Carotenoids and total phenolic contents in plant foods commonly consumed in Korea

Gun-Ae Yoon¹, Kyung-Jin Yeum²§, Yoon-Suk Cho³, C-Y. Oliver Chen², Guangwen Tang², Jeffrey B. Blumberg², Robert M. Russell⁴, Sun Yoon⁵ and Yang Cha Lee-Kim⁵

¹Department of Food and Nutrition, College of Human Ecology, Dong-Eui University, Busan 614-714, Korea
²Jean Mayer USDA-Human Nutrition Research Center on Aging, Tufts University, Boston, MA 02111, USA
³Florida Coastal School of Law, Jacksonville, FL, USA
⁴Office of Dietary Supplements, National Institutes of Health, Bethesda, Maryland 20892, USA
⁵Department of Food and Nutrition, Brain Korea 21 Project, College of Human Ecology, Yonsei University, Seoul 120-749, Korea

Abstract
Phytochemicals are reported to provide various biological functions leading to the promotion of health as well as the reduced risk of chronic diseases. Fat-soluble plant pigments, carotenoids, are extensively studied micronutrient phytochemicals for their potential health benefits. It is noteworthy that specific carotenoids may be responsible for different protective effects against certain diseases. In addition, each carotenoid can be obtained from different types of plant foods. Considering the fact that the phytochemical content in foods can vary according to, but not limited to, the varieties and culture conditions, it is important to establish a database of phytochemicals in locally produced plant foods. Currently, information on individual carotenoid content in plant foods commonly consumed in Korea is lacking. As the first step to support the production and consumption of sustainable local plant foods, carotenoids and total phenolic contents of plant foods commonly consumed in Korea are presented and their potential biological functions are discussed in this review.

Key Words: Phytochemicals, carotenoids, total phenolics, plant foods in Korea

Introduction
Fruits and vegetables containing a wide variety of phytochemicals such as carotenoids and phenolics are consistently reported to reduce the risk of chronic diseases [1-4]. As systemic oxidative stress of cell membranes, DNA, and proteins can contribute to the aging process and risk of various degenerative conditions, the antioxidant functions of phytochemicals may contribute to their protective effect against chronic diseases [5-6]. Indeed, evidence of specific biological functions of various phytochemicals, e.g., anti-inflammation and anti-carcinogenesis, is accumulating [7-14]. In addition, phytochemicals reported to be involved in direct modulation of signal transduction. In particular, carotenoids such as lycopene [15] and lutein have been suggested to control redox sensitive molecular targets and platelet-derived growth factor [16], respectively.

To understand the biological role of fruits and vegetables and apply this knowledge to human health, it is essential to characterize phytochemicals in plant foods. In an effort to document the bioactive phytochemical contents of foods, a carotenoid database for fruits and vegetables was reported in 1993 based on a review of various publications [17], and updated [18] in 1999 in the US. On the other hand, there is no publication available showing the individual carotenoid content of Korean plant foods except for a booklet written in Korean reported by us [19]. In addition, database for phenolic contents of selected foods have been reported in the US [20-22], France [23-25], and Brazil [26], whereas there is no such data available in Korea. Various plant foods commonly consumed in Korea are not found in Western countries. In addition, phytochemical contents in foods can be significantly different depending on the varieties [27-28], genotypes [29] growing conditions [30] as well as cultivation practices [31]. Therefore the characterization of the major phytochemical contents of fruits and vegetables in Korea is an important step toward understanding the biological functions of plant foods consumed in Korea.

This research has been supported in part by Cooperative Research Program for Agriculture Science & Technology Development (Project No. P008755) Rural Development Administration, Republic of Korea and U.S. Department of Agriculture, under Agreement 58-1950-7-707. The contents of this publication do not necessarily reflect the views or policies of the U.S. Department of Agriculture, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.

Corresponding Author: Kyung-Jin Yeum, Tel. 1-617-556-3204, Fax. 1-617-556-3344, Email. kyungjin.yeum@tufts.edu

Received: May 11, 2012, Revised: August 14, 2012, Accepted: September 5, 2012

ⓒ2012 The Korean Nutrition Society and the Korean Society of Community Nutrition

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (http://creativecommons.org/licenses/by-nc/3.0/) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.
This review provides a spectrum of carotenoids and total phenolics in plant foods commonly consumed in Korea and discusses their potential biological functions.

**Proposed biological functions of phytochemicals**

Phytochemicals have been suggested to provide health benefits such as maintaining inflammation balance [32-33], providing cardiovascular [34-40], neurocognitive [41], and visual health [7-14, 42], and reducing the risk of cancer [43-44]. Even though numerous observational studies suggest that diets high in fruits and vegetables play a role in reducing chronic diseases [14, 45-47], several intervention trials failed to show a beneficial effect of relatively high doses of β-carotene (20-30 mg/d) against lung cancer in healthy [48] and high-risk populations [49-50]. Nevertheless, baseline serum β-carotene concentrations are inversely correlated with the subsequent incidence of lung cancer in two of these studies [49-50], suggesting a protective effect of fruit and vegetable consumption on the development of chronic diseases. Thus, it may be due to the combination of various phytochemicals in fruits and vegetables that are required to exert the biological actions that promote health.

For example, antioxidant nutrients in fruits and vegetables can work in a synergistic manner to remove free radicals [51]. Although ascorbic acid is a poor inhibitor of peroxyl radical formation [52], it can effectively recycle α-tocopherol from α-tocopheroxyl radicals (α-TO•) [53]. α-Tocopherol can reduce β-carotene peroxyl radicals (LOO-β-C•) as well as β-carotene radical cations ([β-C•+] [54]. The combination of α-tocopherol and β-carotene has been reported to cooperatively slow down lipid peroxidation in in vitro systems [55]. Interestingly, β-carotene at physiologic concentrations does not show a protective effect against oxidation in a biological model system, whereas the oxidation was decreased by β-carotene with the presence of either α-tocopherol or ascorbic acid [51]. Further, flavanol can directly recycle α-tocopherol through a H-transfer mechanism [56]. Importantly, the additive/synergistic interactions between phytochemicals may occur with respect to not only antioxidant activity but also various other biological functions [57].

