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Effects of food additives and preservatives and shelf life of the processed foods

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Abstract

Foods are the mixture of substances that are either in the form of solid or liquid and are consumed by human being for their nutritional benefits. Food additives are defined as the organic substances that are added in food in a small amount in the processing and production to increase and maintain the shelf life of the processed foods.

Food preservatives is the class of food additives. Food preservatives is that type of substance which are added in food to kill the microorganisms and helps to prevent the food from spoilage. There are two types of food preservatives: class 1(natural preservatives) and class 2(chemical preservatives).

Natural preservatives such as salt, sugar, honey and edible oils and Chemical preservatives such as Benzoates, Sorbates, nitrites, nitrates of sodium or potassium, sulfites, glutamates and glycerides.

Food preservation plays an important role to increase the shelf life of food and to improve the quality of the processed foods. The main aim of this review paper is to highlight the current information about food additives and how it effects the shelf life of the processed products.

Keywords: Foods, additives, preservatives, shelf life, salt, sugar, benzoates, sorbates

Introduction

Food is any substance that provides nutritional value for an organism. It consists of plant or animal origin that contains essential nutrients such as carbohydrates, fats, proteins or vitamins. Food additives are the substances that are added by the food manufacturers in small amount during production or processing in order to improve the palatability of the food. The food additives must be added in limited quantities and it should be within the acceptable daily intakes (ADIs) above that they can have destructive effects on the consumers. They can be used directly or indirectly. Direct additives are those that are added to foods for specific purposes whereas indirect additives are added during its processing, packaging and storing process. Food additives are further grouped as natural and synthetic. Natural food additives derive from natural sources such as plants, animals. Examples such as soyabeans and corn are used to maintain the consistency of food; caramel is derived from caramelized sugar and is used as a colouring agents; aspartame derived from aspartic acid and is used in food preservation. Food Preservatives are used in order to control the growth of bacteria, molds and yeasts in food. Use of food additives and preservatives is necessary in order to control the spoiling of food that have been kept for a prolonged period. Additives and preservatives helps to maintain the quality, consistency, shelf life and palatability of foods. Food chemistry is the study of the interactions and chemical processes that comes in between the biological and non-biological components of foods. The biological substances consists of meat, poultry, beer and milk. With the arrival 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) [8]. Several products such as coffee cream, candies are made from chemicals and consists of completely artificial ingredients. Various researchers have found that most of the food additives that are used by the manufacturers have adverse effects on the consumers (FDA, 1993 and Abdulmumeen *et al.*, 2012) [56, 3].

Nowadays, most people prefer to eat ready-made foods that are available in the market. These types of foods contains some kind of additives and preservatives, to maintain their quality and flavour. Some of the commonly used preservatives and additives are sodium nitrate, butylated hydroxyanisole (BHA), Monosodium glutamate and sodium benzoate. Some artificial colours are used such as erythrosine (red), amaranth (Azoic red), annatto bixine (yellow orange) (Miller and Millstone, 1987).

Food and its classification

In ancient times, people obtain their food from hunting, fishing, farming this is known as agriculture. But nowadays, food is supplied by food industries that are operated by multinational corporations that use intensive farming and industrial agricultural methods.

Classifications of food additives

Food additives can be divided into four general categories:

They are classified as **Nutritional Additives, processing, preservatives and sensory agents.**

1. Nutritional Additives: They are used with the purpose to rejuvenate the nutrients lost during the process of production, fortifying. The fortification of foods was started in 1924 when iodine was added to table salt for the prevention of goitre. Vitamins are used in many foods in order to increase their nutritional value. Vitamins A and D are used in dairy and cereal products, vitamin B are used in flour, cereals, baked goods, and pasta, and vitamin C is used in fruit beverages, cereals, dairy products.

2. Processing agents: Many agents are added in food during processing in order to maintain the consistency of the product.

