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## *Cabbage* (*Brassica oleracea var. capitata*)



Napa cabbage. (Image from Kellis/Shutterstock.)

### *Definition*

Brassica leaf vegetable that is eaten fresh, cooked, and fermented as sauerkraut (white or red cabbage) or kimchee (napa cabbage). Both white cabbage, which is pale green, and red cabbage, which is magenta and white, per 1 cup, are good sources of vitamin C (32 mg, 11% DV) and vitamin K (67  $\mu$ g; 55% DV), and supply glucosinolates and antioxidants; additionally red cabbage is a good source of vitamin A (993 IU, 33% DV).<sup>1-3</sup> In traditional medicine, cabbage juice has been used to treat peptic ulcer.<sup>4,5</sup>

### Scientific Findings

**C** In an in vitro gastric model, cabbage juice extract significantly inhibited ulcer formation, stimulated the synthesis of mucus, increased pH, and decreased hydrogen ions.<sup>5</sup> Brassinin in cabbage exerted chemopreventive properties during the initiation and promotion phases of carcinogenesis in a laboratory study.<sup>6</sup> In a case-control study (n=697 newly diagnosed bladder cancer cases compared to n=708 healthy controls matched to cancer cases by age, gender, and ethnicity), median isothiocyanate (ITC) intake from cabbage family vegetables was statistically significantly lower in bladder cancer cases (1.41 ½-cup servings of cabbage family vegetables) than in healthy controls (1.76 ½-cup servings, significant for green and red cabbage coleslaw and sauerkraut).<sup>7</sup> *Brassica oleracea* var. *capitata* extract raised blood glucose levels in diabetic rats.<sup>8</sup> See also: *Brassica Vegetables*.

### Bioactive Dose

Not known.

### Safety

Presumed safe when consumed in normal dietary quantities by nonallergic individuals. See also: *Brassica Vegetables*.

## Caffeine

### Definition

Bitter alkaloid commonly consumed worldwide that is a nervous system stimulant and diuretic found naturally in over 60 different plants including coffee beans, tea, kola nuts (used to flavor cola), and cacao pods (used to make chocolate products).<sup>9</sup> Caffeine is also produced synthetically for use in foods and drugs.<sup>10</sup> The average adult ingests 200 mg daily, but there is no nutritional need for caffeine.<sup>10</sup> The caffeine content in 8 oz of common beverages include: coffee, 95–200 mg; black tea, 40–120 mg; and green tea, 15–60 mg.<sup>11</sup>

### Scientific Findings

Caffeine improves mental alertness, prevents fatigue, and may relieve a simple headache, though caffeine withdrawal can cause headache and fatigue.<sup>12</sup> Caffeine is an ergogenic aid that increases work output; it

increases the catabolism of serum free fatty acids and muscle triglycerides to enhance performance.<sup>13</sup>

### *Bioactive Dose*

Doses of 100–250 mg have been used for mental alertness, and 1.6–10 mg/kg has been used for athletic performance.<sup>14</sup>

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals. Tolerance varies by individual; and adverse effects include blunted appetite, headache, dizziness, nervousness, irritability, and dependence. Tolerance varies by individual, but amounts greater than 250–300 mg per day have been associated with tachyarrhythmias and sleep disturbances. Elevation in blood pressure may occur with acute caffeine consumption: in six studies of hypertensive adults, 200–300 mg of caffeine raised blood pressure by 3 to 12 mmHg in systolic blood pressure and 3 to 4 mmHg in diastolic blood pressure; two other studies reported an unclear effect of habitual consumption of caffeine on blood pressure.<sup>15</sup> Caffeine's effects in the maternal diet can be summarized as follows: caffeine crosses the placenta but is not considered to be a teratogen. Fetal blood and tissue levels are similar to maternal concentrations. The use of caffeine during pregnancy is controversial; however, moderate consumption, less than 200 mg/day, has not been associated with clinically important adverse fetal effects. Quantities over 200 mg/day are associated with a significantly increased risk of miscarriage. Mothers should keep caffeine consumption below 200 mg/day. This is similar to the amount of caffeine in about 2 cups of coffee or tea. Breast milk concentrations of caffeine are thought to be approximately 50% of maternal serum concentrations, and caffeine is excreted slowly by and may accumulate in infants. Caffeine can cause sleep disturbances, irritability, and increased bowel activity in breastfed infants.<sup>14</sup> Large amounts of caffeine may cause or worsen fibrocystic breast disease.<sup>12</sup>

## *Calcium*

### *Definition*

Major mineral found primarily in the skeleton but necessary in the blood and soft tissue for nerve transmission, muscle contraction, blood clotting, blood pressure maintenance, and other physiological processes.<sup>16–18</sup> Good sources, in addition to dairy products, include many dark green



vegetables, such as bok choy and broccoli; tofu made with calcium (Ca) sulfate; canned fish with edible bones; and beverages such as Ca-, vitamin D (D)-fortified orange juice, almond milk, rice milk, and soy milk.

### Scientific Findings

Adequate, lifelong Ca and D are associated with optimal bone development and bone mineral density (BMD); when coupled with physical activity these reduce the risk of osteoporosis in later life.<sup>19</sup> An estimate of average intake of all age groups in the US found calcium intake to be below requirements.<sup>20,21</sup>

Life Stage Group	Calcium Recommended Dietary Allowance (mg/day)
Infants 0 to 6 months	*
Infants 6 to 12 months	*
1 - 3 years old	700
4 - 8 years old	1,000
9 - 13 years old	1,300
14 - 18 years old	1,300
19 - 30 years old	1,000
31 - 50 years old	1,000
51 - 70 years old	1,000
51 - 70 year old females	1,200
71+ years old	1,200
14 - 18 years old, pregnant/lactating	1,300
19 - 50 years old, pregnant/lactating	1,000

Source: <sup>26</sup>

Some clinical trials and observational studies have found that consuming the recommended amount of Ca can modestly reduce blood pressure in people with or without hypertension.<sup>22</sup> Ca may be more effective at lowering blood pressure in salt-sensitive people and those with low baseline dietary Ca intake.<sup>14</sup> Dietary Ca intake of 800 mg or more per day (primarily from dairy products) reduced systolic blood pressure up to 4.0 mmHg and diastolic blood pressure up to 2.0 mmHg in four of six studies of adults with hypertension.<sup>23</sup> Obesity often coexists with low Ca and vitamin D intake; however, evidence from randomized clinical trials does not support that Ca and vitamin D accelerates weight loss or fat loss in obesity.<sup>24</sup> Higher dietary intakes of Ca have been associated with a decreased risk of metabolic syndrome.<sup>25</sup>

### *Bioactive Dose*

The RDA for Ca is 1,000 mg for 19–50-year-old adults.

