Review Article ISSN 2641-4295

Food Science & Nutrition Research

Food Additives: Overview of Related Safety Concerns

Sunday P. Ukwo[1], Ifiok I. Udo[1] and Nyaudoh Ndaeyo[2*]

[1]Department of Food Science and Technology, University of Uyo, Uyo, Nigeria.

[2]Department of Crop Science, University of Uyo, Uyo, Nigeria.

*Correspondence:
Nyaudoh Ndaeyo, Department of Crop Science, University of Uyo, Uyo, Nigeria.

Received: 28 Apr 2022; Accepted: 24 May 2022; Published: 30 May 2022

Citation: Ukwo SP, Udo II, Ndaeyo N. Food Additives: Overview of Related Safety Concerns. Food Sci Nutr Res. 2022; 5(1): 1-10.

ABSTRACT

Food additives are the basis of the modern food industry, and play a significant role in improving the colour, aroma, and taste of food, altering its nutritional structure, perfecting its processing conditions, and extending its shelf life. The need of food additives in the food processing industries have sharply increased due to consumers' preferences and commercial advantage they provide to the manufactured food because of longer shelf life, standardized composition and convenience in processing. Additives can be added to food directly and intentionally while indirectly, foods are exposed to them during processing, packaging, or storage. Some additives are either natural or from synthetic sources and are classified into several groups, although there overlap exist between them. The use of food additives has been criticized for multiple health impacts such as cancer, asthma, allergies, and behavioral disorders in children. It is therefore important to balance the potential risks of an additive against its perceived benefits and allowing the consumer the choice of consuming or not consuming the food. The Joint FAO/WHO Expert Committee on Food Additives (JECFA) is charged with the responsibility of assessing the risks of food additives to human health and safety through the establishment of the acceptable daily intake (ADI) for additives and in any case, the decision of consuming food with a particular additive is left to consumers.

Keywords

Food additive, Consumer, Health, Food safety.

Introduction

Food additives are substances or mixture of substances that are added to food during preparation, processing, manufacturing, treatment or packaging to modify the chemical, biological, sensory or physical properties of food. Additives add little or no nutritive value to food rather they are added to preserve flavor or enhance its taste, appearance or impart other desirable properties to food [1]. In the last few decades, changes in food processing techniques and dietary pattern have resulted in an increased production and consumption of various processed food items. Food additives have become a critical factor in satisfying consumer demand. Although food additives have been used frequently at present, its utilization has been practiced since primitive era; and probably dating back to much earlier than the hunter-gatherer era. Man has known the addition of chemical substances to food for centuries past. Prehistoric man added chemicals to foods when he smoked meat. Later he began the practice of salting fish, of fermenting plant and animal diets with spices and with the advent of processed foods in the second half of the 20th century. Over the years, more additives have been introduced, of both natural and artificial origin. Today, more chemicals are been added to food and have become a much part of modern life as high-speed transportation requiring very strict regulations. There has been an increase in public interest in food addition. There are signs that commercial interests have been influenced by consumer pressure, as well as food producers manipulating the situation by marketing techniques.

Codex Alimentarius Commission defined food additive as any substance not normally consumed as a food itself and not normally used as a typical ingredient of the food [2], whether or not it has nutritive value, the intentional addition of which to food for a technological (including sensory) purpose in the manufacture, processing, preparation treatment, packing, packaging, transport or holding of such food results, or may be reasonably expected to result, (directly or indirectly) in it or its by-products becoming a component of or otherwise affecting the characteristics of such foods. The term does not include contaminants, or substances added

to food for maintaining or improving nutritional qualities [2]. Food additives are also defined by "The Food Protection Committee of the Food and Nutrition Committee" as "one or more substances, other than the food itself, which are intentionally added to food products for technological purposes in the production, processing, preparation, treatment, packaging, transport or storage of food, becoming directly or indirectly components of such foods [3]. The spread of food additives have reach all kinds of foods, from the minimally processed to the highly processed and transformed foodstuff. The interaction between some food additives and the public has not been peaceful. In the 1980's food additives were considered dangerous to be consumed, which fueled generalized scares and removal of some additives, namely colorants from processed food. Since then, the relation between additive and consumer has improved, although some distrust still lingers [1]. Today, there are still health issues on the consumption of food additives, even though the authorities periodically review the data supporting the safety and correspondent acceptable daily intake.

Natural and Synthetic Food Additives

Food additives are grouped into two according to their source; the natural and the synthetic. The natural ones are derived from natural sources like plants, animals and minerals. Some examples of natural food additives are; soybeans and corn which are used to maintain food consistency; beets, which provide beet powder, is used sometimes as a colouring agents and caramel that is derived from caramelized sugar used as a colouring agents. The synthetic food additives are those that are manufactured from one or several chemical substances through synthetic methods. Some of the synthetics food additives are; aspartame which is derived from aspartic acid ($C_4H_5O_4NH_2$) and used as sweetener, Erythrosine which is the disodium salt of 2, 4, 5, 7-tetraiodofluorescein and used as a colouring agent and Tartarzine which is Trisodium (4*E*)-5-oxo-1-(4-sulfonatophenyl)-4-[(4-sulfonatophenyl) hydrazono]-3-Pyrazolecarboxylate used as a colouring agent. Various research work has revealed that majority of the food additives used by manufacturers have adverse effects on the consumer [3,4]. Nowadays, most people tend to eat the ready-made foods available in the market, rather than preparing them at home. Such foods contain some kind of additives and preservatives, so that their quality and flavour are maintained and bacteria and yeasts do not spoil them. More than 3000 additives and preservatives are available in the market, which are used as antioxidants and antimicrobial agents. Some of the commonly used food additives and preservatives are aluminum silicate, amino acid compounds, ammonium carbonates, sodium nitrate, propyl gallate, butylated hydrozyl toluene (BHT), butylated hydroxyanisole (BHA), monosodium glutamate, white sugar, salt, potassium bromate, potassium sorbate and sodium benzoate. Some artificial colours are also added to the foods to give them an appealing look. Some of these colouring substances are erythrosine (red), cantaxanthin (orange), amaranth (Azoic red), tartrazine (Azoic yellow) and annatto bixine (yellow orange) [5].

