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RESEARCH ARTICLE

EFFECTS OF FOOD ADDITIVES AND PRESERVATIVES ON MAN- A REVIEW

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ABSTRACT

Food additives are organic substances that are intentionally added to food in small quantities during production or processing to improve the organoleptic quality (colour, flavour, appearance, taste and texture) of the food. Food preservative is a class of food additive that help to prevent food spoilage by preventing the growth and proliferation of pathogenic microorganisms like *Clostridium* spp , *Bacillus cereus* and *Staphylococcus aureus*. This can be achieved by bringing down the pH of the food so as to make the environment unfavourable for these microbes. This report aims to review the available literature on the various effects of food additives and preservatives on man as a result of the indiscriminate uses by food producers and food consumers. Many effects like food allergies, food intolerance, cancer, multiple sclerosis (MS), attention deficit hyperactivity disorder (ADHD), brain damage, nausea, cardiac disease among others have been reported.

INTRODUCTION

Food additives are substances that food manufacturers intentionally add to food in small quantity during production or processing to improve the organoleptics of the food (Winter, 1994). They help to increase the shelf life of the food by maintaining product consistency, wholesomeness and freshness. They make possible an array of convenient food without the stress of daily shopping or cooking. The food additives must be added in regulated quantities, concentration and should be within the acceptable daily intakes (ADIs) above which they can have some devastating effects on the consumer. This definition includes any substance used in the production, processing, treatment, packaging, transportation or storage of food (Kunkel and Barbara, 2004). Food additives are also substances added to food to preserve flavour or enhance its taste and appearance. Some additives have been used for centuries, for example, preserving food by pickling (preserving with vinegar), salting, as with bacon and preserving sweets or using sulfur dioxide as in some wines. With the advent of processed foods in the second half of the 20th century, many more additives have been introduced, of both natural and artificial origin (Boca Raton and Smoley, 1993).

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Food Additives are defined by the United States Food and Drug Administration (FDA, 1993) as "any substance, the intended use of which results or may reasonably be expected to result, directly or indirectly, in its becoming a component or otherwise affecting the characteristics of any food". In other words, an additive is any substance that is added to food. Food additives are also defined as chemical substances deliberately added to foods, directly or indirectly in known quantities for purposes of assisting in the processing of foods; preservation of foods; or in improving the flavour, texture, or appearance of foods (Daniel, 2007).

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 (Boca Raton and Smoley, 1993). 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 don't add nutrient to the food. For

instance, minute amounts of packaging substances may find their way into foods during storage (Abdulmumeen et al., 2012). 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 also stabilizing the redox potential of the food so as to make the environment unfavourable for microbes to strive. 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 is 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 ($C_4H_5O_4NH_2$) is used in food preservation, Erythrosine which is the disodium salt of 2, 4, 5, 7-tetraiodofluorescein is used as a colouring agent and Tartarzine which is Trisodium (4*E*)-5-oxo-1-(4-sulfonatophenyl)-4-[(4-sulfonatophenyl) hydrazono]-3-Pyrazolecarboxylate is 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 (FDA, 1993 and (Abdulmumeen *et al.,* 2012).

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 is maintained and they are not spoiled by bacteria and yeasts. 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) (Miller and Millstone, 1987).

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. 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

Food additives can be divided into several groups, although there is some overlap between them.

Antimicrobial agents: These prevent spoilage of food by microorganisms. These include not only vinegar and salt, but also compounds such as calcium propionate and sorbic acid, which are used in products such as baked foods, salad dressings, cheeses, margarines, and pickled foods (Abdulmumeen et al., 2012).

Antioxidants: An anti-oxidant is a substance added to fats and fat-containing substances to retard oxidation and thereby prolong their wholesomeness, palatability, and, sometimes, keeping time. An anti-oxidant should not contribute an objectionable odour, flavour, or colour, to the fat or to the food in which it is present. It should be effective in low concentrations, and be fat soluble. Also, it should not have a harmful physiological effect. Some anti-oxidants used in foods are butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), propyl gallate (PG), and teriarybutyl hydroquinone (TBHQ), which are all phenolic substances (Dalton, 2002). Thiodipropionic acid and dilauryl thiodipropionate are also used as food anti-oxidants. The Joint FAO/WHO Expert Committee on Food Additives has recently considered the Acceptable Daily Intakes (ADls) of BHA and BHT and set them at 0-0.5 mg/kg body weight for BHA and 0-0.3 mg/kg body weight for BHT. Naturally occurring substances that act as anti-oxidants are tocopherols. The tocopherols act as biological anti-oxidants in plant and animal tissues, but they are rarely used as additives because they are more expensive than synthetic anti-oxidants (Sunitha and Preethi, 2000).

Colouring Agents: These include colour stabilizers, colour fixatives, colour retention agents, etc. They consist of synthetic colours and those from natural sources. Even though most colours do not add any nutritive value to foods, without certain colours most consumers will not buy or eat some foods. Thus, colours are frequently added to restore the natural ones lost in food processing or to give the preparations the natural colour we expect. A number of natural food colours extracted from seeds, flowers, insects, and foods, are also used as food additives. One of the best known and most widespread red pigments is bixin, derived from the seed coat of Bixa orellana, the lipstick pod plant of South American origin. Bixin is not considered to be carcinogenic. The major use of this plant on a world-wide basis, however, is for the annatto dye, a yellow to red colouring material extracted from the orange-red pulp of the seeds. Annatto has been used as colouring matter in butter, cheese, margarine, and other foods. Another yellow colour, a carotene derived from carrot, is used in margarine. Saffron has both flavouring and colouring properties and has been used for colouring foods. Turmeric is a spice that gives the characteristic colour of curries and some meat products and salad dressings. A natural red colour, cochineal (or carnum) obtained by extraction from the female insect (Coccus cacti), grape skin extract, and caramel, the brown colour obtained from burnt sugar, are some natural colours that are used as food additives. These are intended to make food more appealing and to provide certain foods with a colour that humans associate with a particular flavour (e.g.

red for cherry, green for lime). Some examples of food colourants are; erythrosine, carmosine (McCann *et al*., 2007). Colour additives are recognized as an important part of many foods we eat (Barrows *et al.*, 2003).

Bleaching agents: These are peroxides, which are used to whiten foods such as wheat flour and cheese (Boca and Smoley, 1993).

Chelating agents: Chelating agents are not anti-oxidants. They serve as scavengers of metals which catalyze oxidation. Recommended usage levels for citric acid typically vary between 0.1 and 0.3 per cent with the appropriate anti-oxidant at levels ranging between 100 and 200 ppm). EDTA is a chelating agent permitted for use in the food industry as a chemical preservative. Calcium disodium EDTA and disodium EDTA have been approved for use as food additives by the United States Food and Drug Administration. The chelating agents are used to prevent discolouration, flavour changes, and rancidity that might occur during the processing of foods, examples include citric acid, malic acid, and tartaric acid (Sunitha and Preethi, 2000).

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 (Sunitha and Preethi, 2000).

Acids: Food acids are added to make flavors "sharper", and also act as preservatives and antioxidants. Common food acids include vinegar, citric acid, tartaric acid, malic acid, fumaric acid, and lactic acid.

Preservatives: A preservative is defined as any substance which is capable of inhibiting, retarding, or arresting, the growth of micro-organisms, of any deterioration of food due to micro-organisms, or of masking the evidence of any such deterioration. It is estimated that nearly one fifth of the world's food is lost by microbial spoilage. Chemical preservatives interfere with the cell membrane of micro-organisms, their enzymes, or their genetic mechanisms. The compounds used as preservatives include natural preservatives, such as sugar, salt, acids, etc, as well as synthetic preservatives. The safe-use period of many foods is greatly extended through the addition of preservatives, which retard spoilage, preserve flavour and colour and keep oils from turning rancid. Preservatives protect foods, such as cured meats, from developing dangerous toxins, such as botulism, a food poisoning illness (Sunitha and Preethi, 2000).

pH Control Agents: These include acids, alkalis and buffers. They not only control the pH of foods but also affect a number of food properties such as flavor, texture, and cooking qualities. They are also used to change or otherwise control the acidity and alkalinity of foods (Abdulmumeen et al., 2012).