**Biological functions of carotenoids**

The various antioxidant actions of carotenoids have been reviewed extensively [58-61], although the existence of a clinical importance of antioxidant effect of these compounds has been questioned by some [62]. Epidemiological studies have suggested that dietary carotenoids play a role in reducing the risk of cancer [63], cardiovascular disease [64-66], macular degeneration [7], and cataracts [8-9]. Specific dietary carotenoids may be responsible for different protective effects. Hydrocarbon carotenoids such as β-carotene may be markers for reduced risk of cancer and heart disease [67-68] in physiological dose, whereas supra dietary doses may lead to increased risk of lung cancer [69-70] as well as gastric cancer [71]. Both epidemiological and laboratory studies consistently indicate an association between oxygenated carotenoids, lutein and zeaxanthin, and the protection of the retina and retinal pigment epithelium from damage induced by UV light and oxygen [10]. For example, Seddon et al. [7] found in a case (n = 356)-control (n = 520) study that the highest quintile of carotenoid intake had a 43% lower risk for age-related macular degeneration compared with those in the lowest quintile, and among the specific carotenoids, lutein and zeaxanthin were most strongly associated with the reduced risk for the disease (P = 0.001). Laboratory human studies identifying the macular pigments as lutein and zeaxanthin support these epidemiologic observations [11-12,72]. However, the intake of dark green vegetables, the major source of lutein, remains low at ~0.2 servings/d in Americans [73]. In addition, data from NHANES III indicate that for women 51-70 y, the medians for 50th & 75th percentiles of lutein/zeaxanthin intake were 1.7 and 2.4 mg/d, respectively [74]. Foods rich in an acyclic carotenoid, lycopene, one of the most abundant carotenoids in human blood and tissues, has been found to be associated with an inverse risk of cervical [75], prostate [76], and colon [77] cancers.

Green leafy vegetables contain both oxygenated and hydrocarbon carotenoids; yellow or orange vegetables have high amounts of β-carotene [78]; tomatoes and watermelon contain high amounts of lycopene [79]. It should be pointed out that most of the measurable carotenoids of human plasma can be increased by moderate alterations in diet within a short time, although the magnitude of the plasma response may be related to the baseline carotenoid concentrations [80].

**Biological functions of phenolics**

Phenolic compounds include a vast array of phenolic acids and polyphenols. Total phenolics in fruits and vegetables show a direct relationship with antioxidant capacity measured by in vitro assays [81-82]. The antioxidant and anti-inflammatory activities of plant foods may derive from the additive/synergistic interactions of the mixture of phenolic compounds and other phytochemicals rather than a single compound or class of compounds [83-84]. Nonetheless, although the data are still limited, some individual phenolic compounds have been reported to show specific biological actions, e.g. anti-inflammation, anti-carcinogenesis.

Flavonoids are a large group of polyphenols present in fruits, vegetables, and beverages including wine and tea as well as tree nuts and whole grains. Flavonols such as quercetin and kaempferol are reported to be rich in onions [21,85] with less amounts in dark green leafy vegetables such as collard greens and kales [86-87]. Various studies have shown an inverse association between quercetin intake and risk of lung cancer [43], cardiova-
scural diseases [88] and biomarkers of inflammation [13]. Flavonols such as catechins rich in tea and dark chocolate can act to protect unsaturated phospholipids [89] and low-density lipoproteins [90] from oxidation and are correlated with a reduced risk of heart disease [91]. However, controlled intervention trials have been inconsistent in revealing a protective effect of tea drinking against ex vivo LDL oxidation [92-93]. The major food sources for flavonones such as hesperitin and naringenin are citrus fruits and citrus-based juices [94], which are also inversely associated with the risk of cardiovascular disease [95]. Importantly, the daily intake of flavonoids is extremely variable and could range from 25 to 1,000 mg/d [91,96].

**Phytochemical contents in commonly consumed foods in Korea**

WHO reported that up to 2.7 million lives could be saved annually with sufficient fruit and vegetable consumption and that low fruit and vegetable intake is among the top 10 selected risk factors for global mortality [97-98]. An WHO/FAO expert consultation report recommends a minimum 400 g (~5 servings) of daily fruits and vegetable intake for the prevention of chronic diseases [99]. As phytochemicals appear to be one of the responsible factors for reducing the risk of chronic diseases, profiling these phytochemicals in Korean fruits and vegetables may help promote consumption of local plant foods as a sustainable option to promote health. Table 1 shows individual carotenoid and total phenolic contents in plant foods commonly consumed in Korea.

**Carotenoid contents in plant foods commonly consumed in Korea**

The major carotenoids in the fruits and vegetables in plant foods commonly consumed in Korea were found to be β-carotene and lutein. Only 3 and 6 of the studied plant foods contained detectable amounts of trans-lycopene and β-cryptoxanthin, respectively. Fig. 1 shows β-carotene content as the median, 25th and 75th percentiles per 100 g fresh weight (FW) in plant foods grouped by family names. Plant families that contain the highest values of β-carotene were Compositae, Umbelliferae, and Chenopodiaceae in descending order (4.13, 4.00 and 3.10 mg/100 g FW, respectively). Liliaceae, Cruciferae and Solanaceae families contain 1.84, 0.56 and 0.33 mg/100 g FW of β-carotene, respectively. The families containing the lowest β-carotene were Cucurbitaceae, Leguminosae, Rosaceae and Rutaceae families (0.113, 0.064, 0.064 and 0 mg/100 g FW, respectively). The β-carotene content in Umbelliferae family was significantly higher than those in Leguminosae, Rosaceae and Rutaceae families.

**Fig. 1.** β-Carotene contents in plant foods commonly consumed in Korea by family names. Umbelliferae (n = 10), Compositae (n = 10), Chenopodiaceae (n = 3), Liliaceae (n = 6), Cruciferae (n = 9), Cucurbitaceae (n = 6), Leguminosae (n = 7), Rosaceae (n = 9), Rutaceae (n = 3), Solanaceae (n = 8), Kruskal-Wallis one-way ANOVA on ranks with Dunn’s test were performed to identify differences among median values. Different letters indicate significant differences (P<0.05).

**Fig. 2.** Lutein contents in plant foods commonly consumed in Korea by family names. Umbelliferae (n = 10), Compositae (n = 10), Chenopodiaceae (n = 3), Liliaceae (n = 6), Cruciferae (n = 9), Cucurbitaceae (n = 6), Leguminosae (n = 7), Rosaceae (n = 9), Rutaceae (n = 3), Solanaceae (n = 8), Kruskal-Wallis one-way ANOVA on ranks with Dunn’s test were performed to identify differences among median values. Different letters indicate significant differences (P<0.05).