When the food is to be stored for a prolonged period, use of additives and preservatives is essential in order to maintain its quality, wholesomeness, taste, appearance and flavour. The excess water in the foods can cause the growth and proliferation of bacteria, fungi and yeasts and hence food spoilage. Use of additives and preservatives prevents spoiling of the foods due to the growth of bacteria and fungi. Additives and preservatives maintain the quality and consistency of the foods [6]. They also maintain palatability and wholesomeness of the food, improve or maintain its nutritional value, control appropriate pH, provide leavening and colour, and enhance its flavour.

Classifications of Food Additives and Their Role

Food additives can be classified into several groups, although overlap exists between them.

Preservatives

Food preservation has become an important part of the food industry today. In simple terms, a food preservative is any substance that prevents food deterioration caused by microorganisms, enzymes, or any other chemical reaction. Many people suffer from hunger due to food inadequacies resulting from spoilage and deterioration and thus, the merits of using food preservatives in food processing are enormous. Food preservatives along with other food additives are under strict control by several regulatory bodies. Most artificial food preservatives impart negative health effects at high doses. For instance, *in vitro* studies have revealed that sodium benzoate and potassium benzoate exhibit genotoxic effects. However, this issue can be dealt with by adhering to the acceptable daily intake values of food additives. Interestingly, despite showing adverse effects at toxic levels, some artificial food preservatives show favorable health effects at nontoxic levels. Natural preservatives are appealing alternative to artificial preservatives, especially with respect to health effects. A novel trend is to explore and utilize essential oils such as clove essential oil and eugenol extracted from cloves, limonene extracted from citrus fruits, and essential oil extracted from cinnamon as food preservatives of numerous food items including fresh cut produce, juices, and fish [7]. As expected, encapsulated natural food preservatives including thyme essential oil and curcumin have shown favourable properties such as sustained release and enhanced antioxidant and antimicrobial properties. Some common preservatives used in food industries include the following; Sorbic acid, Potassium sorbate, Benzoic acid, Sodium benzoate, Potassium benzoate, Calcium benzoate, Sodium ethyl p-hydroxybenzoate, Sulfur dioxide, Sodium sulphite, Sodium hydrogen sulphite, Sodium metabisulphite, Potassium metabisulphite, Calcium sulphite, Calcium hydrogen sulphite, Potassium hydrogen sulphite, Potassium nitrite, Sodium nitrite, Sodium nitrate, Potassium nitrate, Propionic acid, Sodium propionate, Calcium propionate, and Potassium propionate among others.

Antioxidants and acidity regulators

Antioxidants play a vital role in the food industry in combating oxidative stress on reactive oxygen species. The antioxidants used in the food industry are either hydrophilic, lipophilic, or amphiphilic, protecting various types of ingredients. Certain antioxidants function also as acidity regulators. Although the

results of synthetic antioxidants are inconsistent, numerous natural antioxidants have the ability to function as nontoxic anticarcinogenic compounds. Examples include ferulic acid, caffeic acid, curcumin, vitamin E, polyphenolic catechins, and carnosol [8]. As with other food additives, the trend is to utilize and seek for natural food antioxidants. Both pure antioxidants and plant extracts are used and explored these days. Examples of some antioxidants used in food manufacturing is stated below: ascorbic acid, Sodium ascorbate, Calcium ascorbate, Tocopherols, Alpha-tocopherol, Gamma-tocopherol, Erythorbic acid, Sodium erythorbate, Tertiary-butyl hydroquinone (TBHQ), Butylated hydroxyanisole (BHA), Butylated hydroxytoluene (BHT), Extracts of rosemary and 4-Hexylresorcinol. Acidity regulators are also an essential group of food additives as lowering the pH of the food usually assists to retard microbial attack. Acidity regulators such as citric acid, tartaric acid, and phosphoric acid are numbered together with antioxidants in the E numbering system [9]. This approach is very logical as certain acidity regulators, such as citric acid, exhibit antioxidant properties. In fact, citric acid has imparted favorable effects on food, functioning as an acidity regulator and antioxidant simultaneously [7]. The list of acidity regulators commonly used in food manufacturing include: Sodium lactate, Potassium lactate, Calcium lactate, Citric acid, Sodium citrates, Potassium citrates, Calcium citrates, Tartaric acid, Sodium tartrates, Potassium tartrates, Sodium potassium tartrate, Phosphoric acid, Sodium phosphates, and Potassium phosphates.

Colouring Agents

A colour additive is any dye, pigment, or substance, which when added or applied to a food is capable of imparting colour [3]. Food colours are used as food additives mainly to yield better sensory effects, and improve the overall attractiveness of the food. Specifically appearance contentment. The reasons for adding colours to food are manifold. First, colour may be lost due to the processing and storage conditions of food, and thus food colours are added to compensate such loss of colour. Second, food items with natural colours may show a variation of colour, and thus food colours are added to correct such variations in colour. Third, food colours may be added to further improve the natural colour of the food. Fourth, food colours are added to give colour to food items with no colour [3]. A number of natural and synthetic additives are used to colour foods. In addition, sodium nitrite is used not only as an antimicrobial, but also to improve the colour of meat by interaction with meat pigments. The colours are included in the E system as E100–E180 and in the INS as 100–182. As indicated in several studies on colouring agents there has been much controversy regarding their use. Although synthetic colouring agents continue to be used extensively, there has been significant increased interest in natural colourants. Food colours are added to enhance sensory appeal of the foods. Naturally occurring food colours such as curcumin and riboflavin possess other beneficial health effects. In fact, curcumin exhibits numerous bioactivities such as antioxidant, antimicrobial, and anticancer [10]. Riboflavin, also, acts as an antioxidant, and it is linked to several health benefits. List of some common colours used in food industries include Curcumin, Riboflavin, Riboflavin-5'-phosphate, Tartrazine, Quinoline yellow, Sunset Yellow FCF, Orange Yellow S, Erythrosine, Allura Red AC, Patent Blue V, lndigotine, Indigo Carmine, Brilliant Blue FCF, Chlorophylls and chlorophyllins.

