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A Review of Food Additives from Definition and Types to the Method of Analysis

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Abstract

Food additives have been used by man since the earliest times. The safety of food additives is an important issue related to the food industry, so the use of additives in food should be controlled by laws in many countries. For example, in the United States, Congress has entrusted the Food and Drug Administration with the responsibility to ensure that additives to be used in food are safe, thus a new food additive must be approved by Food and Drug Administration before it can be used in food. At present, there are up to 2500 food additives being used worldwide. A large number of studies have confirmed that consuming excessive amounts of synthetic food additives may cause gastrointestinal, respiratory, dermatologic, and neurologic adverse reactions. There is a current worldwide interest in finding new and safe additives from natural sources such as plants, animals, and microorganisms to enhance and prevent the deterioration of food. Additives should be continuously checked by regulation. Currently, liquid, gas, and mass/liquid chromatography are the major types of chromatography used in conventional detection techniques for testing food additives.

Keywords: Food additives, Acceptable daily intake, Regulation, Assessment, and analysis of food additives.

1. Introduction:

There is no way to survive without eating; thus, this commodity is of the biggest significance for the well-being of every man and woman. Although the desire to eat has remained constant throughout history, the manner in which humans consume food has undergone significant changes **(Carocho et al., 2015).** As more people become aware of the crucial connections between food and health, food safety is drawing more attention globally **(Ghany., 2015).** For a person to survive, safe food that meets all of their requirements must be available and consumed **(Shahmohammadi et al., 2016).**

Achieving food safety is critical to improving food security, which occurs when communities have access to enough nutritious food **(Ghany., 2015).** According to estimates, almost one-third of the population in affluent nations suffers from illnesses brought on by their diet. These disorders are caused by more than 250 microbiological, physical, and chemical causes. According to an estimate from the American Center for Disease Control in 2011, 128 thousand individuals are hospitalized each year for illnesses brought on by consuming contaminated food, and 3,000 people die away **(Shahmohammadi et al., 2016)**. The growing customer demand for preservative-free or natural preservative-free food products has driven the food industry to adopt herbal and microbiological preservatives instead of artificial preservatives in their manufacturing. **(Khorshidian et al., 2018).**

The definition of *food additive* has changed over time; the Codex Alimentarius defines it as "Any substance not usually used as a food itself and not used as a typical ingredient in the food" If they have nutritive value or not, they may be added to food for a technological or multipurpose such as organoleptic purpose in the manufacture, processing, preparation treatment, packing, packaging, transport, or holding of such food results. The definition does not include contaminants or substances added to food for keeping or improving nutritional qualities or sodium chloride **(Food and Agriculture Organization of the United Nations (FAO)., 2019).**

In addition, *food additives* refer to any trace compounds added to food or food processing to retain flavor or improve food flavor, appearance, or other consumer-desired attributes and features and preserving food safety. In the last 50 years, advances in food science and technology have resulted in the discovery of novel chemicals that may serve various purposes in diets. These easily accessible food additives include emulsifiers in butter, sweeteners with low-calorie items, and a greater variety of antioxidants and preservatives that prevent product decomposition and rancidity while preserving quality **(Ghany., 2015).**

The usage of dietary additives has expanded dramatically over the last three decades, reaching over 200,000 tons annually. It is believed that 75 percent of the modern diet consists of processed food products. Each individual consumes between 3.6 and 4.5 kilograms of food additives yearly; however, these levels may be significantly higher **(Zengin et al., 2011).**

There has been a rising interest in returning to the use of natural additives, regardless of the fact that synthetic food additives are permitted in many countries that demands the investigation of alternative sources of natural additions that are secure, efficient, and acceptable has been increased over years. Food additives have several issues to be taken in considerations, including their misuse, overuse, and even hazardous additions **(Wu et al., 2021).** The Joint FAO/WHO Expert Committee on Food Additives (JECFA) has been meeting yearly since 1956 to assess additives' safety and modify and set its safety criteria so that we may consider food safety a global concern. Consumers nowadays are aware of the health risks associated with food additives, making them increasingly attracted to "natural" as well as "traditional" foods that have been produced without the use of chemical preservatives **(Balciunas et al., 2013).**

Due to various effects, food additives from different groups may be conflicted. To regulate food additives and inform consumers, they have been categorized and allocated unique numbers in various countries. The European Union numbering system assigns each additive a unique number comprised of an "**E**" (indicating Europe) and a particular number used for all authorized additives in Europe. The Codex Alimentarius Commission has approved and expanded this numbering system to universally identify all additives, independently of whether they are allowed for usage (Codex Alimentarius Commission 1989). This numbering technique makes it simple to divide the additives into groups according to their function. **(Figure1) (Wu et al., 2021).**

Clearly, food additives may provide consumers with considerable sensory pleasure and commercial convenience and pose serious health hazards. Therefore, it is crucial to undertake a quantitative investigation into the concentration of food additives.

