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Food Additives

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The Role of Food Additives

Everyone has seen chemical names of food additives on ingredient labels. As consumer interest in food labels increases, consumers are asking "what are these substances, what is their purpose, and are they safe?"

A food additive is a substance or mixture of substances purposely added to food by the manufacturer to perform a specific, beneficial function. Additives serve a variety of purposes.

Although most food additives have excellent safety records, some additives are controversial because questions raised about their safety have been difficult for scientists to answer. Despite rigorous testing and U.S. Food and Drug Administration (FDA) evaluations, certain additives once widely used have been banned because later research showed that the additive was unsafe. Conversely, additives once banned may later be found safe for use. Thus, the status of any food additive's safety is subject to change.

This fact sheet explores the major food additives, detailing their purpose and outlining some important safety considerations, and discusses some controversial food additives.

Major Food Additive Categories

Color and Flavor Additives

Flavor and color enhancers represent the largest group of

additives. There are about 1,400 natural and synthetic flavors that add pizzazz to foods. Without coloring additives, mint ice cream would be white, not green; maraschino cherries brown, not red; Florida oranges green, not orange.

Color additives. Both natural pigments and synthetic dyes are used as coloring agents. Natural colors are also called uncertified colors. An example of a natural color is the extract of the annatto seed, which gives cheese and butter a yellowish color. Other natural colors include beta carotene, a yellow-orange plant pigment; betalaine, the bright purple-red color in beets; turmeric, the yellow to reddish-brown dye extracted from the East Indian herb of the same name; caramel, a brown substance obtained from heated sugar; and titanium dioxide, a brilliant white pigment.

Artificial dyes, also called certified color additives, are designated with numbers and names. For example, FD&C (Food, Drug, and Cosmetic) Yellow No. 5 is also called tartrazine. Artificial dyes must be labeled separately on an ingredient label. FDA currently allows nine synthetic dyes to be used in foods, three of which have restricted uses:

- Citrus Red 2 -- orange skins only,
- FD&C Blue No. 1 (brilliant blue FCF),
- FD&C Blue No. 2 (indigotine),
- FD&C Green No. 3 (fast green FCF),
- FD&C Red No. 3 (erythrosin) -- restricted uses,
- FD&C Red No. 40 (allura red),
- FD&C Yellow No. 5 (tartrazine),
- FD&C Yellow No. 6 (sunset yellow FCF), and
- Orange BÑs sausage casings only.

Flavor additives. The most commonly used flavor additives are sugars (including dextrose and corn syrups), salt, and spices. Corn syrup and high fructose corn syrup (HFCS) are used in the food industry to replace sucrose (common white sugar) in soft drinks. HFCS is made by converting glucose, a sugar found in corn syrup, into fructose, another type of sugar. HFCS is less expensive and sweeter than ordinary corn syrup, so less can be used in food products.

Other common flavoring agents include artificial sweeteners (such as acesulfame K, aspartame, and saccharin), herbs, autolyzed yeast, hydrolyzed plant and vegetable proteins, ethyl vanillin, and various synthetic flavors that mimic natural flavors. Monosodium glutamate (MSG) does not have much flavor, but it enhances other flavors in foods.

Color and Flavor Preservatives

Antioxidants. Antioxidants are used to prevent undesirable color and flavor changes in foods exposed to oxygen in the air. Foods containing unsaturated fats are likely to undergo oxidation reactions, which cause the food to become rancid. Antioxidants often are found in oil-containing foods, such as potato chips, crackers, sausages, and nuts. The following are common antioxidants:

- ascorbic acid or sodium ascorbate (vitamin C),
- butylated hydroxyanisole (BHA),
- butylated hydroxytoluene (BHT),
- erythorbic acid,
- propyl gallate,
- sodium erythorbate,
- tertiary butylated hydroquinone (TBHQ), and
- tocopherols (vitamin E).

Chelating agents. Certain minerals in food--especially iron and copper--speed up the spoilage of foods through oxidation. To prevent this, special food additives called sequestrants, or chelating agents, are used to tie up these minerals and help prevent undesirable flavor and color changes. Some common chelating agents are disodium EDTA, polyphosphates, and citric acid.

