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Abstract

Purpose: The study focused on food additives and preservatives, their health and nutritional benefits, and their types and safety regulations, including flavourants. Food additives are substances which are added to food to preserve its flavor or enhance its appearance, taste, or other qualities.

Methodology: The systematic review evaluated the current updates and development in food additives and their applications in food industries and homes.

Findings: The food additives currently in use are added to food as emulsifiers, colorants, flavorants, nutrients, or preservatives. Preservatives inhibit the growth of yeasts, bacteria, and molds in foods. Food additives can be directly (intentional) or indirectly (unintentional) added. Foods may contain some residues of chemicals used during production of animal or plant crops, including growth hormones, pesticides, antibiotics, etc. The use of most food additives is visibly beneficial as it results in improved the public health and the prevention of spoilage, which enhances food supply. However, there is controversy over the use of some common food

additives. This is partly due to some individuals are hypersensitive and suffer allergic reactions if they are exposed to some of these chemical additives. Additionally, some individuals hold the belief that low levels of chronic toxicities and diseases might be caused in larger population by exposures to some of these chemical substances. There are many thousand food additives currently in use, all of which are designed to do specific function in making food safer, more nutritious, more appealing, or last longer.

Contribution to theory, practice, and policy: The study provides thorough and concise information on the major food additives that are currently used at home and food industries to preserve food flavor or enhance its appearance, taste, or other qualities.

Key words: *Food additives, Food preservatives, Health and safety of food additives, Types of food additives and preservatives, Flavourants.*

1.0 INTRODUCTION

Additives and preservatives have been in use in foods for centuries. When meats are smoked as means of preserving them, compounds such as butyl gallate and butylated hydroxyl anisole (BHA) are formed and provide both bacteriostatic and antioxidant effects. Salt has been in use as a preservative for centuries. Salt preserves by lowering the water activity (a_w) of meats and other foods as well as inhibits the growth of bacteria. Excess water in foods often can encourage the growth of microorganisms such as fungi and bacteria. Pickling, which involves addition of acids such as vinegar, lowers pH of foods to levels capable of retarding the growth of bacteria. Some herbs and spices, such as cinnamon, chili pepper, and curry, contain antioxidants and may offer bactericidal effects.

Food additives are substances which are added to food to preserve its flavor or enhance its appearance, taste, or other qualities. Some food additives have been under use for centuries, e.g., preserving foods by pickling with vinegar, brining or salting, as with bacon, preserving sweet or using sulfur dioxide as in wines. With the advent of many processed foods in second half of twentieth century, several more additives were introduced; both natural and artificial (or synthetic) origins. Also, food additives include the substances that may be indirectly introduced to foods (known as indirect additives) during the manufacturing process, by packaging, or during transport or storage (FDA, 2017; FDA, 2018). The US Food and Drug Administration (FDA) describes food additives as any substance, intended use of which results or might reasonably be expected to result, indirectly or directly, in its becoming a constituent or otherwise affecting characteristics of any food. The WHO stated that substances which are added to foods to improve or maintain the taste, texture, appearance, safety, or freshness of foods are known as food additives (WHO, 2018). Some food additives have been used for centuries for food preservation, such as salt in meats like bacon or dried fish, sulfur dioxide in wine, or sugar in marmalade. Food additives may also be used to confer a specific functional property in foods (Chinaza, 2019b; Chinaza *et al.*, 2019a). Over time, many food additives have been developed to meet the requirements of food production and food industries, as producing foods on large scale is quite different from making on a small scale at home or for household. Additives are required

to ensure the processed foods remain safe, in good condition, and fresh throughout its journey from the factories or industries, during the course of transportation to shops and warehouses, and finally to the consumers, who often look out for fresh, safe, nutritious, and wholesome foods.