2. Classification of food additives:

To date, almost over 25,000 compounds of food additives have been utilized worldwide (Anderson1986).

2.1. According to the compositions:

2.1.1. Natural additives:

The general population and food manufacturers have become increasingly interested in natural food additives. Purifying the components from plant or animal sources is one way to get them. In general, consumers will choose foods without additives. However, if these are not provided, they will, if feasible, select foods with natural additives over those with synthetic ones **(Carocho et al., 2014).** Natural additives are not specifically categorized; in the EU, they fall under the same "**E**" categorization **(EC., 2011).** The primary types of natural food additives are shown in **(Figure1) (Carocho et al., 2015).**

2.1.2. Synthetic additives:

It is derived from chemical raw materials by them organic or inorganic substances may be separated and purified.

2.2. According to their functions:

2.2.1. Preservatives:

Preservatives are naturally or synthesized compounds applied to vegetables, fruits, processed food, beauty products, and medicines to improve shelf life and preserve quality and efficiency by preventing, delaying, or stopping fermentation, acidification, microbial activity, and breakdown **(AOAC Official Method 970.33., 2015).** Preservatives are also used to control or suppress food spoiling caused by contamination with fungus, bacteria, and microorganisms and to achieve food safety for a longer period **(Carocho et al., 2018).**

Following EU law, preservatives are food additives that prevent the activity of microorganisms (fungi and/or germs) and thus increase the shelf life of the food **(Silva & Lidon., 2016).**

- **Preservatives are split into two major categories:**

2.2.1.1. Natural food preservatives:

Before introducing preservatives, food was stored in clay jars to prevent spoilage. Food storage maybe dates back to early Egyptian, Greek, Roman, Sumerian, and Chinese civilizations. As most germs and fungi need moisture to develop, drying food was a common preservation technique. Fruits, vegetables, and meats were mostly dried for preservation purposes. The early preservatives included sugar and salt, which created food conditions with high osmotic pressure, denying bacteria the aquatic environment they need to survive and multiply. As high-sugar solutions, jams and jellies are preserved, while many types of meat (such as hams) and fish are still salted. Spices were also employed to preserve food by the Eastern Civilizations of India and China. Pickling vegetables with salt, vinegar, lemon juice, or mustard oil was a common preservation technique. Canning, in combination with pasteurization, revolutionized food preservation in the early nineteenth century **(Anand, S.P. and Sati., 2013).** Also, salt, sugar, and vinegar can be used as natural food preservatives **(Pongsavee., 2015a).**

2.2.1.2. Artificial food preservatives:

It is the most efficient method for long-term preservation **(Pongsavee., 2015a).** Current toxicological investigations suggest that certain levels and/or prolonged usage of synthetic preservatives may be significantly mutagenic **(Di Sotto et al., 2014).** Natural chemicals with antimicrobial and antioxidant action are being investigated as alternatives to commonly used artificial preservatives, lowering their quantity in foods and their potential health hazards **(Ramalho & Jorge., 2006).**

Preservatives that are often used are discussed in **(table 1).**

2.2.2. Antioxidants:

There is a similarity between preservatives and antioxidants since they contribute to food preservation. Antioxidants primarily avoid or minimize food deterioration by preventing or inhibiting oxidation **(Lorenzo et al., 2018)**. Natural antioxidants are often used in producing meat, fish, nuts, vegetables, fruits, drinks, and canned foods.