Thickeners, stabilizers, emulsifiers, and gelling agents

Thickeners, stabilizers, emulsifiers, and gelling agents have become an integral part in the current food manufacturing industry. Thickeners increase the volume, change the viscosity, and increase the processability of the food items. Stabilizers, as the name implies, stabilize the food products; sometimes through the utilization of fillers. Emulsifiers assist in the miscibility of otherwise immiscible substances. For instance, water-in-oil or oil-in-water emulsions used in the food industry are made utilizing emulsifiers. Gelling agents mainly contribute to the viscosity and sensory properties of the food products. In sum, all thickeners, stabilizers, emulsifiers and gelling agents contribute to the stability and palatability of the food product. This category of food additives also consist of natural and synthetic compounds. In fact, lecithin that assists in emulsification and stabilization for most food products is mostly extracted from soybean, and thus it is a natural additive [11]. However, studies have been and are being conducted to evaluate the positive effects of synthetic lecithin [12]. Alginate functioning as both a thickener and gelling agent is another natural food additive in this group [13]. Apart from the natural compounds, synthetic emulsifiers such as polysorbates constitute an important component of this group. Although considered food grade, several health concerns have arisen regarding such artificial emulsifiers. Common thickeners-stabilizers-emulsifiers-gelling agents used in food industries include Lecithins, Alginic acid, Sodium alginate, Potassium alginate, Ammonium alginate, Calcium alginate, Propane-1-2-diol alginate, Agar, Carrageenan, Processed eucheuma seaweed, Locust bean gum; carob gum, Guar gum, Tragacanth, Acacia gum; gum Arabic, Xanthan gum, Karaya gum, Tara gum, Gellan gum, Konjac, Soybean hemicellulose, Cassia gum, Polyoxyethylene sorbitan monolaurate; Polysorbate 20, Polyoxyethylene sorbitan mono-oleate; Polysorbate 80, Polyoxyethylene sorbitan monopalmitate; Polysorbate 40, Polyoxyethylene sorbitan monostearate; Polysorbate 60, Polyoxyethylene sorbitan, Pectins, Ammonium phosphatides, Sucrose acetate isobutyrate, Cellulose, Methyl cellulose, Ethyl cellulose, Hydroxypropyl cellulose, Hydroxypropyl methyl cellulose, Ethyl methyl cellulose, Carboxy methyl cellulose, Crosslinked sodium carboxy methyl cellulose.

Flavouring agent

Flavouring agents comprise the greatest number of additives used in foods. Flavours and flavour enhancers are of extremely important in the food industry as they make the food sensational. Flavour is perceived by the taste and aroma via chemical senses. Also, the chemical irritants perceived in the mouth and throat, temperature and texture are factors affecting the flavour of a food. Presently, both natural and artificial substances are used as food flavours the basic universally recognized flavours include: sweet, sour, tangy, bitter, umami, hot, that can be perceived through the tongue. On the other hand, the number of sensations that can be perceived through the nose (smell) is limitless. As a result, the food industry is ever growing utilizing different combinations of

taste and smell. This flavour enhances are highly valued in the food industry as these substances contribute significantly into cost reduction in food manufacturing. Flavours and flavour enhance also are evaluated for their health effects by numerous scientists worldwide. There has been much criticism on the health effects of glutamate—a much consumed flavour enhancer. However, mixed results have been reported and there is no evidence to prove that glutamate possesses negative health effects, according to a recent report [14]. Flavour enhancers magnify or modify the flavour of foods and do not contribute any flavour of their own. Flavour enhancers, which include chemicals such as monosodium glutamate and various nucleotides, are often used in Asian foods or in soups to enhance the perception of other tastes.

Antibiotics

Some antibiotics are used in the food industry to extend the shelf life of several food items, especially perishable food items including milk. Although not directly added during food processing, non-vegetarian food may contain a certain amount of antibiotics since antibiotics are frequently used in animal production. Antibiotics frequently used in food manufacturing include the following; Nisin, Natamycin, Subtilin, Tylosin Phytoncides. Phytoncides are antibiotics obtained from plants. Examples include mustard oil, thyme, cinnamaldehyde, eugenol, etc. Antibiotics permitted as food additives are being experimented heavily, especially to engineer variants that are more potent.

Glazing agents and sweeteners

Glazing agents may be either natural or synthetic. They are used mainly for preservation of food items by forming a thin coat around it. Some glazing agents frequently used in food industry include; Stearic acid, Beeswax, Candelilla wax, Carnauba wax, Shellac, Microcrystalline wax, crystalline wax, Lanolin, Oxidized polyethylene wax, Esters of colophonium, and Paraffin. The most commonly used sweetener in the food industry is sucrose as it is readily available. Thus, the performance of other sweeteners is frequently measured against that of sucrose [15]. Glucose is also frequently used in the food industry, especially in the manufacturing of confectionaries. However, substitutes for common sugars, natural or artificial, are in high demand due to the prevalence of *Dabetes mellitus* among a significant proportion of people worldwide. Other requirements for sugar substitutes include weight loss, dental care, and reactive hypoglycemia. In addition, using sugar substitutes is cost effective since the sugar substitutes are many times sweeter than sucrose. Sweeteners frequently used in food industry are; Sorbitol, Sorbitol syrup, Mannitol, Acesulfame K, Aspartame, Cyclamic acid and its Na and Ca salts, lsomalt, Saccharin and its Na - K and Ca salts, Sucralose, Thaumatin, among others.