### *Safety*

The UL for Ca for non-pregnant adults aged 19–50 is 2,500 mg. High Ca intake may interfere with the absorption of minerals, and is associated with hypercalcemia and milk-alkali syndrome.<sup>26</sup> High Ca intake

suppresses vitamin D activity.<sup>27</sup> The high intake of Ca from supplements, but not foods, is associated with the development of kidney stones.<sup>22</sup> Ca from food sources and Ca from dietary supplements each independently increased the risk of total, advanced, and metastatic prostate cancer, especially at intakes exceeding 2,000 mg/d in a prospective examination of Ca effect on prostate cancer risk in The Health Professionals Follow-Up Study (n=47,781 men) that followed subjects free of cancer at baseline in 1986 through 1994.<sup>26</sup>

## Cantaloupe (*Cucumis melo*)

### *Definition*

Orange-fleshed melon that contains vitamin E (0.9 mg, <1% DV) and fiber (1.6 g, 5% DV), and is a good source of vitamin C (65 mg, 72% DV) and an excellent source of vitamin A (5986 IU, 199% DV) per 1 cup.<sup>28</sup> Cantaloupe also supplies carotenoids, phenolics, and terpenoids.<sup>29</sup>

### *Scientific Findings*

In mice, cantaloupe extract reduced diabetes-induced renal oxidative stress, a precursor of diabetic nephropathy.<sup>30</sup> A case-control study (n=438 Chinese women age-matched to n=438 controls) that examined dietary intake and breast cancer risk found consumption of the “watermelon/papaya/cantaloupe” fruit group was significantly inversely associated with breast cancer risk; further, constituents of cantaloupe, including vitamins C and fiber were inversely associated with breast cancer risk.<sup>31</sup>

### *Bioactive Dose*

Not known.

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

## Canthaxanthin

### *Definition*

A type of xanthophyll carotenoid chemically related to the vitamin A precursor beta-carotene<sup>32</sup> and presumed to be an antioxidant. Found naturally in plant and animal foods such as mushrooms<sup>33</sup> and trout<sup>34</sup> and added to foods such as farmed salmon,<sup>35</sup> drugs, and cosmetics as a colorant.<sup>36</sup>

### *Scientific Findings*

Canthaxanthin scavenged free radicals in a laboratory study.<sup>37</sup> A cross-sectional study (n = 235 women) found mean plasma levels of canthaxanthin and other antioxidants were lower in women with cervical cancer and cervical intraepithelial neoplasia.<sup>38</sup>

### *Bioactive Dose*

Not known.

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals. An experimental study found that canthaxanthin may be associated with the formation of undesirable crystals in the macula lutea membranes of the retina,<sup>31</sup> a condition termed canthaxanthin retinopathy, while other carotenoids have not been reported to cause this phenomenon.<sup>27</sup> An Acceptable Daily Intake of 0.00–0.03 mg/kg body weight has been established for canthaxanthin.<sup>39</sup> Canthaxanthin is likely safe when used orally in amounts commonly found naturally in foods, but likely unsafe when used in amounts higher than those commonly found naturally in foods.<sup>14</sup>

## *Caper* (*Capparis spinosa*)



Caper. (Image from Africa Studio/Shutterstock.)

### *Definition*

The unopened flower bud of the *Capparis spinosa* shrub that is pickled and used as a pungent, salty condiment due to its strong flavor. Capers contain

numerous phytochemicals including phenolics, tocopherols, sterols, alkaloids, glucosinolates, and fatty acids.<sup>40</sup> Traditionally used as a diuretic, astringent, and antidiabetic, antihyperlipidemic, and antirheumatic agent.<sup>36</sup>

### *Scientific Findings*

There is inadequate scientific evidence to support caper's traditional uses. Laboratory studies have demonstrated caper's antioxidant and anti-inflammatory effects.<sup>41,42</sup> In an experimental study, caper extract demonstrated potent lipid-lowering properties in diabetic rats.<sup>43</sup>

### *Bioactive Dose*

Not known.

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

*Capsaicin, see: Pepper, Chili*

## *Carambola* (*Averrhoa carambola*)



Carambola. (Image from EM Arts/Shutterstock.)

### *Definition*

Also called star fruit. Yellow, star-shaped fruit of the *Oxalidaceae* family that is popular in Asian cultures and contains 3 g of fiber (10% DV) and 40

mg of vitamin C (44% DV per fruit), making it a good source of fiber and an excellent source of vitamin C,<sup>44</sup> in addition to a source of polyphenolic compounds.<sup>45</sup>

### *Scientific Findings*

Insoluble fibers in star fruit experimentally adsorbed glucose, retarded glucose diffusion, postponed the release of glucose from starch, and inhibited the activity of  $\alpha$ -amylase in vitro, mechanisms that may be hypoglycemic in human beings.<sup>46</sup> *Avverrhoa carambola* inhibited hepatic lipogenesis and prevented hepatic steatosis in laboratory mice.<sup>47</sup>

### *Bioactive Dose*

Not known.

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals. Carambola should not be used by uremic patients because it has been documented to cause neurotoxicity and nephrotoxicity.<sup>48</sup>

## *Caraway* (*Carum carvi*)

### *Definition*

Aromatic herb whose crescent-shaped seed is used to make rye bread and distilled to produce an essential oil that flavors cheese, sausage, and other products. Source of the phytochemicals quercetin and limonene.<sup>53</sup> Caraway oil is used in herbal products formulated for abdominal discomfort and pain. Caraway contains the monoterpene carvone; foods containing carvone have a history of use as carminatives.<sup>53</sup>

### *Scientific Findings*

Caraway essential oils inhibited colon carcinogenesis in rats.<sup>54</sup> Carvone exhibited analgesic and anti-inflammatory properties in a laboratory study.<sup>55</sup>

### *Bioactive Dose*

Not known.

## Safety

Presumed safe when consumed in normal dietary quantities by nonallergic individuals. Pregnant women should avoid the medicinal use of caraway oil because it may stimulate menstruation.<sup>14</sup>

## Carbohydrate

### Definition

Macronutrient comprised of single monosaccharides (the simple sugars) or multiple monosaccharides (complex carbohydrate) that is metabolized aerobically or anaerobically for energy. Simple sugars are found naturally or may be added to fruit, milk, and grains. Complex carbohydrate—fiber and starch—is abundant in fruit, vegetables, grains, and legumes. Carbohydrate is not found in meat/poultry/fish/eggs or fats/oils. Inadequate dietary carbohydrate available for metabolism can cause ketogenesis, a condition that most commonly occurs in Type I diabetics; however, glucose can be synthesized from amino acid and triglyceride through gluconeogenesis.

