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FOOD ADDITIVES: THEIR ROLE AND IMPACT ON HUMAN LIFE

Yaren ARAY [1] Merve YÜRÜK [2] Meryem AKHAN [3] Burcu ÇAKMAK SANCAR [4]

[1] Istanbul Esenyurt University, Faculty of Health Sciences, Department of Nutrition and Dietetics, 34510, Istanbul, yarenaray@esenyurt.edu.tr, 0000-0002-2258-759X
[2] Istanbul Esenyurt University, Faculty of Health Sciences, Department of Nutrition and Dietetics, 34510, Istanbul, merveyuruk3@gmail.com, 0009-0003-7865-6050
[3] Istanbul Esenyurt University, Faculty of Health Sciences, Department of Nutrition and Dietetics, 34510, Istanbul, meryemakham@esenyurt.edu.tr, 0000-0001-8065-8635
[4] Istanbul Esenyurt University, Faculty of Health Sciences, Department of Nutrition and Dietetics, 34510, Istanbul, burcucakmak@esenyurt.edu.tr, 0000-0002-0737-7009

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ABSTRACT

Food additives are substances added to food to improve quality, sensory properties, shelf life, and safety. This overview is a summary of food additives, including their categorization, technological roles, history of application, regulatory frameworks, and potential impacts on human health. Additives are often functionally divided into antioxidants, colorants, preservatives, sweeteners, emulsifiers, stabilizers, and thickeners. Synthetic antioxidants, such as BHA, BHT, TBHQ, and propyl gallate (PG), are added to processed food as anti-oxidation agents. In contrast, natural antioxidants include vitamins C and E, as well as carotenoids. Colorants, either natural or synthetic, contribute visual appeal and uniformity, while preservatives slow microbial growth and oxidation. Sweeteners provide sweetness without caloric impact, and emulsifiers, stabilizers, and thickeners modify texture and stability. Though additives bring useful technological and nutritional benefits, there is a concern regarding safety. Evidence from animal, in vitro, and human studies presents potential risks including neurotoxicity, hypersensitivity, and behavioral alterations, especially among children. Organizations such as JECFA and national agencies establish safety levels and acceptable daily intake to minimize risks. Overall, the controlled and careful use of food additives should balance technological advantage against consumer health and safety.

Keywords: Food Additives; Food; Health; Food Safety

GIDA KATKI MADDELERİ: İNSAN YAŞAMINDAKİ ROLÜ VE ETKİSİ

ÖZET

Gıdalar, insan sağlığı ve yaşamı için temel gereksinimlerden biridir. Ancak, modern beslenme alışkanlıkları son kırk yılda önemli ölçüde değişmiş, geleneksel ve doğal gıdalar yerine kolay erişilebilir, rafine edilmiş ve görsel olarak cazip gıdalar daha fazla tercih edilmeye başlanmıştır. Bu değişimle birlikte, gıda katkı maddelerinin kullanımı da yaygınlaşmış ve besinlerin raf ömrünü uzatmak, tat, aroma ve renk gibi duyusal özelliklerini iyileştirmek, kıvam sağlamak ve besin değerlerini korumak amacıyla giderek daha fazla kullanılmaya başlanmıştır. Özellikle sanayileşme, küreselleşme ve değişen tüketici talepleri, gıda endüstrisini daha dayanıklı ve cazip ürünler geliştirmeye yönlendirmiştir. Bunun sonucunda, oksidatif ve mikrobiyolojik bozulmaya karşı dirençli gıdaların üretilmesi amacıyla çeşitli kimyasal katkı maddeleri formüle edilmiştir. Ancak, gıda katkı maddelerine uzun süreli maruziyetin insan sağlığı üzerindeki etkileri konusunda önemli endişeler bulunmaktadır. Araştırmalar, bazı katkı maddelerinin belirli kanser türleri, obezite, tip 2 diyabet, alerjik reaksiyonlar ve nörolojik bozukluklar gibi çeşitli sağlık sorunlarıyla ilişkili olabileceğini ortaya koymaktadır. Üstelik bu çalışmaların sonucunda, düzenleyici kurumlar tarafından belirlenen güvenli kullanım seviyelerinde dahi bazı katkı maddelerinin potansiyel riskler taşıdığı öne sürülmektedir. Bu nedenle, katkı maddelerinin sağlık üzerindeki etkileri konusunda farkındalığın artırılması ve toplumun bilinçlendirilmesi büyük önem taşımaktadır. Bu çalışma, gıda katkı maddelerinin çeşitlerini, kullanım amaçlarını ve insan sağlığı üzerindeki olası etkilerini detaylı bir şekilde ele alarak kapsamlı bir bakış sunmayı amaçlamaktadır.