**Fig. 3.** Total phenolic contents in plant foods commonly consumed in Korea by family names. Umbelliferae (n = 10), Compositae (n = 10), Chenopodiaceae (n = 3), Liliaceae (n = 6), Cruciferae (n = 9), Cucurbitaceae (n = 6), Leguminosae (n = 7), Rosaceae (n = 9), Rutaceae (n = 3), Solanaceae (n = 8), Kruskal-Wallis one-way ANOVA on ranks with Dunn’s test were performed to identify differences among median values. Different letters indicate significant differences (P<0.05).
Table 1. Carotenoids, total phenolic contents in plant foods commonly consumed in Korea

| English name | Latin name | Moisture (%) | Carotenoids (mg/100 g FW) | Total phenolics (mg GAE/100 g FW) |
|--------------|------------|--------------|---------------------------|-----------------------------------|
|              |            |              | Lutein | all-trans-β-carotene | Cryptoxanthin | trans-Lycopene |
| Compositae Family |            |              |        |                      |              |                |
| Burdock | Aretium lappa | 79.6 | - | - | - | - | 134.02 |
| Butterbur | Petasites japonicus | 94.2 | 0.06 ± 0.01 | 0.03 ± 0.01 | - | - | 84.24 |
| Chicory | Cichorium intybus | 94.1 | 3.54 ± 0.15 | 2.20 ± 0.08 | - | - | 64.24 |
| Chwi | Aster scaber Thunberg | 85.0 | 9.8 ± 0.54 | 6.15 ± 0.09 | - | - | 274.96 |
| Crown daisy | Chrysanthemum coronarium | 89.6 | 6.55 ± 0.64 | 4.39 ± 0.23 | - | - | 116.42 |
| Gom-chwi | Coriandrum sativum | 87.5 | 8.46 ± 0.33 | 6.25 ± 0.05 | - | - | 613.79 |
| Head lettuce | Lactuca sativa | 94.2 | 0.36 ± 0.02 | 0.28 ± 0.02 | - | - | 17.74 |
| Lactua bungeana | Ixeris Sonchifolia | 87.3 | 5.66 ± 0.18 | 4.13 ± 0.18 | - | - | 443.94 |
| Lettuce | Lactuca sativa | 93.5 | 2.34 ± 0.17 | 2.47 ± 0.11 | - | - | 164.6 |
| Mugwort | Artemisia vulgaris | 82.4 | 11.57 ± 1.11 | 7.21 ± 0.56 | - | - | 542.81 |
| Cruciferae Family |            |              |        |                      |              |                |
| Broccoli | Brassica oleracea italicca | 88.9 | 1.00 ± 0.01 | 0.56 ± 0.02 | - | - | 53.19 |
| Cabbage | Brassica oleracea capitata | 92.7 | 0.14 ± 0.01 | 0.08 ± 0.01 | - | - | 38.34 |
| Cauliflower | Brassica oleracea botrytis | 90.8 | 0.02 ± 0.00 | 0.01 ± 0.00 | - | - | 77.26 |
| Green mustard | Brassica juncea | 90.0 | 3.6 ± 0.42 | 2.63 ± 0.42 | - | - | 80.73 |
| Korean cabbage | Brassica Chinensis | 94.4 | 0.60 ± 0.04 | 0.37 ± 0.01 | - | - | 37 |
| Pak-choi | Brassica campestris | 90.0 | 0.28 ± 0.18 | 2.24 ± 0.11 | - | - | 73.63 |
| Radish | Raphanus sativus niger | 94.6 | - | - | - | - | 13.03 |
| Red cabbage | Brassica oleracea | 93.1 | - | - | - | - | 91.78 |
| Young radish | Raphanus sativus L | 92.1 | 4.11 ± 0.35 | 2.87 ± 0.28 | - | - | 84.17 |
| Cucurbitaceae Family |            |              |        |                      |              |                |
| Cucumber | Cucumis sativus | 95.2 | 0.14 ± 0.01 | 0.07 ± 0.002 | - | - | 6.68 |
| Melon, musk | Cucumis melo | 90.9 | 0.06 ± 0.00 | 0.04 ± 0.00 | - | - | 12.61 |
| Oriental melon | Cucumis melo L | 88.8 | - | - | - | - | 25.71 |
| Pumpkin | Cucurbita maxima | 92.9 | - | 0.69 ± 0.05 | - | - | 7.17 |
| Watermelon | Citrullus vulgaris | 88.5 | - | 0.92 ± 0.08 | 3.33 ± 0.11 | 12.09 |
| Zucchini | Cucurbita pepo | 92.7 | 0.25 ± 0.02 | 0.11 ± 0.01 | - | - | 9.01 |
| Chenopodiaceae Family |            |              |        |                      |              |                |
| Beets | Beta vulgaris | 89.7 | - | - | - | - | 46.07 |
| Chard | Beta vulgaris var. cicla | 90.9 | 4.28 ± 0.13 | 2.94 ± 0.12 | - | - | 65.49 |
| Spinach | Spinacia oleracea | 92.2 | 8.26 ± 0.43 | 3.25 ± 0.07 | - | - | 94 |
| Leguminosae Family |            |              |        |                      |              |                |
| Black beans, dried | Glycine max Merr. | 12.2 | 1.07 ± 0.05 | 0.12 ± 0.005 | - | - | 161.38 |
| Cowpeas, dried | Vigna sinensis | 38.2 | - | - | - | 25.01 |
| Kidney beans | Phaseolus vulgaris | 56.4 | - | - | - | - | 181.34 |
| Mung beans, dried | Phaseolus radiatus | 7.4 | 1.34 ± 0.10 | 0.05 ± 0.00 | - | - | 191.08 |
| Peas | Pismum sativum | 53.1 | 0.52 ± 0.03 | 0.10 ± 0.00 | - | - | 26.88 |
| Small red beans, dried | Phaseolus angularis | 9.0 | - | - | - | - | 176.4 |
| Soy beans, dried | Glycine max | 10.7 | 0.29 ± 0.02 | - | - | - | 97.4 |
| Liliaceae Family |            |              |        |                      |              |                |
| Chinese chive | Allium tuberosum | 92.1 | 4.19 ± 0.46 | 2.34 ± 0.20 | - | - | 58 |
| Garlic | Allium sativum | 63.4 | - | - | - | - | 67.18 |
| Garlic young stem | Allium sativum | 89.7 | 0.44 ± 0.14 | 0.31 ± 0.07 | - | - | 43.4 |
| Leek | Allium porum | 91.1 | 1.78 ± 0.30 | 1.34 ± 0.21 | - | - | 29.17 |
| Onion | Allium sepa | 91.7 | - | - | - | - | 27.54 |
| Scallion | Allium Fistulosum | 91.0 | 4.85 ± 0.13 | 2.99 ± 0.10 | - | - | 81.81 |
| Rosaceae Family |            |              |        |                      |              |                |
| Apple | Malus sylvestris | 86.2 | - | - | - | - | 45.92 |
| Japanese apricot | Prunus mume | 90.2 | 0.07 ± 0.02 | 0.01 ± 0.00 | - | - | 56.24 |
| Nectarine | Prunus persica nectarina | 89.7 | - | 0.09 ± 0.01 | 0.02 ± 0.00 | - | - | 57.48 |
| Peach | Prunus persica | 87.9 | - | - | - | - | 19.46 |
| Pear | Pyrus communis | 86.5 | - | - | - | - | 9.48 |
| English name  | Latin name                  | Moisture (%) | Carotenoids<sup>1</sup> (mg/100 g FW) | Total phenolics<sup>3</sup> (mg GAE/100 g FW) |
|--------------|-----------------------------|---------------|-------------------------------------|-----------------------------------------------|