Humectant and Anticaking agents

Humecants are moisture retention agents (hygroscopic substance). Their function in foods include the control of viscosity and texture, bulking, retention of moisture, reduction of water activity, control of crystallization and improvement or retention of softness. They also improve the rehydration of dehydrated food and solubilization of flavour compounds. Since hygroscopic substances absorb water from the air, they are frequently used in desiccation. When used as a food additive, the humectant has the effect of keeping the foodstuff moist. Examples of humectants include glycerine, propylene glycol, sorbitol, xylitol, or natural extracts like quilla or lactic acid or urea. Lithium chloride is an excellent humectant but is toxic. Anticaking agents help prevent particles from adhering to each other and turning into a solid chunk during damp weather. Anticaking agents are used in such things as edible salt and keep the product from forming lumps, making it better for packaging, transport, and for the consumer. An anticaking agent in salt is denoted in the ingredients for example as anti-caking agent, which is sodium aluminosilicate, a man-made product. This product is present in many commercial table salts as well as dried milks, egg mixes, sugar products, and flours. In Europe, sodium Ferro cyanide and potassium Ferro cyanide are more common anticaking agents in table salt. Natural anticaking agents used in more expensive table salt include calcium carbonate and magnesium carbonate. Some anticaking agents are soluble in water; others are soluble in alcohols or other organic solvents. They function either by adsorbing excess moisture or by coating particles and making them water repellent. Calcium silicate ($CaSiO_3$), a commonly used anti-caking agent, added to e.g. table salt, adsorbs both water and oil.

Nutrient Supplements

Nutrient supplements restore values lost in processing or storage, or ensure higher nutritional value than what nature may have provided. When foods are processed, there may be loss of some nutrients and additives may be added to restore the original value. For example, to produce white flour, wheat is milled in such a way as to remove the brown-coloured part of the grain, which is rich in vitamins and minerals. To restore the nutritive value, thiamine, nicotinic acid, iron and calcium, are added to the flour. Similarly, vitamin C is added to canned citrus fruits to make up the loss of the vitamin during processing. Fibre additives popularity has seen increased in recent years with the increase in consumer interest in dietary fibre. Various cellulose, pectin, and starch derivatives have been used for this purpose. Recently, naturally derived fibre from apples and other fruits as well as sugarbeets has been introduced as a fibre additive. Fibre additives are not well defined and in reality, have little or no direct nutritional value, although they do have indirect nutritional benefits. In some cases, fiber additives also provide improved texture to food products and are categorized in the INS and E systems bulking agents, thickeners, or stabilizers. The number of food additives used for special dietary purposes has increased significantly in recent years with an emphasis on the replacement of fat to reduce calories. United States food processors use more than 7 million tonnes of fat each year and the fat replacement industry grew rapidly in the 1990s, although it appears to have peaked in recent years, and the growth of this sector has subsided [16]. The increased interest in nutrition has also led to the rapid growth of the functional food or nutraceutical industry with the development of several additives for enhancing overall health.

Flour Improvers

These are bleaching and maturing agents; usually, they both bleach and "mature" the flour. These are important in the flour milling and bread-baking industries. Freshly milled flour has a yellowish tint and yields weak dough that produces poor bread. Both the colour and baking properties improve by storing the flour for several months before making bread. Chemical agents used as flour improvers are oxidizing agents, which may participate in bleaching only, in both bleaching and dough improvement, or in dough improvement only. The agent that is used only for flour bleaching is benzoyl peroxide ($(C_6H_5CO)_2O_2$). This does not influence the quality of dough. Materials used both for bleaching and improving are chlorine gas, (Cl_2); chlorine dioxide, (ClO_2); nitrosyl chloride, (NOCI); and nitrogen di and tetra oxides, (NO_2 and N_2O_4). Oxidizing agents used only for dough improvement are potassium bromate, (KBrO3); potassium iodate, (KIO_3); Calcium iodate, [$Ca(IO_3)_2$]; and calcium peroxide, (CaO_2).

Utilization of and Need for Food Additives

Food additives can be used directly or indirectly. Direct additives are those that are intentionally added to foods for a specific purpose while indirect additives are those to which the food is exposed during processing, packaging, or storing [17]. If a substance is added to a food for a specific purpose, it is referred to as a direct additive. For example, the low-calorie sweetener aspartame, which is used in beverages, puddings, yoghurt, chewing gum and other foods, is considered a direct additive. Many direct additives are identified on the ingredient label of foods. Indirect food additives are those that become part of the food in trace amounts during packaging, storage or handling. For examples, some colourants like erythrosine (red), cantaxanthin (orange) and annatto bixine (yellow orange) gives an appealing look to foods that attracts consumers to them even though they do not add nutrient to the food. For instance, minute amounts of packaging substances may find their way into foods during storage [4]. Food preservative is a class of food additive that help to prevent food spoilage by disrupting the food of any pathogenic microorganisms like *Clostridia* spp*, Bacillus cereus, Staphylococcus aureus* and other microorganisms. Food preservatives preserve food by bringing down the pH and stabilizing the redox potential of the food to make the environment unfavorable for microorganisms to strive.