Anti-caking Agents: Anti-caking agents help prevent particles from adhering to each other and turning into a solid chunk during damp weather. They help free flowing of salt and other powders. They also help to keep powders such as milk powder from caking or sticking.

Leavening Agents: Leavening agents produce light fluffy baked goods. Originally, yeast was used almost exclusively to leaven baked products. It is still an important leavening agent in bread making. When yeast is used, ammonium salts are added to dough to provide a ready source of nitrogen for yeast growth. Phosphate salts (sodium phosphate, calcium phosphate) are added to aid in control of pH (Abdulmumeen et al., 2012).

Antifoaming agents: Antifoaming agents reduce or prevent foaming in foods (Abdulmumeen et al., 2012).

Bulking agents: Bulking agents such as starch are additives that increase the bulk of a food without affecting its nutritional value (Abdulmumeen et al., 2012).

Colour retention agents: In contrast to colouring agents, colour retention agents are used to preserve a food's existing colour (Abdulmumeen et al., 2012).

Emulsifiers: Emulsifiers are a group of substances used to obtain a stable mixture of liquids that otherwise would not or would separate quickly. They also stabilize gas-in-liquid and gas –in-solid mixtures. They are widely used in dairy and confectionery products to disperse tiny globules of an oil or fatty liquid in water. Emulsifying agents are also added to margarine, salad dressings, and shortenings. Peanut butter contains up to 10 per cent emulsifiers. Emulsifiers also allow water and oil to remain mixed together in an emulsion, as in mayonnaise, ice cream, and homogenized milk (Sunitha and Preethi, 2000).

Flavours and Flavour enhancers: Flavouring additives are the ingredients, both naturally occurring that when added, gives the characteristic flavour to almost all the foods in our diet. Flavour enhancers are not flavours themselve but they amplify the flavours of other substance through a synergistic effect. Flavour and flavour enhancers constitute the largest class of food additives. Natural flavours are substances, such as spices, herbs, roots, and essential oils, have been used in the past as flavour additives. The flavours are in short supply and the amount of flavour substances in them is very tiny. It would take about tonne of many spices to produce 1 g of the flavour substances, and in some cases only 0.1g can be extracted. Natural food flavours are thus being replaced by synthetic flavour materials. The agents responsible for flavour are esters, aldehydes, ketones, alcohols, and ethers. These substances are easily synthesized and can be easily substituted for natural ones. Typical of the synthetic flavour additives are amyl acetate for banana, methyl anthranilate for grapes, ethyl butyrate for pineapple, etc. Generally, most synthetic flavours are mixtures of a number of different substances. For example, one imitation cherry flavour contains fifteen different esters, alcohols, and aldehydes. One of the best known, most widely used and somewhat controversial flavour enhancer is monosodium glutamate (MSG), the sodium salt of the naturally occurring amino acid glutamic acid which can be

produced by the bacteria *Corynebacterium glutanicum*. Professor Kikunae Ikeda from the imperial university isolated glutamic acid as a new taste substance in 1908 from the seaweed Laminaria japonica, Kombu by aqueous extraction and crystallization and named it "umani" (Lindernann, 2002). He named this product monosodium glutamate and submitted a patent to produce MSG (Ikeda, 1908). Suzuki brothers started the first commercial production of MSG in 1909 as Aji-No-Moto meaning "essence to taste" in English (Chiaki, 2009; Yamaguchi, 1998 and Kurihara, 2009). MSG is now manufactured on a large scale all over the world, and especially in Japan with several trade names as Ac'cent, Aji-No-Moto and Vetsin. As a flovour and in the right amount, MSG can enhance other taste-active compounds, improving the overall taste of certain foods.

MSG mixes well with meat, fish, poultry, many vegetable, sauces, soups and marinades. Since MSG mixes well with many foods, it can also increase the overall preference of certain foods like beef consommé (Yamaguchi, 1991). MSG is generally recognized as safe. However, it was reported some time back that MSG injected to young mice resulted in brain damage. Also, some individuals experience symptoms often comparable to those of heart attack, when served with food containing large amounts of MSG. The matter has now been thoroughly investigated, and it has been concluded that there is no risk in its use. However, MSG which was being added to baby foods is now discontinued, as its benefits to babies are dubious. Flavour enhancers enhance a food's existing flavours. They may be extracted from natural sources (through distillation, solvent extraction, maceration, among other methods) or created artificially (Sunitha and Preethi, 2000).

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, ($KBrO_3$); potassium iodate, (KIO_3); Calcium iodate, [$Ca(IO_3)_2$]; and calcium peroxide, (CaO_2) (Sunitha and Preethi, 2000).

Glazing agents: Glazing agents provide a shiny appearance or protective coating to foods (Abdulmumeen et al., 2012).

Humectants: Humectants are moisture retention agents. Their functions in foods include control of viscosity and texture, bulking, retention of moisture, reduction of water activity, control of crystallization, and improvement or retention of softness. They also help improve the rehydration of dehydrated food and solubilization of flavour compounds. Polyhydroxy alcohols are water soluble, hygroscopic materials which exhibit moderate viscosities at high concentrations in water and are used as humectants in foods. Some of them are propylene glycol ($CH_3.CHOH.CH_2OH$), glycerol, and sorbitol and mannitol [$CH_2OH\ (CHOH)_4CH_2OH$]. Polyhydric alcohols are sugar derivatives and most of them, except propylene glycol, occur naturally (Sunitha and Preethi, 2000).

Tracer gas: Tracer gas allows for package integrity testing preventing foods from being exposed to atmosphere, thus guaranteeing shelf life (Abdulmumeen et al., 2012).

Stabilizers and Thickeners: These compounds function to improve and stabilize the texture of foods, inhibit crystallization (sugar, ice), stabilize emulsions and foams, reduce the stickiness of icings on baked products, and encapsulate flavours. Substances used as stabilizers and thickeners are polysaccharides, such as gum Arabic, carrageenan, agar-agar, alginic acids, starch and its derivatives, carboxy methylcellulose and pectin. Gelatin is one non-carbohydrate material used extensively for this purpose. Stabilizers and thickeners are hydrophilic and are dispersed in solution as colloids. These swell in hot or even cold water and help thicken food. Gravies, pie fillings, cake toppings, chocolate milk drinks, jellies, puddings and salad dressings, are some among the many foods that contain stabilizers and thickeners. Thickeners are added to the mixture; increase its viscosity without substantially modifying its other properties (Czarra, 2009).

Sweeteners: Sweeteners are added to foods for flavouring. Sweeteners other than sugar are added to keep the food energy (calories) low and they are usually recommended for diabetes mellitus, tooth decay and diarrhea patients so that the sugar levels in them will not be elevated (Abdulmumeen et al., 2012).

Artificial flavours and flavour enhancers: These are the largest class of additives; its function is to make food taste better, or to give them a specific taste. Examples are salt, sugar, and vanilla, which are used to complement the flavour of certain foods. Synthetic flavouring agents, such as benzaldehyde for cherry or almond flavour, may be used to simulate natural flavours. Flavour enhancers, such as monosodium glutamate (MSG) help to intensify the flavour of other compounds in a food (Sunitha and Preethi, 2000).

Curing Agents: These are additives used to preserve (cure) meats. They give them desirable colours and flavours, discourage the growth of microorganisms, and prevent toxin formation. Sodium nitrite has been used for centuries as a preservative and colour stabilizer in meat and fish products. The nitrite, when added to meat, gets converted to nitric oxide, which combines with myoglobin to form nitric oxide myoglobin (nitrosyl myoglobin), which is a heat-stable pigment. The curing also contributes flavour to the meat. In addition, nitrite curing inhibits the growth of *Clostridium* and *Streptococcus*, and also lowers the temperature required to kill *Clostridium botulinum* (Abdulmumeen et al., 2012).

