               | 3 (13.0)   | -             | -              | -           |
| Cereals (12)            | 11 (91.7)   | 11 (91.7)        | -               | -          | -             | -              | -           |
| Snack foods (77)        | 21 (27.3)   | 18 (23.3)        | -               | 4 (5.2)    | 1 (1.3)       | -              | -           |
| Pouches (60)            | 15 (25 %)   | -                | 15 (25)         | 2 (3.3)    | -             | -              | -           |
| Beverages (26)          | 2 (7.7)     | -                | 1 (3.9)         | -          | 1 (3.9)       | -              | -           |
| Pasta (2)               | 1 (14.3)    | 1 (14.3)         | -               | -          | -             | -              | -           |
| Total (1057)            | 317         | 215              | 107             | 72 (6.8)   | 63 (6.0)      | 59 (5.6)       | 32          |
Fortification with vitamin B2, vitamin B6, vitamin B12, vitamin K, niacin, biotin, zinc, pantothenic acid: < 1 % of products, fortification with vitamin E, folate < 3 % of products; no fortified products found among oils, meat, fish

Percentage of fortified products in this category

CCF with cereals (i.e. milk cereal meals, fruit cereal meals and cereals) were the categories most often fortified with vitamin B1, products with fruits (i.e. fruits, beverages, pouches) and milk-cereal-meals with vitamin C. Infant menus and milk-cereal-meals were the categories most often fortified with iron. Milk-cereal-meals were also most often fortified with calcium and vitamin D, and the only category fortified with iodine (Table 3).

Ingredients

Apple was the type of fruit listed most often in products with fruits, whereas carrot was the most frequent vegetable among CCF with vegetables. Poultry (e.g. chicken, turkey) was the most frequent meat. Only two species were used for fish products (salmon and pollack). Four of five infants’ and toddlers’ menus and vegetables were prepared with added oil, predominately rapeseed oil (Table 4). In 78 products (27.6 %), a combination of rapeseed oil and other oils was used (data not shown).

Sweeteners (i.e. sugar, honey, syrup, juice) were used in 233 products (23.8 % of all CCF products, excluding beverages, n=977). Juice was the sweetener used most often (n=195, 83.7 % of sweetened products), followed by sugar (n=38, 16.3 %), honey and rice syrup (both n=3, 1.3 %) (data not shown). Other sweeteners, e.g. glucose, fructose, high fructose corn syrup were not found in CCF.

Among cereal-based products, whole grains were listed as ingredients in 139 products (61.0 %) (data not shown).

Salt was added in n=62 infants’ menus (34.4 % of all menus), always as iodized salt. Four infants’ pouches were prepared with an oat mixture with added sea salt (3.6 %). In toddlers’ menus, 80% (n=32) of products were prepared with added iodized salt, two further products with sea salt (11.7 %). Two toddlers’ snack foods were prepared with iodized salt and sea salt, respectively (each 2.4 %) (data not shown).

Flavors, herbs or spices were used in 190 products (18.0 % of all CCF). Vanilla (n=35, 18.4 % of flavored products) was used in milk-cereal-meals (n=16), toddlers’ CCF (n=10) and desserts (n=5). Seventeen products (8.9 %) contained cacao, predominantly milk-cereal-meals and snack foods. Six products were flavored with cinnamon and five beverages (teas) were flavored with aroma. Herbs (e.g. parsley, basil, oregano, marjoram, thyme, lovage, dill) were listed as ingredients in 58 infants’ or toddler’ menus, curry, turmeric and/or ginger in seven products (data not shown).
The most frequent ingredients (types of fruits, vegetable, meat, fish, and fat/oil) in commercial complementary foods for infants and toddlers, results of a 2020 market survey in Germany