Fat Substitutes

The newest category of food additives is fat substitutes. Three major substitutes are olestra (also known by its chemical name, sucrose polyester), polydextrose, and SimpleseTM. Some starches and gums also are used as fat substitutes, usually for oil or shortening in low-fat or fat-free baked goods. Oils and shortenings make a product moist and tender. Starches and gums can absorb water and mimic the moistness and tenderness provided by oils and shortenings. Many other fat substitutes are in developmental stages. Both SimpleseTM and polydextrose have FDA approval, but approval for olestra is pending until its safety is established.

Olestra. Olestra is not absorbed by the body and, therefore, does not contribute any calories. It is stable at high temperatures, so it can be used in shortenings, cooking oils, and products that are heated, such as potato chips and french fries. Another advantage of olestra is that it may help lower blood cholesterol by binding to cholesterol in food and preventing its absorption into the blood.

Polydextrose. Each gram of polydextrose, which was approved by FDA in 1981, provides about 1 calorie. Polydextrose does not have much flavor of its own. It can partially replace both fat and sugar in some low-calorie versions of high-calorie foods, such as cakes and other baked goods, candies, frostings, puddings, and salad dressings.

Simplese™. Simplese™ is made from protein that comes from eggs or skim milk. Through a special process called microparticulation, the protein is formed into tiny round beads. These beads are so small that 50 billion of them fit in a teaspoon. When eaten, they roll over each other on the tongue, mimicking the creamy texture of fat. Simplese™ fools your taste buds, making you think you are eating fat when you are really eating protein.

Unlike olestra, Simplese™ is absorbed through the digestive system, but it only contains 1.3 calories in each gram. This is substantially less than regular fat, which has 9 calories per gram. Because it is made from protein, Simplese^a cannot be heated to high temperatures (it would decompose or congeal). It can, however, be put on hot foods, such as baked potatoes. The first commercial use of Simplese^a was in a frozen dessert. It also can be used to replace some of the fat in sour cream, butter, margarine, yogurt, salad dressings, and processed cheeses.

Antimicrobials

Sugar and salt, two of the most common food additives, help preserve foods as well as provide flavor. They chemically bind to the molecules of water in food, making the water unavailable to micro-organisms that require it for their growth and reproduction. Sugar and salt also destroy bacteria by causing water to flow out of the bacteria, depriving the micro-organisms of this life-supporting nutrient.

Various acids also prevent or slow the growth of molds and micro-organisms and are effective against pathogenic (disease-causing) bacteria. Typical acids used in processed foods include acetic acid, which is used in mayonnaise and catsup and is the chief ingredient in vinegar; phosphoric and citric acids, which are added to many carbonated beverages (citric acid also helps to enhance the flavor of soft drinks); and benzoic acid, which occurs naturally in cranberries and prevents the growth of many micro-organisms.

Mold inhibitors, such as sodium and calcium propionate, are

commonly used in breads and cakes. Sorbic acid, another mold inhibitor, is used in cheese as well as in some beverages and pet foods.

Sodium nitrite helps prevent botulism, a potentially deadly disease, by inhibiting the bacterium *Clostridium botulinum*.

Nutritional Additives

Many nutrients are used to fortify or enrich foods. Fortified foods contain added vitamins and minerals that are not naturally present in the food or that are found only in low levels.

Enriched foods contain nutrients added to replace those that were lost during processing. For example, whole-wheat kernels lose substantial amounts of vitamins, minerals, and fiber when refined into white flour. Some of these lost nutrients, including iron and the B vitamins thiamine, riboflavin, and niacin, are restored through enrichment to approximately their original levels.

Some other commonly used nutritional additives are vitamin C, which is added to fruit juices or fruit drinks to increase the level already present; vitamin A, which is added to margarine to make it nutritionally similar to butter; and calcium, which is sometimes added to milk, orange juice, and flour to help prevent osteoporosis. Milk solids, which contain high-quality protein, can be added to flour to increase its nutritional value and to yogurt to increase its protein and lactose (milk sugar) levels.

During the past several years, food companies have been adding fiber, especially oat bran, to a variety of foods. Oat bran and other types of soluble fiber help lower blood cholesterol when eaten as part of a low-fat, low-cholesterol diet. Examples of other nutritional additives include the following:

- biotin,
- calcium caseinate,
- calcium pantothenate,
- cyanocobalamin (vitamin B-12),
- folic acid,
- iron (ferric orthophosphate, ferric sodium pyrophosphate, ferrous fumarate, ferrous gluconate, and ferrous sulfate),
- magnesium chloride,
- potassium caseinate,
- potassium iodate,

- pyridoxine hydrochloride (vitamin B-6),
- sodium caseinate,
- vitamin A palmitate,
- zinc gluconate, and
- zinc oxide.