Artificial antioxidant that are often used are discussed in **(table 1)**

2.2.3. Sweetener:

Sweetener, often known as a sugar replacement, is an ingredient in food that imparts a sweet flavor similar to sugar but has zero or very few calories **(Martyn et al., 2018).**

In the late 1800s, non-nutritive sweeteners (**NNSs**), also called non-artificial sweeteners or high-intensity sweeteners (e.g., saccharin), were brought into the food supply. The Food Additives Amendment of the Federal Food, Drug, and Cosmetic Act of 1958 first authorized their use as a food additive **(Martyn et al., 2018)**. NNSs make meals and drinks more palatable without adding more calories to them. It has been suggested that the sweeteners' low-calorie content may aid in weight reduction **(Baker-Smith et al., 2019).**

Artificial sweetener that is often used described in **(table 1).**

2.2.4. Colorants:

Colorants are food additives that restore colors lost during food preparation, improve flavor perception, or make food more visually appealing **(Coultate & Blackburn., 2018).**

- **Colorants present in two forms:**

2.2.4.1. Natural food colors:

Refers to naturally occurring colors derived from plants, animals, or minerals. For example, curcumin is mostly used to color foods such as drinks and sauces **(Wu et al., 2021).**

2.2.4.2. Synthetic food colors:

Additionally known as artificially produced fake food colors, quinoline yellow is used to color beverages, ice cream, desserts, and cold fruits.

Food coloring that is often used is discussed in **(table 1).**

2.2.5. Emulsifiers, stabilizers, thickeners, and gelling agents:

Since some of the food additives' activities overlap, thickeners and gelling agents have almost the same functions **(Abid et al., 2018).** Therefore, under the **E-number** categorization, emulsifiers, stabilizers, thickeners, and gelling agents are grouped into one category from E400 to E499 **(Figure1).** *Emulsifiers,* also known as emulgents, are used in creams and sauces, baked goods, and dairy products to link the competing elements in water and oil. Polyglycerol esters are examples of emulsifiers **(McClements & Jafari., 2018).**

Stabilizers are compounds or chemicals that enable incompatible food components to stay in a homogeneous form after combining **(Tekin Pulatsü et al., 2017).** Agar, alginic acid, and its sodium, potassium, ammonium, and calcium salts are major food stabilizers.

Thickeners or *thickening agents*, such as pectin, are chemicals added to food products to increase viscosity without affecting other attributes, such as flavor.

Gelling agents such as konjac, karaya gum, and gellan gum are used in foods to provide certain structure, flow, stability, and eating features that customers want **(Wu et al., 2021).**

Widely used stabilizing, thickening, and gelling agents and emulsifiers are mentioned in **(table 1).**

2.2.6. Glazing agents and flavor enhancers:

Other ingredients in this group, like glazing agents, have additional purposes of enhancing whipping, leavening, and color persistence. Shellac is an example of a glazing agent **(Teixeira., 2018).** In addition, food flavor enhancers like monosodium glutamate and guanylic acid work to improve the taste **(Abdel-Moemin et al., 2018).**

Typical Glazing Agents and Flavor Enhancer Mentioned in **(table 1)**

3. Advantage of additives:

3.1. The food industry commonly employs food additives to extend product shelf life and improve foods' specific properties **(Bruna et al., 2018).**

3.2. In addition to serving as a means of food preservation, food additives also aid in improving the nutritional value of food by enhancing its color, flavor, and flexibility **(Wu et al., 2021).**

3.3. Assist in preventing contamination that might result in foodborne illnesses, such as lethal botulism **(IFIC & FDA., 2010).**

3.4. Healthy food Nutrient enhancers may be added to compensate for nutrition lost during food preparation, preventing malnutrition and nutrient deficit and improving nutrition balance. Many foods have added vitamins, minerals, and fibers to compensate for those missing in a particular food or lost during manufacturing or to improve the nutritional value of a product **(Wu et al., 2021).**

3.5. Preservatives suppress the development of molds, yeasts, and bacteria in sauces, beverages, and juices, among other goods

(Türkoğlu., 2007).

3.6. Antioxidants may avoid or reduce the deterioration of food caused by unstable particles and free radicals**(Wu et al., 2021)**.

3.7. Antioxidants inhibit rancidity and off-flavor development in fats, oils, and meals containing them. Additionally, they keep fresh foods like apples from browning if exposed to the air **(FAO/WHO Expert Committee on Food Additives., 2016)**

3.8. Foods' expected texture and consistency are provided by emulsifiers, stabilizers, and thickeners **(Silva & Lidon., 2016)**

3.9. During baking, leavening chemicals cause produced goods to **(FAO/WHO Expert Committee on Food Additives., 2016).**

3.10. While some substances assist preserve the flavor and attractiveness of meals with low fat content, certain additives help regulate the acidity and alkalinity of foods **(Pongsavee., 2015b).**

4. Disadvantages of Food additives:

4.1. Despite their widespread usage, they are compounds that, like any other medicine, may cause adverse effects such as allergic reactions, behavioural abnormalities, and carcinogenic effects (Abdel-Moemin et al., 2018)

4.2. Abnormal responses in the gastrointestinal, respiratory, dermatologic, and neurological systems may result from excessive doses of synthetic food additives (Wuthrich., 1993).