Anahtar Kelimeler: Gıda Katkı Maddeleri; Gıda; Sağlık; Gıda Güvenliği

Sorumlu Yazar / Corresponding Author: Yaren ARAY, Istanbul Esenyurt University, Faculty of Health Sciences, Department of Nutrition and Dietetics, 34510, Istanbul
E-mail: yarenaray@esenyurt.edu.tr

INTRODUCTION

Foods contain additional components during production and processing. These components are used in processing technologies, regardless of their nutritional value, and are not consumed on their own. Their primary functions are to maintain quality, prevent spoilage and improve characteristics such as taste, smell, texture, appearance and shelf life during production, preparation, packaging, transportation and storage. These components are referred to as food additives (Awulachew, 2021). Food additives are divided into categories according to their function, including antioxidants, bleaching agents, sweeteners, preservatives, colourants, emulsifiers, stabilisers and thickening agents. However, due to their compound structures, some additives have more than one functional property (Wu et al., 2022).

Although the industrial use of food additives is highly developed today, their origins date back to historical times. Throughout history, humanity has developed various preservation methods to delay food spoilage, extend shelf life, and improve quality and usability (Tomaska et al., 2014). It is clear that smoking, salting, vinegar, and burnt sulphur applications were among the most commonly used traditional methods (Küşümler et al., 2020). Archaeological findings prove that food dyes were used in ancient Egypt around 3500 BCE, salt was preferred for preserving meat products around 3000 BCE, and smoke obtained from a wood-salt mixture served a preservative function around 900 BCE (Aksoydan et al., 2012). Sugar and salt, among the first preservatives, were highly effective because they reduced water activity to levels that inhibited microbial growth (Tan et al., 2014) (Figure 1).
In recent decades, consumer preferences have shifted, resulting in a substantial increase in demand for 'clean-label' products — foods perceived as more natural and containing fewer additives. Consequently, food manufacturers are compelled to balance technological performance with customer requirements for health and transparency. This challenge is further compounded by the absence of consensus on definitions for terms such as “clean label” or “natural” (Nabeshima et al., 2024).
Regulatory bodies, including the Joint FAO/WHO Expert Committee on Food Additives (JECFA), play a pivotal role in ensuring the safe use of additives. The responsibility for conducting risk assessments and establishing safety thresholds, such as the acceptable daily intake (ADI), to protect public health is theirs (Ukwo et al., 2022). One of the fundamental rules of food safety is that additives may only be licensed if they are proven not to pose a risk to human health at their proposed levels of application (Codex Alimentarius Commission, 1995; European Parliament and Council, 2008; EFSA, 2025). Consequently, a meticulous evaluation of both the analytical data and the intended use levels is imperative.
Food additives should not reduce or alter the nutritional value of foods, cause vitamin degradation, or impair nutrient absorption (Carocho et al., 2014; Scotter et al., 2004). In this context, both in vivo and in vitro studies are recommended to assess safety and functionality (Weiner, 2016). However, the preponderance of evidence pertaining to the health implications of additives is derived from animal and in vitro studies, and the paucity of human data may result in a discrepancy between current knowledge and real-world exposure scenarios (Walton et al., 1999).
The present review aims to provide a comprehensive overview of food additives, focusing on their categories, technological functions, regulatory frameworks, and, most importantly, their potential impacts on human health.

