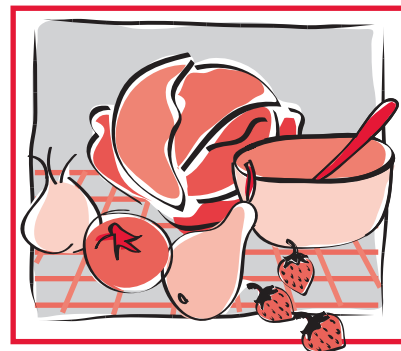


Water-Soluble Vitamins

Fact Sheet No. 9.312

Food and Nutrition Series | Health



by J. Anderson and L. Young*

Vitamins are essential nutrients found in foods. The requirements are small but they perform specific and vital functions essential for maintaining health.

The two types of vitamins are classified by the materials in which they will dissolve. Fat-soluble vitamins – vitamins A, D, E and K – dissolve in fat before they are absorbed in the blood stream to carry out their functions. Excesses of these vitamins are stored in the liver. Because they are stored, they are not needed every day in the diet.

By contrast, water-soluble vitamins dissolve in water and are not stored; they are eliminated in urine. We need a continuous supply of them in our diets. The water-soluble vitamins are the B-complex group and vitamin C.

Water-soluble vitamins are easily destroyed or washed out during food storage or preparation. Proper storage and preparation of food can minimize vitamin loss. To reduce vitamin loss, refrigerate fresh produce, keep milk and grains away from strong light, and use the cooking water from vegetables to prepare soups. (See Table 1.)

Vitamin B-Complex

Eight of the water-soluble vitamins are known as the B-complex group: thiamin (vitamin B₁), riboflavin (vitamin B₂), niacin, vitamin B₆, folate, vitamin B₁₂, biotin and pantothenic acid. These vitamins are widely distributed in foods. (See Table 2.) Their influence is felt in many parts of the body. They function as coenzymes that help the body obtain energy from food. They also are important for normal appetite, good vision, healthy skin, healthy nervous system and red blood cell formation.

Beriberi, pellagra and pernicious anemia are three well-known B-vitamin deficiencies. These diseases are not a problem in the Uni-

ted States, but occasionally they occur when people omit certain foods or overeat certain foods at the expense of others. Alcoholics are especially prone to thiamin deficiency because alcohol replaces food. Vegans will need a B₁₂ supplement.

When grains and grain products are refined, essential nutrients lost during processing are put back into these foods through a process called enrichment. Among the nutrients added during the enrichment process are thiamin, niacin, riboflavin, folate and iron. Some examples of enriched grain products are white rice, many breakfast cereals, white flour, breads and pasta.

For some populations, rice is the main dietary staple. When “polishing” rice (removing its outer layers) became popular, thiamin deficiency, or beriberi, increased significantly.

In the early 1900s, the most widespread vitamin deficiency disease in the United States was pellagra, or niacin deficiency. At that time, pellagra caused thousands of deaths and many cases of mental and physical illness among the poor in the Southeast. The enrichment of flour, rice and wheat products helped to eliminate the deficiency problems found in people who depended on these food items for most of their daily calories.

Table 3 summarizes the new standards for nutrient recommendations: The Dietary Reference Intake (DRI). The recommendations meet the average daily nutritional needs of all healthy people. To ensure the needs of all in the population, the DRI usually exceeds the requirements for most people. They do not cover requirements for illness and special health disorders.

Vitamin C

Why do we need vitamin C? Like the other vitamins, the body needs vitamin C to keep it in good working order. Also known as ascorbic acid, vitamin C helps hold body cells together, aids in wound healing, assists

Quick Facts

- B-complex vitamins and vitamin C are water-soluble vitamins that are not stored in the body and must be replaced each day.
- These vitamins are easily destroyed or washed out during food storage and preparation.
- The B-complex group is found in a variety of foods: cereal grains, meat, poultry, eggs, fish, milk, legumes and fresh vegetables.
- Citrus fruits are good sources of vitamin C.
- Use of megadoses of vitamins is not recommended.