|              |                             | Lutein       | all-trans-β-carotene | Cryptoxanthin | trans-Lycopene       |
| Plum         | Prunus domestica            | 91.4         | 0.12 ± 0.01 | 0.04 ± 0.00 | 0.01 ± 0.00 | - | 160.48 |
| Sour cherry  | Prunus cerasus              | 85.9         | -          | 0.06 ± 0.00 | - | - | 79.17 |
| Strawberry   | Fragaria elatior            | 87.6         | -          | - | - | - | 149.34 |
| Sweet cherry | Prunus avium               | 80.7         | -          | - | - | - | 105.99 |
| Rutaceae Family |                     |              |           |           |           |           |           |
| Lemon        | Citrus limonis             | 88.1         | -          | - | 0.01 ± 0.00 | - | 115.16 |
| Orange       | Citrus sinensis            | 85.2         | -          | 0.01 ± 0.00 | 0.24 ± 0.06 | - | 79.73 |
| Tangerine    | Citrus reticulate          | 87.7         | -          | 0.02 ± 0.01 | 0.42 ± 0.18 | - | 56.70 |
| Solanaceae Family |                     |              |           |           |           |           |           |
| Cherry tomato | Lycopersicum esculentum Mill | 92.7         | -          | 0.48 ± 0.03<sup>4</sup> | - | 4.68 ± 1.77 | 38.94 |
| Eggplant     | Solarium melongena         | 94.2         | 0.14 ± 0.02 | 0.06 ± 0.02 | - | - | 58.62 |
| Green pepper | Capsicum annuum            | 91.7         | 1.23 ± 0.12 | 0.43 ± 0.05 | - | - | 107.2 |
| Green sweet pepper | Capsicum annuum      | 94.8         | 0.41 ± 0.02 | 0.12 ± 0.01 | - | - | 60.36 |
| Potato       | Solarium tuberosum         | 79.5         | -          | - | - | - | 43.39 |
| Red pepper   | Capsicum annuum            | 81.6         | 0.35 ± 0.04 | 1.63 ± 0.30 | - | - | 126.86 |
| Red sweet pepper | Capsicum annuum        | 91.1         | 0.09 ± 0.03 | - | - | - | 100.74 |
| Tomato       | Lycopersicon esculentum    | 94.6         | -          | 0.33 ± 0.02 | 1.94 ± 0.11 | - | 17.89 |
| Umbelliferae Family |                     |              |           |           |           |           |           |
| Myeong Il Yeop | Angelica keiskei        | 78.0         | 26.82 ± 1.72 | 11.53 ± 0.50 | - | - | 331.87 |
| Celery       | Apium graveolens           | 94.3         | 0.67 ± 0.08 | 0.26 ± 0.03 | - | - | 18.37 |
| Cham         | Pimpinella brachycarpa     | 87.8         | 5.45 ± 0.34 | 3.23 ± 0.21 | - | - | 82.69 |
| Coriander    | Coriandrum sativum         | 91.6         | 5.24 ± 0.58 | 3.00 ± 0.33 | - | - | 107.46 |
| Dang-wi      | Radyx angelica gigas       | 83.0         | 9.92 ± 0.70 | 6.62 ± 0.72 | - | - | 260.53 |
| Kale         | Brassica oleracea sabellica | 91.3         | 4.91 ± 0.72 | 2.81 ± 0.43 | - | - | 95.89 |
| Parsley      | Petriselium crispum        | 85.1         | 10.03 ± 1.60 | 5.53 ± 0.83 | - | - | 217.36 |
| Pumpkin young leaves | Cucurbita maxima | 88.4         | 10.72 ± 0.73 | 4.77 ± 0.38 | - | - | 181.14 |
| Red pepper leaves | Capsicum annuum       | 84.1         | 17.45 ± 0.88 | 10.07 ± 0.40 | - | - | 409.25 |
| Small water dropwort | Oenanthe javanica | 90.1         | 3.40 ± 0.52 | 1.36 ± 0.26 | - | - | 238.65 |
| Others       |                            |              |           |           |           |           |           |
| Amaranth     | Amaranthus mangostanus     | 88.5         | 9.4 ± 0.66 | 6.20 ± 0.47<sup>4</sup> | - | - | 134.27 |
| Bamboo shoot | Bambusa spp                | 91.1         | -          | - | - | - | 101.07 |
| Banana       | Musa Sapientum             | 96.6         | 0.01 ± 0.00 | 0.01 ± 0.00<sup>5</sup> | - | - | 10.22 |
| Bonnet bellflower root | Codonopis lanceolata | 80           | -          | - | - | - | 28.54 |
| Bracken fern, boiled | Pteridium aquilinum   | 91.4         | 0.15 ± 0.01 | 0.02 ± 0.00<sup>5</sup> | - | - | 1.58 |
| Bud of aralia | Aralia elate               | 89.1         | 4.35 ± 0.16 | 2.40 ± 0.10 | - | - | 88.53 |
| Carrot       | Platyodon grandiflorum     | 90.5         | 0.17 ± 0.06 | 5.47 ± 1.30 | - | - | 6.92 |
| Chinese bellflower root | Comus officinalis     | 77.7         | -          | - | - | - | 34.84 |
| Comus officinalis | Asarum canadense    | 6.6          | -          | - | - | - | 1519.93 |
| Ginger       | Vitis vinifera            | 85.7         | -          | - | - | - | 24.94 |
| Grape berries | Vitis vinifera            | 81           | 0.05 ± 0.01 | 0.04 ± 0.01 | - | - | 112.43 |
| Grape(campbell) | Actinida chinensis     | 84.2         | 0.19 ± 0.1 | 0.15 ± 0.01 | - | - | 161.19 |
| Kiwi         | Nelumbo nucifera          | 82.3         | 0.02 ± 0.01 | - | - | - | 56.41 |
| Lotus root   | Malva verticillata        | 80.8         | -          | - | - | - | 91.67 |
| Mallow       | Glycine max               | 90.2         | 8.03 ± 0.56 | 4.80 ± 0.22 | - | - | 139.9 |
| Mungbean sprout | Perilla frutescens      | 95.2         | 0.03 ± 0.00 | - | - | - | 21.08 |
| Perilla leaves | Ananas comosus            | 84           | 12.38 ± 0.80 | 7.36 ± 0.02 | - | - | 193.33 |
| Pineapple    | Raphanus sativus          | 84.4         | -          | 0.05 ± 0.00 | - | - | 44.14 |
| Radish sprouts | Sedum sarmentosum       | 91.4         | 3.73 ± 0.46 | 2.10 ± 0.17 | - | - | 120.02 |
| Sedum        | Glycine max               | 96           | 2.24 ± 0.21 | 1.25 ± 0.07 | - | - | 50.07 |
| Soybean sprout | Ipomoea batatas         | 91.3         | -          | - | - | - | 53.45 |
| Sweet potato | Ipomoea batatas          | 58           | -          | - | - | - | 89.46 |
| Sweet potato stalk | Dioscorea batatas    | 94           | 0.02 ± 0.01 | - | - | - | 19.47 |
| White yam    | Amaranthus mangostanus    | 81.9         | -          | - | - | - | 19.55 |