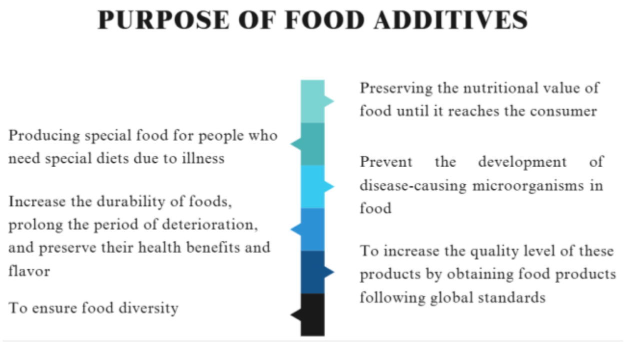

Figure 1. Purpose of Food Additives

E-CODE SYSTEM FOR FOOD ADDITIVES

The term "E-codes" was originally coined by the member states of the European Union, with the initial letter of the word "Europe" (Verbruggen, 2002). The Commission has further elaborated this system of codes to facilitate the identification of all additives on a global scale, irrespective of their utilisation in accordance with authorisation. The purpose of this methodology is to group additives according to their various functions (Codex Alimentarius Commission, 1989). The system under discussion groups additives according to their technological function, and comprises all chemical entities used during food processing, whether of natural or synthetic origin. According to EU legislation, these substances are classified as food additives. The "E" designation indicates that the additive has undergone rigorous safety testing, including toxicological analysis, and has been approved for use in food production

(Atman, 2004). As demonstrated in Figure 2, the classification of food additives is determined by the E-code system.

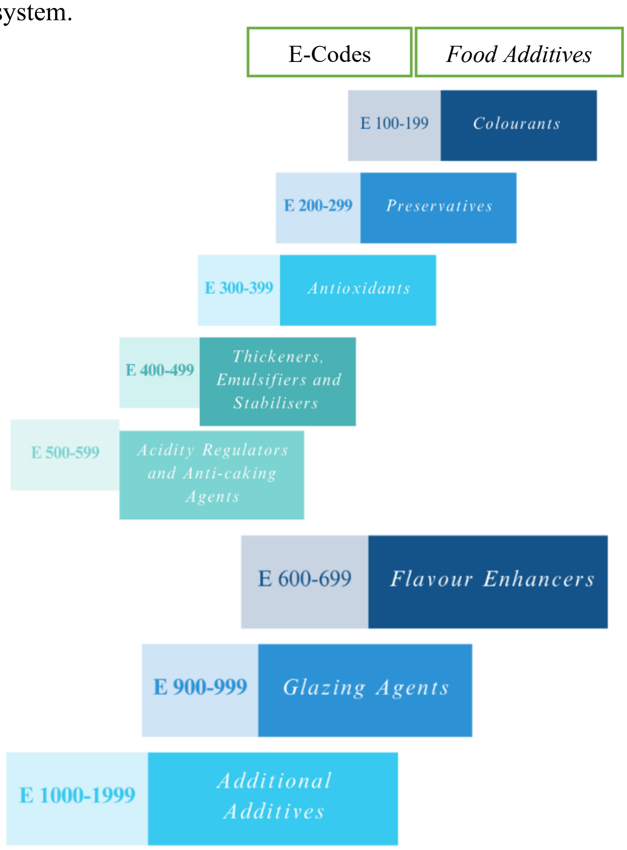

Figure. 2. Categorization of food additives according to the E-code system.

CLASSIFICATION OF FOOD ADDITIVES

The categorisation of food additives is based on their designated technological function, encompassing a diverse array of classes. These include antioxidants, colourants, preservatives, sweeteners, emulsifiers, stabilisers, and thickeners.