Function	Chemical agent found	Product obtained
Anticaking	Sodium aluminosilicate	Salt
Bleaching	Benzoyl peroxide	Flour
Chelating	Ethylenediaminetetraacetic acid (EDTA)	Dressings, sauces and dried bananas
Emulsifiers	Lecithin	Ice cream, bakery products
Humectants	Glycerol	Soft candies and chewing gum
pH Control	Citric acid and lactic acid	Cheese, jams and jellies
Stabilizers and thickeners	Pectin, gelatin, gums	Dressings, jams and jellies, puddings

Source: Singh, R. Paul and Davidson, P. Michael (2018, August 3). Food additive. Encyclopedia Britannica. <https://www.britannica.com/topic/food-additive>

3. Preservatives

They are divided into two groups: Antioxidants and Antimicrobials.

Antioxidants

Table 1: Antioxidants

Chemical agents	Mode of action
Ascorbic acid	Oxygen scavenger
Butylated hydroxyanisole	Free radical scavenger
Citric acid	Enzyme inhibitor
Sulfites	Enzyme inhibitor
Tocopherols	Free radical scavenger

Antimicrobials

Table 2: Antimicrobials

Chemical agents	Mode of action
Acetic acid	Destroy cell membrane function such as yeasts, bacteria and molds
Benzoic acid	Destroy cell membrane and inhibits enzyme such as molds, bacteria and yeasts
Nitrates and nitrites	Inhibit enzymes and destroy cell membrane function.
Sulfites and sulfur dioxide	Inhibit enzymes and forms addition compounds such as yeast and bacteria
Sorbic acid	Inhibit bacterial spore germination such as yeasts, bacteria and molds

4. Sensory Agents: These include the colorants, flavoring's, sweeteners. Two types of colorants are Natural and synthetic colorants.

Antimicrobial agents: They are used to prevent the spoilage of food that is caused by microorganisms. These include vinegar, salt, calcium propionate and sorbic acid that are used in products such as baked foods, salad dressings, cheese and pickled foods.

Antioxidants: An anti-oxidant is a compound which is added to fats and fat containing compounds to delay oxidation and prevent some types of cell damage. An antioxidant should not increase an unpleasant odour, flavour or colour to the food in which it is present. It should be beneficial in low concentrations and should be fat soluble. It

should not have any harmful effect on food. Some examples of antioxidants that are used in foods are butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), tertiary butyl hydroquinone (TBHQ) these are all phenolic substances (Dalton, 2002). Dilauryl thiodipropionate and thiodipropionic acid it is also used as food antioxidants. Tocopherol acts as a naturally occurring anti-oxidant and it acts as a biological antioxidant in plants and animals tissue but it is hardly used as food additives because it is more costly than man-made antioxidant (Sunitha and Preethi, 2000).

Some of the popular antioxidant vitamins include

a) **Ascorbic acid-E300:** These vitamins include vitamin C. It is used in beers, cut fruits, dried potatoes and jams.

They help to prevent the discoloration of food in order to prevent oxidation.

- b) **Citric acid- E330:** It helps to prevent the discoloration of food and helps to regulate the pH in jams and jellies. They are also used in biscuits, alcoholic drinks and dried soup.
- c) **Tocopherols - E307:** In order to reduce the oxidation of fatty acids and vitamins this antioxidant is used in meat pies and oils.
- d) **Butylated hydroxyanisole (BHA) - E320** – It helps to retard the oxidation of vitamin A and fats. This antioxidant is used in crisps and cheese.

Colouring agents: They help to add colour to the food. These colouring agents include the stabilizers, colour retention agents etc. These are added during the process of preparation in order to make the food look more attractive. It is an important sensory characteristics of food.

These are further classified as natural and synthetic colourants

Natural colourants

These are obtained from plants and animals. These are extracted from seeds, flowers like Annatto due it is extracted from orange pulp that is used in butter and cheese. Carotene is obtained from carrot, turmeric is a spice and is used to give colour to curries, meat products and salad dressings, Cochineal is extracted from female insect (*Coccus cacti*).

Synthetic colourants: These are water soluble and are present in the form of powders, pastes and granules. Factors like light, pH, heat and reducing agents can affect the stability of synthetic colourants. Examples include tartrazine, erythrosine etc.