Table 1. Continuation
Lutein content grouped by plant family is shown in Fig. 2. The *Umbelliferae* family had the highest lutein content of 7.69 mg/100 g FW, followed by *Chenopodiaceae, Compositae* and *Liliaceae* families at 6.27, 5.66 and 2.90 mg/100 g FW, respectively. *Cruciferae* and *Leguminosae* families contained 1.0 and 0.80 mg/100 g FW of lutein. *Cucurbitaceae, Rosaceae* and *Rutaceae* families contained the lowest amount of lutein in the range of 0.01 mg/100 g FW and the content were significantly lower than those in *Umbelliferae* family.

According to USDA National Nutrient database [100], kale contains 8.17 mg/100 g of β-carotene. The β-carotene contents in pumpkin, carrot, spinach, parsley and lettuce in this database are 6.94, 5.77, 5.63, 5.05 and 4.44 mg/100 g, respectively. Vegetables commonly consumed in Korea are rich in carotenoids, in particular lutein and β-carotene. For example, Myeong Il Yeop and red pepper leaves contained 11.53 and 10.07 mg/100 g of β-carotene and 26.82 and 17.45 mg/100 g of lutein respectively.

Cryptoxanthin and lycopene were detected only in a few food items. Cryptoxanthin was present in red pepper (0.35 mg/100 g), red sweet pepper (0.089 mg/100 g) as well as nectarine, lemon, Japanese apricot and Korean cherry. Lycopene was present in cherry tomato, watermelon and tomato (4.68, 3.33 and 1.94 mg/100 g, respectively).

**Total phenolic contents in plant foods commonly consumed in Korea**

*Umbelliferae* (199.2 mg gallic acid equivalents [GAE]/100 g FW), *Leguminosae* (161.4 mg GAE/100 g FW) and *Compositae* families (149.3 mg GAE/100 g FW) contained the highest total phenolics, which were significantly higher than *Cucurbitaceae* family (10.6 mg GAE/100 g FW) containing the lowest total phenolic contents ($P < 0.05$). *Rutaceae, Cruciferae* and *Chenopodiaceae* families were in the range of 65.5-79.7 mg GAE/100 g FW of total phenolics. *Solanaceae, Rosaceae* and *Liliaceae* families contained total phenolics in the amounts of 59.5, 57.5 and 50.7 mg GAE/100 g FW, respectively (Fig. 3).

Previous studies reported by others on total phenolics reported that broccoli and spinach contained the highest amount of total phenolics (101.63 and 90.99 mg GAE/100 g, respectively), followed by yellow onion, red pepper, carrot, cabbage, potato, lettuce, celery and cucumber [101]. Of the 10 most commonly consumed fruits in the US, the highest total phenolic contents were found in cranberry, apple, red grape and strawberry with values of 527.2 ± 21.5, 296.3 ± 6.4, 201.0 ± 2.9, 160.0 ± 1.2 mg GAE/100 g, respectively [102]. Compared to the commonly consumed fruit and vegetables in the US, much higher total phenolics were found in vegetables commonly consumed in Korea, where Gom-chwi (613.79 mg GAE/100 g FW), mugwort (542.81 mg GAE/100 g FW), lactoru bungeana (443.94 mg GAE/100 g FW) and red pepper leaves (409.25 mg GAE/100 g FW), Myeong Il Yeop (331.87 mg GAE/100 g FW), Chwi-namul (274.96 mg GAE/100 g FW), Dang-gwi (260.53 mg GAE/100 g FW) and small water dropwort (238.65 mg GAE/100 g FW). Korean local berries and legumes which were dried also showed high total phenolics.

**Commonly consumed plant foods in Korea high in β-carotene, lutein and total phenolic contents**

The top 20 foods for carotenoids and total phenolics in commonly consumed plant foods in Korea are summarized in

| Plant foods     | Lutein (mg/100 g FW) | Plant foods     | β-Carotene (mg/100 g FW) | Plant foods     | Total phenolics (mg GAE/100 g FW) |
|----------------|----------------------|----------------|--------------------------|----------------|-----------------------------------|
| 1. Myeong Il Yeop | 26.82                | 11.53          | Cornus officinalis (dried) | 1519.9         |
| 2. Red pepper, leaves | 17.45                | 10.07          | Gom-chwi                  | 613.8          |
| 3. Perilla, leaves | 12.38                | 7.36           | Mugwort                   | 542.8          |
| 4. Mugwort       | 11.57                | 7.21           | Lactoru bungeana          | 443.9          |
| 5. Pumpkin, young leaves | 10.72                | 6.62           | Red pepper leaves         | 409.3          |
| 6. Parsley       | 10.03                | 6.25           | Myeong Il Yeop            | 331.9          |
| 7. Dang-gwi      | 9.92                 | 6.20           | Chwi-namul                | 275.0          |
| 8. Chwi-namul    | 9.80                 | 6.15           | Dang-gwi                  | 260.5          |
| 9. Amaranth      | 9.40                 | 5.53           | Small water dropwort      | 238.7          |
| 10. Gom-chwi     | 8.46                 | 4.80           | Parsley                   | 217.4          |
| 11. Spinach      | 8.26                 | 4.77           | Perilla leaves            | 193.3          |
| 12. Mallow       | 8.03                 | 4.39           | Mung beans, dried         | 191.1          |
| 13. Crown daisy  | 6.55                 | 4.13           | Kidney beans              | 181.3          |
| 14. Lactoru bungeana | 5.66                 | 3.97           | Pumpkin young leaves      | 181.1          |
| 15. Chwi-namul   | 5.45                 | 3.25           | Small red beans, dried    | 176.4          |
| 16. Coriander    | 5.24                 | 3.23           | Lettuce                   | 164.6          |
| 17. Kale         | 4.91                 | 3.00           | Black beans, dried        | 161.4          |
| 18. Scallion     | 4.85                 | 2.99           | Grape (campbell)          | 161.2          |
| 19. Bud, Aralia elats | 4.35                 | 2.94           | Plum                      | 160.5          |
| 20. Chard        | 4.28                 | 2.87           | Strawberry                | 149.3          |
Table 2. Myeong Il Yeop and red pepper leaves were the highest in both β-carotene (11.53 and 10.07 mg/100 g FW) and lutein (26.82 and 17.45 mg/100 g FW) contents, followed by perilla leaves and mugwort. The top 10 foods containing high amounts of β-carotene were Dang-gwi, Gom-chwi, amaranth, Chwi-namul, parsley and mallow. Pumpkin young leaves, parsley, Dang-gwi, Chwi-namul, amaranth, and Gom-chwi were in top 10 foods with high lutein content.