Antioxidants

Food antioxidants have been shown to play a significant role in maintaining product quality, particularly in products containing fat, by preventing oxidative deterioration (Shahidi & Zhong, 2010). Antioxidants can be categorised as either natural or synthetic. Natural antioxidants encompass vitamins C (ascorbic acid), E (tocopherols), and carotenoids, while synthetic antioxidants include BHA (butylated hydroxyanisole), BHT (butylated hydroxytoluene), TBHQ (tert-butylhydroquinone), and propyl gallate (PG) (Carocho, Barreiro, Morales, & Ferreira, 2014) Synthetic antioxidants are extensively utilised in processed food products with a view to extending shelf life while preserving nutritional and sensory value. It has been demonstrated that elevated doses and prolonged exposure may have cytotoxic, genotoxic and potentially carcinogenic outcomes (Shahidi & Zhong, 2010). It has been reported that BHA and BHT are toxic to liver and kidney tissue, and that the metabolites of these compounds may produce cellular damage (Carocho et al., 2014). Propyl gallate (PG) is employed in the prevention of lipid oxidation and is considered safe within the limits stipulated by the European Food Safety Authority (EFSA) in 2015. It is acknowledged that a proportion of individuals may be susceptible to allergic reactions or induce skin sensitisation (Carocho et al., 2014). Within the legal framework of Turkey, the Turkish Food Codex governs the utilisation of these synthetic antioxidants, albeit with certain restrictions (TGK, 2017).

In addition to synthetic antioxidants, natural antioxidants have attracted significant attention due to their health-promoting properties and functional potential in foods. Natural sources encompass plant extracts from fruits, vegetables, spices, culinary herbs, and byproducts from agro-industrial processing, which are abundant in polyphenols, carotenoids, and vitamins C and E (Gutiérrez-Del-Río et al., 2021; Velázquez et al., 2021). These compounds have been incorporated into various food matrices, including meat, seafood, and chocolate, thereby demonstrating their ability to delay lipid and protein oxidation, extend shelf life, and preserve sensory qualities without adversely affecting product quality (Aubourg, 2021; Oancea, 2021). Furthermore, innovative techniques, including microencapsulation, nanoemulsion, and active packaging, have been applied to enhance the stability and bioavailability of natural antioxidants during processing and storage (Velázquez et al., 2021; Aubourg, 2021).

Colourants

Colourants are added to foods in order to provide appealing coloration, hide unattractive tones, stabilize homogeneity, and change the intensity or brightness of natural colors (Carocho et al., 2014). Colourants can be categorised as either synthetic or natural. Synthetic colourants include tartrazine, Sunset Yellow and carmoisine, while natural colourants encompass anthocyanins, betalains, carotenoids, chlorophylls and curcuminoids (Lo Wu et al., 2022; Vega et al., 2023).

Anthocyanins, the pigments responsible for the red to blue colouration observed in plants, have been the focus of extensive research due to their potential health benefits, including anti-inflammatory, antioxidant, and cardioprotective properties (Khoo et al., 2017). However, these pigments are susceptible to light, pH, and temperature fluctuations, which can compromise their stability and bioavailability (Khoo et al., 2017). Betalains are water-soluble pigments that impart red-violet to yellow-orange colours in beetroot, amaranth, and cactus fruits. Furthermore, they have been shown to possess potent antioxidant and antimicrobial properties, with the capacity to enhance food quality and potentially offer health benefits. Carotenoids, which vary in colour from yellow to red, are lipophilic fruit and vegetable pigments found in tomatoes and persimmons. They are renowned for their eye and cardiovascular protective properties (Vega et al., 2023). Finally, chlorophylls, the pigments responsible for the characteristic green colouration of leafy vegetables, have been demonstrated to possess both antioxidant and antimutagenic properties. As with the majority of natural pigments, chlorophylls are sensitive to light, heat, oxygen, and pH. These factors have the capacity to affect not only the colour stability of the pigments, but also their performance (Ferruzzi & Blakeslee, 2007).

Preservatives

Food preservatives are additives in foods that slow down the development of microorganisms and prevent chemical reactions such as oxidation to extend the shelf life and maintain the sensory and nutritive quality (Teshome et al., 2022). Food preservatives can be categorised into three distinct groups: natural, synthetic, and microbial preservatives. Each of these groups possesses a unique mechanism and function (Khama et al., 2024).