The use of additives in foods is only justified when their use does not mislead consumers, has technological need, and serves well-defined technological function, such as to enhance the stability of the food or preserve the nutritional quality of the food. Food additives can be derived from animals, plants, or minerals, or can be synthetic. They are added to food intentionally to perform some technological purposes which the consumers often take for granted (WHO, 2018), or unintentionally added through food-package interactions or from other sources such as pesticides used in growing crops, mycotoxins such as aflatoxin, patulin (Chinaza *et al.*, 2019b) found in grains and other foods; also, some components such as methanol and ethyl carbamate (Igwe *et al.*, 2018a; Igwe *et al.*, 2018b) may be formed in some traditional beverages and become part of the foods. There are several thousand food additives in use, which are all designed to do specific job in making foods more appealing, safer, or nutritious. Bisphenols, perfluoroalkyl chemicals (PFCs), and phthalates are indirect additives used in packaging or manufacturing. In July 2018 the American Academy of Pediatrics (AAP) called for more study of Bisphenols, perfluoroalkyl chemicals (PFCs), and phthalates, along with food coloring and nitrates, as they might harm the children during development (American Academy of Pediatrics, 2018).

The safety assessments completed by the Joint Expert Committee on Food Additives (JECFA) are used by the Codex Alimentarius Commission, a joint intergovernmental body of the FAO and WHO that sets food standard, to establish the levels for maximum use of preservatives and additives in food and drinks (WHO, 2018). Codex standards serve as reference for national standards for the consumer protection, and for international trade in foods, so that consumers everywhere will be confident that the foods they consume meet the agreed standards for quality and safety, no matter where they were produced (WHO, 2018). Once a food additive is found safe for use by the JECFA and the maximum use levels established in Codex General Standard for Food Additives, the national food regulations require to be implemented permitting actual use of food additive. The use of food additives in the US is closely regulated by the governmental agencies responsible for health, agriculture, and consumer safety. This is also the case in other developed nations in Europe, Canada, etc. (Encyclopedia, 2020). Chemicals cannot be used as food additives in those countries except regulators are convinced, they have been shown to be toxicologically safe, with wide margin of security. Additionally, chemicals added to commercially made foods must be listed on packaging so that the consumers will know what is present in the foods they choose to eat (Branen, 2002; Encyclopedia, 2020; Clydesdale, 1997; Potter and Hotchkiss, 1995). As a result of the intrinsic nature of low-level, toxicological risk, especially those associated with the diseases that may take long time to develop, researchers and scientists are never able to show that trace exposures to any chemical or additive are absolutely safe—there is often a level of risk, no matter how small.

2.0 FOOD ADDITIVES AND PRESERVATIVES

2.1 The purpose of food additives

Direct additives are the food additives that are intentionally added to food for specific purpose. Indirect additives are the ones to which the foods are exposed to during processing, storing, or packaging. Preservatives are the additives that inhibit the growth of yeasts, molds, and bacteria in foods. In the US, food additives and preservatives play important roles in ensuring that food supply remains safe and abundant in the world. A major task of the US FDA is to regulate the use and the approval of thousands of approved additives for foods, and to evaluate their safety. Regardless of consumer concern about use of additives and preservatives in foods, there is very little or negligible scientific evidence that the levels at which they are used are harmful.

Table 1: Uses of food additives and preservatives

Type of ingredients	Typical examples of uses	Purpose	Names seen on product labels
Color Additives	Many processed foods such as candies, cheese, pie fillings, soft drinks, jellies, jams, snack foods margarine, gelatins, and pudding	Offset color loss as a result of exposure to temperature extremes, light, air, moisture and storage conditions; enhance colors that occur naturally; correct natural variations in color; provide color to the colorless and fun foods	FD&C Green No. 3, FD&C Blue Nos. 1 and 2, FD&C Red Nos. 3 and 40, FD&C Yellow Nos. 5 and 6, Citrus Red No. 2, Orange B, annatto extract, cochineal extract or carmine, beta-carotene, grape skin extract, paprika oleoresin, caramel color, saffron, fruit and vegetable juices NB: Exempt color additives are not needed to be declared by the name on labels but might be declared simply as color added or colorings
Fat Replacers	Baked goods, frozen desserts, confections, dressings, dairy products, cake and dessert mixes	Provide expected texture and creamy mouth-feel in the reduced-fat foods	Olestra, polydextrose, modified food starch, cellulose gel, carrageenan, guar gum, xanthan gum, microparticulated egg white protein, whey protein concentrate
Flavor Enhancers	Many processed foods	Enhance flavors already present in food (not providing their own separate flavor)	Monosodium glutamate (MSG), autolyzed yeast extract, hydrolyzed soy protein, disodium guanylate or inosinate