### Scientific Findings

“Evidence has also shown that replacing saturated fats with carbohydrates reduces blood levels of total and LDL cholesterol but increases blood levels of triglycerides and reduces HDL cholesterol. Replacing total fat or saturated fats with carbohydrates is not associated with reduced risk of CVD. Additional research is needed to determine whether this relationship is consistent across categories of carbohydrates (e.g., whole versus refined grains; intrinsic versus added sugars), as they may have different associations with various health outcomes.”<sup>49</sup>

The OmniHeart Trial found that replacing some of the carbohydrates in the Dietary Approaches to Stop Hypertension (DASH diet) with the same amount of either protein or unsaturated fats lowered blood pressure and LDL cholesterol levels more than the original DASH dietary pattern which is high in complex carbohydrate.<sup>48</sup> A case-control study (n=281 women with an incident of polycystic ovarian syndrome [PCOS] and 472 age-matched controls) showed high dietary glycemic index and glycemic load and low fiber intake are significantly associated with the development of PCOS.<sup>50</sup> See also: *Fiber*.

### Bioactive Dose

Calories from added sugars should not exceed 10%, or approximately 7 teaspoons of added sugars, per day.<sup>48</sup> 130 g or 45–65% of total calories for carbohydrate with no more than 10% of calories per day from added

sugars are Daily Nutritional Goal, Dietary Reference Intake, and AMDR carbohydrate recommendations. *See also: Fiber for separate dietary recommendations specific to fiber.*

### *Safety*

Safe when consumed in normal dietary quantities by nonallergic individuals.

## *Carnitine*

### *Definition*

Also called L-carnitine which is the form found in food, as well as skeletal and cardiac muscle. Dietary sources of carnitine include meats, especially red meats; dairy products; breads; and vegetables.<sup>51</sup> The average adult consumes 60–180 mg of carnitine daily and vegans consume 10–12 mg daily.<sup>50</sup> Healthy people do not need to ingest carnitine because it is nonessential, that is, made in vivo from lysine and methionine via the liver and kidney in quantities that are probably sufficient to meet daily requirements,<sup>52</sup> with the exception of certain preterm infants unable to synthesize sufficient amounts.<sup>51</sup>

### *Scientific Findings*

Carnitine transports long-chain fatty acids into the mitochondria for oxidation and energy production and transports waste compounds out of the mitochondria.<sup>50</sup> Primary carnitine deficiency is a genetic condition that prevents the body from using certain fats for energy, signs, and symptoms of which typically appear during infancy or early childhood and may include encephalopathy, cardiomyopathy, confusion, vomiting, muscle weakness, and hypoglycemia.<sup>50</sup>

### *Bioactive Dose*

Not known.

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

## *Carotenoids*

### *Definition*

Subclass of terpenoids that includes two distinct types of molecules: carotenes and xanthophylls. More than 600 types of naturally occurring

carotenoids have been identified, of which approximately 50 have provitamin A activity.<sup>56</sup> Carotenoid sources include fruits, vegetables, and oils.<sup>57</sup>

### *Scientific Findings*

Numerous observational studies have found that people who ingest more carotenoids in their diets have a reduced risk of several chronic diseases, including cancer, cardiovascular disease, age-related macular degeneration, and cataract.<sup>56</sup> Major public health benefits could be achieved by increasing consumption of carotenoid-rich fruits and vegetables.<sup>56</sup>

### *Safety*

No UL has been established for beta-carotene (or other carotenoids) and no adverse effects except for carotenoderma, the yellow discoloration of the skin, is thought to occur from ingesting excessive amounts of dietary beta-carotene. Carotenoderma is harmless when it occurs due to the intake of food sources of carotenoids.<sup>58</sup> ULs have not been established for carotenoids.

### *Bioactive Dose*

Not known.

## *Carrot (Daucus carota L.)*

### *Definition*

Root vegetable widely recognized for its role in vision because it is a rich source of provitamin A carotenoids. Vitamin A performs functions essential to the eye and visual process (*see also: Vitamin A*). Carrots are a good source of insoluble fiber,<sup>59</sup> and the purple cultivar is rich in anthocyanins.<sup>60</sup> Commonly eaten fresh and as part of processed foods, carrots are among the ten most economically important vegetable crops grown worldwide.<sup>60</sup>

### *Scientific Findings*

*Daucus carota* exhibited anticancer and antioxidant activities in laboratory research, and in an experimental study, its oil suppressed proliferation and induced apoptosis of human colon adenocarcinoma cells.<sup>61</sup> Consumption of carrot juice led to a marked increase in beta-carotene and alpha-carotene in fecal markers which in turn showed high dose-dependent cytotoxic and antiproliferative effects on colon adenocarcinoma cells in a small randomized, crossover-design study (n = 22 healthy young men).<sup>62</sup>

*Bioactive Dose*

Not known.

*Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

*Catechin**Definition*

Polyphenol flavonoids found in black, oolong, and green tea, apples, pears, chocolate, and broad beans.<sup>63</sup> Types of catechins include epicatechin, epicatechin gallate, and epigallocatechin gallate (EGCG).

*Scientific Findings*

A number of human observational studies found that tea catechins were associated with a reduced risk of stroke.<sup>64</sup> A beneficial effect of a high intake of catechins against chronic obstructive pulmonary disease was seen in a large observational trial (n=13,651 adults) in which total catechin intake was positively associated with pulmonary function and inversely associated with a chronic cough.<sup>65</sup> The Netherlands Cohort Study (n=4,280 men and women aged 55–69 years at baseline) assessed the association between Body Mass Index (BMI) and catechins over a 14-year period. Women with the highest intake of total catechins had a significantly lower BMI increase, while no significant change in BMI was observed in men.<sup>63</sup> Catechin intake was inversely associated with ischemic heart disease mortality but not associated with myocardial infarction or stroke incidence in the Zutphen Elderly Study (n=806 men), a prospective cohort study.<sup>66</sup> Catechins exhibited the following properties in laboratory studies: antioxidant, antiproliferative, vascular-protective (antihypertensive, anti-inflammatory, anti-thrombogenic, lipid-lowering), and monoamine oxidase inhibitory.<sup>67–69</sup> A meta-analysis of 11 studies (n=763) found that catechins or an EGCG–caffeine mixture had a small positive effect on weight loss and maintenance, and that effects in Asians vs. Caucasians were more pronounced, and lastly that caffeine > 300 mg/d attenuated these effects.<sup>69</sup>

*Bioactive Dose*

Not known.