Natural preservatives include salt, sugar, vinegar, and plant extracts such as rosemary or green tea extracts. Salt and sugar perform a mechanism of reducing water activity that discourages microbial growth, whereas plant extracts may include polyphenolic compounds with antioxidant and antimicrobial properties (Prakash et al., 2017). Rosemary extract is used extensively in meat and oil-based food to prevent lipid oxidation and spoilage and contribute towards flavor stability (Lorenzo et al., 2021)

Synthetic preservatives such as sodium benzoate, potassium sorbate, and nitrates are commonly used to preserve foods like beverages, dairy products, bakery items, and meat products. Sodium benzoate prevents growth of yeast and mold in foods that are acidic in nature, e.g., soft drinks, while potassium sorbate works well for cheese, yogurt, and dried fruits (Warner et al., 2024).

The application of microbial preservatives, otherwise referred to as biopreservatives, involves the utilisation of beneficial microorganisms such as lactic acid bacteria, which are capable of producing organic acids, hydrogen peroxide, and bacteriocins. These substances have been demonstrated to be potent inhibitors of food spoilage microorganisms and foodborne pathogens, rendering them particularly well-suited for use in fermented foods or minimally processed foods. An example is nisin, a bacteriocin produced by Lactococcus lactis, which is extensively employed in the production of cheese and canned food to regulate Listeria monocytogenes (Putri et al., 2024).

Sweeteners

Sweeteners are food components incorporated to impart a product sweetness without including the caloric contribution of sugar, allowing for sugar reduction while maintaining palatability (Sylvetsky & Rother, 2018). They are present in the form of natural, artificial, or sugar alcohols with inherent functional properties and applications in beverages, baked foods, dairy foods, and confections (Goyal et al., 2010).

The natural sweeteners include stevia glycosides, monk fruit extract (mogrosides), and honey. Steviol glycosides from Stevia rebaudiana are utilized in bulk as beverages and desserts of high sweetness strength and zero-calorie properties, but with antioxidant activity (Goyal et al., 2010). Sugar alcohols such as xylitol, erythritol, and sorbitol are polyols that provide bulk and sweetness, reduce glycemic response, and can prevent dental caries (Bornet et al., 2002). Artificial sweeteners, including sucralose, aspartame, and acesulfame potassium, are chemically synthesized compounds in processed foods and beverages. They deliver intense sweetness at low doses to enable caloric reduction. Though usually perceived as harmless, research shows careful monitoring of their intake due to potential metabolic and gut microbiota effects (Magnuson et al., 2016).

Choice of sweetener is dictated by desired sweetness profile, stability under conditions of processing, and possible health effects (Sylvetsky & Rother, 2018). Similar to colorants and preservatives, sweeteners must also be subjected to safety testing, functional performance, and compatibility with the product matrix to gain consumer acceptance and regulatory approval (Goyal et al., 2010).

Emulsifiers, Stabilizers and Thickeners

Emulsifiers, thickeners, and stabilizers are significant food additives that improve the texture, stability, and sensory characteristics of food products (Henao-Ardila et al., 2024). Emulsifiers reduce the interfacial tension between immiscible liquids (e.g. water and oil), enabling the formation and stabilisation of emulsions (McClements, 2015). They are typically added to foods such as ice cream, mayonnaise and salad dressing to prevent phase separation and maintain a uniform texture (Garti, 1999).

Stabilizers prevent undesirable change in food systems, such as sedimentation, crystallization, or phase separation. In dairy food like yogurt, stabilizers help to maintain products uniform and prevent syneresis, producing a smooth and uniform product (Lal, 2006).

Thickeners increase the viscosity of food without significantly altering its other properties. They are used in sauces, soups and beverages to provide the desired texture and mouthfeel (Saha & Bhattacharya, 2010).

Together, these additives play a vital role in ensuring product stability, quality and consumer acceptance (Henao-Ardila et al., 2024; McClements, 2015).