Flavors and Spices	Gelatin dessert mixes, pudding and pie fillings, cake mixes, candies, soft drinks, ice cream, salad dressings, BBQ sauce	Add specific flavors (both natural and synthetic)	Natural flavoring, spices, and artificial flavor
Preservatives	Fruit sauces and jellies, baked goods, cured meats, beverages, oils and margarines, dressings, snack foods, cereals, fruits and vegetables	Prevent food spoilage from molds, fungi, bacteria, or yeast (antimicrobials); maintain freshness; prevent or slow changes in color, texture, or flavor, and delay rancidity (antioxidants)	Ascorbic acid, citric acid, calcium propionate, sodium erythorbate, sodium benzoate, sodium nitrite, calcium sorbate, BHA, BHT, EDTA, potassium sorbate, tocopherols (Vitamin E)
Sweeteners	Beverages, baked goods, table-top sugar, confections, substitutes, many processed foods	Add sweetness with or without extra calories	Sucrose (sugar), fructose, glucose, sorbitol, mannitol, high fructose corn syrup, sucralose, corn syrup, saccharin, aspartame, neotame, acesulfame potassium (acesulfame-K)

Despite anecdotal reports of monosodium glutamate exacerbating asthma or triggering headaches, the JECFA of the UN FAO, the WHO, the American Medical Association (AMA), the European Community's Scientific Committee for Food (ECSCF), and the National Academy of Sciences (NAS) have all affirmed the safety of monosodium glutamate at normal consumption levels.

Table 2: Food additives and their uses

Types of ingredients	Typical examples of uses	Purpose	Names seen on product labels
Anti-caking agents	Salt, confectioner's sugar, baking powder	Prevent moisture absorption, powdered foods free-flowing	Calcium silicate, silicon dioxide, iron ammonium citrate
Dough strengtheners and conditioners	Breads, other baked goods	Produce more stable dough	L-cysteine, ammonium sulfate, azodicarbonamide
Emulsifiers	Salad dressings, peanut butter, margarine, chocolate, frozen desserts	Allow smooth mixing of ingredients, avoid separation, emulsified products stable, control crystallization, keep ingredients dispersed, help products dissolve more easily, reduce stickiness	Soy lecithin, egg yolks, polysorbates, mono- and diglycerides, sorbitan monostearate
Enzyme preparations	Cheese, dairy products, meat Enzymes, papain, lactase, rennet, chymosin	Modify proteins, fats, and polysaccharides	
Firming agents	Processed fruits and vegetables	Maintain firmness and crispness	Calcium chloride, calcium lactate
Gases	Oil cooking spray, carbonated beverages, whipped cream	Serve as propellant, create or aerate carbonation	Carbon dioxide, nitrous oxide
Humectants	Shredded coconut, soft candies, confections, marshmallows	Retain moisture	Glycerin, sorbitol
Leavening agents	Breads, other baked goods	Promote rising of the baked goods	Baking soda, calcium carbonate, monocalcium phosphate

Nutrients	Flour, cereals, rice, macaroni, breads, margarine, salt, milk, energy bars, instant breakfast drinks, fruit beverages	Replace micronutrients (vitamins and minerals) lost during processing (enrichment), add the nutrients which may be lacking in diet (fortification)	Thiamine hydrochloride, niacin, niacinamide, folate or folic acid, riboflavin (Vitamin B2), Vitamin D, beta carotene, iron or ferrous sulfate, potassium iodide, alpha tocopherols, ascorbic acid, amino acids (L-lysine, L-leucine, L-tryptophan, L-methionine)
pH Control agents and acidulants	Beverages, chocolate, low-acid canned foods, frozen desserts, baking powder	Control acidity and alkalinity, prevent spoilage	Citric acid, lactic acid, ammonium hydroxide, sodium carbonate
Stabilizers, thickeners, texturizers, binders,	Frozen desserts, dairy products, pudding and gelatin mixes, cakes, dressings, jams, jellies, sauces	Produce uniform texture, improve the mouth-feel	Gelatin, guar gum, carrageenan, pectin, xanthan gum, whey
Yeast nutrients	Breads, other baked goods	Promote growth of yeast	Ammonium phosphate, calcium sulfate

