

Dietary supplement

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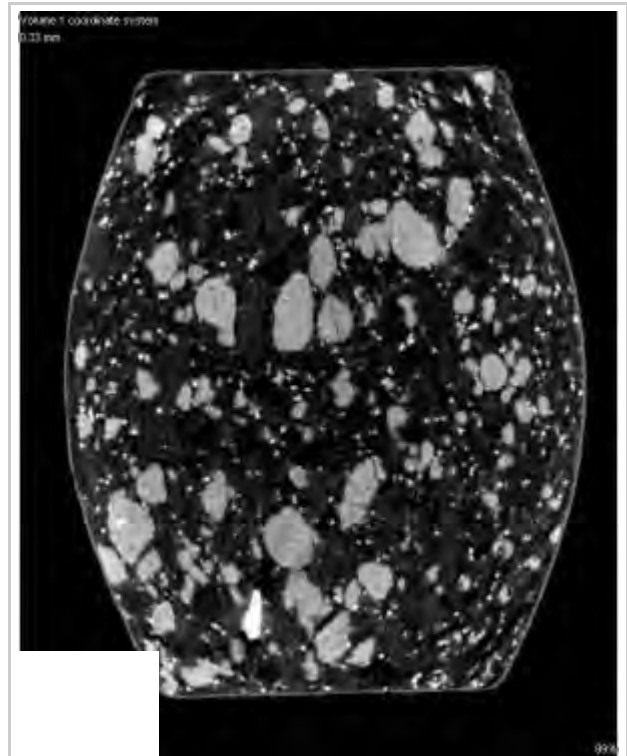
A **dietary supplement** is intended to provide nutrients that may otherwise not be consumed in sufficient quantities.

Supplements as generally understood include vitamins, minerals, fiber, fatty acids, or amino acids, among other substances. U.S. authorities define dietary supplements as foods, while elsewhere they may be classified as drugs or other products.

There are more than 50,000 dietary supplements available. More than half of the U.S. adult population (53% – 55%) consume dietary supplements with most common ones being multivitamins.^{[1][2]}

These products are not intended to prevent or treat any disease and in some circumstances are dangerous, according to the U.S. National Institutes of Health. For those who fail to consume a balanced diet, the agency says that certain supplements "may have value."^[3]

Most supplements should be avoided, and usually people should not eat micronutrients except people with clearly shown deficiency.^[4] Those people should first consult a doctor.^[5] An exception is vitamin D, which is recommended in Nordic countries^[6] due to weak sunlight.



Flight through a CT image stack of a multivitamin tablet "A-Z" by German company Abtei

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Definition

According to the United States Food and Drug Administration (FDA), dietary supplements are products which are not pharmaceutical drugs, food additives like spices or preservatives, or conventional food, and which also meet any of these criteria:^[7]

1. The product is intended to supplement a person's diet, despite it not being usable as a meal replacement.^[7]
2. The product is or contains a vitamin, dietary element, herb used for herbalism or botanical used as a medicinal plant, amino acid, any substance which contributes to other food eaten, or any concentrate, metabolite, ingredient, extract, or combination of these things.^[7]
3. The product is labeled as a dietary supplement.^[7]

In the United States, the FDA has different monitoring procedures for substances depending on whether they are presented as drugs, food additives, food, or dietary supplements.^[7] Dietary supplements are eaten or taken by mouth, and are regulated in United States law as a type of food rather than a type of drug.^[8] Like food and unlike drugs, no government approval is required to make or sell dietary supplements; the manufacturer checks the safety of dietary supplements but the government does not; and rather than requiring risk–benefit analysis to prove that the product can be sold like a drug, risk–benefit analysis is only used to petition that food or a dietary supplement is unsafe and should be removed from market.^[7]

Medical uses

The intended use of dietary supplements is to ensure that a person gets enough essential nutrients.^[9]

Dietary supplements should not be used to treat any disease or as preventive healthcare.^[10] An exception to this recommendation is the appropriate use of vitamins.^[10]

Supplements may create harm in several ways, including over-consumption, particularly of minerals and fat-soluble vitamins which can build up in the body.^[11] The products may also cause harm related to their rapid absorption in a short period of time, quality issues such as contamination, or by adverse interactions with other foods and medications.^[12]

Types

There are many types of dietary supplements.