IMPACT OF FOOD ADDITIVES ON HUMAN HEALTH

Tartzarine

Tartrazine (E102) is a food additive commonly used to impart a yellow color to food and beverages. It is frequently used in various food products, including jams, potato chips, ice cream, cakes, and ready-made sauces (Rovina et al., 2017). The safety limit for tartrazine set by the Joint Expert Committee on Food Additives (JECFA) is ‘0-10 mg/kg bw’. Compared to other food additives, tartrazine has been documented to elicit a more pronounced allergic response (Dey et al., 2022). Furthermore, the potential carcinogenic effect of tartrazine preparations has also been highlighted, given the possibility of containing aromatic amines (Silva et al., 2022). A study examining the relationship between tartrazine and microbiota revealed that, when carp were fed 0.1, 5.5, and 10 mg/kg of tartrazine per day, tartrazine consumption led to alterations in gut microbiota at the branch and class levels.Notably, a reduction in Planctomycetota and Fusobacteriota was observed, accompanied by an increase in Proteobacteria and Actinobacteriota following tartrazine consumption (Lo Wu et al., 2022). In another study, tartrazine, at concentrations of 0.45 and 4.5 mg/kg, was found to increase fetal resorptions and mortality. Skeletal malformations, such as the absence of sternebrae, coccygeal vertebrae, hind limbs, and ribs, as well as irregular rib formation, were also observed in fetuses. Additionally, tartrazine exposure resulted in cardiomegaly, hepatorenal damage, and splenic pigmentation in fetuses (Hashem et al., 2019). Furthermore, Cemek et al. (2014) documented alterations in copper and iron concentrations in the liver, kidney, and brain of rats exposed to tartrazine (Cemek et al., 2014).

Carmosine

Carmosine (E122) is defined as a synthetically produced azo dye. Carmoisin is derived from petroleum derivatives (Monisha et al., 2023). It belongs to the group of colourants and is generally used to give red colour to foods such as jelly and cheesecake. The safe daily intake recommended by the Joint FAO/WHO Meeting on Food Additives (JECFA) is 4 mg/kg bw/day. As stated by Subramaniyan et al. (2023), the administration of carmoicin at a dose of 20 mg/kg bw/day in mice resulted in the deterioration of brain tissue. This phenomenon was ascribed to an escalation in glutamate levels and a decline in antioxidant enzymes, including catalase and γ-aminobutyric acid (Subramaniyan et al., 2023). In a separate study, the toxic and carcinogenic effects of carmoicin were investigated. Significant liver exposure and abnormal functions of vital organs were observed in mice following oral administration of four doses of the compound over a 120-day period. Consequently, it was determined that carmoicin increases the likelihood of overall hepatocellular damage at high doses and could potentially result in carcinogenesis (Reza et al., 2019).

Sodium Benzoate - Benzoic Acid

For commercial purposes, synthetically produced benzoic acid (E200) and sodium benzoate (E211) are substituted for the naturally occurring benzoic acid in various fruits, especially strawberries and plums. It is known to be used as a preservative in the food industry, especially in acid-containing sauces, pickles and carbonated beverages to stop the growth of microorganisms. The overabundance of benzoic acid has been demonstrated to degrade vitamin B1 in foodstuffs and render calcium insoluble, which may consequently impede the body's capacity to absorb calcium. Moreover, it has been reported that the long-term consumption of these preservatives may result in an elevated risk of cancer (Javanmardi et al. 2019). Sasaki et al (2002) investigated the genotoxic effect of benzoic acid (2000 mg/kg) in 8 mouse organs which are urinary bladder, stomach, kidney, lung, liver, colon, brain, bone marrow by using Comet test. As a result of the research, they found that benzoic acid did not cause DNA damage on organs (Sasaki et al., 2002). In a study conducted to investigate the effects of benzoic acid, human peripheral lymphocytes were cultured and chromosome abnormality test, micronucleus test, sister chromatid exchange test and Comet test were performed. As a result of the tests, it was observed that at 50, 100, 200, and 500 μg/ml concentrations of benzoic acid, the tested parameters increased significantly at almost all doses compared to the control group (Yılmaz et al., 2008). In another study, the effects of coloring and sodium benzoate on hyperactivity in children were investigated. Children were given a diet free of colorants and sodium benzoate for one week, while the others were given 20 mg of colorants and 45 mg of sodium benzoate daily for three weeks. At the end of the study, it was reported that hyperactive behaviors decreased when the additives were removed from the diet, and hyperactive behaviors increased again when these substances were given again (Bateman et al., 2004). In another study investigating the relationship between preservative additives sodium benzoate and sodium sulfite and obesity, a decrease in the secretion of leptin hormone, which is effective against obesity formation, was observed in mice given 10 mm and 20 mm sodium benzoate and 1 mm and 10 mm sodium sulfite. The fact that the leptin level was lower than it should be was estimated that these additives may be effective in predisposition to obesity (Ciardi et al., 2012).