2.2 Micronutrients as food additives

A subset of food additives, micronutrients (vitamins and minerals) added in the processes of food fortification preserve nutrient value by providing the vitamins and minerals to the foods such as breakfast cereals, flour, milk, and margarine which usually would not retain such high levels (Weaver *et al.*, 2014; Awuchi *et al.*, 2020a). Added ingredients, such as bacteria, fungi, air, and yeast, also contribute some manufacturing and flavor qualities, as well as reduce spoilage (The European Food Information Council, 2010; Chinaza *et al.*, 2019a). Many foods are fortified with vitamins and minerals. One such example is iodized salt (table salt), which has added iodine (as potassium iodide) to help fight/prevent goiter in general population (Awuchi *et al.*, 2020b; Awuchi *et al.*, 2020c). Goiter was relatively common but it is now rare, partly because of the extensive use of iodized salt worldwide. Other foods commonly fortified with vitamins and minerals include margarine and milk (with vitamins A and D), flour (with niacin, iron, thiamine, riboflavin), and some commercial breakfast cereals and breads (with various vitamins and minerals, mostly in some commercial cereal preparations).

2.3 Categories of food additives

Food additives can be further divided into many groups, though there is some overlapping because some additives have at least two effects; e.g., salt is both a preservative and a flavor (Erich and Gert-Wolfhard, 2002; FDA, 2017); citric acid is a preservative, adds flavor, and an acidity regulator.

- a) **Acidity regulators:** Acidity regulators are used to control the pH of foods for stability or to affect the activities of enzymes.
- b) **Antioxidants:** Antioxidants, such as vitamins E and C, BHA, BHT, are preservatives by inhibiting food degradation by oxygen.
- c) **Bulking agents:** The bulking agents (e.g. starch) are additives which increase the bulk of food without affecting its taste.
- d) **Food coloring:** The food colorings are added to foods to replace the colors lost during preparation or processing, or to make food more attractive.
- e) **Anticaking agents:** The anticaking agents keep powders, e.g., milk powder, from sticking or caking.
- f) **Foaming and antifoaming agents:** Antifoaming agents prevent or reduce foaming in foods. Foaming agents do the opposite.
- g) **Acidulents:** Acidulants confer acid or sour taste. Common acidulents include citric acid, tartaric acid, vinegar, malic acid, lactic acid, and fumaric acid.
- h) **Fortifying agents:** Minerals, vitamins, and dietary supplements to increase nutritional value of foods.
- i) **Flavor enhancers:** Flavor enhancers improve the existing flavors of foods. A common example is monosodium glutamate (MSG). A number of flavor enhancers have their own flavors which are independent of the food.
- j) **Color retention agents:** Contrary to colorings, the color retention agents are used in foods to preserve the existing color of the foods.
- k) **Flour treatment agents:** These treatment agents are added to the flours to improve their color or their use in baking.
- l) **Emulsifiers:** Emulsifiers allow oils and water to remain mixed together in emulsion, as in ice cream, mayonnaise, and homogenized milk.
- m) **Tracer gas:** Tracer gas allow package integrity testing to prevent the foods from exposure to the atmosphere, thus guaranteeing shelf life.
- n) **Preservatives:** Preservatives are one of the most important components of foods, especially commercially made foods. Preservatives inhibit or prevent spoilage of food due to bacteria, fungi, and other spoilage microorganisms.
- o) **Flavors:** Flavors are food additives that give food a specific smell or taste, and can be derived from natural ingredients or made artificially.
- p) **Glazing agents:** Glazing agents provide protective coating or shiny appearance to foods.

- q) **Thickeners:** Thickening agents are food additives which, when added to the food mixture, increase the viscosity of the food without substantially modifying other properties of the food.
- r) **Humectants:** Humectants prevent the foods from drying out.
- s) **Stabilizers:** Stabilizers, food thickeners and gelling agents, such as agar or pectin give foods firmer texture. They help to stabilize emulsions, although they are not true emulsifiers.
- t) **Sweeteners:** Sweeteners are added to food for flavoring. Sweeteners other than sugar, such as sugar alcohols, are added to keep the calories (or food energy) low, (Chinaza and Echeta, 2019; Awuchi, 2017) or because of their beneficial effects regarding tooth decay, diabetes mellitus, or diarrhea.