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Table 1. Water-soluble vitamins and their characteristics.

Common food sources	Major functions	Deficiency symptoms	Overconsumption symptoms	Stability in foods
Vitamin C (ascorbic acid)				
Citrus fruits, broccoli, strawberries, melon, green pepper, tomatoes, dark green vegetables, potatoes.	Formation of collagen (a component of tissues), helps hold them together; wound healing; maintaining blood vessels, bones, teeth; absorption of iron, calcium, folacin; production of brain hormones, immune factors; antioxidant.	Bleeding gums; wounds don't heal; bruise easily; dry, rough skin; scurvy; sore joints and bones; increased infections.	Nontoxic under normal conditions; rebound scurvy when high doses discontinued; diarrhea, bloating, cramps; increased incidence of kidney stones.	Most unstable under heat, drying, storage; very soluble in water, leaches out of some vegetables during cooking; alkalinity (baking soda) destroys Vitamin C.
Thiamin (vitamin B₁)				
Pork, liver, whole grains, enriched grain products, peas, meat, destroyed legumes.	Helps release energy from foods; promotes normal appetite; important in function of nervous system.	Mental confusion; muscle weakness, wasting; edema; impaired growth; beriberi.	None known.	Losses depend on cooking method, length, alkalinity of cooking medium; by sulfite used to treat dried fruits such as apricots; dissolves in cooking water.
Riboflavin (vitamin B₂)				
Liver, milk, dark green vegetables, whole and enriched grain products, eggs.	Helps release energy from foods; promotes good vision, healthy skin.	Cracks at corners of mouth; dermatitis around nose and lips; eyes sensitive to light.	None known.	Sensitive to light; unstable in alkaline solutions.
Niacin (nicotinamide, nicotinic acid)				
Liver, fish, poultry, meat, peanuts, whole and enriched grain products.	Energy production from foods; aids digestion, promotes normal appetite; promotes healthy skin, nerves.	Skin disorders; diarrhea; weakness; mental confusion; irritability.	Abnormal liver function; cramps, nausea; irritability.	
Vitamin B₆ (pyridoxine, pyridoxal, pyridoxamine)				
Pork, meats, whole grains and cereals, legumes, green leafy vegetables.	Aids in protein metabolism, absorption; aids in red blood cell formation; helps body use fats.	Skin disorders, dermatitis, cracks at corners of mouth; irritability; anemia; kidney stones; nausea; smooth tongue.	None known.	Considerable losses during cooking.
Folacin (folic acid)				
Liver, kidney, dark green leafy vegetables, meats, fish, whole grains, fortified grains and cereals, legumes, citrus fruits.	Aids in protein metabolism; promotes red blood cell formation; prevents birth defects of spine, brain; lowers homocystein levels and thus coronary heart disease risk.	Anemia; smooth tongue; diarrhea.	May mask vitamin B ₁₂ deficiency (pernicious anemia).	Easily destroyed by storing, cooking and other processing.
Vitamin B₁₂				
Found only in animal foods: meats, liver, kidney, fish, eggs, milk and milk products, oysters, shellfish.	Aids in building of genetic material; aids in development of normal red blood cells; maintenance of nervous system.	Pernicious anemia, anemia; neurological disorders; degeneration of peripheral nerves that may cause numbness, tingling in fingers and toes.	None known.	
Pantothenic acid				
Liver, kidney, meats, egg yolk, whole grains, legumes; also made by intestinal bacteria.	Involved in energy production; aids in formation of hormones.	Uncommon due to availability in most foods; fatigue; nausea, abdominal cramps; difficulty sleeping.	None known.	About half of pantothenic acid is lost in the milling of grains and heavily refined foods.
Biotin				
Liver, kidney, egg yolk, milk, most fresh vegetables, also made by intestinal bacteria.	Helps release energy from carbohydrates; aids in fat synthesis.	Uncommon under normal circumstances; fatigue; loss of appetite, nausea, vomiting; depression; muscle pains; anemia.	None known.	