4.3. When taken over the ADI, some preservatives, notably antimicrobial compounds, may be toxic and genotoxic as well as induce urticaria and behavioural disorders such as hyperactivity and Attention-deficit/hyperactivity disorder (ADHD) (Gören et al., 2015).

4.4. Children that consumed too much sodium benzoate were hyperactive, had urticaria, and their Deoxyribonucleic Acid (DNA) was also severely harmed (DNA) (Zhang & Ma., 2013).

4.5. Potential health risks from high dosages of propyl gallate include apoptosis and DNA breakage (Vikraman et al., 2013).

4.6. It was noted that butylated hydroxy anisole enhanced the likelihood of fore stomach hyperplasia and that the greater dosage significantly increased the likelihood that rats would develop papilloma and squamous cell cancer (Wu et al., 2021).

5. Regulation of food additives:

Many additives are widely utilized and serve to improve the quality of food. However, most food safety accidents result from illicit activity, particularly the misuse and unlawful use of food additives, which has sparked global alarm. Consequently, legislation and monitoring additives are the two most efficient means of standardizing market activity and enhancing safety. We must ensure that only safe additives are used in foods. Therefore, several regulations on the safety of food additives should be addressed in order to bring new, safer chemicals and eliminate those of dubious safety **(Wu et al., 2021).**

- Food additives regulations among different countries:

a. The United States:

The United States has classified compounds intentionally added to processed food into four categories: **(food additives, coloring agents, pre-approved substances, and GRAS substances).** *Food additives* are compounds added to food to be a part of or alter its qualities. Therefore, compounds intended for use in food production, manufacture, packaging, processing, or transportation may be termed food additives **(Wu et al., 2021).**

b. The European Union:

Eu defines *food additives* as compounds that are not typically ingested as food but are introduced purposely for technical reasons. However, compounds without a technical function employed to give flavor, nutrition, or both should not be considered food additives. The approval procedure for novel additives needs premarket applications that include administrative, toxicological, risk assessment, and management data **(Wu et al., 2021).**

c. China:

In Chinese food regulation, *food additives* are defined as chemosynthetic and natural compounds present in food to enhance its quality, color, aroma, and flavor or even to preserve food and process technology. Food additives include coloring agents, sweeteners, flavoring agents, preservatives, antioxidants, processing acids, nutritive additives, and gum-based compounds**(Wu et al., 2021).**

d. Australia and New Zealand:

In the food rules of Australia and New Zealand, food additives are differentiated from processing acids and nutritional ingredients. The food additives are non-edible compounds added to food to fulfil technical purposes; the by-products may stay in the final food product **(Wu et al., 2021).**

6. Assessment of food additives:

Illegal food additives or the misuse of food additives are typically evaluated in two ways: constituent identification and content estimation under laws, regulations, and standards. The first seeks to determine if additives are being used unlawfully, and the second seeks to determine whether additives are being used excessively. From this perspective, identifying food composition and additive content is a crucial problem in informing legislation and guaranteeing the population is fed with safe food consequently, it is crucial to develop sensitive and trustworthy analytical techniques for examining food additives **(Figure2)**.

Numerous international and national organizations that deal with food safety and consumer safety, such as the Joint Expert Committee on Food Additives **(JECFA)** of the Food and Agriculture Organization **(FAO)**/World Health Organization (**WHO),** the US Environmental Protection Agency (**US-EPA),** the **FDA,** the European Food Safety Authority **(EFSA)**, and the European Chemicals Agency (**ECHA),** have conducted human risk assessments of additives for large numbers of substances over the past 50 years **(Ghany., 2015).**

The international evaluation of food additives is supported by the Acceptable Daily Intake (ADI) regulatory system, which was designed by the Food and Agriculture Organization of the United Nations **(JECFA., 2017).** Awareness of the potential toxicological concerns posed by frequent and/or excessive exposure to these compounds is essential. ADI is described as a quantitative measure of the additive that a person may consume every day without posing a danger to their health, assessed in proportion to body weight. It has been designed to safeguard consumers against potential harmful health impacts **(Türkoğlu., 2007).**

A food additive or its derivatives must undergo testing and a proper toxicity evaluation in order to evaluate any potential negative effects **(Food and Agriculture Organization of the United Nations (FAO)., 2019).** Every food additive should continue to be monitored and evaluated as necessary, taking into account the use circumstances and any new scientific.