2.4 Uses of food additives and preservatives

Additives and preservatives are used in foods to maintain or improve nutritional value, maintain product quality and consistency, provide leavening, control pH, maintain palatability and wholesomeness, provide color, or enhance flavor. Food additives can be classified as:

- a) Thickening and stabilizing agents, which alter the food texture. Examples include carrageen, which is used as thickener in low-calorie jellies and ice creams, and the emulsifier lecithin, used to keep oil and vinegar blended in the salad dressings.
- b) Chelating agents are used to prevent discoloration, rancidity, and flavor changes that may occur during food processing. Examples are malic acid, citric acid, and tartaric acid
- c) Bleaching agents, e.g. peroxides, are used in foods to whiten the foods such as cheese, wheat flour.
- d) Artificial colors are intended to make foods more appealing and to provide some foods with color which humans associate with a particular flavor; for example, green for lime, yellow for banana, brown for chocolate or coffee, red for cherry.
- e) Antioxidants, which prevent damage to foods caused by oxygen and rancidity in foods containing fats. Examples of antioxidants include BHA (butylated hydroxyl anisole), BHT (butylated hydroxyl tolene), propyl gallate, vitamin C, and vitamin E.
- f) Antimicrobial agents, which prevent the spoilage of food by microorganisms. These include vinegar, salt, calcium propionate, sorbic acid, etc., which are used in food products such as salad dressings, cheeses, baked goods, margarines, and pickled foods
- g) Nutrient additives, including micronutrients (vitamins and minerals), are added to food during fortification or enrichment. For instance, rice is enriched with thiamin, riboflavin, and niacin; milk is fortified with vitamin D; salt is iodized.
- h) Artificial flavors and flavor enhancers are the largest class of food additives. They function to give foods a specific taste or to make foods taste better. Common examples are sugar, salt, and vanilla used to complement flavor of some foods. The synthetic flavoring agents, e.g. benzaldehyde for almond or cherry flavor, might be used to

simulate the natural flavors. Flavor enhancers, e.g. monosodium glutamate (MSG), intensify flavor of other compounds in foods.

2.5 Numbering of food additives

To regulate additives and inform consumers, every additive is assigned a unique number known as an "E number". This numbering system has been adopted and extended by *Codex Alimentarius* Commission to globally identify all the additives, irrespective of whether they have been approved for use. The E numbers are all prefixed by the letter "E", but countries outside the Europe often use only the number, irrespective of whether the additive is approved in the Europe or not; acetic acid is has the E number E260 on the products sold in Europe, but is basically known as additive 260 in many countries. Alkannin, additive 103, is not approved for use in the Europe so does not have E number, though it is approved for use in New Zealand and Australia. Australia has an approved system of labelling for food additives in packaged food products. Each food additive is numbered or named. The numbers are the similar to that in Europe, but without the E prefix. The US FDA lists these items as GRAS (generally recognized as safe); (FDA, 2020) they are listed under both Chemical Abstracts Service number and the FDA regulation under US Code of Federal Regulations.

2.6 Safety and regulation of additives

With the increasing use of processed food ever since the 19th century, the food additives are more in used worldwide. Many countries regulate the use of food additives. Boric acid was extensively used as a food preservative from 1870s to 1920s, but was banned after the World War I because of its toxicity, as demonstrated in the animal and human studies. During the World War II, urgent need for cheap, available food additives, mostly preservatives led to their use again, but was finally banned in 1950s (Bucci, 1995). Such cases led to general mistrust of food additives, and application of precautionary principle led to conclusion that only food additives known to be safe have to be used in foods. In the US, this led to adoption of the Delaney clause, which is an amendment to the 1938 Federal Food, Drug, and Cosmetic Act, stating that no carcinogenic substances could be used as additives in foods. After the ban on cyclamates in Britain and the US in 1969, saccharin, the only legal artificial sweetener remaining at that time, was shown to cause cancer in the rats. Widespread public outcry in the US, partly communicated to the Congress by postage-paid postcards delivered in packaging of sweetened soft drinks, resulted in the retention of saccharin, regardless of its violation of the Delaney clause. Nevertheless, in 2000, saccharin was indicated to be carcinogenic in rats only due to their unique urine chemistry (Whysner and Williams, 1996; Dybing, 2002). Use of plant materials in foods claimed to have medicinal effects (Chinaza, 2019a) is strictly regulated in most parts of the world.