Total phenolics were the highest in dried *Cornus officinalis* (Local Korean berry). Gom-chwi (613.8 mg GAE/100 g FW) and mugwort (542.8 µmol/g FW) showed high total phenolics, followed by lactuca bungeana, red pepper leaves, Myeong Il Yeop, Chwi-namul, and Dang-gwi (443.9, 409.3, 331.9, 275 and 260.5 mg GAE/100 g FW, respectively). As shown in Table 2, the top 20 plant foods with high β-carotene content were all green leafy vegetables plus carrots. Lutein was also high in green leafy vegetables. Total phenolics were high in green leafy vegetables and in non-green leafy vegetables such as Korean berry (dried), legumes, grapes, and plum. In general, the phytochemicals investigated in this study were higher in plant foods commonly consumed in Korea, especially in green leafy vegetables, than in common plant foods such as parsley, spinach, kale and lettuce, which are listed to contain high phytochemicals in the US database [21].

Conclusions

Plant foods commonly consumed in Korea, in particular, green-leafy vegetables belonging to the *Compositae* and *Umbelliferae* families, are good sources of phytochemicals such as β-carotene, lutein, and total phenolics, and their contents are higher than those of commonly consumed plant foods reported by others. These phytochemicals in plant foods commonly consumed in Korea may contribute substantially to reduce the risk of chronic diseases as illustrated in Fig. 4. Thus, plant foods commonly consumed in Korea can be an important source of phytochemicals that can contribute to the promotion of health and prevention of chronic diseases.

References

1. Vattem DA, Ghaedian R, Shetty K. Enhancing health benefits of berries through phenolic antioxidant enrichment: focus on cranberry. Asia Pac J Clin Nutr 2005;14:120-30.
2. Liu S, Manson JE, Lee IM, Cole SR, Hennekens CH, Willett WC, Buring JE. Fruit and vegetable intake and risk of cardiovascular disease: the Women’s Health Study. Am J Clin Nutr 2000;72:922-8.
3. Van Duyn MA, Pivonka E. Overview of the health benefits of fruit and vegetable consumption for the dietetics professional: selected literature. J Am Diet Assoc 2000;100:1511-21.
4. Liu RH. Health benefits of fruit and vegetables are from additive and synergistic combinations of phytochemicals. Am J Clin Nutr 2003;78:517S-520S.
5. Temple NJ. Antioxidants and disease: more questions than answers. Nutr Res 2000;20:449-59.
6. Willett WC. Balancing life-style and genomics research for disease prevention. Science 2002;296:695-8.
7. Seddon JM, Ajani UA, Sperduto RD, Hiller R, Blair N, Burton TC, Farber MD, Gragoudas ES, Haller J, Miller DT, Yannuzzi LA, Willett W. Dietary carotenoids, vitamins A, C, and E, and advanced age-related macular degeneration. Eye Disease Case-Control Study Group. JAMA 1994;272:1413-20.
8. Jacques PF, Chylack LT Jr, Hankinson SE, Khu PM, Rogers G, Friend J, Tung W, Wolfe JK, Padhye N, Willett WC, Taylor A. Long-term nutrient intake and early age-related nuclear lens opacities. Arch Ophthalmol 2001;119:1009-19.
9. Hankinson SE, Stampfer MJ, Seddon JM, Colditz GA, Rosner B, Speizer FE, Willett WC. Nutrient intake and cataract extraction in women: a prospective study. BMJ 1992;305:335-9.
10. Hammond BR Jr, Curran-Celentano J, Judd S, Fuld K, Krinsky NI, Wooten BR, Snodderly DM. Sex differences in macular...

Fig. 4. Proposed functions of phytochemicals. Plant foods in parenthesis represent the major source of each phytochemical.
42. Jia Z, Song Z, Zhao Y, Wang X, Liu P. Grape seed proanthocyanidin extract protects human lens epithelial cells from oxidative stress via reducing NF-small k, CyrillicB and MAPK protein expression. Mol Vis 2011;17:210-7.

43. Neuhausser ML. Dietary flavonoids and cancer risk: evidence from human population studies. Nutr Cancer 2004;50:1-7.

44. Cai Y, Luo Q, Sun M, Corke H. Antioxidant activity and phenolic compounds of 112 traditional Chinese medicinal plants associated with anticancer. Life Sci 2004;74:2157-84.

45. Li C, Ford ES, Zhao G, Balluz LS, Giles WH, Liu S. Serum alpha-carotene concentrations and risk of death among US Adults: the Third National Health and Nutrition Examination Survey Follow-up Study. Arch Intern Med 2011;171:507-15.

46. Liu S, Lee IM, Ajani U, Cole SR, Buring JE, Manson JE; Physicians’ Health Study. Intake of vegetables rich in carotenoids and risk of coronary heart disease in men: The Physicians’ Health Study. Int J Epidemiol 2001;30:130-5.

47. Greenberg ER, Sporn MB. Antioxidant vitamins, cancer, and cardiovascular disease. N Engl J Med 1996;334:1189-90.

48. Hennekens CH, Buring JE, Manson JE, Stampfer MJ, Rosner B, Cook NR, Belanger C, LaMotte F, Gaziano JM, Ridker PM, Willett W, Peto R. Lack of effect of long-term supplementation with beta carotene on the incidence of malignant neoplasms and cardiovascular disease. N Engl J Med 1996;334:1145-9.

49. The effect of vitamin E and beta carotene on the incidence of lung cancer and other cancers in male smokers. The Alpha-Tocopherol, Beta Carotene Cancer Prevention Study Group. N Engl J Med 1994;330:1029-35.

50. Omenn GS, Goodman D, Thornquist MD, Balmes J, Cherniack M, Cullen M, Glass A, Koegh J, Liu D, Mveyskens F Jr, Perloff M, Valanis B, Williams J Jr. Chemoprevention of lung cancer: the beta-Carotene and Retinol Efficacy Trial (CARET) in high-risk smokers and asbestos-exposed workers. IARC Sci Publ 1996:67-85.