Texture-Improving Additives

A variety of additives are used to improve the texture of foods.

Anticaking agents. These additives are used in dry, powdery foods. They absorb water so the product remains dry and flows freely without clumps. Two common anticaking agents are silicates (used in table salt) and cornstarch (added to sugar). Magnesium stearate, magnesium carbonate, and dextrose also are used.

Dough conditioners. Also called dough improvers or maturing agents, these additives act on starch or wheat protein (gluten) in a variety of ways to improve the baking performance of flour. Some conditioners are added at the flour mill, whereas others are added at the bakery. Some are for general use, and others are used specifically in either breads or cakes.

Dough conditioners called oxidizing agents (for example, bromate, ascorbic acid, and azodicarbonamide) cause chemical changes in the protein, producing a stronger gluten, which helps bread retain its structure after rising and baking. Oxidizing agents give baked products more volume, softer texture, finer grain, and finer crumbs. Additives called reducing agents (such as cysteine hydrochloride) make the gluten more extensible to provide dough that would otherwise be too tough.

Some dough conditioners play more than one role. Stearoyl-2-lactylate, for example, softens crumbs and strengthens dough. Monoglycerides are dough conditioners that keep bread soft over time and help prevent staling.

Freshly milled flour has a yellowish tint and its baking quality is not good. During storage, the color whitens and the baking quality slowly improves. Some dough conditioners can speed up this process. For example, benzoyl peroxide and chlorine dioxide gas bleach flour and are also used in cakes to produce the desired fluffiness and tenderness.

Certain enzymes also function as dough conditioners.

Lipoxygenase helps make bread white by oxidizing fatty acids. Protease enzymes, derived from fungi, make bread dough more pliable and extensible, and alpha-amylase helps the fermentation of bread dough.

Emulsifiers. Sometimes called surface active agents, these additives prevent the separation of the oil and water portions of a food product and help maintain a uniform consistency. In salad dressings, for example, emulsifiers help break the oil into small droplets and keep them evenly suspended. Emulsifiers also help prevent bread from staling and coffee creamers from separating. Food emulsifiers include the following:

- calcium stearoyl lactylate,
- diglycerides,
- dioctyl sodium sulfosuccinate,
- hydroxypropyl cellulose,
- lecithin,
- monoglycerides,
- polysorbate 60, 65, and 80,
- propylene glycol,
- sodium hexametaphosphate,
- sodium lauryl sulfate,
- sodium stearoyl lactylate, and
- sorbitan monostearate.

Humectants. These substances help foods retain moisture. Glycerin and sorbitol, which regulate water activity and control moisture equilibrium, are humectants used in candies, confections, and shredded coconut. Certain gums also have humectant properties when used in candies.

Meat tenderizers. Meat tenderizers are not used by commercial slaughter houses nor meat processing plants. They are used occasionally by meat wholesalers who supply meat to restaurants. However, most meat tenderizers are used by consumers, who apply them to meat at home.

Two substances used for tenderizing meat are bromelin, which comes from pineapples, and papain, which is derived from leaves of the papaya plant. These are called proteolytic enzymes because they break down and soften meat protein.

Thickeners. These additives are used to create smoothness and add body to many foods, including gravies, pie fillings, chocolate milk, and puddings. They also can cause foods to gel. Gums and starches, which combine with water to increase viscosity, are common thickeners.

Gums come from several sources. Carrageenan, derived from seaweed, often is used in chocolate milk. Agar, which also comes from seaweed, gives gelatin its unique texture. Pectin is the major gum found in fruits and is necessary for producing jellies. Other plant gums include locust bean, acacia, and tragacanth. All these gums have a chemical makeup similar to that of a carbohydrate and are widely used in the food industry.

Starches typically come from wheat, potatoes, corn, or tapioca and serve many functions as food additives. For example, cream-style corn requires starch for its creamy texture. Although many natural starches lose their ability to hold water during freezing or heating, they can be chemically modified to improve their stability in foods; thus, the term "modified starch" appears on many ingredient labels.

Algin, alginic acid, xanthan gum, microcrystalline cellulose, carboxymethylcellulose (CMC), and polydextrose also are thickening agents. They are found in baked goods, salad dressings, puddings, and fruit pie fillings.