2.7 Hyperactivity of food additives

Periodically, concerns have been expressed about linkage between food additives and hyperactivity, however no clear and direct evidence of ADHD was given (Amchova *et al.*, 2015). In 2007, the Food Standards Australia New Zealand (FSANZ) published official

guidance for shoppers with which the concerns of the food additives as well as their labeling are mediated (Food Standards Australia New Zealand, 2007). In the EU it may take at least 10 years to obtain approval for any new food additive. This includes 5 years of safety testing, followed by 2 years for evaluation by the EFSA (European Food Safety Authority) and more 3 years before the food additive receives EU-wide approval for use in all the countries in the EU. Apart from analyzing and testing food products during the entire production process to ensure the safety and compliance with the regulatory standards, Trading Standards officers in the United Kingdom protect the public from illegal use or possibly dangerous misuse of food additives by carrying out random testing of food products.

Significant controversy associated with the risks and benefits of food additives has been in existence. Natural additives may be similarly unsafe or cause allergic reactions in some individuals (Martin, 2008). For example, safrole used to flavor root beer was shown to be carcinogenic; its use was stopped as a result. Due to the Delaney clause application, it may not be added to food, even as it naturally occurs in sassafras and sweet basil (Fennema, 1996). Lectin, a hemagglutinin, found in most grains and other food materials (Udeogu and Awuchi, 2016) may unintentionally be introduced to foods.

2.8 Evaluating the health risks of food additives

The WHO, in cooperation with the UN FAO, is responsible for assessing risks of food additives to human health and safety. Risk assessment of food additives are done by an independent, international expert scientific group known as the Joint FAO/WHO Expert Committee on Food Additives (JECFA). Only the food additives that have undergone JECFA safety assessment, and found not to present appreciable health risk to the consumers, can be used (WHO, 2018). This applies whether the food additives come from natural source or just synthetic. National authorities, either based on a national assessment or the JECFA assessment, can then authorize the use of additives in food at specific levels for specified foods. The JECFA evaluations are based on the scientific reviews of all the available toxicological, biochemical, and any other relevant data on a given additive, such as research studies, mandatory tests in animals, and observations in humans.

The toxicological tests required by the JECFA are acute, long-term, and short-term studies which determine how the food additive is distributed, absorbed, excreted, and likely harmful effects of the food additive or its by-products at some levels of exposure. The starting point for determining whether a given food additive may be used without having any harmful effects is to establish acceptable daily intake (ADI) of the additive (WHO, 2018). The ADI is a total estimate of the amount of a given additive in food or drinking water which can be consumed safely every day over a lifetime without any adverse health effects. Nitrites are controversial additives. When used together with salt, nitrites add flavor and color to meats, as well as serve as antimicrobials. However, nitrite salts is known to react with some amine in food to produce nitrosamines, lots of which are known carcinogens. The food manufacturers must indicate that there will be no formation of nitrosamines in harmful amounts, or the formation will be prevented, in their products.

The flavoring enhancer monosodium glutamate (MSG) is another known controversial food additive. MSG is produced commercially from natural fermentation process using sugar and starch. In Europe, additives and preservatives are evaluated by European Commission's Scientific Committee on Food (ECSCF). Regulations in EU countries are similar to the regulations in the US. The UN FAO and the WHO Expert Committee on Food Additives work together to examine the safety of the food additives, and contaminants, residues of veterinary drugs, and naturally occurring toxicants in foods (WHO, 2018). The ADIs are established based on toxicology and other information.

Table 3: List of unhealthy food additives

<i>Name</i>	<i>Example products</i>	<i>Additive description</i>
Aspartame	Sugar substitutes, diet sodas, etc.	Artificial sweetener associated with headaches, dizziness, rashes, depression, etc.
Brominated vegetable oil (BVO)	Sodas, etc.	It is used as emulsifier and clouding agent. Bromate, its main ingredient, is a poison.
Butylated hydroxytoluene (BHT)/butylated hydroxyanisole (BHA)	Cheese/cereal packaging	Prevents rancidity in food and is added to food packaging. Slows the transfer of the nerve impulses and affects sleep, weight in test animals, and aggressiveness.
Citrus red dye #2	Oranges	Used to color oranges. A probable carcinogen. The US FDA has recommended its banned.
Monosodium glutamate (MSG)	Processed and packaged food. Fast food.	A flavor enhancer that may cause heart palpitations, headaches, and nausea.
Nitrites	Wine and cured meats.	Used as preservatives, nitrites and have been associated with cancer and birth defects and also form cancer-causing compounds in the GI tract.
Saccharin	Sugar substitutes, diet sodas, etc.	An artificial sweetener and may be carcinogenic.
Sulfites	Shrimp, dried fruits, frozen potatoes	Used as a preservative in foods, and have been linked to over four deaths as reported to FDA in the US.
Tertiary butylhydroquinone (TBHQ)	Candy bars, fast foods, and baking sprays	It is extremely toxic even in low doses and has been associated with childhood behavioral problems.