51. Yeum KJ, Beretta G, Krinsky NI, Russell RM, Aldini G. Synergistic interactions of antioxidant nutrients in a biological model system. Nutrition 2009;25:839-46.

52. Doba T, Burton GW, Ingold KU. Antioxidant and co-antioxidant activity of vitamin C. The effect of vitamin C, either alone or in the presence of vitamin E or a water-soluble vitamin E analogue, upon the peroxidation of aqueous multilamellar phospholipid liposomes. Biochim Biophys Acta 1985;835:298-303.

53. Liebler DC, Kaysen KL, Buring JE. Peroxyl radical trapping and antioxidation reactions of alpha-tocopherol in lipid bilayers. Chem Res Toxicol 1991;4:89-93.

54. Mortensen A, Skibsted LH. Relative stability of carotenoid radical cations and homologue tocopheroxy radicals. A real time kinetic study of antioxidation hierarchy. FEBS Lett 1997;417: 261-6.

55. Palozza P, Krinsky NI. beta-Carotene and alpha-tocopherol are synergistic antioxidants. Arch Biochem Biophys 1992;297:184-7.

56. Aldini G, Yeum KJ, Carini M, Krinsky NI, Russell RM. (−)-Epigallocatechin-3-gallate prevents oxidative damage in both the aqueous and lipid compartments of human plasma. Biochem Biophys Res Commun 2003;302:409-14.

57. Bertipaglia de Santana M, Mandarino MG, Cardoso JR, Dichi I, Dichi JB, Camargo AE, Fabris BA, Rodrigues RJ, Fatel EC, Nixdorf SL, Simão AN, Cecchini R, Barbosa DS. Association between soy and green tea (Camellia sinensis) diminishes hypercholesterolemia and increases total plasma antioxidant potential in dyslipidemic subjects. Nutrition 2008;24:562-8.

58. Krinsky NI. The antioxidant and biological properties of the carotenoids. Ann N Y Acad Sci 1998;854:443-7.

59. Krinsky NI, Yeum KJ. Carotenoid-radical interactions. Biochem Biophys Res Commun 2003;305:754-60.

60. Palozza P, Krinsky NI. Antioxidant effects of carotenoids in vivo and in vitro: an overview. Methods Enzymol 1992;213:403-20.

61. Yeum KJ, Aldini G, Russell RM, Krinsky NI. Antioxidant/Pro-oxidant Actions of Carotenoids. Basel, Boston, Berlin: Birkhauser Verlag; 2009.

62. Rice-Evans CA, Sampson J, Bramley PM, Holloway DE. Why do we expect carotenoids to be antioxidants in vivo? Free Radic Res 1997;26:381-98.

63. Ziegler RG. Vegetables, fruits, and carotenoids and the risk of cancer. Am J Clin Nutr 1991;53:251S-259S.

64. Gaziano JM, Hennekens CH. The role of beta-carotene in the prevention of cardiovascular disease. Ann N Y Acad Sci 1993;691:148-55.

65. Riemersma RA, Wood DA, Macintyre CC, Elton RA, Gey KF, Oliver MF. Risk of angina pectoris and plasma concentrations of vitamins A, C, and E and carotene. Lancet 1991;337:1-5.

66. Greenberg ER, Baron JA, Karagas MR, Stukel TA, Nierenberg DW, Steven MM, Mandel JS, Haile RW. Mortality associated with low plasma concentration of beta carotene and the effect of oral supplementation. JAMA 1996;275:699-703.

67. Herberg S, Kesse-Guyot E, Druesne-Pecollo N, Tovier M, Favier A, Latino-Martel P, Briançon S, Galan P. Incidence of cancers, ischemic cardiovascular diseases and mortality during 5-year follow-up after stopping antioxidant vitamins and minerals supplements: a postintervention follow-up in the SU.VI.MAX Study. Int J Cancer 2010;127:1875-81.

68. Kim J, Kim MK, Lee JK, Kim JH, Son SK, Song ES, Lee KB, Lee JP, Lee JM, Yun YM. Intakes of vitamin A, C, and E, and beta-carotene are associated with risk of cervical cancer: a case-control study in Korea. Nutr Cancer 2010;62:181-9.

69. Omenn GS, Goodman GE, Thornquist MD, Balmes J, Cullen MR, Glass A, Koegh JP, Mveyskens FL Jr, Valanis B, Williams JH Jr, Bannhart S, Cherniack MG, Brödkin CA, Hamm A. Risk factors for lung cancer and for intervention effects in CARET, the Beta-Carotene and Retinol Efficacy Trial. J Natl Cancer Inst 1996;88:1550-9.

70. Albanes D, Heinonen OP, Taylor PR, Virtamo J, Edwards BK, Rautalahti M, Hartman AM, Palmgren J, Freedman LS, Haapakoski J, Barrett MJ, Pietinen P, Malila N, Tala E, Lippon K, Salomaa ER, Tangrea JA, Teppo L, Askin FB, Taskinen E, Erozan Y, Greenwald P, Huttenen JK. Alpha-Tocopherol and beta-carotene supplements and lung cancer incidence in the alpha-tocopherol, beta-carotene cancer prevention study: effects of base-line characteristics and study compliance. J Natl Cancer Inst 1996;88:1560-70.

71. Druesne-Pecollo N, Latino-Martel P, Norat T, Barrandon E, Bertrais S, Galan P, Hercberg S. Beta-carotene supplementation and cancer risk: a systematic review and metaanalysis of randomized controlled trials. Int J Cancer 2010;127:172-84.

72. Handelman GJ, Dratz EA, Reay CC, van Kuijk JG. Carotenoids in the human macula and whole retina. Invest Ophthalmol Vis Sci 1988;29:850-5.