Monosodium Glutamate

Monosodium Glutamate (MSG) is a flavor enhancer widely used in the food industry (Stańska et al., 2016). MSG is added to a wide variety of processed foods, including sausages, instant soups, jelly beans, and ready-to-eat items like French fries (Lo Wu et al., 2022). The safe dose of MSG for long-term daily use has not yet been established, however, the Food and Drug Administration views MSG as safe when taken in moderation (U.S. Food and Drug Administration, 2012). According to reports, MSG, which is used in Chinese restaurants to improve the flavor of the meal, may cause some people to experience negative symptoms including headaches, sweating, oedema, rash, and chest pain (Bawaskar et al., 2017). In a study conducted with Xenopus laevis embryos, it was found that embryo death and abnormalities increased with the increase in 120 mg/dL value of MSG applied, and it was also found that their length growth decreased compared to those in the control group (Boga Pekmezekmek et al., 2020). Celestino et al. carried out a study with 6 and 18 month old male mice to investigate the effects of monosodium glutamate on the kidney. Mice were given water (control group), sodium chloride (0.3%) or MSG (1%) in addition to their normal diet for 2 months. Proteinuria, hyperfiltration, increased activity and excretion of aquaporin 2 were observed in the sodium chloride group, while mice in the MSG group showed similar results to those in the water group. As a result, it has been reported that long-term administration of MSG to mice has a more harmless effect on the kidney than sodium chloride, but it is likely to cause hypertension in young mice (Celestino et al., 2021). A recent study found that monosodium glutamate damages male reproductive functions by causing oxidative damage in reproductive organs, histomorphological changes in testicular tissues, hormonal dysfunction, and decreased sperm quality (Oluwole et al., 2024).

Sweeteners (Saccharin, Aspartame, Acesulfame-K)

Saccharin is the first artificial sweetener discovered in 1878. It was also approved by the US Food and Drug Administration (FDA) in 1981 (Özdemir et al., 2014). The daily allowable intake is 5 mg/kg (Joint FAO/WHO Expert Committee on Food Additives, 2011) (Table 1). Despite its 300-500-fold greater sweetness compared to sucrose, it has been observed to leave a bitter taste in the mouth. The substance's resistance to high temperatures renders it suitable for use in a variety of culinary applications, including hot beverages, reduced-sugar jams, baked goods, and canned vegetables. It is a widely utilised sweetener, particularly among diabetic patients, due to its non-digestive nature. A study by Amin et al. (2016) and Mitsutomi et al.

(2014) revealed that 85-95% of the sweetener is absorbed in the small intestine, reaches the kidneys, and is excreted in the urine. The findings of the research undertaken by Toews et al. suggest that exposure to a 5-day diet containing commercial saccharin resulted in glucose intolerance being observed in half of the healthy subjects. This is anticipated to elevate the likelihood of future metabolic disease. In addition, studies have indicated that individuals who consume low-calorie sweeteners exhibit elevated glycosylated hemoglobin values (Toews et al., 2019).

Aspartame is a sweetener food additive approved by the FDA with the number E95. It has 200-300 times more sweetness than sucrose (Czarnecka et al., 2021). Aspartame, which is a white and odorless powder, is not heat resistant and loses its flavor when heated. Therefore, it is not suitable for cooking (Magnuson et al., 2007). The daily acceptable value is 40 mg/kg dose (Joint FAO/WHO Expert Committee on Food Additives, 2011) (Table 1). Since phenylalanine metabolite is formed as a result of the metabolism of aspartame, people with phenylketonuria (PKU), a hereditary disease, should not consume foods containing aspartame (Chattopadhyay et al., 2014). It is frequently used as a sweetener by the beverage industry (Kroger et al., 2006). In a long-term study conducted on rats to investigate the carcinogenic effects of aspartame, an increase in the incidence of leukemia, renal, lymphoma, and ureteral carcinomas was detected in rodents given different amounts of aspartame. They achieved this result even at doses below the maximum daily intake recommended in America and Europe (Haighton et al., 2019).