Bleaching agents: These are peroxides (means two oxygen atoms are linked together) used to whiten foods such as wheat flour and cheese. They are added to flour during or after milling in order to improve the Colour. The pigments that are present in flour are carotene and Xanthophylls. The agents that are added to flour after the milling are Benzoyl peroxide (make flour look whitish) and oxidising agent such as potassium bromate, chlorine oxide are used in order to enhance baking quality.

Anti-caking agents: They acts as a free flowing agents and also helps to prevent lumping and caking by absorbing the moisture. Examples such as Table salt (in this the salt crystals are coated with anticaking agent in order to keep the particles separate from one another), Sodium dioxide (they are used in powdered eggs and also for filtering beer), Stearic acid (it is a fatty acid that is found in cow's milk fat, it helps to increase the shelf life of food).

Antifoaming agents: These are used to prevent the formation of foams in the food. Examples such as in the production of fruit juices.

Chelating Agents: They act as scavengers of metals which cause oxidation. EDTA is a chelating agent that is certified for use as a chemical preservative. United States Food and Drug Administration have certified the use of food additives such as Calcium disodium EDTA and disodium EDTA.

These agents are used to reduce discoloration, flavour changes and oxidative of fats that are caused during the processing of foods. Examples such as citric acid and tartaric acid.

Emulsifiers: They are used to stop fats from clotting together. They are used to control uniform dispersion of one liquid in another such as oil in water. They are mostly used in dairy and bakery products. They are also used in salad dressings and shortenings. About 10 percent of emulsifiers is present in peanut butter. Examples such as egg yolk (Lecithin is present), Milk is an emulsion of fat and water, Butter is an emulsion of water in fat.

Flavors and flavour enhancers: They are used to provide flavour to the food. The idea of flavour enhancer is derived in Asia, where seaweed is added to soup stocks in order to give richer flavour to foods. The flavour- enhancing components that are used in seaweed was identified as amino acid L-glutamate and monosodium glutamate (MSG) and it became the first flavour enhancer to be used commercially. Umami is the rich flavour that is associated with L- glutamate. Monosodium glutamate is added in the processed foods such as soups and sauces. Spices and herbs are the examples of natural flavour additives whereas ethyl butyrate for pineapple is the example of synthetic food additives.

Sweeteners: They are used in foods for flavoring. There are nutritive and non-nutritive sweeteners. Nutritive sweeteners are used to give energy in the form of carbohydrates. Nutritive sweeteners are high in calories. Examples such as sucrose, glucose, fructose, corn- syrup. Non-nutritive sweeteners are low in calories. Examples such as saccharin, aspartame. Saccharin is present in chewing gums and soft drinks. Aspartame can be used in beverages such as sodas, dairy products and low flavoured milk.

Preservatives: These are the chemical additives that are used to control the spoilage that is caused by chemical changes such as growth of molds. About one fifth of the world's food is lost due to microbial spoilage.

Food Preservatives are categorized into two groups: Antioxidants and Antioxidants are used to prevent oxidation of foods. Antimicrobial agents are used to slow down the growth of spoilage and microorganisms in food.

Antioxidants such as ascorbic acid, butylated hydroxyanisole, citric acid and Antimicrobial agents such as acetic acid, benzoic acid and sorbic acid.

pH control agents: They are used to control the pH of foods. They also affect properties of foods such as flavour, texture and other cooking qualities. They are also used to control the acidity and alkalinity of foods. Chemical agents such as citric acid and lactic acid and are used in products like cheese, jams and jellies.

Stabilizers and thickener: They are used to increase the viscosity of the food without affecting properties like taste. These functions to improve the texture of foods, slow down crystallization (sugar, ice) and also reduce the adhesiveness of icings on baked products. Polysaccharides such as gum Arabic, carrageenan, agar-agar, alginic acids are used as stabilizers and thickeners. Gelatin is one of the non-

carbohydrate material that have been used widely for this purpose. Stabilizers and thickeners have the tendency to dissolve in water (hydrophilic). Stabilizers and thickeners are contained in foods such as gravies, cake toppings, chocolate milk drinks, jellies, puddings and salad dressings. Examples such as Agar- Agar (source-algae) and is used in dairy products, soups and sauces. Pectin (source- Fruits) and is used in bakery products and dairy products. Guar- gum (source-Legume) and is used in dairy products, soft drinks, bread, pastery and puddings.