73. Johnston CS, Taylor CA, Hampil JS. More Americans are eating “5 a day” but intakes of dark green and cruciferous vegetables remain low. J Nutr 2000;130:3063-7.
74. Food and Nutrition Board, Institute of Medicine. Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids. Washington, D.C.: National Academies Press; 2000.
75. Batsiea AM, Armenian HK, Norkus EP, Morris JS, Spate VE, Comstock GW. Serum micronutrients and the subsequent risk of cervical cancer in a population-based nested case-control study. Cancer Epidemiol Biomarkers Prev 1993;2:335-9.
76. Clinton SK, Emenscher C, Schwartz SJ, Bostwick DG, Williams AW, Moore BJ, Erdman JW Jr. cis-trans lycopene isomers, carotenoids, and retinol in the human prostate. Cancer Epidemiol Biomarkers Prev 1996;5:823-33.
77. Guil-Guerrero JL, Ramos-Bueno R, Rodríguez-Garcia I, López-Sánchez C. Cytoxicity screening of several tomato extracts. J Med Food 2011;14:40-5.
78. Micozzi MS, Beecher GR, Taylor PR, Khachik F. Carotenoid analyses of selected raw and cooked foods associated with a lower risk for cancer. J Natl Cancer Inst 1990;82:282-5.
79. Stahl W, Sies H. Uptake of lycopene and its geometrical isomers is greater from heat-processed than from unprocessed tomato juice in humans. J Nutr 1992;122:2161-6.
80. Yeum KJ, Booth SL, Sadowski JA, Liu C, Tang G, Krinsky NI, Russell RM. Human plasma carotenoid response to the ingestion of controlled diets high in fruits and vegetables. Am J Clin Nutr 1996;64:594-602.
81. Eberhardt MV, Lee CY, Liu RH. Antioxidant activity of fresh fruits. Nature 2000;405:903-4.
82. Liu M, Li XQ, Weber C, Lee CY, Liu RH. Antioxidant and antiproliferative activities of raspberries. J Agric Food Chem 2002;50:2926-30.
83. de Kok TM, van Breda SG, Manson MM. Mechanisms of combined action of different chemopreventive dietary compounds: a review. Eur J Nutr 2008;47 Suppl 2:51-9.
84. Liu RH. Potential synergy of phytochemicals in cancer prevention: mechanism of action. J Nutr 2004;134:3479S-3485S.
85. Somerset SM, Johannot L. Dietary flavonoid sources in the United Kingdom. Food Nutr Bull 2002;23:152-6.
86. Lin LZ, Harnly JM. Dietary antioxidant flavonoids and risk of coronary heart disease: a review. Eur J Clin Nutr 2011;65:443-50.
87. Olsen H, Aaby K, Borge GI. Characterization and quantification of flavonoids and hydroxyphenolic acids in curly kale (Brassica oleracea L. Convar. acephala Var. sabellica) by HPLC-DAD-ESI-MSn. J Agric Food Chem 2009;57:2816-25.
88. Hertog MG, Feskens EJ, Hollman PC, Katan MB. Dietary antioxidant flavonoids and risk of coronary heart disease: the Zutphen Elderly Study. Lancet 1993;342:1007-11.
89. Chen C, Tang HR, Sutcliffe LH, Belton PS. Green tea polyphenols react with 1,1-diphenyl-2-picrylhydrazyl free radicals in the bilayer of liposomes: direct evidence from electron spin resonance studies. J Agric Food Chem 2000;48:5710-4.
90. Fuhrman B, Aviram M. Flavonoids protect LDL from oxidation and attenuate atherosclerosis. Curr Opin Lipidol 2001;12:41-8.
91. Hertog MG, Kromhout D, Aravanis C, Blackburn H, Buzina R, Fidanza F, Giampaoli S, Jansen A, Menotti A, Nedeljkovic S, Pekkarinen M, Simic BS, Toshima H, Feskens EJ, Hollman PC, Katan MB. Flavonoid intake and long-term risk of coronary heart disease and cancer in the seven countries study. Arch Intern Med 1995;155:381-6.
92. Hodgson JM, Paduey JB, Croft KD, Burke V, Mori TA, Caccetta RA, Beilin LJ. Acute effects of ingestion of black and green tea on lipoprotein oxidation. Am J Clin Nutr 2000;71:1103-7.
93. van het Hof KH, de Boer HS, Wiseman SA, Lien N, Westrate JA, Tijburg LB. Consumption of green or black tea does not increase resistance of low-density lipoprotein to oxidation in humans. Am J Clin Nutr 1997;66:1125-32.
94. Zamora-Ros R, Knaze V, Luján-Barroso L, Slimani N, Romieu I, Fedirko V, de Magistris MS, Ericson U, Amiano P, Trichopoulou A, Dilis V, Naska A, Engeset D, Skeie G, Cassidy A, Overvad K, Peeters PH, Huerta JM, Sánchez MJ, Quíroz JR, Sacerdote C, Grioni S, Tumino R, Johansson G, Johansson I, Drake I, Crowe FL, Barricarte A, Kaaks R, Teucher B, Bueno-de-Mesquita HB, van Rossum CT, Norat T, Romaguera D, Vergnaud AC, Tjønneland A, Halkjær J, Clavel-Chapelon F, Boutron-Ruault MC, Touillad M, Salvini S, Khaw KT, Wareham N, Boeing H, Förster J, Riboli E, Gonzalez CA. Estimated dietary intakes of flavonols, flavanones and flavones in the European Prospective Investigation into Cancer and Nutrition (EPIC) 2011:24 hour dietary recall cohort. Br J Nutr 2011;106:1915-25.
95. Yamada T, Hayasaka S, Shibata Y, Ojima T, Saegusa T, Gotoh T, Ishikawa S, Nakamura Y, Kayaba K; Jichi Medical School Cohort Study Group. Frequency of citrus fruit intake is associated with the incidence of cardiovascular disease: the Jichi Medical School cohort study. J Epidemiol 2011;21:169-75.
96. Hollman PC, Feskens EJ, Katan MB. Tea flavonols in cardiovascular disease and cancer epidemiology. Proc Soc Exp Biol Med 1999;220:198-202.
97. World Health Organization. The World Health Report 2002 - Reducing Risks, Promoting Healthy Life. Geneva: World Health Organization; 2002.
98. World Health Organization. Fruit and Vegetable Promotion Initiative. A Meeting Report; 2003 Aug 25-27. Geneva: World Health Organization; 2003.
99. World Health Organization. Fruit and Vegetable Promotion Initiative. A Meeting Report; 2003 Aug 25-27. Geneva: World Health Organization; 2003.
100. World Health Organization; Food and Agriculture Organization of the United Nations. Diet, Nutrition and the Prevention of Chronic Diseases: Report of a Joint WHO/FAO Expert Consultation. Geneva: World Health Organization; 2003.
101. Haytowitz DB, Lemar LE, Pehrsson PR, Exler J, Patterson KK, Thomas RG, Nickle MS, Williams JR, Showell BA, Khan M, Duvall M, Holden JM, USDA National Nutrient Database for Standard Reference, Release 24. Beltsville: U.S. Department of Agriculture, Agricultural Research Service; 2011.
102. Chu YF, Sun J, Wu X, Liu RH. Antioxidant and antiproliferative activities of common vegetables. J Agric Food Chem 2002;50:6910-6.
103. Sun J, Chu YF, Wu X, Liu RH. Antioxidant and antiproliferative activities of common fruits. J Agric Food Chem 2002;50:7449-54.