Other Additives: There are a number of food additives that provide functions other than those indicated above. Clarifying agents like bentonite, gelatins, synthetic resins (polyamides and poly vinyl pyrrolidone) are used to remove haziness or sediments and oxidative deterioration products in fruit juices,

beers and wines. Enzymes are added to bring about desirable changes; rennin for producing curd and cheese, papain for tenderizing meat, and pectinase for clarifying beverages. Firming agents like aluminium sulphates and calcium slats are used to keep the tissues of fruits and vegetables crisp. Freezing agents like liquid nitrogen and dichloro fluoro methane, which are extremely volatile and rapidly evaporate at ordinary temperatures, are used to chill foods. Solvents like alcohol, propylene glycol and glycerine are used to dissolve suspended flavours, colours, and many other ingredients. Packing gases, such as inert gases like Helium, Neon are added to packets of instant foods to prevent oxidative and many other changes (Sunitha and Preethi, 2000).

E-Numbering

To regulate these food additives, and inform consumers about the nature of the additives, each additive is assigned a unique number termed as "E numbers" which is used in Europe 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. For example, acetic acid is written as E260 on products sold in Europe, but is simply known as additives 260 in some other countries. Additives 103, alkanet, is not approved for use in Europe so does not have an E number, although it is approved for use in Australia and New Zealand since 1987. Australia has had an approved system of labeling for additives in packaged foods. Each food additive has to be named or numbered. The numbers are the same as in Europe, but without the prefix 'E'. Some E number for some food additives are; Tartrazine (E102), Quinoline Yellow (E104), Carmosine (E122) and Amaranth (E123).

Food Preservatives

A Preservative is a natural occurring or synthetically produced substance that is added to products such as foods, pharmaceuticals, paints, biological samples, woods, etc. to prevent decomposition by microbial growth or by undesirable chemical changes. Preservatives can be divided into two types, depending on their. Class I preservatives refer to those preservative which are naturally occurring, everyday substances, examples include salt, honey and wood smokes (ANON, 2013) Class II preservatives refer to preservative which are synthetically manufactured. Food Preservative can be used alone or in conjunction with other methods of preservation. Food preservatives are often added to food to prevent their spoilage, or to retain their nutritional value and /or favour for a longer period (Abdulmumeen et al., 2012). The basic approach is to eliminate microorganisms from the food and prevent their growth. This achieved by methods such as high concentration of salt or reducing the water content, this inhibits spoilage of the food item by microbial growth. Preservatives may be antimicrobial preservatives, which inhibit the growth of bacteria or fungi, including mold, or antioxidants such as oxygen absorbers, which inhibit the oxidation of food constituents. Common antimicrobial preservatives include calcium propionate, sodium nitrite (and sodium nitrate which converts to sodium in situ), sulfites (sulfur dioxide, sodium bisulfite, potassium hydrogen sulfite, etc.) and disodium EDTA (Dalton, 2002 and Dalton, 2002). The benefits and safety of many artificial food additives (including preservatives) is the subject of debate among academics and regulators specializing in food science, toxicology, and food microbiology. Natural substances such as salt, sugar, vinegar, alcohol, and diatomaceous earth are also used as traditional preservatives. Smoking salting and drying have been used since prehistoric time to preserve food. Processes such as freezing and pickling are also used to preserve food. Another group of preservatives targets enzymes in fruits and vegetables that continue to metabolize after they are cut. For instance, citric and ascorbic acids from lemon or other citrus juice can inhibit the action of the enzyme phenolase which turns surfaces of cut apples and potatoes brown. Most foods contain enzymes or natural chemicals, such as acids or alcohols that cause them to begin to lose desirable characteristics almost immediately after harvest or preparation. A host of environmental factors, such as heat and the presence of microorganisms are known to act and change foodstuffs in ways that may harm the food product and make them unacceptable for consumption. Food preservation traditionally has three goals namely the preservation of nutritional characteristics, the preservation of appearance, and a prolongation of the time that the food can be stored.

Traditional methods of preservation usually aim to exclude air, moisture, and microorganisms, or to provide environments in which organisms that might cause spoilage cannot survive (Daniel, 2007). Among the earliest preservatives were sugar and salt (NaCl), which produced food environments of high osmotic pressure that denied bacteria the aqueous surroundings they needed to live and reproduce. Jams and jellies are preserved as solutions of high sugar content, and many meats (e.g., hams) and fish are still preserved by salting. Unlike other microorganisms, molds can often withstand the effects of high salt or sugar concentrations in foods. Fortunately, they seldom cause illness. Early methods of air removal included the sealing of foods inside containers (such as jars), or the covering of food surfaces with hot paraffin. The invention of canning by Nicolas Appert enabled commercial preparations of foodstuffs (Abdulmumeen *et al*., 2012). In response to a prize offered by Napoleon in 1795, Appert developed a method of canning and preserving fruits and vegetables in glass containers for sea voyages. His process was used commercially in 1910 by Peter Durand in England, using metal cans.

During the earliest days of canning, some persons (including some Arctic explorers) probably died as a result of exposure to the lead that was once used to solder cans. Modern techniques of air removal include vacuum sealing and the use of plastic wrappings. Chemical preservatives include free radical scavengers (also known as antioxidants), such as vitamin C and compounds such as BHA (butylated hydroxyanisole), and bacterial growth inhibitors, such as benzoic acid, sulfur dioxide, and sodium nitrite ($NaNO_2$). Ethanol (CH_3CH_2OH) has long been used as a preservative, both of itself (as in wine), and of other foods (e.g. fruits stored in brandy). Some chemical preservatives may be harmful: Sulfur dioxide (often used to preserve wines) is irritating to the bronchial tubes of persons who have asthma, and nitrites have been implicated as carcinogens (Sanchez-Echaniz, 2001 and Dusdieker, 1994). The irradiation of foods has the advantage of enabling food packaging and preparation in which there is less person-to-food contact, thus decreasing

the possibility of contamination and decreasing the need for chemical preservatives, some of which may be harmful. The ionizing radiation that is used to irradiate foods, wherein the foods are exposed to bursts of high-intensity x-rays or streams of electrons, disrupts bacterial DNA. Some persons have objected to the irradiation of foods because of an (unfounded) fear of radioactivity. As pathogens such as virulent strains of coliform bacteria have caused food poisoning, the irradiation of animal carcasses and, in particular, of hamburger during its preparation has become more desirable. Irradiation currently extends the shelf life of foods such as strawberries. Irradiation does not make foods radioactive, but may cause changes in food color or texture (John, 2003).

Advantages of Food Additives and Preservatives

Food additives play a vital role in today's food supply. They allow our 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 miles 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 (Houghton, 2002). The importance of preserving food is that, it lengthens the shelf life of a food and it 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, too much of a good thing is not 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 impact 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 (Hoover and Milich, 1994).

Additives are used in foods for five main reasons:

To maintain 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.

To improve or maintain 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.

To maintain palatability and wholesomeness: 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.

To provide leavening or control acidity/alkalinity: 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.

To enhance flavour or impact desired colour: Many spices, natural and synthetic flavours enhances the taste of foods. Colours, for instance help to enhance the appearance of certain foods to meet consumer expectations.

To maintain product consistency and quality: They help to improve or maintain nutritional value, maintain palatability and wholesomeness, provide leavening, control pH, enhance flavor, or provide colour.

Food Additives and Malnutrition

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 (Tuula, 1994). 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 (Tuula, 1994).