### Safety

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

## Cauliflower (*Brassica oleracea*)

### Definition

*Brassica* vegetable consumed raw or cooked that is an excellent source of vitamins C and K<sup>70</sup> and a source of glucosinolates.

### Scientific Findings

In a laboratory study, an antioxidant in cauliflower neutralized free radical activity and inhibited the peroxidation of linolenic acid.<sup>71</sup>

The 6.3-year Netherlands Cohort Study (n = 120,852 men and women aged 55–69 years) examined the consumption of 21 vegetables and nine fruits and urothelial cancer risk and found a statistically significant inverse association between cauliflower and urothelial cancer risk, whereas total vegetable consumption did not appear to be associated with urothelial cancer risk.<sup>72</sup> See also: *Brassica Vegetables*.

### Bioactive Dose

Not known.

### Safety

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

## Celery (*Apium graveolens*)

### Definition

Salad herb and umbelliferous (hollow, umbrella-shaped aromatic) vegetable that is commonly sautéed or added cooked or uncooked for its characteristic flavor and crisp texture. While not an appreciable source of any particular nutrient, a stalk of celery contains about 2 g of fiber, and celery contains important flavonoids, such as the flavonol quercetin and flavones, such as luteolin and apigenin, and celery is considered to be a principal dietary source of flavones in the US diet, along with parsley and peppermint.<sup>73–75</sup> Celery and celery seed have been traditionally used as carminatives. Umbelliferous vegetables are considered to be among the foods and herbs having the highest anticancer activity.<sup>76</sup>

### *Scientific Findings*

Of six case-control studies examining dietary flavonoid intake and cancer risk, total flavonoids and quercetin were associated with a reduced risk of lung cancer in two studies but a nonsignificant increased risk in a third study.<sup>75</sup> “The magnitude of protection ranged from 30% to 42% reduction in risk for persons in the top vs. bottom quantiles of intake.”<sup>75</sup> A carminative dose of celery seed is 1–4 g;<sup>77</sup> however, neither dose nor efficacy has been proven.

### *Bioactive Dose*

Not known.

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals. Celery oil or seeds in amounts larger than are normally consumed in the diet should be avoided during pregnancy because celery may have uterine stimulant or abortifacient effects.<sup>78</sup> Dietary allergy to celery has been reported.<sup>79,80</sup>

## *Chamomile* (*Matricaria recutita* [*German chamomile*], *Chamomilla* *recutita* [*Roman chamomile*])

### *Definition*

Herb that is made into one of the most popular single-ingredient herbal, caffeine-free teas.<sup>81</sup> Chamomile tea is negligible in nutrients but supplies many phytochemicals, including apigenin.<sup>82,83</sup> German chamomile is the most commonly consumed type of chamomile tea in the U.S.<sup>80</sup> Chamomile has been traditionally and is currently used for sleeplessness, anxiety, and gastrointestinal conditions such as upset stomach, gas, and diarrhea, although its efficacy for any of these uses is unknown and studies examining chamomile alone are lacking.<sup>80</sup>

### *Scientific Findings*

A randomized, double-blind, placebo-controlled study (n=57 subjects with anxiety) found significant reductions in total Hamilton Depression Rating scores for chamomile for 8 weeks for all participants vs. placebo.<sup>84</sup> In a laboratory analysis, apigenin was anti-inflammatory, antioxidant, and anticarcinogenic properties.<sup>81</sup>

*Bioactive Dose*

Not known.

*Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals. Allergic reactions and anaphylaxis have been reported in people who have consumed or come into contact with chamomile.<sup>85–90</sup>

*Cheese (see also: Feta Cheese)**Definition*

High-protein, low-carbohydrate dairy food made by converting fluid milk to a semisolid mass, or curd, through the use of a coagulating agent, such as an edible food acid. Cheese is generally high in fat, for example, full-fat feta cheese made from goat's milk is approximately 45% fat.<sup>91</sup> It is a good source of Ca (200 mg, 15% DV per 1–1.5-oz serving), protein, riboflavin, vitamin B12, and potassium,<sup>92</sup> and fermented cheese may or may not contain appreciable lactose and/or probiotics. Cheese is not routinely fortified with vitamin D except for American cheese and a few others that list “vitamin D” in “ingredients.”

*Scientific Findings*

Cheeses such as aged cheddar, Swiss, blue, Monterey Jack, mozzarella, Brie, Gouda, and American processed can help to prevent cavity formation when consumed with cariogenic foods because their nutrient constituents (protein, Ca, and phosphorus) neutralize plaque acids even in the presence of sucrose.<sup>93,94</sup> The cheese-making process changes protein into peptides that possess antioxidant, antimicrobial, anti-inflammatory, immunomodulatory, and analgesic/opioid activity. In addition, these peptides can inhibit angiotensin-converting enzymes and produce functional lipids, such as conjugated linoleic acid that has anti-inflammatory, anticarcinogenic, antimicrobial, hypotensive, diuretic, and vitamin synthetic properties.<sup>95</sup>

*Bioactive Dose*

Not known.

*Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

## *Cherimoya* (*Annona cherimola*)



Cherimoya. (Image from EsHanPhot/Shutterstock.)

### *Definition*

Green-skinned fruit with yellowish, creamy flesh and large, inedible seeds. Grown in the US, but believed to be native to South America,<sup>96</sup> cherimoya has been described as succulent and custard-like with a flavor blending banana, pineapple, papaya, peach, and strawberry. It can be made into juice or used to make fruit salad. Cherimoya has been used in traditional Mexican medicine for its antianxiety, anticonvulsant, and tranquilizing properties.<sup>97</sup>

### *Scientific Findings*

In an animal study, *Annona cherimola* extract administered intraperitoneally significantly decreased plasma total cholesterol, triglycerides, and LDL cholesterol, and increased HDL cholesterol levels.<sup>98</sup> Cherimoya is a source of fiber, magnesium, potassium, cryptoxanthin, lutein, and zeaxanthin.<sup>99</sup>

### *Bioactive Dose*

Not known.

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

## *Cherry, sweet* (*Prunus avium*) and *Cherry, sour or tart* (*Prunus cerasus*)

### *Definition*

Smallest member of the *Rosaceae* stone-fruit family. Fresh, dried, or canned, ½ cup of raw sweet cherries contains vitamin C (5 mg 5.5% DV) and potassium (103 mg 5% DV) in addition to phenolic compounds that contribute to cherries' color, taste, aroma, and flavor,<sup>100–103</sup> and cherries are a natural source of melatonin.