Leavening agents: It is defined as it is a type of substances which is added in dough and batters and causes a foaming actions and helps to make the mixture soft and lighten. The most common used leavening Agents are yeast, baking soda, baking powder, sodium phosphate and calcium phosphate. Yeast is an important leaving agent that is used in bread making. Ammonium salts are added in dough in order to provide a ready source of nitrogen for the growth of yeast. Phosphate salts such as sodium phosphate, calcium phosphate are added in order to help in control of pH.

Nutrient supplement: Nutrient supplements are used to improve the value lost in processing or storage. When foods are prepared there may be some loss of nutrients and additives may be added in order to improve the original value. For example, in order to manufacture white flour, wheat is milled to remove the brown coloured part of the grain that is rich in vitamins and minerals. In order to improve the nutritive value thiamine, nicotinic acid, calcium and iron are added to the flour. Vitamin C is also added in canned citrus fruits to make up the loss of vitamin during processing.

Bulking Agents: They are used to increase the volume or weight of food. They also increases the bulk of food but does not affect its nutritional value. Some bulking Agents are soluble fibres like guar gum. Bulking Agents are used in a variety of foods like bakery confectionery products, sauces and soups. They can be used in processed meat. Bulking Agents such as starch are used to increase the bulk of food without affecting its nutritional value.

Tracer gas: Tracer gas- are used for package integrity testing that prevents the foods from being exposed to Atmosphere, thus protecting the shelf life.

Glazing Agents: Glazing agents are used to provide shiny appearance or providing the protective coating to foods in order to prevent water loss from a surface and to provide other protection.

Humectants: They are hygroscopic substances that are used to keep things moist. They are used in products such as food, cosmetics and medicines. Some humectants include egg yolk, aloe vera gel, honey. Their main function is to

control viscosity and texture, bulking and reduce water activity. They also help to restore rehydration of dehydrated food.

Curing agents: They are used to cure meats. They help to give those colours and flavours and prevent the growth of microorganisms. Sodium Nitrite is used as a preservative and colour stabilizers in meat and fish products. When these nitrites are added to meat they get converted to nitric oxide that combines with myoglobin to form nitric oxide myoglobin that is a heat stable pigment. The curing also gives flavour to the meat. The Nitrite curing inhibits the growth of Clostridium and Streptococcus and lowers the temperature that is required to kill Clostridium botulinum.

Other additives: Other food additives that provide functions. Clarifying agents such as bentonite, gelatins and synthetic resins are used to haziness. Enzymes are used to bring desirable changes such as renin for producing curd and cheese, papain for tenderizing meat and pectinase for beverages. Firming agents such as calcium salts and aluminium sulphates are used to maintain the tissues of fruits and vegetables crisp. Freezing agents such as liquid nitrogen are used to chill foods. Solvents such as alcohol and glycerine are used to dissolve flavours, colours and other ingredients. Packing gases like inert gases (helium, neon) are added to packets of instant foods in order to prevent oxidative and other changes.

E- Numbering

E-numbers (E stands for "Europe") are the codes that are used as food additives that are found naturally in many foods such as vitamin C. To manage these food additives and to inform consumers about the nature of the additives, each additive is assigned a unique number termed as "E numbers" that is used in Europe for approved additives. For example, Additives 103, alkanet, is not approved for use in Europe and therefore does not have the number E, although it has been approved for use in Australia and New Zealand since 1987. Australia has an approved system for labeling additives to packaged foods. Each meal supplement should be named or numbered. The numbers are the same in Europe, but without the beginning 'E'. The other E number of other dietary supplements is; Tartrazine (E102), Quinoline Yellow (E104), Carmosine (E122) and Amaranth (E123).