Effect of Food Additives and Preservatives

The effects of food additives may be immediate or may be harmful in the long run if one have constant exposure or accumulations. Immediate effects may include headaches, change in energy level, and alterations in mental concentration, behaviour, or immune response (Pandey, and Upadhyay, 2012). Long-term effects may increase one's risk of cancer, cardiovascular disease and other degenerative conditions. Some modern synthetic preservatives have become controversial because they have been shown to cause respiratory or other health problems (Pandey, and Upadhyay, 2012). Some studies point to synthetic preservatives and artificial colouring agents aggravating ADD & ADHD symptoms in those affected (Gustafsson *et al*., 2003). Parental reports were more accurate indicators of the presence of additives than clinical tests (ANON, 2004). Allergic preservatives in food or medicine can cause an anaphylactic

shock in susceptible individuals, a condition which is often fatal within minutes without emergency treatment. It is almost a certainty that few really know what it is, that is part of their foodstuffs, and yet may present threats and danger. Essentially, there are two main sources of dangerous or threatening additives. The first is those that are put in as part of the processing operation. These include the colourings, preservatives, flavours and flavour enhancers, sweeteners, texture agents and processing agents. Details of these must be included on the labeling and can be identified with a little knowledge and some attention to the information provided by the manufacturer. The second source of additives to our food is from packaging, storing and handling of food and these informations are not normally included on the label of the food. Food that has no additives at all is to be preferred, most especially if it is to be used to feed children. Many foods available in the market contain different types of preservatives. These chemicals can give rise to certain health problems (Abdulmumeen *et al.,* 2012).

Additives consistently maintain the high quality of foods. Food preservatives are the additives that are used to inhibit the growth of bacteria, molds and yeasts in the food. Some of the additives are manufactured from the natural sources such as corn, beet and soybean, while some are artificial, man-made additives. Many people are allergic to certain food additives or colours. When someone has a reaction after eating certain foods, an allergy is suspected. Unfortunately, some people do not have a reaction until a day or two later, so it is difficult to know what is causing the problem. When a certain food additive is believed to cause an allergic reaction, the blood is mixed with materials known to trigger allergies. The test measures the level of allergy antibodies in the blood that are present with an allergic reaction. Such test for synthetic additives is not reliable. Thus, people have to go on an elimination diet. They stop eating all foods that might be problematic and introduce one at a time to see if a reaction occurs. It is best to eat a preservative-free diet if at all possible. The reaction from these additives can be very mild to life-threatening. They can be immediate or build up in the body over time. Only in recent years have researchers seriously considered the physical impact of these additives over the long term (Pressinger, 1997).

Some Food Additives and Preservatives and their Side-Fects

Some food additives and preservatives have been shown to have side effects in human and animal model.

Tartrazine: Tartrazine (trisodium 5-hydroxy-1-(4-sulfonatophenyl)-4-(4-sulfonatophenylazo)-H-pyrazol-3-carboxylate) is also known as FD&C Yellow no. 5 and E 102. It is an artificially synthesized azo pigment and its use is permitted as a colorant in food products, cosmetics and pharmaceuticals, with a recommended acceptable daily intake (ADI) of 7.5 mg/kgbw. However long-term and excessive ingestion of tartrazine may cause a variety of adverse effects (Amin *et al*., 2010; Demirkol *et al*., 2012; Henschler and Wild, 1985; Kashanian and Zeidali, 2011; Soheila, 2011; Soheila and Sahar, 2011; Tanaka, 2006; Tanaka *et al*., 2008 and Ward, 1997). Mpountoukas *et al.* indicated that tartrazine had genotoxic potential towards human lymphocytes and could bind directly to DNA (Mpountoukas *et al*., 2010). Kashanian *et al.* also reported similar results and pointed out that tartrazine was potentially toxic to calf thymus DNA *in vitro* (Kashanian and Zeidali, 2011). A study by Tanaka *et al.* reported that tartrazine could exert adverse effects on neurobehavioral parameters (Tanaka *et al*., 2008), while Gao *et al.,* indicated that tartrazine could cause neurotoxicity and deficits in learning and memory in mice and rats (Gao *et al*., 2011). Li and co-workers investigated the toxic interaction between tartrazine and bovine hemoglobin (BHb), and found that tartrazine had an obvious toxic effect (Li *et al*., 2013). Due to this potential toxicity, it is crucial to control the amount of tartrazine used in food products and it is therefore necessary to develop analytical methods capable of evaluating the exposure of the general population to tartrazine. To date, various methods have been reported for the detection of tartrazine, such as chromatography (Feng *et al*., 2011; Khanavi *et al*., 2012 and Minioti *et al*., 2007), spectrophotometry (Huang *et al*., 2012; Nevado *et al*., 1994 and Sahraei *et al*., 2013), electroanalytical methods (Ghoreishi *et al*., 2012; Medeiros et al., 2012 and Yang *et al*., 2011), and novel nanosensor detection methods (Gan *et al*., 2012 and Ghoreishi *et al*., 2011). However, most of these methods are expensive, time consuming or complicated, and therefore not suitable for routine extensive monitoring of tartrazine. In contrast, an enzyme-linked immunosorbent assay (ELISA) could be an ideal alternative technology, due to its high sensitivity, time-efficiency and cost-effectiveness.

Boric Acid: Boric acid (H_3BO_3) is a boron compound which is soluble and circulates in plasma (Di Renzo et al., 2007). It is colourless and water soluble white powder which has been used as pesticide to kill mites, insects, fungi and algae and also the fleas, cockroaches, termites and wood decay fungi (Cox, 2004). Boric acid is widely used as food preservative (4gm/L) in food products like caviar (The ministry of Agriculture of Turkey, 1997). It is also used for preserving meats, caviar and dairy products (Arslan et al., 2008) Food colours are water soluble and are extensively used in almost every type of edible preparations like soft drinks, foodstuffs, jams and jellies, sweets, candies, ice creams, sauces and pickles (Hallagan et al, 1995). The possible harmful effect of colouring matters and all other food additives to foodstuffs are a subject of public concern. Accordingly there is an increase in application of legislative control so as to restrict the use of harmful colouring matters in food and to check certain permitted items which have not any harmful effect when subjected to rigorous examination (Tripathi et al., 2007). Boric acid and borates are toxic to cell (Yiu et al., 2008). Boric acid is harmful to human health if consumed in higher amounts (See et al., 2010). However, due to unawareness of the risk of boric acid, it is continued to be used in many foodstuffs. The similar cytotoxic behavior of these food additives was also reported by Donbak et al (2002). It was reported by several workers that boric acid suppressed the sperm release from the testes and when the animals were treated with high amount of boric acid; it inhibits DNA synthesis in sperm cells and hence reduces fertility and it impairs fertility in male rodents (Cox, 2004).

Curcumin: Clinical trials in human have been used to study the effects of curcumin on various, including multiple myeloma, pancreatic cancer, myelodysplastic syndromes, colon cancer, psoriasis and alzheimer's disease (Hatcher et al.,

2008). In vitro and in vivo studies suggest that curcumin can have carcinogenic effect (Burgos-Moron *et al*., 2010; Dance-Barnes *et al*., 2009 and Lopez-Lazaro *et al*., 2008). Clinical studies in humans with high doses (2-12grams) of curcumin have shown few side effects, with some subjects reporting mild nausea or diarrhea (Hsu and Cheng, 2007). Curcumin have been found to alter iron metabolism by chelating iron and suppressing the protein hepcidin, potentially causing iron deficiency in susceptible patients (Jiao *et al*., 2009). Curcumin also has embryotoxic and teratogenic effects on zebrafishes (*Daniorerio*) embryos (Wu *et al*., 2007). In vitro and in vivo studies carried out by Mohamed *et al* (2011) suggested that curcumin may cause carcinogenic effects.

Nitrites and Nitrates: The nitrate binds to hemoglobin (the compound which carries oxygen in blood to tissues in the body), and results in chemically-altered hemoglobin (methemoglobin) that impairs oxygen delivery to tissues, resulting in the blue color of the skin (Knobeloch, 2000). 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 in some studies (Sanchez-Echaniz, 2001; Dusdieker, 1994; U.S. Environmental Protection Agency. 1991; Preston-Martin, 1996; Ward, 2000; Pogoda and Preston-Martin, 2001; Sarasua and Savitz, 1994; McCredie *et al*., 1994 and Volkmer *et al.,* 2005). Reduced oxygenation of hemoglobin (methemoglobinemia) has been reported after exposure to nitrate and nitrite contaminated drinking water; also called the "blue baby syndrome" because of the cyanotic (oxygen-deficient) symptoms that result from the reduced oxygenation of the blood.