Vitamins

Vitamin is an organic compound required by an organism as a vital nutrient in limited amounts.^[13] An organic chemical compound (or related set of compounds) is called a vitamin when it cannot be synthesized in sufficient quantities by an organism, and must be obtained from the diet. Thus, the term is conditional both on the circumstances and on the particular organism. For example, ascorbic acid (vitamin C) is a vitamin for humans, but not for most other animals. Supplementation is important for the treatment of certain health problems but there is little evidence of benefit when used by those who are otherwise healthy.^[14]



Dietary mineral

Dietary elements, commonly called "dietary minerals" or "minerals", are the chemical elements required by living organisms, other than the four elements carbon, hydrogen, nitrogen, and oxygen present in common organic molecules.

Amino acids and proteins

Amino acids are biologically important organic compounds composed of amine ($-NH_2$) and carboxylic acid ($-COOH$) functional groups, along with a side-chain specific to each amino acid. The key elements of an amino acid are carbon, hydrogen, oxygen, and nitrogen, though other elements are found in the side-chains of certain amino acids.

Amino acids can be divided into three categories: essential amino acids, non-essential amino acids, and conditional amino acids. Essential amino acids cannot be made by the body, and must be supplied by food. Non-essential amino acids are made by the body from essential amino acids or in the normal breakdown of proteins. Conditional amino acids are usually not essential, except in times of illness, stress, or for someone challenged with a lifelong medical condition.

Essential fatty acids

Essential fatty acids, or EFAs, are fatty acids that humans and other animals must ingest because the body requires them for good health but cannot synthesize them.^[15] The term "essential fatty acid" refers to fatty acids required for biological processes but does not include the fats that only act as fuel.

Bodybuilding supplements

Bodybuilding supplements are dietary supplements commonly used by those involved in bodybuilding and athletics. Bodybuilding supplements may be used to replace meals, enhance weight gain, promote weight loss or improve athletic performance. Among the most widely used are vitamin supplements, protein drinks, branched-chain amino acids (BCAA), glutamine, essential fatty acids, meal replacement products, creatine, weight loss products and testosterone boosters. Supplements are sold either as single ingredient preparations or in the form of "stacks" – proprietary blends of various supplements marketed as offering synergistic advantages. While many bodybuilding supplements are also consumed by the general public their salience and frequency of use may differ when used specifically by bodybuilders.

Industry

In 2013, the global market of vitamins, minerals, and nutritional and herbal supplements (VMHS) was valued at \$82 billion, with roughly 28 percent of that in the U.S., where sales increased by approximately \$6 billion between 2007 and 2012.^[16]

The vitamins and dietary supplements sector in the U.S. grew 4% in 2015, to reach US\$27.2 billion. The U.S. market was highly competitive in 2015, as no single company accounted for more than a 5% share of value sales.^[17]

Controversy

According to University of Helsinki food safety professor Marina Heinonen, more than 90% of dietary supplement health claims are incorrect.^[18] In addition, ingredients listed have been found to be different from the contents. For example, Consumer Reports reported unsafe levels of arsenic, cadmium, lead and mercury in several of the protein powders that were tested.^[19] Also, the CBC found that protein spiking (the addition of amino acid filler to manipulate analysis) was not uncommon,^[20] however many of the companies involved challenged their claim.^[20]

