

# Food Additives



# Summary

Protecting food from spoilage, loss of taste, and changes in texture has been a challenge since the early days of human food production. Early in recorded history, people discovered ingredients like salt could help preserve meat from spoiling rapidly and the process of drying could protect food from spoilage. Humans have since been on a journey of slowly identifying ingredients and processing tools to preserve their food for longer periods of time (1, 2, 3).

In our modern food system, ingredients, and processes for preserving and enhancing foods have significantly evolved. Among these are food additives, which help preserve, add nutrients, and enhance textures and taste of food, and food preservatives, a subset of additives that are solely used to prevent spoiling.

Food additives help improve shelf life, reduce microbiological growth, enhance taste, modify texture, and improve appearance; some even bolster nutritional attributes. The positive impact of food additives helps ensure a safe, acceptable, available, and affordable food supply while simultaneously reducing food loss and waste. Despite all the positives, as the addition of these ingredients has increased over the past decades, so has confusion over their benefits and detriments (4). This toolkit was created to provide science-based information about the use of food additives and preservatives in the production of foods.



## Food Additive

Any substance used in the production, processing, treatment, storage, packaging, or transportation of food. There are two types of food additives: direct and indirect.



## Direct Additive

An ingredient used in food or beverage for a specified purpose. They are required to be labeled within the ingredients on a food or beverage package.



## Indirect Additive

Substances that become part of a food or beverage due to contact, methods of packaging or storage, unintentional addition or other handling.



## Food Additives – A Brief History

Food additives and preservatives like salt, vinegar, and spices have been safely used for thousands of years. Records of the use of natural food colors can be found in 1500 BC in Egypt, where they were used to provide coloration to candies. The ancient Greeks burned sulfur over wine casks to create sulfur dioxide to preserve wine, and sulfur dioxide is still used today as a preservation agent for wine. From salt to preserve dried meat to numerous spices and flavorings, additives to preserve and enhance the taste and texture of food have been in use since the beginning of human civilization. In ancient China, paraffin wax was burnt to ripen fruit—this worked because it caused traces of ethylene and propylene to combine with the food. The Egyptians colored food with saffron, while the Romans added alum (potassium aluminum sulfate) to bread to make it whiter. Other additives, like minerals, have found their way into food products and edible supplements as sources of nutrition (e.g., calcium carbonate). Food additives and preservatives expanded over centuries as humanity in different regions learned about their usefulness through trial and error. The addition of vinegar or alcohol to preserve products (pickling), sometimes in combination with salt or sugar, has been used for centuries to preserve foods that would otherwise spoil (11).

**In the Roman Empire, black pepper from India and Southeast Asia was highly prized and was so desired that Alaric, king of the Visigoths, included 3,000 pounds of pepper as part of the ransom when he besieged Rome in the fifth century AD (10).**

During the industrial revolution, cities grew and the food supply moved from being locally made to requiring transportation, storage, and preservation to enable delivery to consumers. With this shift, food additives became more prevalent. An example is the use of sodium bicarbonate, or baking soda, a derivative of potash, which is first found used in food in a U.S. published cookbook in 1796 as a leavening agent to help raise bread dough. With the advent of glass jars with lids, pickling became much more common and numerous products on store shelves today use these food additives to deliver prolonged shelf life. Those same glass jars and lids first used wax, then rubber, and now plastic materials as sealants to protect the product inside, early forms of indirect food additives. As the food system evolved, governments enacted rules to ensure food safety and protect consumers from deleterious food additives. In 1860, the English Parliament passed the Adulteration of Food Drink Act, the first of a series of laws to prohibit food adulteration and protect consumers. About that same time, in the United States, the U.S. Department of Agriculture (USDA) was created, and in 1883, Harvey Wiley was appointed the chief of the Bureau of Chemistry for the USDA. Wiley's work eventually led to the Pure Food and Drug Act of 1906, which was the first of a series of U.S. federal laws to protect consumers from adulterated foods. Eventually, the USDA's Bureau of Chemistry became the U.S. Food and Drug Administration (FDA) in 1931 and in 1953 was moved to the Department of Health, Education and Welfare (now HHS). Through the 20th century, developed countries began enforcing more controls over food additives used in the food industry. In 1963, the United Nations (UN) Codex Alimentarius Committee met for the first time, and since has provided a foundation for global food safety guidelines regarding food additives for countries to follow. By the end of the 20th century, food adulteration had become quite uncommon due to defining acceptable food additives and enforcement actions against businesses that adulterated food in many countries. While food adulteration has been an ongoing issue over the last two centuries, safe food additives have expanded to enable enhanced food safety and preservation, food convenience, healthfulness, and enjoyment, while maintaining a relatively lower-cost food supply.