7. Analysis of additives:

Currently, liquid, gas, and mass/liquid chromatography are the major types of chromatography used in conventional detection techniques for testing food additives. Although these techniques exhibit benefits like great sensitivity, excellent stability, and repeatability, they have drawbacks like professional operations, sample pre-treatment, a relatively lengthy test duration, and high cost **(Taghdisi et al., 2019).** In addition, spectrophotometry, such as Uv-vis absorbance and fluorescence spectroscopy, has easy operation and high sensitivity, but stability is a major problem **(Nguyen & Waterhouse., 2019).** High-performance capillary electrophoresis is characterized by ease of processing, good accuracy, and sensitivity but needs electrophoresis paint of superior quality **(Papetti & Colombo., 2019).** Ion chromatography has recently been widely employed in examining of food additives because it can detect small amounts of components even at high concentration of substrate, simplifying or eliminating the sample pre-treatment procedure and achieving detection of numerous components.

Numerous newly developed analytical techniques, including lateral flow immunoassay (LFIA), enzyme-linked immunosorbent assay (ELISA), fluorescence assay, electrochemical or electroluminescence assay, surface enhanced Raman spectroscopy (SERS), and their associated biosensors, have been developed to analyse food additives, greatly improving the performance of the analytical techniques. These recently created techniques are capable of detecting food additives both quantitatively and qualitatively, quickly, with great sensitivity, and with excellent specificity.

Previously method for analysis of some additives are shown in **(table 2).**

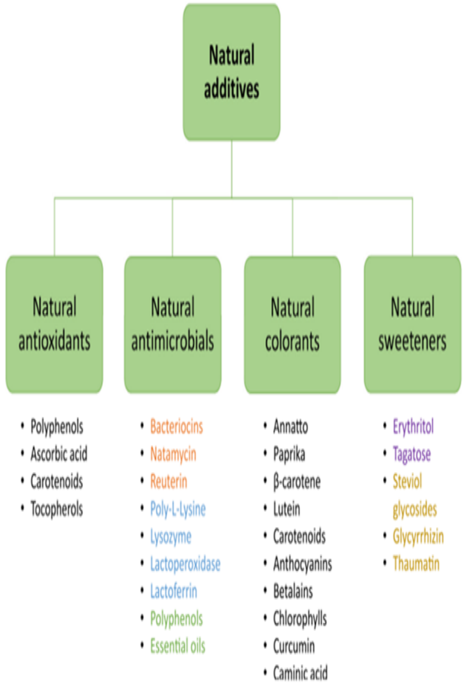

Figure 1: The most prevalent additives are shown by category.

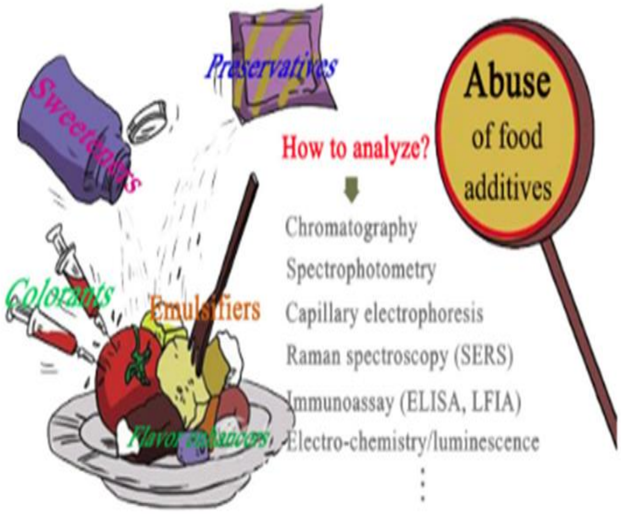

Figure 2: The plan for the misuse of food additives and the associated analytical procedures

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Table 1: Types of food additives