Other health effects following fetal exposure to elevated levels of nitrates in drinking water included intrauterine growth retardation (Bukowski *et al.,* 2001), increased incidence of Sudden Infant Death Syndrome (SIDS) (George, *et al.,* 2001), cardiac defects (Cedergren *et al.,* 2002), and increased risk of nervous system defects (Croen *et al.,* 2001). Studies have reported other health effects that are possibly associated with nitrate exposure in children, including increased incidence of childhood diabetes (Virtanen *et al.,* 1994), recurrent diarrhea (Gupta *et al.,* 2001), and recurrent respiratory tract infections (Gupta *et al.,* 2000). Brain tumors, leukemia, and nasopharyngeal cancers in children have also been reported (Preston-Martin *et al.,* 1996; Ward *et al.,* 2000; Pogoda and Preston-Martin, 2001; Sarasua and Savitz, 1994; McCredie *et al.,* 1994; Bunin *et al.,* 1994; Bunin *et al.,* 1993; Mueller *et al.,* 2001; Lubin, *et al.,* 2000 and Law *et al.,* 1999). Maternal (during pregnancy) or child consumption of nitrite-containing meats may be associated with increased incidence of brain tumors in children (Preston-Martin, *et al.,* 1996; Pogoda and Preston-Martin, 2001; Sarasua and Savitz, 1994; McCredie *et al.,* 1994).

Annatto: Annatto is safe for most people when used in small amounts; however, it can cause rare allergic reaction for those who are sensitive to it (ANON, 2011, Magee, 2011). Annatto has been linked to cases of food-related allergies (Myles and Beakes, 2009). In one 1978 study among 61 consecutive patients suffering from chronic hives and/or angioedemas, 56 patients where orally provoked by annatto extract during the elimination diet (Mikkelsen *et al.,* 1978). Annatto has accounted for 40 years of irritable bowel syndrome due to unrecognized sensitivity to annatto (Floch, 2009). Annatto dye is a potential rare cause of anaphylaxis (Stein, 2009).

Butylated Hydroxytoluene (BHT) and Butylated Hydroxyanisole (BHA): Butylated Hydroxytoluene (BHT) and butylated Hydroxyanisole (BHA) are synthetic monocyclic phenolic compounds. They are commonly used in many food formulations as food preservatives for their antioxidant properties (Aml, 2013). BHA and BHT have been suspected of inducing health risks such as child hyperactivity, damage to the lungs, liver, and kidneys, and most importantly, cancer (Tran, 2013). Research studies have shown that BHA and BHT can be carcinogenic at high doses and a concentration greater than 3000 ppm, has been known to induce forestomach squamous cell carcinomas in rodents while BHT at 250 mg/kg/day increases spontaneous neoplasms and tumor-promoting activity (Williams *et al.,* 1999). BHA can chemically induce tumors in rats' forestomach (Whysner *et al.,* 1994). BHA and BHT can act as chemopreventive agents at low doses, but can be carcinogenic at high doses (Branen, 1975; Williams *et al.,* 1999. Another study showed that BHA caused forestomach hyperplasia and cytotoxicity (Ito *et al.,* 1986).

Vinegar: Esophageal injury by applying cider vinegar table has been reported, and, because vinegar products sold for medical purposes are neither regulated nor standardized, they varied widely in content, pH, and other respect (Hill *et al.,* 2005). Long term heavy vinegar ingestion has one recorded case of possibly causing hypokalemia, hyperreninemia and osteoporosis (Lhotta et al., 1998).

Artificial Sweeteners: These contribute to one of the several side effects of food additives because of their sweet nature which make them to be used indiscriminately by food producers and individual as well. Artificial sweeteners considered in this review include Saccharin, Aspartame, Sucralose and Neotame.

Saccharin: The safety concerns of consuming products with saccharin remain even with the removal of the warning. According to a report written in 1997 by the Center for the Science in Public Interest (CSPI) in response to the National Toxicology Program (NTP) removing saccharin from the list of potential carcinogens, "*It would be highly imprudent for the NTP to delist saccharin. Doing so would give the public a false sense of security, remove any incentive for further testing, and result in greater exposure to this probable carcinogen in tens of millions of people, including children (indeed, fetuses). If saccharin is even a weak carcinogen, this unnecessary additive would pose an intolerable risk to the public. Thus, we urge the NTP on the basis of currently available data to conclude that saccharin is 'reasonably anticipated to be a human carcinogen' because there is 'sufficient' evidence of carcinogenicity in animals (multiple sites in rats and mice) and 'limited' or 'sufficient' evidence of carcinogenicity in humans (bladder cancer)* (Kroger, 2006) and not to delist saccharin, at least until a great deal of further research is conducted. Another possible danger of saccharin is the possibility of allergic reactions. The reaction would be in response to it belonging to a class of compounds known as

sulfonamides, which can cause allergic reactions in individuals who cannot tolerate sulfa drugs. Reactions can include headaches, breathing difficulties, skin eruptions, and diarrhea (Kovacs, 2011). It's also believed that the saccharin found in some infant formulas and can cause irritability and muscle dysfunction. For these reasons, many people still believe that the use of saccharin should be limited in infants, children, and pregnant women (Hallorsson, 2010). Without research to support these claims, the FDA has not imposed any limitations. Bladder cancer associated with saccharin ingestion was also found to be specific to rodent physiology (Kroger, 2006).

Aspartame: Aspartame is one of the most controversial artificial sweeteners. Aspartame is likely one of many dietary triggers of migraines in a list that includes cheese, chocolate, citrus fruits, hot dogs, monosodium glutamate, fatty foods, ice creams, red wines and beer (Millichap and Yee, 2003).There are numerous web sites, books, and articles stating various reasons why aspartame should not be consumed. Some site studies to support their theories while others base their claims on industry-related conspiracies. One fact is that aspartame does get metabolized, meaning that it doesn't get excreted in the same form that it is when ingested. Aspartame is not strictly non-caloric (4kcal/g) and is forbidden for people with phenylketonuria (PKU) (Kroger, 2006). This is the reason why it can't be consumed by people with the metabolism disorder PKU. The following is a summary of some of the controversial dangers of consuming aspartame.

Industry conspiracies: Conflicts of interest in the studies performed on aspartame and the way in which its approval was obtained is an ongoing controversy. Dr. Robert Walton surveyed the studies of aspartame in the peer-reviewed medical literature 2011 and observed that of the 166 studies felt to have relevance for questions of human safety, 74 had Nutrasweet industry (those who make aspartame) related funding and 92 were independently funded (Kovacs, 2011). One hundred percent of the research performed by the company who makes aspartame confirmed aspartame's safety, whereas 92% of the independently funded research found problems with consuming aspartame. Other reports of Federal employees working for the companies responsible for the testing and distribution of aspartame are cited on all of the sites and books opposing the use of aspartame (Roberts, 2001).

Aspartame disease: Roberts, H.J. MD, coined the term "aspartame disease" in a book filled with over 1,000 pages of information about the negative health consequences of ingesting aspartame. Dr. Roberts reports that by 1998, aspartame products were the cause of 80% of complaints to the FDA about food additives (Roberts, 2001). Some of these symptoms include headache, dizziness, change in mood, vomiting or nausea, abdominal pain and cramps, change in vision, diarrhea, seizures/convulsions, memory loss, and fatigue. Along with these symptoms, links to aspartame are made for fibromyalgia symptoms, spasms, shooting pains, numbness in your legs, cramps, tinnitus, joint pain, unexplainable depression, anxiety attacks, slurred speech, blurred vision, multiple sclerosis, systemic lupus, and various cancers (Raben, 2002). While the FDA has assured us that the research does not show any adverse health complications from aspartame, there has been some evidence to suggest that some of the following symptoms can be related to aspartame.