Table 3: Each meal supplement should be named or numbered

Uses	E Numbers
Food colours	E100- 199
Preservatives	E200-299
Antioxidants	E300-399
Emulsifiers and stabilizers	E400-499
Anticaking agents	E500-599
Flavour enhancers	E600-699
Sweeteners	E900-999

E Numbers**Table 4:** E Numbers

Number	Name	Description	Examples
E100	Curcumin	Naturally occurring orange and yellow colour that is extracted from spice turmeric.	Used in pastries, sauces and soups.
E101	Riboflavin	Naturally occurring B group vitamin that is obtained from yeast.	Added to processed cheese as yellow and orange colour
E102	Tartrazine	Used as yellow or orange colour	Found in cakes, biscuits, meat products and sauces
E120	Cochineal	It is a natural red colour that is obtained from egg yolk.	Red colour used in foods
E123	Amaranth	It is a synthetic coal tar dye and is red in colour	Used in gravy, blackcurrant drinks
E127	Erythrosine	It is a synthetic coal tar dye and is red in colour and rich in mineral iodine	Used in tinned strawberries and certain flavours of chips and potato based snacks
E140	Chlorophyll	It is a naturally occurring green pigment that is found in leaves and stems of plants	Used in green vegetables in order to enhance colour
E150	Caramel	Used as brown colour and flavouring agent that is made from burning of sugar by heat	It is used in soft drinks, gravy, cakes, biscuits and beef products
E160 a-f	Carotenoids	It is a plant pigment that is derived from carrots, oranges and rosehip.	Helps to provide a range of colours from yellow to red.
E162	Betanin (beetroot red)	It is a naturally occurring red or purple colour in beetroot	Added to oxtail soup
E163	Anthocyanins	These are plant pigments that have colours ranging from red to blue	They are present in red cabbage and grapes.
E172	Iron oxide	They are added to fortify food	Used in flour and cereals.
E200	Sorbic acid	These are generally manufactured synthetically for use as a food preservative.	Used in soft drinks, pizza and cakes.
E210	Benzoic acid	Occurs in cherry bark, raspberries and tea.	They acts as a preservative and anti-oxidant in fruits products, salad dressings and soft drinks
E260	Acetic acid	It is a natural component of vinegar that is generally manufactured from wood and is used as preservative and acid.	It is used in pickles and chutneys.
E270	Lactic acid	It is produced by fermentation of lactose. Occurs in yogurt and soured milk that acts as a preservative.	Used in cakes, biscuits and salad dressings.
E306	Tocopherols (vitamin E)	They are obtained from wheat germ, cotton seed, maize and green leaves and is used as antioxidant and nutrient.	Added in fats and oils.
E330	Citric acid	Occurs in Citrus fruits and can be prepared from fermentation of molasses. Used as an antioxidant, preservative and flour improver	They are added in pickles, dairy and baked products.
E334	Tartaric acid	These are natural product of wine making that are used as acid regulator.	They are added to baking powder.
E412	Guar Gum	Obtained from seed gum from a tree of pea family and is used as thickener and stabilizer.	They are added to sauces, soups and ice cream
E415	Xanthan Gum	These are made from fermentation of carbohydrates by bacteria and is used as emulsifiers, thickeners and stabilizers.	Used in ice cream and bottled sauces.

Author: Hon. Assoc. Prof. Marius Rademaker, Dermatologist, Hamilton, New Zealand, 2003.

Food Preservatives

Preservative is a natural or synthetic substance added to products such as food, medicine, paints, organic samples, wood, etc. preventing rot by microbial growth or undesirable chemical mutations. Preservatives can be divided into two types, depending on their type. Class I preservatives refer to those naturally occurring preservatives, everyday substances, for example salt, honey and wood smoke. Class II preservatives refer to artificial preservatives. Food Preservative can be used alone or in combination with other preservatives. Food additives are often added to food to prevent their spoilage, or to maintain their nutritional value and / or favor for a long time the basic premise is to eradicate microorganisms from food and prevent their growth. This is achieved by means such as excessive salt intake or reduction of water volume, which prevents food spoilage through microbial growth. Preservatives can be antimicrobial preservatives, which inhibit the growth of bacteria or fungi, including fungi, or antioxidants such as oxygen absorbers, which inhibit the mixing of nutrients. Common antimicrobial preservatives

include calcium propionate, sodium nitrite, sulfites (sulfur dioxide, sodium bisulfite, potassium hydrogen sulfite, etc.) and disodium EDTA. Benefits and safety of many synthetic dietary supplements. Natural substances such as salt, sugar, vinegar, alcohol are used as traditional preservatives. Smoking salt and drying have been used since prehistoric times to preserve food. Processes such as freezing and dehydration are also used to preserve food. Another group of preservatives is targeted at fruit and vegetable enzymes that continue to be digested after cutting.