### *Scientific Findings*

In an animal model of arthritis, cherry anthocyanins were anti-inflammatory antioxidants.<sup>104</sup> Cherry phenols demonstrated anti-inflammatory properties in vitro and in vivo.<sup>102</sup> Sweet cherry and sour cherry anthocyanins suppressed cyclooxygenase (COX) enzymes “comparable to ibuprofen and naproxen,” according to researchers, and sweet yellow Rainier cherries were potent against pro-inflammatory COX-1 and -2 enzymes;<sup>102,105</sup> Tart cherries contain high levels of anti-inflammatory substances comparable to a number of nonsteroidal anti-inflammatory products.<sup>106</sup> Tart cherry juice 30 mL standardized to contain 1.42 µg/mL of melatonin twice daily for seven days (n=20 healthy adults) significantly increased melatonin, total sleep time and sleep efficiency compared to placebo, although there was no change in circadian rhythm which would have been a desirable effect.<sup>106</sup> A randomized, placebo-controlled, double-blind, crossover trial (n=43 adults with insomnia) found that 8 oz of tart cherry-apple juice—containing the equivalent of 50 whole tart cherries with approximately 60 mg of anthocyanins and 550 mg of total phenolic compounds—twice daily for 2 weeks modestly improved sleep.<sup>107</sup>

### *Bioactive Dose*

Not known.

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

## *Chia* (*Salvia Hispanica L.*)

### *Definition*

Seed that forms a mucilaginous gel in water.<sup>108</sup> Among its marketed forms, chia fresca refers to chia seeds mixed with a beverage, and chia

seeds also are added to ready-to-eat mixed fruit cups, used to make chia pudding, made into bars, and ready-to-eat chia seeds are sold alongside seeds and nuts. Chia seeds are a source of soluble and insoluble fiber (9.8 g total fiber, 35% DV per 1 oz) and supply linolenic acid. Other chia constituents include approximately 5 g of protein (10% DV) and 15.6 µg of selenium (28% DV) per 1 oz;<sup>109</sup> in addition to quercetin, kaempferol, caffeic acid, and chlorogenic acid.<sup>110</sup> Chia seeds were used as an offering to the Aztec gods<sup>111</sup> and have a history of use as a medicine, though modern health claims that it reduces risks of cardiovascular heart disease, cognitive decline, and cancer<sup>111</sup> have not been proven.

### *Scientific Findings*

A meta-analysis of 14 clinical trials (n=526 healthy subjects) examining chia seed doses ranging from 7 g to >15 g daily found that high doses significantly reduced diastolic (but had no effect on systolic) BP; had modest but not clinically significant effects on postprandial blood glucose and HDL cholesterol (and no effect on total cholesterol, LDL, triglycerides, or VLDL). However, the quality of evidence was low or very low indicating substantial uncertainty about any effects.<sup>111</sup> Using some of the same studies, an earlier meta-analysis of seven clinical trials (six randomized and one nonrandomized n=200), of which five were blinded, found no statistically significant relationship of chia seed consumption on CVD risk factors.<sup>112</sup> An animal study found that chia improved dyslipidemia and insulin resistance in dyslipidemic rats.<sup>113</sup>

### *Bioactive Dose*

Not known.

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

## *Chicory* (*Cichorium intybus*)

### *Definition*

Perennial with a periwinkle blue flower that grows in the wild. The leaves are used raw in salads, the roots are boiled and eaten, and, roasted, ground roots may be used to enhance the richness of coffee.<sup>114</sup> The fructan inulin, a natural, low-calorie sweetener, is sourced from *Cichorium intybus*.

*Scientific Findings*

In laboratory studies, *Cichorium intybus* exhibited antioxidant, antimicrobial, anthelmintic, antidiabetic, hepatoprotective, gastroprotective, analgesic, antiallergic, and tumor-inhibitory activity.<sup>115,116</sup> See also: *Fructan*.

*Bioactive Dose*

Not known.

*Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals. Chicory is possibly unsafe when used orally in excessive amounts because it may induce menstruation or miscarriage.<sup>78</sup> The secondary metabolites in *C. intybus* have shown potential toxicological effects.<sup>113</sup>

*Chive (Allium schoenoprasum)**Definition*

Long green stem of a bulbous allium vegetable whose leaves are used as a culinary herb fresh or dried for eggs, soups, salads, and vegetables.<sup>117</sup> One tablespoon (3 g) of fresh chives provides: 1 calorie; negligible fat, protein, and carbohydrate (less than 1 g of each), vitamins A (131 IU), C (1.7 mg), vitamin K (6.4 µg), folate (3 µg), calcium (3 mg), magnesium (1 mg), phosphorus (2 mg); and potassium (9 mg).<sup>118</sup>

*Scientific Findings*

In a population study (n=238 men with confirmed cases of prostate cancer compared to n=471 male control subjects), intake of allium vegetables, including chives, was inversely associated with the risk of prostate cancer: men in the highest of three intake categories of total allium vegetables (>10.0 g/day [3–4 tablespoons of chives=9.5–10 g]<sup>119</sup>) had a statistically significantly lower risk of prostate cancer than those in the lowest category (<2.2 g/day).<sup>120</sup>

*Bioactive Dose*

Not known.

*Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

## *Chocolate* (*Theobroma cacao*)



Cacao bean. (Image from eversummerphoto/Shutterstock.)

### *Definition*

Confection made from the cacao bean that can be made with or without milk, the latter of which, dark chocolate, is richer in flavonoids. High in fat, 1 oz (28 g) of dark chocolate (45–59% cacao solids) is a source of magnesium (41 mg, 9% DV) and a good source of iron (2.27 mg, 13% DV).<sup>121</sup> Chocolate products and cocoa are “among the most concentrated sources of the procyanidin flavonoids catechin and epicatechin.”<sup>122</sup> Approximately 3.5 oz of dark chocolate (100 g) contains about 50 mg of flavanols and milk chocolate (100 g) contains about 13 mg of flavanols.<sup>123</sup> “Epidemiological studies suggest that cocoa-rich products reduce the risk of cardiovascular disease. Flavanols found in cocoa have been shown to increase the formation of endothelial nitric oxide which promotes vasodilation and therefore blood pressure reduction.”<sup>124</sup>

### *Scientific Findings*

Intake of flavonoid-rich foods and risk for cardiovascular disease are inversely related, due possibly to flavonoid-induced changes in oxidant defense, vascular reactivity, and platelet reactivity.<sup>122</sup> Meta-analyses of hypertensive adults have reported that average daily flavanol intake ranging from 30 mg to 1000 mg reduced systolic and diastolic blood pressure and found dark chocolate superior to placebo in reducing systolic hypertension and diastolic prehypertension.<sup>125</sup> A meta-analysis of 35 clinical trials in healthy adults ( $n=1,804$ ) found a small but statistically significant blood pressure-reducing effect of flavanol-rich cocoa products compared with controls in trials of 2–18 weeks’ duration. This study concluded that

systolic blood pressure was reduced by 4 mmHg, a significant reduction, in hypertensive subjects, and a lower effect was seen in prehypertensive subjects, while there was no significant difference in normotensive subjects.<sup>124</sup>