Headaches: Headaches are the common symptom that is being reported by consumers (Magnuson *et al*., 2007). One study confirmed that individuals with self-reported headaches after the ingestion of aspartame were indeed susceptible to headaches due to aspartame. Three randomized double blind, placebo-controlled studies with more than 200 adult migraine sufferers showed that headaches were more frequent and more severe in the aspartame-treated group.

Depression: In a study of the effect of aspartame on 40 patients with depression, the study was cut short due to the severity of reactions within the first 13 patients tested. The outcome showed that individuals with mood disorders were particularly sensitive to aspartame and recommended that it be avoided by them (Kovacs, 2011).

Sucralose: The presence of chlorine in sucralose is thought to be the most dangerous component of sucralose. Chlorine is considered a carcinogen and has been used in poisonous gas, disinfectants, pesticides, and plastics (Kovacs, 2011). The digestion and absorption of sucralose is not clear due to a lack of long-term studies on humans. The majority of studies were done on animals for short lengths of time. The alleged symptoms associated with sucralose are gastrointestinal problems (bloating, gas, diarrhea, nausea), skin irritations (rash, hives, redness, itching, swelling), wheezing, cough, runny nose, chest pains, palpitations, anxiety, anger, moods swings, depression, and itchy eyes (Abou-Donia, 2008). The only way to be sure of the safety of sucralose is to have long-term studies on humans done. Splenda is a product that contains the artificial sweetener sucralose, but that is not all that it contains. Sucralose does have calories, but because it is 600 times sweeter than sugar, very small amounts are needed to achieve the desired sweetness so you most likely won't consume enough to get any calories.

Acesulfame K: The problems surrounding acesulfame K are based on the improper testing and lack of long-term studies. Acesulfame K contains the carcinogen methylene chloride. Long exposure to methylene chloride can cause headaches, depression, nausea, mental confusion, liver effects, kidney effects, visual disturbances, and cancer in humans (Kovacs, 2011). There has been a great deal of opposition to the use of acesulfame K without further testing, but at this time, the FDA has not required that these tests be done (Yang, 2010).

Neotame: Neotame entered the market much more discreetly than the other artificial sweeteners. While the web site for neotame claims that there are over 100 scientific studies to support its safety, they are not readily available to the public. Opponents of neotame claim that the studies that have been done do not address the long-term health implications of using this sweetener. The chemical similarity that it has to aspartame may mean that it can cause the same problems that are associated with that. Without scientifically sound studies done by independent labs, there is no way to know if this is safe and for whom it is safe (Betty, 2011).

Safety of a Food Additive

The limit should be established with due importance to following factors;

Table 1. Some food additives and perservatives that should be avoided

Colour	Worldwide Status	Where Found	Possible Negative Effects	References
Erythrosine FD&C Red No. 3	Banned for use in cosmetics and external drug, but not food and ingested drugs in the U.S.	Cocktail, canned fruits salads Confections dairy products snack foods.	Cancer	*The WashingtonPost*, February7, 1990CBS News, June 3,2008
Tartrazine (E102) FD&C Yellow No. 5	Banned in Norway and Austria.	Ice cream Carbonated drinks Fish sticks	Hyperactivity, asthma, skin rashes, and migraine headaches.	UKFoodGuide.http://www.ukfoodguide.net/e102.htm. Retrieved 2007FDA, 2007
Quinoline yellow (E104)	* Banned in Australia, Japan, Norway and the U.S. Restricted to max. permitted levels in U.K.	Soft drinks Ice creams, Candies Cosmetics Medications	Asthma, rashes and hyperactivity. Potential carcinogen in animals: implicated in bladder and liver cancer. Altered reproduction in animals.	efsa.europa.eu -EFSA updates safety advice on sixfood colours 091112
Sunset yellow (E110)* Yellow FCF Orange Yellow S	Banned in Norway, Sweden and Finland. Restricted to maximum permitted levels in U.K.	Sweets Snack foods Ice-creams, Yoghurts Drinks	AVOID in allergies & asthma. Cancer – DNA damage, increases tumors in animals. Growth retardation and severe weight loss in animals.	091113 efsa.europa.eu doi:10.1016/S0140-6736(07)
Carmosine (E122)*	Banned in Canada, Japan, Norway, Austria, Sweden and the U.S. Restricted to maximum permitted levels in U.K.	Yoghurts Sweets	DNA damage and tumours in animals.	Food additives *CBC News*. 29 September 2008
Allura red (E129)* FD&C Red No. 3	Banned in Denmark, Belgium, France, Germany, Switzerland, Sweden, Austria and Norway	Carbonated drinks Bubble gum, snacks, Sauces, preserves, Soups, wine, cider.	May worsen or induce asthma, rhinitis (including hayfever), or urticaria (hives).	*UK Food Guide*, a British food additives website. Last retrieved 20 May 2007
Ponceau 4R (E124)* Conchineal	Banned in US, Canada, Norway, Sweden & Japan. Restricted to maximum permitted levels in the UK	Carbonated drinks Ice-creams Confectioneries Desserts	Cancer - DNA damage and tumours in animals. Can produce bad reactions in asthmatics	Food And Drug Administration Compliance Program Guidance Manual p.10
Amaranth (E123) Wine	Banned in the U.S.	Alcoholic drinks Fish roe	May worsen or induce asthma, allergies or hives.	FDA/CFSAN Food Compliance Program: Domestic Food Safety Program
Indigo Carmine (E132)*	Banned in the US, Japan, Australia and Norway. UK, use restricted to maximum permitted levels	Ice-creams, Sweets Baked goods, Confectionery items, Biscuits	May cause nausea, vomiting, skin rashes, and brain tumors. DNA damage and tumors in animals	United States Food and Drug Administration
Brilliant Blue (E133)*	Banned in Austria, Belgium, France, Norway, Sweden, Switzerland and Germany. Restricted to maximum permitted levels in U.K.	Dairy products Sweets Drinks	Hyperactivity and skin rashes. Listed as human carcinogen by the US EPA. Causes DNA damage and tumors in animals	FDA, 1993
Sodium benzoate (E211)*		Carbonated drinks, Pickles Sauces, Certain medicines (even some "natural and homeopathic" medications for kids)	Aggravates asthma and suspected to be a neurotoxin and carcinogen, may cause fetal abnormalities. worsens hyperactivity	Food Standards Agency issues revised advice on certain artificial colours, 2007
Sulphur Dioxide (E220)*	Not banned anywhere.	Carbonated drinks Dried fruit Juices Cordials Potato products	May induce gastric irritation, nausea, diarrhea, asthma attacks, skin rashes. Destroys vitamin B1. Causes fetal abnormalities and DNA damage in animals.	International Chemical Safety Card 0074
Sodium Metabisulphite		Preservative and antioxidant.	May provoke life threatening asthma	http://www.fedupwithfoodadditives.info/factsheets/Factsafeadditives.htm
Potassium nitrate (E249)	Not banned Anywhere	Cured meats and canned meat products.	May lower oxygen carrying capacity of blood; may combine with other substances to form nitrosamines that are carcinogens; may negatively affect the adrenal gland.	International Chemical Safety Card 1069