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# Need for Food Additives and Preservatives

Without the multitude of food additives, the modern food supply chain would have products with short shelf life and more rapid flavor loss, a reality that would result in significantly more food waste. Direct additive ingredients enable prolonged product shelf life, creative textures, enhanced appearance, innovative flavors, prevention of products sticking together, nutritional benefits, and low- or zero-calorie sweetening. Indirect additive tools allow large-scale production of food products using mechanical equipment (e.g., food grade lubricants, gaskets, and sanitizers), add useful properties to final product packaging, enable packaging to be properly sealed to prevent spoilage, and provide protective characteristics to processing equipment (e.g., metallic alloys, plastic tubing strengtheners). Many U.S. consumers are unaware that many of the additive materials used to manufacture the plastic water tubing in their homes or to make plastic cups, knives, and forks all must meet the same regulatory criteria as the processing equipment or packaging materials used for food products purchased at the grocery store (12).

Direct and indirect food additives continue to be developed to address the changing needs of the food industry, driven by both consumers and technology advances. Direct or indirect food additives can be from natural or synthetic origin, and some natural additives meet organic standards. Consumer perceptions and marketing have led to the growth of natural and organic products. The development of naturally sourced, organic, high-intensity sweeteners from the stevia plant has been driven by consumers' desire to reduce calorie intake and avoid consumption of synthetically derived high-intensity sweeteners (13). Natural and organic food colorants have been developed to similarly meet consumer preferences to replace synthetic food dyes. The expansion of natural and organic additives has been particularly evident in the areas of food colorings, sweeteners, stabilizers, thickeners, and acidulants (14). Regulatory bodies maintain that natural, organic, and conventional products are all safe. Organic standards create a framework to ensure consistency in production, manufacturing and labeling of organic products.

As consumer desires, manufacturing needs, and science innovation evolve, food additives and preservatives will be developed, following the complex regulatory processes designed to protect consumer health and well-being.



# Key Benefits of Food Additives

## Food Safety and Preservation

Delivery of a safe food supply is a paramount issue globally. Numerous food additives are used by the food industry to help deliver a safe food supply. One example is acidifying agents and acidity regulators that are crucial to preserving the safety of many foods by managing the pH of the finished food or beverage to protect from microbial growth. Products such as no-sugar-added fruits in clear plastic containers or juice beverages often use acidifying agents to keep the pH low to maintain safety and shelf life. Ensuring safety of low acid foods is critical, global regulatory bodies maintain requirements for pH of acidified and low acid foods to ensure safety.

Another important food safety tool is the use of microbial preservatives; some are synthetic molecules and others are naturally occurring. One highly utilized preservative is potassium sorbate, used in both foods and beverages to inhibit microbial growth. Interestingly, it was originally derived from the berries of the mountain ash tree, but now is made synthetically. Sodium lactate is a food preservative used in the meat and cheese industries that can be made from natural, organic sources or synthetically. Its use helps to reduce the need for nitrates in refrigerated processed meats.

Food preservatives play a crucial role in the modern food supply chain. Managing their use is important to enabling delivery of food safety and shelf life, while not causing health issues.