Controversial Food Additives

Artificial Dyes

Because the sole purpose of dyes is to make foods look better, some people argue that food dyes are frivolous. Also, artificial dyes, as well as other food additives, have been suspected of causing hyperactivity in children. However, there have been no scientific studies that support this supposition. Since the enactment of the Color Additive Amendments of 1960, a number of synthetic dyes have been eliminated from food, including Violet No. 1, which had been used to stamp USDA inspection grades on beef carcasses, and Red Dyes No. 2 and No. 4. All were banned by FDA because they were suspected of being carcinogenic.

Red Dye No. 2 was widely used in this country in lipsticks, candy, and beverages, but the United States banned it in 1975 when international studies questioned its safety. In Canada, however, it still is used.

In some people, Yellow Dye No. 5 (tartrazine) causes allergic reactions, such as hives, itching, or nasal congestion. FDA requires that tartrazine be listed on ingredient labels. Beginning in 1994, when the newly designed food label is used on food products, all color additives that FDA certifies for food must be listed on the

label.

Artificial Sweeteners

In a diet-conscious society, any ingredient that cuts calories is a boon. The artificial sweeteners saccharin, cyclamate, aspartame, and acesulfame K are calorie-free or low-calorie sugar substitutes. They have all been subjects of controversy except acesulfame K.

Aspartame. Aspartame, commonly known as NutraSweet™ or Equal™, was discovered in 1965. It is about 180 times sweeter than ordinary sugar, so only a small amount is needed to sweeten food. Today, it dominates the artificial sweetener market. In 1981, FDA approved aspartame, but questions immediately arose about whether it could cause tumors in animals or epileptic-type seizures in people. Although repeated scientific studies have found no conclusive evidence for these harmful effects since aspartame was approved for use in soft drinks in 1983, there have been consumer reports that the sweetener causes headaches, dizziness, and other minor symptoms. The safety of aspartame has been affirmed by FDA, but FDA continues to monitor the complaints. Researchers continue to investigate aspartame.

Cyclamate. Cyclamate, which is 30 times sweeter than sugar, was discovered in 1937 and was commonly used in the 1950's and 1960's. It was banned by FDA in 1970 because studies suggested that it caused cancer in rats. However, new research indicates that cyclamate may be safe after all, and the sweetener is currently under FDA review to decide if the ban can be lifted.

Saccharin. Saccharin has been around the longest of any artificial sweetener. Discovered in 1879 at Johns Hopkins University, it is a petroleum-based product that has no calories and is 300 times sweeter than sugar. In 1977, FDA proposed banning saccharin because studies showed that it caused bladder tumors in rats. The public vigorously protested, as it was the only artificial sweetener then available. In response to the consumer demand for saccharin, Congress imposed an 18-month moratorium on the ban until further research could be conducted. The moratorium, known as the Saccharin Study and Labeling Act, has been extended several times and probably will continue to be renewed. Saccharin remains available to consumers but must carry this warning label: "Use of this product may be hazardous to your health. This product contains saccharin, which has been determined to cause

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cancer in laboratory animals."

Monosodium Glutamate

Monosodium glutamate or MSG (trade name: AccentTM) is an additive sometimes found in soups, broths, and restaurant food. It also is a component of other food ingredients, including hydrolyzed vegetable protein and yeast extract.

The main function of MSG is to intensify the flavors already present in food. Recent studies have shown that MSG may provide a fifth basic taste (in addition to sweet, sour, salty, and bitter). This flavor is called "umami" (a Japanese word connoting savory) and is elicited by several substances naturally occurring in food.

Although it is considered safe for adults, some people who eat MSG report headaches, dizziness, chest pains, and flushing. FDA concluded that a small portion of the population may be mildly sensitive to MSG, but FDA is not aware of scientific evidence showing that low doses of MSG can cause severe or life-threatening reactions. As a precaution, MSG is not allowed in baby food.

Nitrates and Nitrites

Sodium nitrate and nitrite were used for centuries to preserve meat. Today, nitrates are not often used, but nitrites continue to be added to some cured meats, such as hot dogs, bacon, salami, bologna, and other luncheon meats. The function of nitrite is threefold: it provides the desirable pink color in these products, adds flavor, and inhibits the bacterium that causes botulism.