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Calcium benzoate (E213)	Not banned Anywhere	Drinks, low-sugar products, cereals, meat products.	May temporarily inhibit digestive enzyme function and may deplete levels of the amino acid glycine. AVOID with allergies, hives, & asthma.	http://www.fedupwithfoodadditives.info/factsheets/Factsafeadditives.htm
Calcium sulphite (E226)	In the U.S., sulphites are banned from many foods, including meat	In a vast array of foods from burgers to biscuits, from frozen mushrooms to horseradish. Used to make old produce look fresh.	May cause bronchial problems, flushing, low blood pressure, tingling, and anaphylactic shock. Avoid them if you suffer from bronchial asthma, cardiovascular or respiratory problems and emphysema.	http://www.fedupwithfoodadditives.info/factsheets/Factsafeadditives.htm
Butylated Hydroxy-anisole (E320) BHA/BHT		Particularly in fat containing foods, confectionery, meats.	BHA/BHT is may be carcinogenic to humans. BHA also interacts with nitrites to form chemicals known to cause changes in the DNA of cells.	doi:10.1021/jm00191a020
Benzoic acid (E210)		Drinks, low sugar products, cereals, meat products.	May temporarily inhibit digestive enzyme function. May deplete glycine levels. AVOID inasthma, or allergies.	International Chemical Safety Card 0103
Monosodium Gluatamate MSG (E621)* **	Not banned Anywhere	Processed foods & drinks, soup mixes.	Destroys nerve cells in brain and linked with aggravating or accelerating Huntington's, Alzheimer's and Parkinson's diseases. Causes cancer, DNA damage and fetal abnormalities in animals, Increases hyperactivity.	doi:10.1111/j.1365-2222.2009.03221.x
Aspartame (E951)*	US Air Force pilots are banned from drinking soft drinks containing aspartame.	200 times sweeter than sugar	May cause neurological damage, especially in younger children where brain is still developing. Breaks down in the body to phenylalanine (neurotoxin -may cause seizures), aspartic acid (damage developing brain) and methanol (converts to formaldehyde). Crosses the lacental barrier from mother to baby, even in small doses. Implicated in diseases such as MS and Non- Hodgkin's Lymphoma. May contribute to obesity.	FDA Consumer Magazine, 1999
Acesulphame K (E950)*	Not banned anywhere.	200 times sweeter than sugar	Causes cancer in animals. Linked to hypoglycemia, lung tumours, increased cholesterol and leukemia. May contribute to obesity	British Pharmacopoeia Commission Secretariat, 2009
Saccharine (E954)*	Banned in Germany, Spain, Portugal,Hungary, France, Malaysia, Zimbabwe, Fiji, Peru, Israel, Taiwan.	350 times sweeter than sugar	May interfere with blood coagulation, blood sugar levels and digestive function. Causes cancer of the bladder, uterus, ovaries, skin and blood vessels in animals. Linked to DNA damage and congenital abnormalities in animals. May contribute to Obesity.	USDA, 1972
High Fructose Corn Syrup (HFCS)	Not banned Anywhere	Carbonated Drinks other sweetened drinks (juices) baked goods candies canned fruits jams & jellies dairy products	Obesity Accelerated aging Insulin resistance Diabetes mellitus Complications of diabetes Fatty liver Increased triglycerides Increased uric acid Chronic diarrhea Irritable bowel syndrome Hives.	The American Medical Association, 2007

*All of these additives are considered the "Dirty Dozen Food Additives" and are prohibited in the UK for foods marketed for children less than 36 months.
**MSG-intolerant people can develop MSG symptom complex, which is characterized by one of more of the following:
• A burning sensation in the back of the neck, forearms and chest.
• Numbness in the back of the neck, radiating to the arms and back.
• A tingling, warmth and weakness in the face, temples, upper back, neck and arms.
• Facial pressure or tightness, swelling of lips/face
• Chest pain, rapid heartbeat
• Headache, nausea, drowsiness
• Bronchospasm (difficulty breathing) in MSG-intolerant people with asthma.
SOURCE: Pandey and Upadhyay, (2012)

a. The estimated level of consumption of the food product by the consume world for which the additive is proposed.
b. Finding out minimum levels which would produce significant deviation from physiological behavior.
c. An adequate margin of safety to reduce any hazard to a minimum.
d. Legal control over the use of food additives. This can be accomplished only when a list of permitted additives exists with specified safe levels and toxic levels.
e. Stringent labeling on foods i.e., declaring the usage of additives in food and their quantities.
f. Employing trained food inspectors, food control laboratories and reliable analytical methods are of utmost important for regulation / control over usage of food additives.

Safety Evaluation of Food Additives

Under Food additives Amendment two groups of ingredients are exempted from regulation.

Group I: Prior sanctioned substances that FDA or USDA has determined safe for use in food prior to 1958 amendment. E.g., Sodium nitrate and Potassium nitrate

Group II: It includes GRAS, all the substances approved by experts as safe based on their extensive history of use in food before 1958 or based on published scientific evidence. Eg: Salt, sugar, MSG.

In 1969, President Nixon directed the FDA to update safety aspects of all GRAS substances on the basis of current scientific investigations. In 1972 a committee from Federation of American societies for experimental biology reviewed the safety of all GRAS substances on the basis of published and other available information. The committee placed all reviewed substances in five categories.

Category I: Includes all those additives whose GRAS status was reaffirmed. This means that the available information presented no evidence of toxic hazards of the substance in question. These substances are generally used according to GMP.

Category II: It includes those substances whose GRAS status was reaffirmed at current level of use. This means that the available information presented no evidence of toxic hazard at the level of current use and practice.

Category III: Substances whose safety is reaffirmed at the level of current use and practice. However certain uncertainties exist so that additional studies are required.

Category IV: Include those substances for which information is incomplete to "reaffirm safety". This means evidence of toxicity has been reported, however the level and manner of current use the information is insufficient to determine the effect on public health.

Category V: Those substances for which no biological studies are available to judge their safety.

Regulations of Food and Perservatives

There are several 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 (FDA, 1993) 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 (Haley, and Lyn, 2010). 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

Table 2. Some of the permitted gras food additives and tolerances level

Additive	Food used	Function	Tolerance Level
Al, ca silicate	Table salt	Anticaking agent	2.0%
BHA	Various foods	Antioxidants	≤0.02%
BHT	Various foods	Antioxidants	≤0.02%
Caffeine	Cola type beverages	Multipurpose Anticaking	0.02% 2.0%
Ca. silicate	Table salt, Baking powder Cashew nuts	Fumigants Flavouring agent	5.0%
Ethylformate	Baking powder	Flavouring agent	0.05%
Gelatin	Puddings fillings		0.03%
KMS	General preservative	Antimicrobial	GMP
Sodium bisulphate	Various food	Antimicrobial	GMP
Sodium sulphite	Various food	Antimicrobial	GMP
SO_2	Wines, fruit juices, Dehydrated fruits	Antimicrobial	GMP
Stearylcitrate Thiodipropionic acid	Various foods Various fat containing foods	Sequestrants Antioxidants	0.15% 0.02%

Source: Sunitha and Preethi, (2000).

ordinarily render it injurious to health" (Food and Drug Act, 1906). Congress passed the Food Additives Amendment, Section 409 of the Food, Drug, and Cosmetic Act, in 1958, as well. This amendment exempts two important groups of substances from the food additive definition. Those are:

(a) Substances generally recognized as safe (GRAS) among experts qualified by scientific training and experience to evaluate safety.
(b) Substances that either FDA or the U.S. Department of Agriculture (USDA) had sanctioned for use in food prior to 1958 (so-called "prior sanction" substances). The amendment does not pertain to pesticides in or on raw agricultural commodities.

According to current U.S Federal law and regulations, any substance that is Generally Recognized As Safe (GRAS) for a particular use may be used in food for that purpose without pre-market approval from FDA. General recognition of safety (i.e., a GRAS determination) must reflect the views of experts qualified by scientific training and experience to evaluate the safety of substances directly or indirectly added to food. Those expert views must be based on "scientific procedures," supplemented in the case of substances used in food prior to 1958 by experience based on common use in food. According to the Code of Federal Regulations, the term "safe" means that there is reasonable certainty in the minds of competent scientists that a substance is not harmful under intended conditions of use (CFR, 2007). The 1958 Food Additives Amendment forbids the use of any food additive not approved by FDA, and the agency may only approve additives shown to be "safe." The act outlines the requirements for requesting approval for a food additive (i.e., "Petition to establish safety") and details the action to be taken by FDA in dealing with such a petition. According to Coppens *et al.,* (2006), food supplements were nationally regulated in the EU until 2002, when the Food Supplements Directive 2002/46/EC came into effect. This directive provides a list of the vitamins and minerals that can be used in the manufacture of food supplements.