## Form and Function

Additives help ensure foods maintain desirable attributes for longer periods. Additives can help improve texture, color, flavor, taste, and appearance of foods. Food additives can help to preserve the flavor or texture of a food product. Some are multipurpose, like sodium nitrate and sodium lactate effects on microbial safety, flavor, and texture, while others focus on one benefit, like clove oil to prevent potatoes from sprouting.



**Citric acid, from sources like lemon juice, is an acidifying agent that helps keep the pH low to maintain the safety of foods.**

## Shelf Life and Convenience

Food additives can contribute to convenience and prolonged shelf life of food products. Thickeners, stabilizers, and antioxidants are examples of food additives that can be beneficial for consumer food preparation or extended taste preservation, making ready-to-eat food products possible. The complexity of modern food supply chains, the desire to reduce trips to the store by consumers, and the need to minimize food waste, all drive the use of certain types of preservative food additives.

The combination of consumers' desire for convenience and simple ingredients (clean label) will drive continued demand for naturally sourced replacements for synthetic food additives. Products that eliminate such additives, including naturally sourced organic versions, to create label simplicity will have more limited acceptable shelf lives and likely higher cost for consumers.

## Enrichment and Fortification

Vitamin-, mineral-, and nutrient-rich food additives can have substantial health benefits to consumers. Vitamins such as A and D in fortified milk or folate in enriched grain products can be a major health benefit. Enrichment and fortification of products like milk, breads, and grains is standardized in the United States and other regions and was originally developed to address nutrient deficiencies in populations. These nutrient additions are usually sourced from synthetic vitamins and minerals, providing an affordable cost and consistent nutrient content.

In addition to public health interventions for enhancing nutrition of food products, consumer health and nutrition preferences are also driving the addition of various additives. This includes the addition of protein ingredients such as isolated proteins (e.g., pea protein added to a product to increase its protein level), probiotics, and prebiotics.

The addition of food additives to enhance the health and nutrition benefits of foods via nutrition or digestive health is an area of significant, ongoing scientific research and will continue to expand substantially going into the future.

## Food in Times of Crisis

Food additives are essential ingredients in delivering safe and nutritious foods in times of crisis such as wartime supply chain disruptions, pandemics, and natural disasters or any other occasion when distressed populations need humanitarian relief. Food additives enable stability and extend shelf life, ensuring distribution and availability are steady in times of disruption. Foods with vitamin-, mineral-, and other nutrient-rich additives can help support nutritional needs of populations when accessibility and availability of nutrient-rich foods are limited.

Orange juice is often fortified with calcium and vitamin D in the U.S.



# Concerns Over Food Additives

## Public Health

As public health research focuses on prevention of chronic diseases, including cancer, obesity, and others, new studies evaluating the relationship between food ingredients and health have emerged. Studies on specific additives related to chronic health problems, including cancer, nervous system damage, and hyperactivity, have sparked concerns. These studies require careful consideration and review, particularly evaluating the potential hazard and determining the risk related to the individual additive. Understanding exposure level is essential to establishing a safe level of use.

Protecting public health is the basis for food safety. As new evidence emerges, careful evaluation and review is essential to ensuring the benefits of individual additives continue to outweigh potential risks.

## Varying Regulations Globally

While scientific studies to evaluate additives are often the same, the interpretation and application to different populations can be different. When a regulatory body evaluates a potential risk, they assess the uses, the dose, the consumption patterns of their population and much more. These evaluations can create different regulations, allowed uses and levels of additives around the world. This globally variable regulatory framework is confusing for consumers and leads to concerns over the safety of some additives not permitted in some countries.

## Chemical Sounding Names

Many regulatory authorities require scientifically accurate nomenclature in ingredient labels. This results in ingredients being referenced by unfamiliar technical terms that consumers do not understand. For example, in the U.S., labels note thiamine, riboflavin, niacin, and folic acid, which sound very different than vitamin B1, vitamin B2, vitamin B3 and vitamin B9, even though they are the same. In the E.U. you may find E300 as an ingredient, which is vitamin C. Technical terminology and scientific names, without the related common name or context that notes the purpose of the ingredient in a product, causes consumers confusion.