Adverse effects

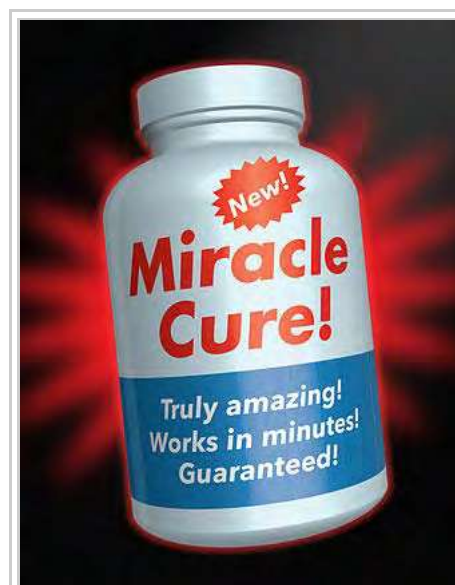
Among general reasons for harmful effects of dietary supplements are: a) absorption in a short time; b) quality and contamination; and c) enhancing both positive and negative effects at the same time.^[21] The number of incidents of liver damage from dietary supplements has tripled in a decade. Most of the products causing that effect were bodybuilding supplements. Some of the victims required liver transplants and some died. A third of the supplements involved contained unlisted steroids.^[22] Mild to severe toxicity has occurred on many occasions due to dietary supplements, even when the active ingredients were essential nutrients such as vitamins, minerals or amino acids. This has been a result of adulteration of the product, excessive usage on the part of the consumer, or use by persons at risk for the development of adverse effects. In addition, a number of supplements contain psychoactive drugs, whether of natural or synthetic origin.^{[23][24]}

Physical and chemical properties

Adulteration in North America

BMC Medicine published a study on herbal supplements in 2013. Most of the supplements studied were of low quality, one third did not contain the active ingredient(s) claimed, and one third contained unlisted substances.^{[25][26]}

An investigation by the New York Attorney General's office reported in 2015 analyzed 78 bottles of herbal



Some products make extraordinary claims and contain active ingredients which may not have been proven effective.

supplements from Walmart, Target, Walgreens and GNC stores in New York State using DNA barcoding, a method used to detect labeling fraud in the seafood industry. Only about 20% contained the ingredient on the label.^{[27][28]}

Some supplements were contaminated by rodent feces and urine.^[29]

Only 0.3% of the 55,000 U.S. market dietary supplements have been studied regarding their common side effects.^[22]

Society and culture

Public health

Work done by scientists in the early 20th century on identifying individual nutrients in food and developing ways to manufacture them raised hopes that optimal health could be achieved and diseases prevented by adding them to food and providing people with dietary supplements; while there were successes in preventing vitamin deficiencies, and preventing conditions like neural tube defects by supplementation and food fortification with folic acid, no targeted supplementation or fortification strategies to prevent major diseases like cancer or cardiovascular diseases have proved successful.^[30]

For example, while increased consumption of fruits and vegetables are related to decreases in mortality, cardiovascular diseases and cancers, supplementation with key factors found in fruits and vegetable, like antioxidants, vitamins, or minerals, do not help and some have been found to be harmful in some cases.^{[31][32]} In general as of 2016, robust clinical data is lacking, that shows that any kind of dietary supplementation does more good than harm for people who are healthy and eating a reasonable diet but there is clear data showing that dietary pattern and lifestyle choices are associated with health outcomes.^{[4][33]}

As a result of the lack of good data for supplementation and the strong data for dietary pattern, public health recommendations for healthy eating urge people to eat a plant-based diet of whole foods, minimizing processed food, salt and sugar and to get exercise daily, and to abandon Western pattern diets and a sedentary lifestyle.^{[34][35]:10}

Legal regulation

United States

The regulation of food and dietary supplements by the U.S. Food and Drug Administration is governed by various statutes enacted by the United States Congress and interpreted by the U.S. Food and Drug Administration ("FDA"). Pursuant to the Federal Food, Drug, and Cosmetic Act ("the Act") and accompanying legislation, the FDA has authority to oversee the quality of substances sold as food in the United States, and to monitor claims made in the labeling about both the composition and the health benefits of foods.