Discovered in 1967 and approved in 1988, acesulfame is 200 times sweeter than sucrose. It is generally used to increase the sweetness of foods and preserve their flavor. Since it is heat-resistant, it may also be used in cooking and baking. Acesulfame is not metabolized by the human body and has no calories. When used alone, it may leave a slightly bitter taste in the mouth, similar to saccharin, and is usually used with other sweeteners (Kroger et al., 2006). Animal studies have shown that acesulfame potassium consumed by pregnant women during pregnancy crosses the placenta. This suggests that acesulfame potassium consumption during pregnancy may increase the baby's perception of sweetness and increase the risk of obesity. It has also been stated that by-products of acesulfame potassium may cause DNA damage by causing breaks in DNA chains (Moriconi et al., 2020). The table below shows the acceptable daily intake and threshold doses of acesulfame potassium and some food additives that do not cause side effects (Table 1).

Table 1. Quantities of Food Additives

Food Additives	Acceptable Daily Intake	Threshold Dose for No Adverse Effects
Monosodium Glutamate	30 mg/kg	3200 mg/kg
Carmoisine	0-4mg/kg bw/day	400 mg/kg bw/day
Sodium benzoate	0-0.7 mg/kg	500 mg/kg bw/day
Acesulfame K	0-9 mg/kg bw/day	900 mg/kg bw/day
Aspartame	0-40 mg/kg bw/day	Not specified
Saccharin	0-5 mg/kg bw/day	500 mg/kg bw/day
Tartzarin	0-10 mg/kg bw/day	100 mg/kg bw/day

Kg:kilogram Mg: milligram Bw: body weight

Source: Joint FAO/WHO Expert Committee on Food Additives. (2011). *Evaluation of certain food additives and contaminants: Seventy-fourth report of the Joint FAO/WHO Expert Committee on Food Additives* (WHO Technical Report Series No. 966, pp. 1–210). World Health Organization.

CONCLUSIONS

Food additives, with their long history in human society and crucial role in modern food systems, remain vital in ensuring food safety, extending shelf life, and enhancing sensory and technological qualities. The range of their applications, which includes colourants, preservatives, sweeteners, stabilisers and emulsifiers, attests to their diverse functions and importance in meeting the needs of industry and consumers. Furthermore, regulatory frameworks such as those established by the Joint FAO/WHO Expert Committee on Food Additives (JECFA), the Codex Alimentarius, and governments play an important role in safeguarding public health through the evaluation of risks, toxicological investigation, and establishment of acceptable daily intake.

Notwithstanding their manifest advantages, food additives remain the subject of scientific debate and public concern. A mounting body of evidence underscores the conclusion that, while the majority of additives are deemed safe within their stipulated parameters, the presence of elevated or persistent levels of certain compounds has the potential to compromise human health, giving rise to a range of adverse outcomes, including allergic reactions, metabolic diseases, and even carcinogenicity. The paucity of extant studies necessitates the conduct of more comprehensive, well-designed clinical trials to complement information derived from in vitro and animal studies.

Concurrently, the mounting demand for clean-label and natural source additives underscores the evolving consumer preference towards transparency, sustainability, and perceived healthiness. This trend poses a significant challenge to the food industry, requiring innovation to replace synthetic chemicals with natural alternatives without compromising on food quality or safety.

Finally, the use of food additives necessitates an integrated approach encompassing technological performance, nutritional value, regulatory management, and consumer trust. It is imperative that future research endeavours encompass the elucidation of the health ramifications associated with prevalent food additives. This undertaking should be complemented by the exploration of the development of safer and more natural alternatives, in addition to the reinforcement of global regulatory convergence. It is evident that the food industry has the capacity to optimise the role of additives in a manner that is conducive to this process.

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