### *Bioactive Dose*

Blood-pressure-lowering effects resulted from consuming 30–1,218 mg of flavanols/d (mean=670 mg of flavanols) found in 1/3 oz to 3.6 oz of dark chocolate.<sup>124,125</sup>

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

## *Choline*

### *Definition*

Vitamin that serves as a precursor for the neurotransmitter acetylcholine, a methyl donor that is used for phospholipid synthesis, and is necessary to convert homocysteine to methionine.<sup>126,127</sup> Betaine is its metabolite. The average adult consumes 730–1,040 mg of choline a day in food sources such as milk, liver, eggs, peanuts, milk, and orange juice.<sup>126,127</sup>

### *Scientific Findings*

Preconception dietary intakes of choline between 350 and 544 mg or more were associated with reduced risk of neural tube defects in an epidemiological study (n=424 mothers of children with neural tube defects and n=440 mothers of healthy children).<sup>127</sup> Neural tube defect risk estimates were lowest for women whose diet 3 months prior to conception were rich in choline.<sup>127</sup>

### *Bioactive Dose*

The AI for adults aged 19–50 years old is 425–550 mg; for pregnant women, it is 450 mg per day.

### *Safety*

A UL of 3.5 g of choline has been established for adults.

## *Chromium*

### *Definition*

Ultra-trace mineral necessary for insulin action that is referred to as the glucose tolerance factor.<sup>57,128</sup> Chromium is widespread in plant and animal foods in minuscule amounts, and eating a variety of whole grains, fruits, vegetables, meats, and milk products is recommended to obtain adequate amounts. Broccoli contains 11 µg per ½ cup; grape juice supplies 8 µg per 1 cup; dried basil supplies 2 µg per tablespoon; and green beans supply 1 µg per ½ cup.<sup>128</sup>

### *Scientific Findings*

Chromium may improve insulin sensitivity, which can modify the risk of diabetes and cardiovascular disease (CVD).<sup>129</sup> Diabetic men with CVD had lower toenail chromium than healthy control subjects in a cross-sectional analysis comparing men with diabetes only (n = 688), diabetes with prevalent CVD (n = 198), and healthy control subjects (n = 361).<sup>129</sup>

### *Bioactive Dose*

The AI for chromium is 25–35 µg for adults aged 19–50.

### *Safety*

No UL has been established for chromium because few adverse events have been reported for excess intake of chromium from food.

## *Cilantro* (*Coriandrum sativum*)

### *Definition*

Herb grown from coriander seeds. Cilantro leaves and stems are chopped and used in Latin, Thai, and other cuisines, for example, freshly chopped or torn and used as the aromatic green herb in salsa, pico de gallo, and the fried noodle and vegetable dish pad Thai. Though normally consumed in insignificant quantities to be an appreciable source of nutrients, cilantro contains vitamins A and K, and contains numerous phytochemicals including caffeic acid, chlorogenic acid, quercetin, and limonene.<sup>130,131</sup> Coriander has been used in traditional medicine to treat cystitis.<sup>132</sup>

*Scientific Findings*

Laboratory studies have shown coriander essential oils to have antioxidant and hepatoprotective properties.<sup>133</sup> Coriander extract exerted anti-anxiety activity in a laboratory study.<sup>134</sup>

*Bioactive Dose*

Not known.

*Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

*Cinnamon* (Cinnamomum cassia)*Definition*

A spice sourced from the bark of a tree native to Asia that is used as a flavored stick or as a finely ground powder to flavor fruit or savory dishes. Contains the phytochemical cinnamaldehyde.<sup>135</sup> Cinnamon is rich brown in color and has a delicately fragrant aroma and warm, sweet flavor. Cinnamon was once more valuable than gold.<sup>136</sup>

*Scientific Findings*

In animal models, cinnamon exhibited hypoglycemic, antimicrobial, antifungal, antiviral, antioxidant, antitumor, blood pressure-lowering, cholesterol-lowering, lipid-lowering, gastroprotective, and anticholinesterase properties.<sup>137,138</sup> According to a meta-analysis of ten randomized, controlled trials (n=543 patients with Type II diabetes), the consumption of cinnamon was associated with a statistically significant decrease in fasting plasma glucose, total cholesterol, LDL cholesterol, and triglyceride levels, and an increase in HDL cholesterol but no significant effect on hemoglobin A1C.<sup>139</sup>

*Bioactive Dose*

Cinnamon doses of 120 mg/d (approximately ½ teaspoon) to 6 g/d (2 ½ teaspoons)<sup>140</sup> for 4–18 weeks reduced levels of fasting plasma glucose, total cholesterol, LDL cholesterol, and triglycerides; and increased levels of HDL cholesterol in Type II diabetics in a meta-analysis of 15 randomized, controlled clinical trials.<sup>139</sup>

## Safety

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

## Citrus

### Definition

Juicy, segmented fruits of the genus *Citrus* that are vitamin C- and folate-rich and among the best sources of flavonoids, such as naringenin, hesperidin, nobiletin, and tangeretin, in addition to others. The skin, peel, and rinds of citrus fruits are rich in essential oils and contain more phytochemical compounds on a per gram basis than the edible interior flesh.<sup>141</sup> Otherwise inedible fruit peels are consumed, for example, when lemon peel is scraped and added to recipes as lemon “zest”; a small piece of lime is twisted to expel its juice and the peel is added to a beverage (lime “twist”); or sour orange rind is consumed in marmalade. Citrus rinds contain a variety of phytochemicals including carotenoids, flavanone glycosides, and flavonoids.<sup>142</sup>