Substances which the FDA regulates as food are subdivided into various categories, including foods, food additives, added substances (man-made substances which are not intentionally introduced into food, but nevertheless end up in it), and dietary supplements. The specific standards which the FDA exercises differ from one category to the next. Furthermore, the FDA has been granted a variety of means by which it can address violations of the standards for a given category of substances.

Regulation in European Union

The European Union's Food Supplements Directive of 2002 requires that supplements be demonstrated to be safe, both in dosages and in purity.^[36] Only those supplements that have been proven to be safe may be sold in the bloc without prescription. As a category of food, food supplements cannot be labeled with drug claims but can bear health claims and nutrition claims.^[37]

The dietary supplements industry in the United Kingdom (UK), one of the 28 countries in the bloc, strongly opposed the Directive. In addition, a large number of consumers throughout Europe, including over one million in the UK, and various doctors and scientists, had signed petitions by 2005 against what are viewed by the petitioners as unjustified restrictions of consumer choice.^[38]

In 2004, along with two British trade associations, the Alliance for Natural Health (ANH) had a legal challenge to the Food Supplements Directive^[39] referred to the European Court of Justice by the High Court in London.^[40]

Although the European Court of Justice's Advocate General subsequently said that the bloc's plan to tighten rules on the sale of vitamins and food supplements should be scrapped,^[41] he was eventually overruled by the European Court, which decided that the measures in question were necessary and appropriate for the purpose of protecting public health. ANH, however, interpreted the ban as applying only to synthetically produced supplements, and not to vitamins and minerals normally found in or consumed as part of the diet.^[42]

Nevertheless, the European judges acknowledged the Advocate General's concerns, stating that there must be clear procedures to allow substances to be added to the permitted list based on scientific evidence. They also said that any refusal to add the product to the list must be open to challenge in the courts.^[43]

Research

Effects of most dietary supplements have not been determined in randomized clinical trials and manufacturing is lightly regulated; randomized clinical trials of certain vitamins and antioxidants have found increased mortality rates.^{[44][45]}

See also

- Bodybuilding supplement
- Essential nutrient
- Food fortification
- Megavitamin therapy
- Nutraceutical
- Nutritional genomics
- Dietary Supplement Act of 1992
- Multivitamin
- Superfood
- Dietary Supplements (database) (PubMed)
- ConsumerLab.com
- Natural Standard
- Haarlemmerolie

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Further reading

- Dietary Supplements: General Resources for Consumers (PDF|131 KB) (<http://www.nal.usda.gov/fnic/pubs/bibs/gen/dietarysupplementsconsumers06.pdf>), Food and Nutrition Information Center, National Agricultural Library. List of resources that provides an overview of herbal and dietary supplements, including use, regulation, research, and cautionary information.
- Questions to Ask Before Taking Vitamin and Mineral Supplements (<http://www.nutrition.gov/dietary->

supplements/questions-ask-taking-vitamin-and-mineral-supplements), Nutrition.gov (<http://www.nutrition.gov>).

- Dietary Supplement Fact Sheets (<http://ods.od.nih.gov/factsheets/list-all/>), NIH Office of Dietary Supplements (<http://ods.od.nih.gov/>).

External links

- Dietary Supplements Labels Database (https://www.nlm.nih.gov/medlineplus/druginfo/herb_All.html), from the United States National Library of Medicine
- PubMed Dietary Supplement Subset (http://ods.od.nih.gov/Research/PubMed_Dietary_Supplement_Subset.aspx) from the U.S. National Institutes of Health Office of Dietary Supplements and United States National Library of Medicine
- Dietary Supplement Information (<http://www.cfsan.fda.gov/~dms/supplmnt.html>) from the U.S. Food and Drug Administration
- What's in the Bottle? An Introduction to Dietary Supplements (<http://nccih.nih.gov/health/bottle/>), from the U.S. National Center for Complementary and Integrative Health
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