Table 2. Major food sources of water-soluble vitamins.

	Grains	Fruits	Vegetables	Meats, Eggs	Legumes, Nuts, Seeds	Milk, Dairy
Thiamin	X			X	X	
Riboflavin	X					X
Niacin	X			X	X	
Biotin			X	X	X	
Pyridoxine	X			X		X
Pantothenic acid	X	X	X	X	X	X
Vitamin B ₁₂				X		X
Folate	X		X			
Vitamin C		X	X			

Table 3. Dietary reference intakes (DRI). Selected recommended levels for individual intakes.

Nutrient	RDA or A ¹ (ages 19-50 yrs)	
	Male	Female
Thiamin (mg)	1.2	1.1
Riboflavin (mg)	1.3	1.1
Niacin (mg)	16	14
Vitamin B ₆ (mg)	1.3	1.3
Folate (mcg)	400	400
Vitamin B ₁₂ (mcg)	2.4*	2.4*
Pantothenic acid (mg)	5*	5*
Biotin (mcg)	30*	30*
Vitamin C (mg)	90	75

(mg = milligrams, (mcg = micrograms)

¹RDA and Adequate Intake (AI) values from the 1997/1998 DRI reports.

* AI value.

in bone and tooth formation, strengthens the blood vessel walls, is vital for the function of the immune system, and improves absorption and utilization of iron. It also helps prevent nutritional ailments such as scurvy, the disease that did the most to bring public attention to vitamin deficiency diseases.

Our bodies cannot make vitamin C. Therefore, every day we must eat foods containing this vitamin. Although the body has a constant need for vitamin C, it has a limited storage capacity. A regular and adequate intake is essential.

Eating vitamin C-rich foods is the best method to ensure an adequate intake of this vitamin. While many common foods contain vitamin C, the best food sources are citrus fruits. One orange, a kiwi fruit, 6 oz. of grapefruit juice or 1/3 cup of chopped sweet red pepper each supply enough vitamin C for one day.

Some conditions have been shown to increase vitamin C requirements. They are:

- environmental stress,
- use of certain drugs (such as oral contraceptives),
- tissue healing of wounds,
- growth (children and pregnant women),
- fever and infection, and
- smoking.

The controversy over megadoses of vitamin C to prevent or cure the common cold and other disorders has not been resolved. Vitamin supplements will not necessarily provide extra energy, clear up skin problems, or prevent and cure the common cold, heart disease, and cancer. Unlike pellagra, beriberi, or scurvy, these problems are not the result of a vitamin deficiency. What is known is that the only disease a vitamin will cure is the one caused by a deficiency of that vitamin.

Vitamin C also serves as an antioxidant. It works with vitamin E as a free-radical scavenger. Studies suggest that vitamin C may reduce the risk of certain cancers, heart disease, and cataracts. Research continues to document the degree of these effects.

Definitions

Dietary Reference Intake (DRI):

The new standards for nutrient recommendations that can be used to plan and assess diets for healthy people. Think of Dietary Reference Intakes as the umbrella term that includes the following values.

Estimated Average Requirement (EAR): A nutrient intake value that is estimated to meet the requirement of half the healthy individuals in the group. It is used to assess nutritional adequacy of intakes of population groups. In addition, EARs are used to calculate RDAs.

Recommended Dietary Allowance (RDA): This value is a goal for individuals and is based on the EAR. It is the daily dietary intake level that is sufficient to meet the nutrient requirement of 97 to 98 percent of all healthy individuals in a group. If an EAR cannot be set, no RDA value can be proposed.

Adequate Intake (AI): This is used when an RDA cannot be determined. A recommended daily intake level based on an observed or experimentally determined approximation of nutrient intake for a group (or groups) of healthy people.

Tolerable Upper Intake Level (UL):

The highest level of daily nutrient intake that is likely to pose no risks of adverse health effects to almost all individuals in the general population. As intake increases above the UL, the risk of adverse effects increases.

Source: *Food Insight*, September/October 1998.

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