Benefits of Food Additives

Food additives play a vital role in today's food supply. They allow the growing urban population to have a variety of foods year-round and, they make possible an array of foods without the inconvenience of daily shopping. Food additives perform a variety of useful functions in foods that are often taken for granted. Since most people no longer live on farms, additives help keep food wholesome and appealing while en-route to markets sometimes thousands of kilometers away from where it is grown or manufactured. Additives also improve the nutritional value of certain foods and can make them more appealing by improving their taste, texture, consistency or colour [18]. The importance of preserving food is that, it lengthens the shelf life of a food and slows down the spoilage of food, which is caused by microorganisms present in the container, or the hands that held it before putting it inside a container. The importance of food preservation is so that the food cannot be spoilt or can cause illness. Although preservatives are essential to maintain food safety, excess of a good thing is known not to be healthy. Besides allergies, these foods may cause stomach pains, vomiting, breathing problems, hives and skin rashes. Some of the worst additives include benzoates, which can cause skin rashes, asthma and perhaps brain damage. Bromates can cause nausea and diarrhea. Saccharin may lead to toxic reactions that affect the gastrointestinal tract and heart, as well as cause tumors and bladder cancer. Red Dye 40 may result in certain birth defects. Sodium chloride can lead to high blood pressure, kidney failure, stroke and heart attack [19].

Other reasons additives are used in foods include:

Safer and More Nutritious Foods

There is no question that the preservative and other additives used in foods increase the safety and overall value of many food products. The use of several antimicrobials is known to prevent food poisoning from various bacteria and molds. Antioxidants, used to prevent the development of off-flavours, also prevent the formation of potentially toxic autoxidation products and maintain the nutritional value of vitamins and lipids [20].

Greater Choice of Foods

Markets and stores today display several food items, thereby providing the consumer with wide varieties of food products. The availability of additives has allowed the production of numerous out-of-season foods and a variety of new food products. Additives have increased the development of convenience foods, snack foods, low-calorie and health promoting (functional) foods, exotic foods, and a variety of food substitutes. Additives allow these foods to be pre-prepared and still maintain acceptable flavour, texture, and nutritional value. Although many of these foods can have added convenience with new packaging approaches or other processing methods, most depend on preservatives and texturizing agents. It is estimated that the shelf life of cereal products can be increased over 200% by the use of antioxidants [20]. In addition, the snack food industry has continued to grow successfully due to the use of colouring and flavouring additives make available wide varieties of snack items. These items, which are commonly subjected to high-temperature processing and are expected to have an extended shelf life, also contain preservatives. The increased interest by consumers in dieting has resulted in a proliferation of low-calorie food items. The use of saccharin, cyclamates, aspartame and other low-calorie sweeteners have opened the market for various food products with reduced calories. However, many emulsifiers and stabilizers have allowed a reduction in the lipid content of foods, thus also lowering calories. Stabilizers, emulsifiers, and coloring and flavoring additives have also allowed development of a number of food substitutes, especially dairy and meat substitutes. Margarine and soya meat products would simply not exist without the use of additives. The same is true of many soft drinks, which are primarily a mixture of food additives. Although the market for beverages has leveled out in recent years, the beverage industry continues to be the greatest user of food additives. The greatest

increase in food additive use in the next several years is likely to be in the functional food and nutraceutical industry. Although definitions vary, Sloan [21] defined a functional food as a food or beverage that imparts a physiological benefit that enhances overall health, helps prevent or treat a disease/condition, or improves physical or mental performance via an added functional ingredient, processing modification, or biotechnology.

Lower-Priced Foods

Although there have been few recent studies to indicate that additives reduce the overall price of foods, a study reported in 1973 cited by Branen and Haggerty [20], indicated that, at least for some processed foods, total removal of additives would result in higher prices. This study was based on the premise that the consumer would still desire the same type of foods in the absence of additives. The researchers reported that if, for example, additives were removed from margarine, consumers would have no alternative but to purchase a higher-priced spread such as butter, which usually contains few or no additives. They also reported that if additives were removed from bread, franks, wieners, and processed cheese, new processing procedures, increased refrigeration, and improved packaging would be required, at a higher cost, to keep the same type of products available. It is also important to realize that the assumption that food additives lower the price of foods is based on maintaining the same type and quality of foods that we currently have available. Without additives, we could still have an excellent food supply at a reasonable cost. However, to provide consumers with the variety of foods along with the other benefits mentioned, would cost more without additives.

Maintenance of product consistency

Emulsifiers give products a consistent texture and prevent them from separating. Stabilizers and thickeners give smooth uniform texture. Anti-caking agents help substances such as salt to flow freely [22].

Improvement of nutritional value

Vitamins and minerals are added to many common foods such as milk, flour, cereal and margarine to make up for those likely to be lacking in a person's diet or lost in processing. Such fortification and enrichment has helped reduce malnutrition among the U.S. population. All products containing added nutrients must be appropriately labeled.

Maintenance of palatability and wholesomeness of food

Preservatives retard product spoilage caused by mold, air, bacteria, fungi or yeast. Bacterial contamination can cause food borne illness, including life-threatening botulism. Antioxidants are preservatives that prevent fats and oils in baked goods and other foods from becoming rancid or developing an off flavour. They also prevent cut fresh fruits such as apples from turning brown when exposed to air [22].

Provision of leavening or control acidity/alkalinity in food

Leavening agents that release acids when heated can react with baking soda to help cakes, biscuits and other baked goods to rise during baking. Other additives help to modify the acidity and alkalinity of foods for proper flavour, taste and colour.

Enhancement of flavour and impartation of desired colour

Many spices, natural and synthetic flavours enhance the taste of foods. Colours, for instance, help to enhance the appearance of certain foods to meet consumer expectations.