### Scientific Findings

Epidemiological data suggest that frequent consumption of citrus fruits is associated with reduced risk of CVD, cerebral infarction, and ischemic stroke.<sup>143</sup> A systematic review of 22 observational and preclinical studies from 1970 through 2017, examining the effect of citrus juices on cancer risk reduction, concluded that the evidence strongly corroborates the role of citrus juices and their derivatives as a potential resource against cancer.<sup>144</sup> Epidemiological, experimental, and limited clinical studies suggest constituents in citrus foods, including flavonoids such as hesperidin, naringenin, nobiletin, and the terpenoid carvone, exert antimicrobial; lipid-lowering; insulin-sensitizing; antihypertensive; anti-inflammatory; antinociceptive; cardioprotective, and vascular-protective effects.<sup>55,145–151</sup> Tangeretin, a flavone found in citrus peel,<sup>152</sup> has been shown to have antiatherogenic and anti-inflammatory properties.<sup>153</sup> A review of ten clinical trials examining the effect of citrus juice on markers of blood lipids found weak, but positive, evidence in five of the studies that one or more blood lipids may be positively influenced by consumption of 100% citrus fruit juice.<sup>154</sup> In one study, 750 mL of orange juice daily, for 4 weeks, increased HDL cholesterol by 21% and decreased the LDL-to-HDL cholesterol ratio by 16% in hypercholesterolemic patients (n = 16 healthy men and 9 healthy women with elevated plasma total and LDL cholesterol and normal plasma triglycerides); however, it raised triglycerides by 30%.<sup>155</sup> A dosage of 200 mL of orange juice three times daily (600 mL/d) compared

to placebo for 4 weeks reduced endothelial dysfunction in male subjects with two CVD risk factors (n=25 and high LDL).<sup>156</sup> Women consuming  $\geq 1$  serving of citrus fruits a day had a 22% lower endometriosis risk in a large (n=70,835 premenopausal Nurses' Health Study II cohort female subjects) observational study.<sup>157</sup>

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals. Consuming citrus or coming into physical contact with citrus peel has resulted in allergic reactions. Citrus flavonoids have low or no cytotoxicity to healthy, normal cells.<sup>158</sup>

## *Clove* (*Eugenia caryophyllata*)

### *Definition*

Spice sourced from an evergreen tree commonly used in fruit-based dishes, such as pumpkin pie and mulled wine (wine to which mulling spices, such as cinnamon and cloves have been added). Clove oil, which contains eugenol, is most popularly known as being a toothache remedy topically; however, according to FDA, efficacy is lacking for this use. In addition to eugenol, other phytochemical components in clove include phenolics.<sup>159</sup>

### *Scientific Findings*

Clove was shown to have anti-inflammatory effects in a laboratory study.<sup>160</sup> Clove is not effective for vomiting, upset stomach, nausea, gas, or diarrhea.<sup>161</sup>

### *Bioactive Dose*

Not established.

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals. Ingesting clove oil has been linked to reports of coagulopathy, liver damage, and other serious side effects in infants and children.<sup>55</sup>

## *Coconut* (*Cocos nucifera*)

### *Definition*

Large *Areaceae* family nut used in shredded form in baked products. The flesh of coconuts is a source of potassium and saturated fat,<sup>162</sup> in addition

**Table C.1** Nutrient Comparisons in Milk vs. Coconut Milk

Nutrient	Fortified 1% milk per 8 oz	Coconut milk per 8 oz
Ca, mg	300	451
Vitamin D, IU	120	101
Vitamin D, µg	3.0	2.5

Sources: <sup>188,209,210</sup>

to flavonoids and saponin. Coconut water contains potassium (400 mg, 8% DV per 1 cup). Coconut milk is an emulsion of grated coconut meat<sup>14</sup> and is used as a cooking ingredient; when it is prepared as a milk-alternative beverage, coconut milk is fortified with Ca and vitamins A, D, and B12, similar to fortified milk (Table C.1).

Coconut products include coconut water, oil, flour, shavings, and coconuts and its derivatives are added to snack foods and baby food.<sup>163</sup> Coconut has been used in traditional medicine for the treatment of metabolic disorders and as an anti-inflammatory, antimicrobial, and analgesic.<sup>164</sup>

### *Scientific Findings*

The saturated medium-chain triglycerides in coconut oil increase total serum cholesterol but affect HDL cholesterol levels favorably, and are easier to digest and absorb than long-chain triglycerides, and are therefore used during fat malabsorption.<sup>165</sup> Diets rich in coconut oils have been shown to reduce coronary artery disease risk factors, such as tissue plasminogen activator antigen and lipoprotein(a),<sup>155</sup> however, current recommendations are to limit saturated fats, including coconut oil to no more than 7% of calories.<sup>166</sup> Lauric acid, the most abundant fatty acid in coconut oil, is effective in preventing tooth decay and plaque buildup.<sup>155</sup> Saponin and polyphenols in coconut were attributed with anti-inflammatory and antinociceptive properties in an animal study.<sup>167</sup>

### *Bioactive Dose*

Not known.

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

## Coenzyme Q<sub>10</sub>

### Definition

**C** Also called CoQ<sub>10</sub>. A fat-soluble antioxidant synthesized in the body<sup>168</sup> that occurs in virtually all cells—it is ubiquitous—hence it is also known as “ubiquinone.” A participant in ATP generation in aerobic metabolism that is essential for electron and proton transport in the mitochondrial respiratory chain.<sup>169</sup> It is present in the highest quantities in the heart, liver, kidney, and pancreas.<sup>78</sup> Rich dietary sources include meat, fish, nuts, and certain oils, while dairy products, vegetables, fruits, and cereals provide smaller amounts.<sup>170</sup> The average daily intake of CoQ<sub>10</sub> from foods has been estimated in the European diet to be approximately is 3–6 mg.<sup>171</sup> “In humans, normal blood levels of coenzyme Q<sub>10</sub> have been defined variably, with reported normal values ranging from 0.30 to 3.84 µg/mL.”<sup>158</sup>

### Scientific Findings

Endogenous coenzyme Q<sub>10</sub> production decreases with age.<sup>172</sup> Secondary deficiency may be linked to the use of statins to treat hyperlipidemia.<sup>173</sup> Coenzyme Q<sub>10</sub> deficiency is thought to be a rare condition, the symptoms of which include weakness, fatigue, and seizures.<sup>174</sup> Low blood levels of ubiquinone have been found in cancer patients with myeloma, lymphoma, and cancers of the breast, lung, prostate, pancreas, colon, kidney, and head and neck.<sup>175</sup> “CoQ<sub>10</sub> has also been studied for a variety of other conditions, including amyotrophic lateral sclerosis (Lou Gehrig’s disease), Down syndrome, Huntington’s disease ... male infertility,” migraine headache, and CVD, but the research is too limited for any conclusions to be drawn.<sup>176,177</sup>

### Bioactive Dose

Not known.

### Safety

Presumed safe when consumed in normal dietary amounts by nonallergic individuals.

## Coffee (*Coffea arabica*)

### Definition

Seed that is roasted to make one of the most consumed beverages in the world. Its caffeine constituent prevents fatigue and improves mental alertness, varying in content per 1 cup (8 oz) between 75–150 mg with darker roasts providing less caffeine than light roasts.