| Product categories | Most frequently\(^1\) listed ingredients                                                                 |
|--------------------|------------------------------------------------------------------------------------------------------------|
| Type of fruits\(^1\) in fruit-cereal-meals, fruit products, fruit pouches, milk-cereal-meals in jars \(n=398\) products | Apple \(n=285\) (71.6 %), banana \(n=178\) (44.7 %), pear \(n=100\) (25.1 %), berries \(n=89\) (22.4 %), mango \(n=65\) (16.3 %), peach \(n=53\) (13.3 %), apricot \(n=24\) (6.0 %), grape \(n=31\) (7.8 %) |
| Type of vegetables\(^1\) in menus, vegetables and vegetable pouches \(n=308\) products | Carrots \(n=234\) (76.0 %), tomato \(n=118\) (38.3 %), onions \(n=125\) (40.6 %), parsnip \(n=54\) (17.5 %), zucchini \(n=47\) (15.3 %), pea \(n=44\) (14.3 %), corn \(n=37\) (12.0 %), pepper \(n=24\) (7.8 %), spinach \(n=24\) (7.8 %), broccoli \(n=21\) (6.8 %), leek \(n=20\) (6.5 %), celery \(n=17\) (5.5 %), |
| Type of meat menus and meat products \(n=142\) | Poultry \(n=67\) (47.2 %), beef \(n=59\) (41.6 %), pork \(n=15\) (10.6 %) |
| Type of fish in fish-menus and fish-jars \(n=23\) | Salmon \(n=14\) (60.9 %), pollack \(n=9\) (39.1 %) |
| Type of added fat/oil in menus and vegetable products \(n=283\) | Rapeseed oil \(n=210\) (74.2 %), sunflower oil \(n=67\) (23.7 %), corn germ oil \(n=36\) (12.7 %) |

\(^1\) listed in \(\geq 5\%\) of products

**Discussion**

**Products**

Compared to a similar study conducted 20 years ago in Germany (16), the number of infants’ CCF has increased (in 2020: infants’ CCF \(n=598\), toddlers’ CCF from \(n=38\)). A recent survey of infants’ CCF in 10 European countries (19) included between \(n=99\) and \(n=768\) baby foods per country.

Pouches, which made up the largest group in the snack category, were not listed in the 2000 market survey in Germany (16). Pouches are criticized for their ingredients and texture (20) and are suspected to promote caries (21). As in Australia (20), pouches were mainly declared to older children aged 6 months on up. However, during this age infants should be gradually accustomed to lumpy or solid foods (22, 23).

Sugar content of fruit juices is similar to soft drinks. The American Academy of Pediatrics recommended to avoid any fruit juice during the first year of life (24). Furthermore, children should be accustomed to water as a drink from the very beginning, to shape healthy dietary habits from the early age.

Menus accounted for the largest share of complete meals. The majority of menus were producted with meat. As iron requirement during the complementary feeding period is high, meat or iron fortified cereals are recommended (25, 2, 3, 17). It is worth to mention, that in Germany only one iron fortified infant cereal
was available. However, it should be noted that common whole grains, e.g. oat, millet, or wheat, have a high natural iron content, but bioavailability is lower than of iron from meat (25).

In Germany, in contrast to other countries (26, 27), fish has hardly been included in complementary feeding (28). Beside the observed association of fish consumption during weaning and the risk reduction of allergies (27, 26), sea fish is a good source of iodine, and in case of fatty fish, of long-chain polyunsaturated fatty acids (29). However, 40 % of fish products in our survey were prepared with a low-fat species (pollack).

Iodine is a potential critical nutrient during weaning (30, 3, 16). Except fish, non-fortified complementary food in general is low in iodine whether self-prepared or commercial (30). In our survey, less than 4 % of all products were fortified with iodine.

**Fortification**

The overall prevalence of fortification has decreased from 70 % in 1998 (16) to around 30 % of products in the current survey. This could be due to a shift to more organic produced CCF, which is not supposed to be fortified. Vitamin B1, calcium and vitamin D were the nutrients most commonly used for fortification. The extent to which this is necessary is questionable, since the reference values for calcium and vitamin B1 can be achieved without fortification (17). However, the EU law prescribes fortification with vitamin B1 for infant cereals. As vitamin D is supposed to be generally supplemented in the first year of life (31, 1), the need of vitamin D fortified CCF is also questionable. In case of iron, young children are at special risk for iron deficiency and iron-rich complementary foods are recommended. However, high iron intakes may have adverse effects (25). Furthermore, to the best of our knowledge there are no studies that prove the benefit of additional supplementation of meat-containing CCF, which is rich in heme iron with high bioavailability (17). Iodine fortification could be a strategy to improve iodine supply in infancy, however, risk assessments would be necessary to avoid excessive uptake.