Maintenance of product consistency and quality of food

They help to improve or maintain nutritional value, maintain palatability and wholesomeness provide leavening, control pH, enhance flavor, or provide colour. The 21st century brings to man, a high degree of urbanization as well as emphasis on speed and efficiency. As technological development continues, there is an increasing shift from large inefficient time-consuming systems/ methods of food production, storage, processing, transportation and distribution to innovative miniaturized systems. Foods with built in-preparation also known as convenience foods are now very popular. A can of vegetable soup, a can of tomato, a hot dog, take-away from Fast food and so on are examples of convenience foods. Convenience foods are simply foods that have various degrees of the preparation labor moved from the household or restaurant to the food processor or manufacturer. These foods save considerable amount of time and effort in their preparation at home, restaurant, industrial or school cafeteria, hospitals, airlines, military installation among others. This convenience food revolution would not have been possible without food additives. Additives permit for vitamins and minerals among other things to be manufactured so that foods can be fortified for example, common salt fortified with potassium iodide eliminates goiter, and rice or bread enriched with B-complex vitamins can eliminate pellagra and sugar fortified with vitamin A will improve the eyesight. Addition of preservatives to foods helps in the conservation of food quality against agents causing deterioration particularly in high moisture content foods. Additives are also used to colour chemical reactions in food. Food additives are needed to maintain the nutritional quality of food, enhance stability with resulting reduction in waste, make food more attractive and provide efficient aids in processing, packing and transport.

International Numbering System for Food Additives (E Numbers')

To regulate these food additives, and inform consumers about the nature of the additives, each additive is assigned a unique number termed "E numbers" which is used in European Union for all approved additives. E-numbers are all prefixed by "E" but countries outside Europe use only the number whether the additives is approved in Europe or not. The European Union adopted directives, which set the criteria by which additives are assessed. European Food Safety Authority oversees additive safety against the established criteria. Specific directives have been established for sweeteners, colours, and other food additives [23]. Nutrients are not included in the E-system. Almost all safe-to-use food additives are given 'E numbers' by the European Food Safety Authority. In order to get to this status, the food additive must pass all the safety checks. Following are the general categories

of food additives and their E numbers. However, when one food additive has more than one function, it is given only one E number. Chemical compounds and other species are constantly added to the list of safe-to-use food additives as the food additives pass the safety checks. An up-to-date list of food additives and their E numbers could be obtained from official United Kingdom food standards agency.

Food Additives, Malnutrition and Related Risks Associated with Food Additives

One important risk posed by additives is the loss of the nutritional value of foods, which can result in inappropriate diets and subclinical malnutrition. The wide use of food additives can contribute to malnutrition in the following ways; the common factor in most foods containing additives is high salt, sucrose and fat content. Pure sucrose, by definition, contains literally no nutrients, only calories; fat, on the other hand, contains few nutrients and is very high in calories. In addition, foods containing additives are mainly processed foods, which have lost a substantial proportion of their nutritional value through the processing procedure. Even though some vitamins and/or minerals are sometimes added to some foods after processing, the ratio of essential nutrients to calories is usually still quite inadequate, resulting in a high calorie, but a low nutritional, intake. This type of diet, because of the high calorie and low nutritional content, can result in less than optimum nutrition and therefore subclinical and/or marginal malnutrition.

Although additives are essential for food storage, they can give rise to certain health problems. They can cause different allergies and conditions such as hyperactivity and attention deficit disorder in some people who are sensitive to specific chemicals [22]. The foods containing additives can cause asthma, hay fever and certain reactions such as rashes, vomiting, headache, tight chest, hives and worsening of eczema. Some of the known dangers of food additives and preservatives are as follows:

Tartrazine is an artificially synthesized pigment and its use is permitted as a colorant in food products. Long-term and excessive ingestion of tartrazine may cause a variety of adverse effects indicating that tartrazine had genotoxic potential towards human lymphocytes. Boric acid is widely used as food preservative in food products like meats, caviar and dairy products Boric acid is harmful to human health if consumed in higher amounts. However, due to unawareness of the risk of boric acid, it is continued to be used in many foodstuffs. Nitrites and nitrates are used in meat industry and food preservation. The nitrate binds to hemoglobin and the exposure to higher levels of nitrates or nitrites has been associated with increased incidence of cancer in adults, and possible increased incidence of brain tumors, leukemia, and nasopharyngeal (nose and throat) tumors in children. Butylated Hydroxytoluene (BHT) and Butylated Hydroxyanisole (BHA) have been suspected of inducing health risks such as child hyperactivity, damage to the lungs, liver, and kidneys, and most importantly, cancer. Research studies have shown that BHA and BHT can be carcinogenic at high doses. Artificial sweeteners such as saccharin, aspartame and sucralose. The safety concerns associated with consuming some of these artificial sweeteners include headaches, breathing difficulties, skin eruptions, and diarrhea migraines. The presence of chlorine in sucralose is thought to be the most dangerous component of sucralose because of it carcinogenic nature. In addition, aspartame is associated with depression that individuals with mood disorders were particularly sensitive to aspartame [22].

Other related risks associated with food additives as listed by Pandey and Upadhyay [1] are listed below;

- Benzoates can trigger the allergies such as skin rashes and asthma as well as believed to be causing brain damage.
- Bromates destroy the nutrients in the foods. It can give rise to nausea and diarrhea.
- Butylates are responsible for high blood cholesterol levels as well as impaired liver and kidney function.
- Caffeine is a colorant and flavorant that has diuretic, stimulant properties. It can cause nervousness, heart palpitations and occasionally heart defects.
- Saccharin causes toxic reactions and allergic response, affecting skin, gastrointestinal tract and heart. It may also cause tumors and bladder cancer.
- Red Dye 40 is suspected to cause certain birth defects and possibly cancer.
- Mono and di-glycerides can cause birth defects, genetic changes and cancer.
- Caramel is a famous flavoring and coloring agent that can cause vitamin B6 deficiencies. It can cause certain genetic defects and even cancer.
- Sodium chloride can lead to high blood pressure, kidney failure, stroke and heart attack.

To minimize the risk of developing health problems due to food additives and preservatives, you should avoid the foods containing additives and preservatives. Before purchasing the canned food, you must check its ingredients. You should buy organic foods, which are free from artificial additives. Try to eat the freshly prepared foods as much as possible rather than processed or canned foods.