DISCUSSION

According to (Tuula, 1994), the use of food additives has increased enormously in the last few decades. As the result, it has been estimated that today about 75% of the Western diet is made up of various processed foods, each person consuming an average 8-10lbs of food additives per year, with some possibly eating even more. The following adverse effects have been attributed to the consumption of various food additives; eczema, urticaria, angioedema, exfoliative dermatitis, irritable bowel syndrome, nausea, vomiting, diarrhoea, rhinitis, bronchospasm, migraine, anaphylaxis, hyperactivity and other behavioural disorders (Smith, 1991). There is also now clear evidence that the health of the nation in the U.K. has deteriorated considerably during the last few decades (Tuula, 1994). This was found by Dr Michael Wadsworth, when he compared the health records of over 5000 people born in 1946 to their first-born children a generation later. The survey found among the new generation a substantial increase in hospital admissions of children up to the age of four, a tripling of instances of asthma, a six-fold increase in both eczema and juvenile diabetes, as well a double increase in obesity (Wadsworth, 1985). The number of children admitted to psychiatric hospitals had also raised sharply. The latest official figures have shown between 1985 and 1990 a 42% rise in the number of under 10 year olds seen by the psychiatric services and a 65% increase in children aged between 10 to 14, whilst the admissions of 15 to 19 year old juveniles to psychiatric hospitals had increased 21%. Even some children as young as 5 years of age are ending up in psychiatric wards (Thompson and Pudney, 1990) and (Gorman, 1993). Crime is also presently on top of the political agenda. In fact the present rising trend of the criminal statistics and violence resembles today more of an epidemic disease, with symptoms including mental disarrangement combined with a complete lack of any behavioural or emotional control (Bryce-Smith, 1994). This review paper has shown that inappropriate nutrition can modify brain function resulting, in susceptible individuals, in a severe mental dysfunction, including manifestations of criminal and violent behaviour. When this happens, several nutritional factors might be working together; however the following fundamental dietary factors must be taken into consideration when confronting anyone displaying an inappropriate behaviour pattern: is the person concerned living on a high sucrose, high food additive diet which lacks an appropriate amount of good protein?

Is the diet completely lacking in foods high in vitamin and mineral content such as fresh fruits and/or salads? Could the person have an allergic intolerance to any foods he or she is consuming regularly? Could the person suffers from a toxicological burden of heavy metal contamination, such as lead, cadmium and/or aluminum, and a deficiency of an essential trace element. It must be stressed that this paper is most definitely not trying to insinuate that all negative behaviour manifestations are nutritional in origin, as socio-political influences certainly do play a part. However, it must be always remembered that a healthy and non-toxic brain can usually receive information and process it in an intelligent and positive manner, as opposed to a malnourished and toxic brain which simply does not possess the same capability. As seen from the above, inadequate nutrition and subclinical malnutrition seem to be two of the basic reasons for a myriad of physical and mental health problems of today.

This could be easily rectified by reducing the wide use of non-essential food additives, which in turn would simply restrict the amount of non-nutritious foods presently on sale, resulting in a wider uptake of more nutritionally dense foods. The main excuse of the food manufacturers and the government officials for the importance of the use of preservatives is that without them foods would soon spoil. This argument is indeed quite realistic. However, it is interesting to note that of the nearly 4000 different additives currently in use, over 3640 are used purely for cosmetic reasons and as colouring agents, the preservatives accounting for less than 2% of all additives when counted by number or by weight (The London Food Commission, 1988).The other continued reason for the approval of the use of additives is based on the argument that they are present in foods on such a minute scale that they must be therefore completely harmless. This argument may be almost acceptable regarding additives with a reversible toxicological action. However, with additives which have been found to be both

mutagenic and carcinogenic, neither the human nor animal body is able to detoxify. Therefore even very minute doses of these additives, when consumed continuously, will eventually result in an irreversible toxic burden, resulting finally in cancer formation and/or in chromosomal and fetal damage. This is quite unacceptable, particularly as the majority of these dangerous agents belong to the food colouring group (Tuula, 1994).

Recommendations

In order to improve the present situation, the following recommendations are therefore suggested;

- All non-essential food additives should be banned, particularly all cosmetic agents such as food colourants.
- The various regulating agencies should ensure that it is only those food additives which are generally recognized as safe (GRAS) that is added to foods.
- All foods which include additives with carcinogenic, mutagenic and teratogenic properties should be clearly labeled with the appropriate warning.
- All food additives should be banned from foods which may be consumed by infants and young children.
- All food additives that are not generally recognized as safe (Non GRAS) must not exceed the acceptable Daily Intakes (ADIs)
- The amount of TV advertising which encourages children to buy and eat unhealthy junk food should be vigorously cut down by various regulating agencies as children are presently surrounded by images promoting extremely unhealthy eating habits.
- All foods that have little or no nutritional value should be discouraged from all promotions.
- Regulating agencies should ensure that Good Manufacturing Practices (GMP) are adhere to by various food producing and processing industries
- Government should re-introduce free nutritious school meals, preferably using organic foods, which will be available to all school-children to discourage them from patronizing these colourant food additives.
- Local Education Authorities should include in their health education curricula specific lectures stressing the prime importance of good nutrition in both physical and mental health of children.
- All foods, drinks or medications currently exempt from declaring additives must in future be required to do so. This is particularly important and timely in connection with medicines, as presently there is no legal requirement by current labeling regulations to oblige the drug manufacturers to disclose the presence of any of their pharmacological adjuvants. Adverse reactions to drugs themselves have been recognized, but the ever-expanding range of synthetic exipients currently in use can no longer be considered either inert or non-toxic. In fact it has been already suggested that adverse reactions to undisclosed exipients should be always suspected whenever patients present with recurrent, unexplained symptoms, particularly allergies (Smith, 1991).
- Finally, all young children diagnosed as hyperactive, including children currently seen by psychiatric services, should always be screened first for evidence of a possible food/chemical intolerance as even the simplest dietary changes i.e. by avoiding foods containing food additives such as coloured sweets, fizzy and sugary drinks etc., can bring about a remarkable improvement in their health and behavior (Bunday and Colquhoun, 1990). It would be appropriate to suggest that we must now finally insist that the Government pass a law refusing permission for the food industries to add continuously into our everyday foods and beverages demonstrably toxic agents for cosmetic purposes only. If not for any other reason, at least in order to protect the health of our significant population of young children, youths, adolescents and adults, as well as the health of our future generation because a healthy nation is a wealthy nation.

Conclusion

This review work has examined the various effects of food additives and preservatives on man. Additives have been used for many years to preserve, flavour, blend, thicken and colour foods, and have played an important and essential role in reducing serious nutritional deficiencies (Nutrition Supplement Additives). Additives help to assure the availability of wholesome, appetizing and affordable foods that meet consumer's demands from season to season while also helping to preserve food from spoilage from microorganism. Food additives play a vital role in the food industries, but the various adverse effects associated with them remain a problem that need to be fought by us. Synthetic food additives react with the cellular component of the body leading to the various food disturbances (effects). If we must use food additives, because of their advantages, they should be the natural ones which have minimal effects and those that are generally recognized as safe (GRAS) and in the case of those not generally recognized as safe (Non GRAS), the acceptable daily intakes (ADIs) should not be exceeded. To minimize the risk of developing health problems due to food additives and preservatives, one should avoid the foods containing these additives and preservatives. Before purchasing the canned food, its ingredients should be checked. Purchase only organic foods, which are free from artificial additives. Although it may seem difficult to change habits and find substitutes for foods that one enjoy, remind yourself that you will be adding to your diet some new wholesome foods that you will come to enjoy even more. Look for foods that are not packaged and processed, but enjoy nature's own bounty of fresh fruits, vegetables, grains, beans, nuts and seeds. Find foods that resemble what they looked like when they were originally grown.

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