**Ingredients**

International authorities are unanimous in recommending that complementary foods should not be prepared with added sugar (2, 3, 1, 17). The use of classic sweeteners as sugar and honey was low this survey. However, when fruit juice was included in the added sugars definition (19), the proportion of sweetened CCF clearly increased. Furthermore, the intense pureeing process liberates intrinsic sugar from fruits and vegetables. Hence, sugars from these foods can be considered as free sugars, too (19). That is why a large portion of the total sugar as declared on CCF in our survey would have to be considered free sugars. It is noteworthy that total sugar content for nearly all product categories was above 10 %E, the free sugar limit recommended by the WHO for over 2-year-olds (18).
Our survey confirms the low variety of ingredients and tastes in CCF (7, 10). Particularly, bitter tasting types, as spinach, broccoli, and cauliflower, were used in few products. The innate dislike of bitter tasting substances in humans (32) can be overcome by repeated exposure (33). Therefore, the complementary feeding period is regarded as a ‘window of opportunity’ (34), when exposure to a wider range of flavors increases acceptance and reduces reluctance towards disliked and novel tastes even in the long term (35). By the observed monotony of types of fruits and vegetables in CCF, the chance to shape preferences in the sense of a healthy diet is missed. However, it should not be concealed that the variety of vegetables offered has increased in Germany in recent years. A 2012 review of fruits and vegetables in complementary foods identified 16 different vegetables in menus and vegetable preparations (7). In the present market survey, there were 21 varieties, which is an increase of 31 % since 2012.

Benefits of cereals during weaning are the impact on nutrient intake, in particular iron, the promotion of an ‘adult like’ microbiota, and the semi-solid texture and consistency (36). Due to the higher iron and fiber intake, these benefits can be easier achieved by whole grain products instead of refined grains. In addition, the complementary feeding period is regarded as important period for the acceptance of whole grains later in life (36).

It has not yet been systematically studied what influence the use of spices and flavors has on children's long-term food preferences. Hence, to the best of our knowledge, there is no official recommendation on the use of spices or herbs during infancy.

**Strengths and limitations**

We present data on products offered on the German food market. However, the food market is changing constantly. Furthermore, we did not have current consumption data of CCF among infants and toddlers. In our study, all available brands and product information in Germany were collected. A further limitation is the use of declared energy and nutrient contents. No laboratory analyses were available, which could have provided more valid assessments of energy and nutrient contents. However, it can be assumed that the market is regulated by demand and only products are offered that are also bought by families.

**Conclusion**

Both the categories of the products offered (e.g. snacks, caloric beverages) as well as the high sugar content of most products may promote unhealthy dietary habits during infancy and young childhood. As CCF intake is common (9, 14), parents need to be educated about the optimal selection of products. This includes in particular the avoidance of products with added salt and/or sweetened foods, including juice-sweetened products, snack foods, pouches and desserts (and not using fruit products as desserts). Furthermore, parents should be encouraged to select a variety of vegetables that should not be mixed with fruit, as well as products with fish.
Furthermore, our market survey supports the claims of Hutchinson et al. (19), i.e. the ban of added sugars and sweet snacks, the limited use of pureed fruit in some food categories, and the limitation of total sugar content of ‘savory’ snacks. We would further support to ban the production of sugar sweetened beverages intended to infants, even if the sugar is natural in case of juices and mixtures of juice with tea or water.

**Abbreviations**

CCF Commercial Complementary Food, %E percentage of energy content

**Declarations**

**Ethics approval and consent to participate**

As this study does not include humans nor animals, no ethics approval or consent to participate Statement was necessary.

**Consent for publication**

Not applicable

**Availability of data**

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

**Competing interests**

UA received once lecture fee from one company producing commercial complementary food. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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**Authors’ contributions**
UA and SK conceived the project. JJD carried out the data collection and data entry. JJD and UA conducted the data analysis and wrote the manuscript. All authors made substantial contributions, critically read and revised the manuscript as well as approved the final version.

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Figures
Figure 1

Declared macronutrient content (% of energy content) of commercial complementary food products (means of product category), results of a 2020 market survey in Germany

Supplementary Files

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- Supplementarytable1.docx