Evaluating the Health Risks of Food Additives

The WHO, in conjunction with the 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. This applies whether the food additives come from natural source or just synthetic. Either national authorities, 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. 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, European Commission's Scientific Committee on Food (ECSCF) evaluates additives and preservatives. 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. The ADIs are established based on toxicology and other information.

Food Additives and Food Intolerance

Additives have often been blamed for causing intolerance or allergic reactions, especially hyperactivity in children. Whilst there is no doubt that certain foods and food ingredients, including additives, are responsible for intolerance reactions, the prevalence of such reactions has often been greatly exaggerated. Genuine intolerance to food additives is extremely rare. It has been estimated that the true prevalence of intolerance to foods is about 2% in adults and up to 20% in children, and for food additives from 0.01 to 0.23%. The substantial overestimation of such reactions by the public probably owes itself to the adverse media coverage and anti-additives campaigning of the 1980s, when popular belief was that additives were responsible for harmful behavioural effects and hyperactivity was attributed solely to the consumption of tartrazine (E102). The result was that tartrazine, a synthetic colour, was removed from a wide range of products, especially sweets and soft drinks that were likely to be consumed by children, as consumers in their droves ceased to buy anything that was labelled as containing it. Manufacturers are still reluctant to use this colour, unless there is nothing else in the palette of yellow colours authorised for the product. Such is the power of consumer choice, be it informed or otherwise. Food intolerance, and especially allergy, is again under the spotlight, not now because of alleged hyperactivity in children, but, far more seriously, because of the seemingly growing prevalence of severe allergic reactions, particularly to peanuts. Since the mid-1990s, there have been a number of widely reported incidents, including several tragic deaths as a result of anaphylactic shock, a severe allergic reaction to specific proteins, most commonly those found in tree nuts and peanuts and a small number of other foods, including milk, wheat, eggs, soya, fish and shellfish. The reasons for such reactions are not yet fully understood and are still under investigation, as are the causes of this apparently growing problem, but the need to address the issue and do everything possible to assist the small but significant number of people affected by this most severe form of allergy caused the European Commission to task its former Scientific Committee for Food (SCF) with identifying the scope of the problem and the foods and ingredients associated with it. This 1996 Report reaffirmed the SCF's earlier (1982) estimation of intolerance to additives as affecting from 0.01 to 0.02% of the European population [22]. More specifically, the prevalence of intolerance to food additives in the population was put at 0.026%, or about 3 people per 10,000 of the population. This compares with the prevalence of adverse reactions to cows' milk of 1 to 3%. The most commonly observed reaction is now to Sulphur dioxide (E220) and sulphites, especially in asthma sufferers, again growing in number or perhaps being more frequently reported. It must be understood that the incidence of genuine intolerance to additives is very low. Accurate labelling is the key to avoiding unnecessary suffering of an adverse reaction, such as urticaria, asthma or atopic symptoms, in the case of sensitized consumers, or adverse publicity in the case of food producers, and for this reason the EC Labelling Directive 2000/13/EC was amended in 2002, 2003, 2006 (to establish a list of potential allergens that must be declared by name on food labels) and in 2007.

Clean Labels

The growing demand from health-conscious consumers is for the replacement of artificial food additives with 'natural' ingredients, which perform similar technological functions. Thus, food processors are continuously seeking natural alternatives to food additives as, when these are listed on labels as the named ingredients rather by E-number, it gives the food product a 'clean label' declaration. Clean label declarations are not regulated; however, the Food Standards Agency in the UK has issued "Criteria for the use of the terms Fresh, Pure, Natural etc." which could be used as guidance. In addition, when incorporating new substances into foods one would also need to comply with the EC Regulation 258/97 concerning Novel Foods and Novel Food Ingredients. A number of ingredients are now being manufactured that claim to give foods a clean label status e.g. emulsifiers such as lecithin and soya protein; antioxidants including grape seed, chestnut and olive leaf extracts; colours for example, lycopene, anthocyanin and chlorophyll; and preservatives including cinnamic acid, carvacol, chitosan, and lysozyme [1]. Some bacterial cultures, known as 'protective cultures', able to inhibit the growth of pathogenic bacteria and mycotoxin-producing mould are being used as inhibitors of foodborne microorganisms. These protective cultures produce antimicrobial metabolites like organic acids (lactic and acetic acid), and bacteriocins (nisin and natamycin), and are substitutes for conventional additives, helping manufacturers make the 'Clean Label' claim. It will be some time before we see a complete shift to clean label products, and in some situations, this may not be possible due to a lack of suitable natural alternatives.

Need To Regulate Food Additives

There are many governmental bodies and regulating agencies that determine what must be added to food and food supplements and the quantities that they must be added so they will not have deleterious effects on the consumers. These substances are termed as generally recognized as safe (GRAS). Each country of the world has its own regulations though there might be similarities among them. In Nigeria, for instance, before anything can be added to food, it must be approved by the National Agency for Food and Drug Administration and Control (NAFDAC) in conjunction with the Standard Organization on Nigeria (SON). In Nigeria, the drug and related products (registration, etc.) act 1996 (as amended) and food additives regulation of 2005 of the NAFDAC gave several regulations that every food and drugs companies must adhere to or face penalty or sanctions. These regulations are; Label declaration for substances used as food additives, Labeling of synthetic colour and mixture of colours in food, Food additives not to be described falsely, Food additives to bear certain information, Processing aids and carry-over of food additives, Prohibition against sale of food containing non-permitted food additive, Conditions for a request to add to or change food additive, Restriction on sale, of baby foods containing food additive, Conditions for allowing more than one preservative, Ionizing radiation. Some of the penalties. In the U.S., food ingredients may either be FDA-approved food additives or generally recognized as safe (GRAS). Food packaging manufacturers must prove to the U.S. Food and Drug Administration [24] that all materials coming in contact with food are safe, before they are permitted for use in such a manner. Food additives were first subjected to regulation in the United States under the Food and Drug Act of 1906 [25]. The act states that a food shall be deemed adulterated: "If it bears or contains any poisonous or deleterious substance, which may render it injurious to health; but in case the substance is not an added substance, such food shall not be considered adulterated under this clause if the quantity of such substance in such food does not 1906). Congress passed the Food Additives