Nitrates are found in many vegetables, such as broccoli and artichokes. When eaten, they are converted in the stomach into nitrites. Nitrites, in turn, react with chemicals called amines to form nitrosamines, which are carcinogens associated with liver cancer in some animals. Because nitrites occur naturally in saliva, much debate has centered on the actual danger to people posed by nitrates, nitrites, and nitrosamines.

When Federal agencies announced plans to phase out nitrates in 1978, there were many arguments, as scientists questioned the validity of some of the studies linking nitrates and nitrites to cancer. Scientists reviewed these studies and found that some interpretations may have been faulty, and the proposed ban was dropped in 1980. Although nitrites continue to be used, the allowable levels have been

lowered, and when they are added to a product, vitamin C also is added to help prevent the formation of nitrosamines. (Cooking bacon at a low temperature also inhibits nitrosamine formation.)

Sulfites

Sulfites are used to reduce or prevent spoilage and discoloration during preparation, storage, and distribution of many foods. Sulfites prevent dried apples from darkening, help potatoes stay white, and keep shrimp from discoloring. Sulfites also are used as preservatives in some drugs and in wine. In wine, sulfites prevent the growth of undesirable micro-organisms. In most other foods, sulfites prevent discoloration by interfering with chemical reactions that cause browning. Sulfites also have antioxidant properties. Sulfites are applied to foods as a spray, dip, or gas (sulfur dioxide).

Some people who suffer from asthma are extremely sensitive to sulfites. After eating sulfite-containing foods, asthmatics may have difficulty breathing or go into shock and pass out. Other symptoms include vomiting, nausea, diarrhea, abdominal pain, and hives. Although a rare occurrence, some asthmatics have died because of a reaction to sulfites. FDA banned the use of these additives on raw fruits and vegetables in July 1986, largely as a result of complaints about sulfite use in salad bars; however, sulfites are still being used in some dried fruit, fruit juices, dried soups, condiments, relishes, dehydrated vegetables, and baked goods. Sulfites are being gradually phased out of the food supply; when they are added to a processed food, they must be listed on the ingredient label.¹

Food Additive Regulations

Delaney Clause

In 1958, the U.S. Congress passed the Food Additive Amendment, which addressed the safety of food additives. The amendment states that anyone wishing to market a new food additive must provide convincing scientific data showing that the additive is safe and performs its intended function in food. This amendment also contains the Delaney Clause, sometimes called the cancer clause, which prohibits the use of substances in food shown to cause cancer in either people or animals, regardless of how minute the amount present.

The Delaney Clause was designed to protect the public from

carcinogens in food, but there is mounting concern that the clause is too rigorous and no longer practical. When the amendment was originated, laboratory methods for analyzing food were primitive compared to techniques used today. Modern laboratory instruments are so sensitive that they routinely detect trace amounts of chemicals, including carcinogens in food, in parts per quadrillion--the equivalent of one grain of sugar in a lake the size of 1,000 Olympic-size swimming pools.

A growing number of experts believes the Delaney Clause should be changed to read that if an additive or other chemical is estimated to cause only one additional case of cancer per million people over a lifetime of exposure, the additive is considered safe and permitted in food. This negligible-risk concept may someday replace the zero-risk standard of the Delaney Clause.

Adverse Reaction Monitoring System

To help monitor the effects of food additives and to deal with consumer complaints, FDA established the Adverse Reaction Monitoring System (ARMS). FDA investigates complaints received from the general public, physicians, and from food companies that track consumer complaints about their products. Since its founding in 1985, ARMS has received over 8,000 telephone calls and letters. Most of the complaints are about MSG, aspartame, and sulfite preservatives.

If you experience an adverse reaction to a food additive and would like to report it to the FDA, send a written complaint to the following address:

Adverse Reaction Monitoring System
HFS-636
U.S. Food and Drug Administration
Center for Food Safety and Applied Nutrition
200 C Street, NW
Washington, DC 20204

The Value of Food Additives

Without food additives, there would be fewer convenience foods, such as frozen dinners, breakfast cereals, cake mixes, and low-calorie foods, and consumers would need to shop often, buying only small quantities of perishable food. The safety of many additives is continually reevaluated. If new scientific data reveal problems with an additive, that additive may be banned from the food supply.

The risks and the benefits of additives must be weighed. No substance in food, be it synthetic or natural, is completely safe if used inappropriately. When used appropriately, however, food additives can allow greater selection in the supermarket, decrease the chances of food spoilage, and make foods more nutritious.

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