Category	Sub Category	E-number	Mainly Used	Maximum dosage range (mg/kg bw)
Preservatives	Natural preservative	Nisin (E234)	Canned foods, coffee, tea, soy sauce, and meat and dairy items	0.15 - .5
		Natamycin (E235)	Cake, cheese, yoghurt, raw ham, and dry sausage	< 0.1
		Lysozyme (E1105	Products made from cheese, drink, infant food, pork, and seafood	—
	Artificial preservative	Sorbic acid (E200) and potassium sorbate (E202)	Aquatic goods, dairy products, soy products, processed veggies, and prepared meat items	0.075 - 2.0
		Benzoic acid (E210) and sodium benzoate (E211)	A variety of condiments, pickled goods, alcoholic beverages, and fruit wines	0 - 5
		P-hydroxybenzoates (E214-219)	Products such as preserves and sauces, as well as carbonated beverages	0.012 - 0.5
		Sodium nitrite (E250)	Items made from soybeans and meat, products made from fish and seafood, baked goods and puffed snacks	1.0 - 10
		Propionic acid (E280)and sodium propionate (E281)	Soybean products, wet flour products, bread, pastry, vinegar and soy sauce.	0.25 - 2.5
Antioxidant		Ascorbic acid and its salts (E300-302)	Fresh fruits and vegetables, wheat flour, and fruit goods	0.2 - 5.0
		Propyl gallate (E310)	Nuts and candies, grilled meat, fried noodles,snacks	0 - 1.4

Cont. Table 2: Types of food additives

Category	Sub Category	E-number	Mainly Used	Maximum dosage range (mg/kg bw)
Antioxidant		Tocopherol (E306) and its geometric isomers (E307-309)	Fish, poultry, and other seafood products; nuts; vegetables; fruits; juices; and canned goods	—
		Tert-butyl hydroquinone (E319)	Mooncakes, quick noodles, biscuits, baked food fillings	0.2
		Butyl hydroxyanisole (E320)	Products with fat, oil, as well as coarse grain and instant rice noodles	0.5
		Butylated hydroxytoluene (E321), etc.	Fried noodles, gum-based candies, and air-dried fish and seaweed.	0.2 - 0.4
Sweeteners	Natural sweetener	Sorbitol (E420)	Products made from dairy, jams, wet flour, baked goods, drinks, and soybeans	0.5 - 30
		Mannitol (E421)	Candy, gum, and other sweets	0.2
		Thaumatin (E957), etc.	Candy, cookies, canned meat	—
		Stevioside (E960)	Fermented milk with flavors, candy, condiments, canned fruits, flavoured syrup, and tea product	0.17 - 10.0
		Maltitol, maltitol sirup (E965).	Soybean products and frozen fruits	—
		Lactitol (E966)	Cheese, Butter, Spices	—
		Xylitol (E967)	Milk products, tea products, alcoholic drinks, spices, starch products, and fruits and vegetables that have been processed.	—
	Artificial sweetener	Aspartame (E951)	Cereals, frozen fruits and vegetables, dairy products, and starch-based desserts.	0 - 40
		Sucralose (E955)	Prepared dairy products, jams, products made with coarse cereals, baked goods	0.25 - 5.0

Cont. Table 3: Types of food additives

Category	Sub Category	E-number	Mainly Used	Maximum dosage range (mg/kg bw)
Sweeteners	Artificial sweetener	Cyclamate (E952)	Canned fruits and vegetables, jams, mixed wine, food mixes for instant noodles, and other condiments.	0.65 - 8.0
		Saccharin and its salts (E954)	a variety of frozen beverages, dried fruits, dehydrated mangos, and dried figs	0.15 - 5.0
		Neotame (E961)	Cereals, frozen fruits and vegetables, dairy products, and starch-based desserts	0.01 - 0.35
Colorants	Natural food colors	Natural carotene (E160a	Milk, frozen drinks, processed fruits, dried vegetables, and products made from soybeans	—
		Anthocyanins (E163)	Products such as jams and jellies, as well as soft drinks and sodas	—
		Curcumin (E100)	Confectionery, beverages, and sauces	< 0.01
		Canthaxanthin (E161g)	Tanning pills, fruit spreads, candies, syrups, condiments, and carbonated beverages	0.001 - 0.03
	Artificial food colors	Tartrazine (E102)	Products such as soups, sauces, ice creams, ice lollies, sweets, chewing gum, marzipan, jam, jelly, and marmalade, mustard yoghurt, and ice lollies	0.015 - 0.018
		Ponceau 4R (E124)	Beverage, soda, soya drink, , ice cream, yogurt wine, candy, pastry	0.001 - 0.01
		Allura red (E129)	Candy coating, jelly, biscuit sandwich, meat enema, fried chicken, western ham	0.004 - 0.0085