Yellow dye #6	Candy, sodas	Increases the number of adrenal gland and kidney tumors in lab rats. It is banned in some countries such as Sweden and Norway.
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2.9 Flavorants

Some chemicals are added to enhance food flavor; mostly true for commercially processed foods, such as frozen foods and canned vegetables. One of the most popularly added flavorants is sodium chloride (table salt), a vital nutrient for humans and animals. However, in large amounts, sodium chloride can predispose individuals to developing high blood pressure (high BP), a factor that is significant in strokes as well as other circulatory and heart diseases (Branen, 2002; Encyclopedia, 2020). MSG is commonly used as flavor enhancer, mostly in prepared soups, oriental foods, and processed meats. Some individuals are relatively sensitive to this additive, developing headaches and other symptoms which are sometimes known as Chinese food syndrome. Sucrose (table sugar), manufactured from sugar beets or sugar cane, and fructose (fruit sugar) are commonly used to sweeten foods such as artificial drinks, sweetened fruit juices, sugar candies, chocolate products, peanut butter, jams, most commercial breads, and ketchup. Sugars are easily assimilated from foods in the body and are useful form of metabolic energy. However, in large amounts, sugars can cause tooth decay, weight gain, as well as diabetes and hypoglycemia in genetically predisposed individuals (Branen, 2002; Encyclopedia, 2020; Clydesdale, 1997; Potter and Hotchkiss, 1995). Artificial sweeteners such as aspartame, sodium cyclamate, and saccharine avoid the nutritional problems linked to eating much sugar. However, these non-sugar sweeteners might have their own problems, and some individuals consider them to be low-level health hazard. Sweeteners such as some sugar alcohols may also be used to replace sugars in foods and soft drinks (Chinaza and Echeta, 2019; Awuchi, 2017). Other flavorants used in processed foods are herbs, vanilla, spices, mustard, peanuts, nuts, and wine (Encyclopedia, 2020; Clydesdale, 1997; Branen, 2002; Potter and Hotchkiss, 1995). Some individuals are very allergic to even minute exposures to nuts or peanuts and can quickly develop condition referred to as anaphylactic shock that is life-threatening unless rapidly treated with medication. Many flavorants are natural. However, synthetic flavorants are increasingly being discovered and used in home and food industries; vanilla was extracted only from particular species of tropical orchid, which made it rather expensive flavorant. Currently, a synthetic vanilla flavorant can be manufactured from wood-pulp lignins, making the pleasant flavor more readily available and less expensive than it was.

3.0 CONCLUSION

Food additives are added to food as preservatives, flavorants, nutrients, colorants, or emulsifiers. Additionally, foods may contain the residues of chemicals used during production of plant crops or livestock, including pesticides, growth hormones, and antibiotics. The use of many food additives is clearly beneficial as it results in improved health and prevention of food spoilage, which improves food supply. However, there is controversy over the presence of contaminants and the use of some common additives in food. This is partly due to some individuals are

hypersensitive and suffer allergic reactions if exposed to some of these chemical substances. Also, some individuals believe low levels of chronic toxicity and diseases can be caused in the larger populations by the exposures to some of these chemical substances. Although there is no persuasive scientific evidence that this is certainly the case, the likelihood of chronic damage caused by additives and chemical residues in foods is a significant social and scientific issue. Food additives can be direct or indirect. Direct additives are the additives that are added intentionally to foods for specific purpose, while the indirect additives are the additives to which the food is exposed during the processing, packaging, or storing stages. Preservatives are additives that prevent the growth of bacteria, molds, and yeasts in foods. The use of additives in foods is only justified when their use does not mislead consumers, has technological need, and serves well-defined technological function, such as to enhance the stability of the food or preserve the nutritional quality of the food.

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