For example, citric and ascorbic acids from lemon or other citrus juices can inhibit the activity of the enzyme phenolase that converts sliced apples and potatoes into brown. Many foods contain natural enzymes or chemicals, such as acids or alcohol that cause them to lose their desirable properties almost immediately after harvest or processed. Traditional conservation methods usually aim to remove air, microorganisms, or provide an environment in which living things that can cause decay cannot survive. Among the ancient preservatives were sugar and salt (NaCl), which produced foods with high osmotic concentrations that kept

bacteria in the watery area they needed to survive and reproduce. Jams and jellies are stored as solutions for high sugar content, and most meat (e.g., hams) and fish are still salted. Unlike other insects, fungi can withstand the effects of too much salt or too much sugar in their diet. Fortunately, they do not usually cause illness. Early methods of ventilation included enclosing food inside containers (such as pots), or covering the dining area with hot paraffin. The invention of canning by Nicolas Appert allows for the preparation of commercial food. Responding to an award given to Napoleon in 1795, Appert developed a method of canning and storing fruits and vegetables in glass containers for sea voyages. His method was used commercially in 1910 by Peter Durand in England, using metal cans. The ionizing radiation used to lighten food, when food is exposed to high x-ray or electron streams, disrupts bacterial DNA. Some people have objected to food burning because of the (unfounded) fear of radioactivity. As germs such as the dangerous forms of coliform bacteria have caused food poisoning, the radiation of dead animals and, in particular, the hamburger during its preparation has become very desirable. Irrigation currently extends the shelf life of foods such as strawberries. Radiation does not cause food to emit rays, but it can cause changes in food coloring or composition.

Preservatives are classified into class 1 and class 2 preservatives

Class 1 Preservatives are salt, sugar, vegetable oils, spices, vinegar, glucose and honey.

Class 2 Preservatives are Sodium benzoate, benzoic acid and Nitrites.

1. **Sodium benzoate:** Chemical formula of sodium Benzoate is $\text{NaC}_7\text{H}_5\text{O}_2$. It is mostly used food preservative in food processing industries. It is mainly produced by the neutralization of benzoic acid. Sodium benzoate can be used upto 0.1%. It is mostly used in Acidic food, medicines and cosmetics.
2. **Titanium dioxide:** It is a nano particle that is also known as ultrafine titanium dioxide. It is white, crystalline, fine, low solubility powder and odorless that is considered to exhibit relatively low toxicity. It helps to preserve food and increase the shelf life of food products. It is used in paints, ink, cosmetics, sunscreen, paper and printing.
3. **Sodium Chloride:** It is a most common food preservative because it is inexpensive and non-toxic. Salt is regarded as a effective preservatives because it helps to reduce the water activity of the food products in order to control the growth of microorganisms and also increases the shelf life of food.

Salt has the following characteristics

1. Helps to change the pH.
2. Sodium and chloride ions are toxic.
3. Helps to produce osmotic effect.
4. It helps to restrict oxygen solubility.