Cont. Table 4: Types of food additives

Category	Sub Category	E-number	Mainly Used	Maximum dosage range (mg/kg bw)
Colorants	Artificial food colors	Quinoline yellow (E104)	Products such as frozen fruits, dairy ice creams, baked goods, chocolate, bread, cheese sauces, and beverages	< 0.1
		Sunset yellow FCF (E110)	dairy products, jams, starch desserts cocoa products, beverage products, compound condiments,	0.005 - 0.0887
		Carmoisine (E122)	ice cream, green plum, beverage, wine, candy, bayberry	0.005 - 0.015
(Emulsifiers, stabilizers, thickeners)		Polyglycerol esters (E475	Soy milk drinks, chocolate, toffee	5 - 10
		Sorbitan esters (E491-495)	Milk, breads, cakes, soya products biscuits, , dried yeast, drinks ice-creams	0.05 - 10
		Sodium alginic acid (E400)	Milk products, margarine, cheese, freezing drinks	10
		Agar (E406)	Ice cream, dairy products, low-fat spreads, mayonnaise, salad dressings	
		Pectin (E440)	Jam, candy, jelly, yoghurt, cheese sauce,	3.0
		Gelling gum (E418)	Pudding, drinks, jelly, jam products	
Flavor enhancers		Monosodium glutamate (E621)	Soup, canned food, sausage, puffed food, jelly chili sauce,	0.2 - 0.5
		Guanylic acid (E626)	Meat, bacon, ham, soy sauce, food condiments	0.5
Glazing agents		Carnauba wax (E903)	Candy, baked goods, dried food, sugar products, marshmallows, fruit,	
		Shellac (E904)	Apples, roasted coffee, wafer biscuits, gum sugar base, chocolate	0.2

Table 5: Method for additives analysis

Additives	Method	Reference
Tartrazine , Sunset Yellow , Allura Red, Carmoisine , And Brilliant Blue	Rp-HPLC–DAD UPLC-MS/Ms	(Hameed et al., 2022)
acesulfame-K (ACE-K), saccharin (SAC), aspartame (ASP), alitame (ALI), neohesperidin dihydrochalcone (NHDC), rebaudioside-A (RBA) and neotame (NEO)	HPLC-DAD using a core-shell particle column	(Sezgin et al., 2021)
colorants (Tartrazine – TT, E102; Sunset Yellow FCF – SY, E110; Ponceau 4R – 4R, E124; Allura Red AC – AR, E129; Brilliant Blue FCF – BB, E133; Brilliant Black BN – BC, E151) and preservatives (sodium benzoate E211 – SBe, potassium sorbate E202 – PSo	High Performance Liquid Chromatography and capillary electrophoresis methods evaluated using the red-green-blue model	(Nowak,, 2020)
Monosodium Glutamate	HPLC method With Ultraviolet/Diode Array detection	(Soyseven et al., 2021)
Benzoic Acid	Microfluidic Paper-based chip platform	(Liu et al., 2018)
Tert-Butylhydroquinone, Propyl Gallate, and Butylated Hydroxyanisole	Flow-Injection Analysis with multiple-pulse Amperometric detection	(Bavol et al., 2018)
Nitrite and Nitrate In Vegetable	HPLC	(Najdenkoska, 2016)
Formaldehyde In Food and Feed	HPLC	(Wahed et al., 2016)
Oxalic Acid, Tartaric Acid, Malic Acid, Ascorbic Acid, Lactic Acid, Acetic Acid, Citric Acid, Fumaric Acid	HPLC/DAD	(Kalkan et al., 2017)
(Butylated Hydroxyanisole and Butylated HydroxyTolune) In Pharmaceutical Preparations and Chewing Gums	Spectrophotometer	(Özgür et al., 2017)
Sodium Benzoate, Potassium Sorbate, and Natamycin	HPLC and Chemometric Analysis	(Zamani Mazdeh et al., 2017)
Methylparaben (Mp), Ethylparaben (Ep), Propylparaben (Pp), Isopropylparaben (Ipp), Bp, Ibp, Benzoic Acid, Salicylic Acid, Sorbic Acid , Eydroacetic Acid And Phenoxy Ethanol	HPLC	(Aoyama et al., 2014)
Hexamethylenetetramine	High-Performance Liquid Chromatography	(Lim et al., 2014)
(Oxalic, Citric, Tartaric, Malic, Ascorbic And Lactic Acids	HPLC	(Nour et al., 2010)
(Butylated Hydroxyanisole and Butylated Hydroxy Toluene, ad tert butyl hydroquinone	Reversed Phase HPLC -Uv	(Shasha., 2014)
Benzoic Acid, Benzyl Alcohol and Parabens (Hydroxybenzoates).	Subcritical Water Chromatography	(Yang et al., 2012)
Nitrite, Phosphates, Lead And Cadmium	Spec-Trophotometer (Unico-Uv-2100 Spectrophotometer, Usa	(Maky et al., 2020)