## Emerging Science

As science advances, questions, confusion, and concerns over new ingredients emerge. One example is nanotechnology, which offers control of particle size and shape providing novel functional capabilities. Another example is mass spectrometry, which has brought new insights for consideration with more sensitive testing. New technologies and methodologies enable identification of additives at ever lower levels, including cases that were previously undetectable. These advancements enhance precision control.

As science and technology advances, continued safety assessment and additional research of previously determined acceptable limits for both dose and material properties are necessary. Additionally, education on the technologies and ingredients produced by them is essential to enable consumer trust.





# Food Law

## Regulatory Oversight

While many direct food and beverage additives are approved across the world, approvals (including use, amounts, and other qualifications) vary by country. It is important to check the status of an additive with the appropriate regulatory agency for that country/region (5, 6, 7). An excellent starting point for assessing globally aligned food additives is often with the UN Food and Agriculture Organization (FAO) Codex Alimentarius Commission and its list of approved food additives (5). Indirect additives are handled differently in various parts of the world and usually are not required to be labeled. Local regulatory agencies generally have lists of approved indirect additives (9). New ingredients being developed by suppliers undergo approval processes that vary by country. Often an ingredient supplier will choose one or two countries or regions to seek approval in before proceeding more broadly.

Food additives and preservatives have a significant role in the modern food supply. A food additive in the United States must meet one of two criteria: either it must be defined as generally recognized as safe (GRAS) through a detailed regulatory process set by the FDA, or it must apply and be accepted for pre-market approval by the FDA (8). Likewise, in the European Union, new food additives must go through a lengthy assessment process by the European Food Safety Authority (EFSA) prior to being allowed. Food ingredients (including additives) are connected to their intended use in a food product (purpose of use and maximum quantity to be used). As a result, an ingredient can be GRAS for one intended use in a product category and not GRAS in a different category.

Often, safe consumption thresholds are defined via numerous studies prior to introduction of any new food additive. The FAO has been involved in assessing the food safety for human consumption of food additives since 1956 via a globally sourced, scientific review board, Joint Expert Committee on Food Additives (JECFA), in support of the Codex Alimentarius Commission Committee on Food Additives and its General Standards on Food Additives. JECFA usually meets twice annually to conduct risk assessments and safety evaluations for new food additives or to review the status of existing additives considering new scientific information. JECFA has conducted such assessments for over 2,500 food additives (16).

Most approved food additives and preservatives have been safely used for over 50–60 years with no detrimental effects identified. In some cases, new research has identified potential negative health impacts associated with additives. Many of these concerns are related to the level of consumption, leading to health challenges. Numerous reevaluations conducted by regulatory agencies such as EFSA or FDA have primarily modified levels of allowed usage due to concerns about consumption thresholds

While rigorous regulatory evaluations of additives by international, country, and regional agencies protect consumers from the danger of inappropriate use of additives, updating assessments of additives based on new scientific research and testing methodologies is essential to ensure safety and consumer trust.

# Conclusion

While food additives have contributed to the preservation of foods for centuries, concerns over certain food additives as science evolves coupled with consumer desires for simple, easy-to-read ingredient labels have driven reformulation. While simple labels are beneficial because they are more easily understood by consumers, there can be trade-offs, with challenges to the safety, shelf life, cost, and convenience of foods made with fewer additives. Continued evaluation of science and consumption patterns are essential to ensuring safe use of additives in the food supply.

Food additives, and processed foods made from them, have substantially enhanced accessibility, improved microbiological preservation, and prolonged acceptable taste, texture, and appearance over the shelf life of food products. These benefits help ensure a safe, acceptable, available, and affordable food supply while simultaneously helping to reduce food loss and waste. Food additives are ingredients with a big impact.

Additives were originally developed to support public health, improve food safety, and ensure nutrient adequacy. As public health concerns shift, we must continuously evaluate additives to ensure their benefits remain with no additional health risk.



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