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**Caffeine Content of Coffee**

Percolated (including K-cup®), light and dark roasts	75–150 mg
Instant coffee	85–100 mg
Decaffeinated coffee	8 mg

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Sources: <sup>14,178</sup>

The average adult ingests 200 mg of caffeine per day.<sup>179</sup> Coffee is a source of phytochemicals including polyphenols such as chlorogenic acid.<sup>180</sup>

### *Scientific Findings*

Coffee consumption has been inversely associated with the prevalence of Type II diabetes mellitus in observational studies.<sup>181,182</sup> Coffee consumption may also be protective against the development of gallstones.<sup>183</sup> Epidemiological evidence suggests that drinking more than 3 cups of coffee daily may significantly reduce the risk of rectal cancer.<sup>14</sup> In experimental research, chlorogenic acid protected cells from oxidative damage, induced growth of beneficial microorganisms in colon cancer cells, and exerted preventative effects against cardiovascular disease and Type II diabetes.<sup>180,184</sup>

### *Bioactive Dose*

The typical dose of caffeine for headache relief or restoring mental alertness is up to 250 mg per day or up to about 2 cups of coffee.<sup>168</sup>

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals. Coffee consumption has been associated with hyperhomocysteinemia in some observational studies, but not in others.<sup>185</sup> See also: *Caffeine*.

## *Copper*

### *Definition*

Trace mineral found in shellfish, nuts, beans, organ meats, and whole grains that functions as a component of a number of metalloenzymes and that is involved in red blood cell formation, immunity, and in maintenance of blood vessels, nerves, and bones.<sup>57</sup> The median dietary intake

of copper by US women is 1.0–1.1 mg/day (1000–1100 µg), men consume 1.2–1.6 mg/day (1200–1600 µg).<sup>179</sup>

### *Scientific Findings*

One measure of copper deficiency is serum copper.<sup>57</sup> Copper deficiency, although rare, causes normocytic, hypochromic anemia, leukopenia, and neutropenia.<sup>176</sup> Copper is an antimicrobial agent.<sup>186</sup>

### *Bioactive Dose*

The RDA for adults aged 19–50 years old is 1,000 µg.

### *Safety*

A UL of 10,000 µg has been established.

## Corn (*Zea mays*)

### *Definition*

*Poaceae* family fruit that is sometimes eaten as a starchy vegetable (e.g., corn on the cob) and other times as a grain (e.g., popcorn).<sup>187</sup> Corn is a source of fiber (1.8 g, 5% DV per 1 cob)<sup>188</sup> and phytochemicals such as lutein, zeaxanthin, and ferulic acid.<sup>204</sup> It is notably deficient in the amino acids lysine and tryptophan, the latter of which is converted into niacin. In the pellagra epidemic of the 1800s in the Southern US, consumers who ate a corn-based diet with little variety developed pellagra due to deficiency of niacin or its precursor tryptophan, both of which were absent in corn. Eaten cooked, canned, frozen, and used to make oil, flour, starch, and other food products, such as high-fructose corn syrup. Traditional medicinal uses of *Zea mays* include use as a diuretic and for treating dropsy (edema), hypertension, hemorrhage, warts, and diabetes.<sup>179</sup>

### *Scientific Findings*

*Zea mays* exhibited antioxidant properties and slowed glucose absorption in a laboratory study.<sup>190</sup> Its glycemic index, a measure of how quickly the carbohydrate in a food is digested and absorbed, is “low” (52) on a scale where <55 is low and >70 is high.<sup>191</sup>

### *Bioactive Dose*

Not known.

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

## *Cranberry* (*Vaccinium macrocarpon*)

### *Definition*

Bitter fruit of an evergreen shrub that is consumed as a fruit or juice cocktail, dried, and fresh or canned as cranberry sauce. Cranberry is a source of choline, vitamins C, A, and K,<sup>194</sup> and proanthocyanidins.

### *Scientific Findings*

Daily doses of 120–4,000 mL/day of cranberry juice or 400 mg of cranberry extract have been used to help prevent urinary tract infections (UTIs)<sup>77</sup> based on the results of small studies that postulated cranberry prevents bacteria from sticking to the cells that line the bladder.<sup>195</sup> A review including 24 studies (n=4,473 subjects) concluded that cranberry juice cannot currently be recommended for the prevention of UTIs, and that although some small studies demonstrated a small benefit for women with recurrent UTIs, there were no statistically significant differences when the results of a much larger study were included.<sup>196</sup> Nonetheless, certain practice guidelines currently recommend consumption of pure cranberrylingonberry juice as an option for preventing recurrent UTI.<sup>197</sup>

### *Bioactive Dose*

Not known.

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

## *Cucumber* (*Cucumis sativus*)

### *Definition*

Low-calorie gourd vegetable that is high in water similar to watermelon and cantaloupe members of the *Cucumis* genus.<sup>198</sup> Cucumbers contain vitamin K (8.5 µg, 6% DV per ½ cup) and are so low in calories (8 calories per ½ cup)<sup>199</sup> that they are considered to be calorie-free for purposes of weight and diabetes management. A common salad vegetable and staple

food of the Greek and Middle Eastern diets, the cucumber is thought to be native to India, where it has been cultivated for more than 3,000 years.<sup>198</sup> Cucumber has a history of use in ancient medicine for cooling, diuresis, and as an antihelminthic.<sup>200,201</sup>

### *Scientific Findings*

Cucurbitacins<sup>200</sup> demonstrated anticancer properties in colon, breast, lung, and central nervous system cancer cell lines, and inhibited the COX-2 enzyme and lipid peroxidation.<sup>202</sup>

### *Bioactive Dose*

Not known.

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals.

## *Cumin* (*Cuminum cyminum*)

### *Definition*

Ground seed that supplies the characteristic aromatic and earthy flavor of taco seasoning. Because it is usually consumed in minuscule amounts, cumin's nutrient content is negligible but includes antioxidant vitamins.<sup>203</sup> Cumin is used in traditional Indian medicine for the treatment and management of sleep disorders, indigestion, and hypertension.<sup>204</sup> Cumin complements the flavor of chili peppers, cilantro, cinnamon, coriander seed, garlic, mint, orange, parsley, saffron, and scallion.<sup>205</sup>

### *Scientific Findings*

*Cuminum cyminum* in animal models exerted antihypertensive,<sup>204</sup> antihyperglycemic,<sup>206</sup> and anticarcinogenic effects.<sup>207</sup>

### *Bioactive Dose*

Not known.

### *Safety*

Presumed safe when consumed in normal dietary quantities by nonallergic individuals. Safrole, a natural mutagenic compound that is degraded by cooking, is a constituent of cumin.<sup>208</sup>

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