Conclusion

Food additives are added to food as preservatives, flavourants, nutrients, colourants, and emulsifiers or thicken foods. 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 still controversy over the presence of contaminants and the use of some common additives in food. This is partly because some individuals are hypersensitive and suffer allergic reactions if exposed to some of these chemical substances. Additives have been used for many years in food processing, and have played a significant and essential role in reducing serious nutritional deficiencies. Additives help to ensure the availability of wholesome, appetizing and affordable foods that meet consumer's demands from season to season while also helping to preserve food from deterioration and spoilage from microorganism. Different adverse effects associated with food additives remain a significant challenge that need to be examined. Synthetic food additives can react with the cellular component of the body leading to the various food disturbances (effects). Therefore, if food additives are to be used because of their advantages, they should be the natural ones (forms) which have minimal effects and those that are generally recognized as safe (GRAS). In the case of those not generally recognized as safe (Non-GRAS), the acceptable daily intakes (ADIs) should not be exceeded. On the whole, to minimize the risk of developing health problems due to use of food additives and preservatives, one should avoid foods containing unsafe additives and preservatives. Before purchasing any canned food, its ingredients should be properly checked. Purchase of only organic foods, which are free from artificial additives, remains a better option. Although it may seem difficult to change habits and find substitutes for foods that one enjoys, it is good to remind us that doing so will simply adding to one's diet some new wholesome foods that one can enjoy even more later.

Food additives in the food processing industries have sharply increased due to consumers' preferences and commercial advantage they provide to the manufactured food because of longer shelf-life, standardized composition and convenience in processing. Some additives are either natural or from synthetic sources and are classified into several groups. The use of food additives has been criticized for multiple health impacts such as cancer, asthma, allergies, and behavioural disorders in children. It is therefore important to balance the potential risks of an additive against its perceived benefits and allowing the consumer the choice of consuming or not consuming the food.

References

1. http://www.intechopen.com/books/food-additive/food-additive
2. Codex Alimentarius Commission. Class names and the international numbering system or food additives. Codex Alimentarius: Vol. 1A-General Requirements. 2001.
3. FDA. Food Additives & Ingredients - Overview of Food Ingredients, Additives and Colors FDA Center for Food Safety and Applied Nutrition. 2017.
4. Abdulmumeen H.A, Ahmed N.R, Agboola R.S. Food: Its Preservatives, additives and applications. Int'l J. of Chemical and Biochemical Sciences. 2012; 1: 36-47.
5. Miller M, Millstone E. Food Additives Campaign Team: Report on Colour Additives. FACT, 25 Horsell Road, London N5 1XL. 1987.
6. FDA. "Food Ingredients and Packaging Terms". FDA. January 4, 2018. Retrieved 9 September 2018.
7. Chen X, Ren L, Li M, et al. Effects of clove essential oil and eugenol on quality and browning control of fresh-cut lettuce. Food Chemistry. 2017; 214: 432-439.
8. Huang M.T, Ferraro T. Phenolic compounds in food and cancer prevention. In: Phenolic Compounds in Food and Their Effects on Health II. ACS Symposium Series. 1992; 507: 8-34.
9. EFSA European Food Standards Agency. Current EU approved additives and their E Numbers. 2015.
10. Souza E.L.D, Almeida E.T.D.C, Guedes J.P.D.S. The potential of the incorporation of essential oils and their individual

constituents to improve microbial safety in juices: A review. Comprehensive Reviews in Food Science and Food Safety. 2016; 15: 753-772.

11. Lima M, Rocha L.A, Molina E.F, et al. Thermoanalysis of soybean oil extracted by two methods. Quimica Nova. 2008; 31: 527-529.
12. Onaderra M, Monsalve R.I, Manchero J, et al. Food mustard allergen interaction with phospholipid vesicles. European Journal of Biochemistry. 1994; 225: 609-615.
13. Rioux L.E. Characterization of polysaccharides extracted from brown seaweeds. Carbohydrate Polymers. 2007; 69: 530-537.
14. Jinap S, Hajeb P. Glutamate. Its applications in food and contribution to health. Appetite. 2010; 55: 1-10.
15. Barrett L, Geddes J.E, Mangano S.F, et al. Chewy Confectionery Product. United States Patent. US. 6531174. 2003.
16. Sloan A.E. Food industry forecast: consumer trends to 2020 and beyond. Food Technol. 1998; 52: 37.
17. Boca F.L, Smoley C.K. U.S. Food and Drugs Administration. Everything Added to Food in the United States. CRC Press, Inc., New York. 1993; 171.
18. Houghton M. The American Heritage Food Science Dictionary. 2002.
19. Hoover D, Milich R. Food Additives may affect kid's hyperactivity. Journal of Abnormal Child Psychology. 1994; 22: 501-515.
20. Branen A. Toxicology and biochemistry of butylated hydroxyanisole and butylated hydroxytoluene. Journal of the American Oil Chemists' Society. 1975; 52: 59-63.
21. Sloan A.E. The top ten functional food trends. Food Technol. 2000; 54: 33.
22. Inetianbor J.E, Yakubu J.M, Ezeonu S.C. Effects of Food Additives and Preservatives on Man- A Review Asian Journal of Science and Technology. 2015; 6: 1118-1135.
23. Jukes D. Food Additives in the European Union. 2000. Food Law. 2001.
24. FDA. Toxicological principles for the safety assessment of direct food additives and color additives used in food (draft), "Redbook II." U.S. Food and Drug Administration, Center for Food Safety and Applied Nutrition. 1993.
25. Haley C.S, Lyn O.N. How food ingredients are approved. The International Food. 2010.