Cont. Table 6: Method for additives analysis

Additives	Method	Reference
Propyl Gallate (Pg), Octyl Gallate (Og), 2-And 3-Tert-Butyl-4-Hydroxyanisole (Bha), 3,5-Di-Tert-Butyl-4-Hydroxytoluene (Bht) And Tert-Butylhydroquinone (Tbhq)	HPLC With Photodiode Array Detection	(Nour et al., 2010)
Patent Blue V, Quinoline Yellow, Brilliant Blue, Tartrazine, Azorubine Ponceau 4r, Curcumine, Indigo Carmine ,Cochineal , Methyl Violet, Mixed Carotenes, Plain Caramel, Erythrosine B ,Orange Yellow S, Aspartame , Acesulfame K, Sodium Cyclamine ,Benzoic Acid	Thin-Layer Chromatography	(Baranowska et al., 2004)
Glutamic Acid, Monosodium Glutamate	HPLC	(Populin et al., 2007)
Butylated Hydroxyanisole Tertiary Butyl Hydroquinone, 2,4,5-Trihydroxybutyrophenone, Di-Tertbutyl-4-Hydroxymethylphenol, Propyl Gallate, Octyl Gallate ,Nordihydroguaiaretic Acid and 4-Hexylresorcinol	High Performance Liquid Chromatography Time-Of-Flight Mass Spectrometry (Hplc/Tof-Ms)	(Xiu-Qin et al., 2009)
Benzoic Acid, Sorbic Acid And Four Para-Hydroxybenzoic Acid Esters (Methyl P-Hydroxybenzoate, Ethyl P-Hydroxybenzoate, Propyl P-Hydroxybenzoate, Butyl P-Hydroxybenzoate)	HPLC	(Nour et al., 2010)
F Acetaldehyde, O-Anisidine, Ascor- Bic Acid, Benzoic Acid, Butylated Hydroxyanisole, Butylated Hydroxy- Toluene, Butyraldehyde, Butyric Acid, Cinnamaldehyde, Fumaric Acid, Furfural, Lactic Acid, Lauric Acid, Maleic Acid, Dl-Malic Acid, 1- Octanol, Oleic Acid, Propionic Acid, Propyl Gallate, Salicylic Acid, Sodi- Um Benzoate, Sodium Nitrate, Sodium Nitrite, Sodium Sulfite, Sodium Tartrate, Sodium Thiocyanate, Sodium Thiosulfate, Sorbic Acid, Tar- Taric Acid, And Vitamin E Has	Thin Layers Of Titanium(Iv) Silicate Ion-Exchanger	(Ghoulipour et al., 2010)
L(+)-AscorbicAcid (Aa), Ascorbyl Palmitate (Ap), Dl-A-Tocopherol(C(T), Butyl Hydroxytoluene(Bht), Butylhydroxyanisole (Bha), Propyl Gallate (Pg), Octyl Gallate (Og) And Dodecyl Gallate (Dg).	HPLC	(Grosset et al., 1990)
Potassium Sorbate And Sodium Benzoate	HPLC And Comparison With Spectrophotometry	(Bahremand & Eskandari., 2013)
Aspartame And Sodium Saccharin	High-Performance Thin-Layer Chromatographic	(Yilmaz & Afşar., 2012)
Bha, Bht, Pg, Tbhq, Bisphenol (Bpa), Hexadecyl Trimethyl Ammonium Bromide (Ctab, 99%), Sodium Dodecyl Sulfate (Sds, 99%)	Enzymatic Biosensor Of Horseradish Peroxidase Immobilized On Au-Pt Nanotube/Au-Graphene	(Wu et al., 2016)

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