Table 5: Chemical Preservatives

Preservatives	Types of food where used	Acts on	Optimum pH	Mechanism of action
Propionates	Cheese, baked foods, helps to prevent ropiness in baked products	The growth of <i>Bacillus subtilis</i> is responsible for ropiness. It is used to inhibit the growth of mold, yeast and bacteria.	Below 5.5	Inhibit microbial growth
Sorbic acid	Cocktail, dried fruits, cheese, pickles and baked goods	It is used to inhibit the growth of mold and yeast. It is effective against <i>Salmonella</i> coliforms	pH(5.5- 6)	It can affect membrane transport and can cause cell death.
Nitrites and nitrates	Used in meat curing	Acts on <i>Clostridium botulinum</i>	-	Used to prevent the formation of ATP from Pyruvate
Benzoic acid	Used in jam, jellies, juices and pickles	Acts on yeast and molds	pH – 2.5-4	Retard cellular uptake of substrate molecules
BHA and BHT	It is used in meat, baked foods, cereals and also an antioxidant	Acts on free radical scavenger	pH-4.8	Acts by blocking the propagation of free radical scavenger
Sodium benzoate	Salad dressings, jams, juice, fruits and pickles	It Acts as a bacteriostatic and fungistatic preservative	pH- 2.5-4	Works by entering the cells in the food products and balance it's pH level, increasing the acidity of food
Sulfites and Sulfur dioxide	Used in raisins, apricot, meat products, soft drinks, wine and beer	Inhibit the growth of bacteria, yeast and molds	Acidic pH less than 4	React with cellular adenosine triphosphate (ATP). Inhibit cellular metabolism enzymes.

Source: pmg.engineering/introduction-to-chemical-preservatives/

Advantages of Food additives and Preservatives

Food additives plays an important role in the availability of modern food. They allow our growing urban population to have a wide variety of foods throughout the year as well, enabling a plentiful supply of food without the hassle of daily shopping. They perform a variety of useful functions in foods that are often taken for granted. Since many people no longer live on farms, additives help to keep food healthy

and attractive while on the way to markets sometimes thousands of miles away from where they are grown or produced. Additives also enhance the nutritional value of a particular food and can make them attractive by enhancing your taste, texture, consistency or color.

The importance of storing food, however, is that it increases the meal time and reduces food spoilage caused by germs in the container or hands you carry before you put it in the

container. The importance of storing food so that food does not spoil or cause illness. Although preservatives are essential for maintaining food security, the best thing is health. In addition to allergies, these foods may cause abdominal pain, vomiting, respiratory problems, rashes and skin rashes. Other serious side effects include benzoate, which can cause skin rashes, asthma and possibly brain damage.

Additives are used in food for some reasons

1. In order to maintain consistency: Emulsifiers helps to give a consistent texture and helps to control them from separating and give smooth and uniform texture. Anticaking agents acts as a free flowing agents they help the substances such as salt to flow freely.

2. To maintain and enhance nutritional value: Vitamins and minerals are added to many common foods such as milk, flour, grains and margarine for those who may be deficient in diet or loss of appetite. Such fortification and enrichment have helped to reduce malnutrition among the U.S. population. All products containing extra nutrients should be properly labeled.

3. To maintain palatability and enrichment: Preservatives helps to reduce production, spoilage that are caused by bacteria, yeast, fungi, molds and air. Antioxidants are that type of preservatives which help fats and oils in bakery products and other food items from rancidity and maintaining flavour.

4. To provide control acidity: Leavening Agents release acids and when they are heated they react with baking soda to help cakes, biscuits and many other baked goods to rise during baking. Other additives helps to alter the alkalinity and acidity of foods for their proper flavour, colour and taste.

5. Improving the taste or effect of the desired color: Many flavors, natural and artificial flavors enhance the taste of food. Colors, for example, help to improve the appearance.

6. To maintains consistency and product quality: Helps to improve or maintain a healthy diet, retains taste and beauty, provides leavening, control pH, improves taste, or gives color.

Food Additives and Malnutrition

One important risk posed by supplements is the loss of nutritional value, which can lead to malnutrition. Extensive use of dietary supplements can contribute to malnutrition in the following ways; a common feature in many foods that contain additives of salt, sucrose and fat. Pure sucrose, by definition, literally contains nutrients, only calories; fats, on the other hand, contain fewer nutrients and are much higher in calories. In addition, nutritious foods are mainly processed foods, which have lost a significant amount of nutrients as a result of the processing procedure. Even though some vitamins and minerals are sometimes added to other foods after processing, the amount of essential nutrients in calories is usually insufficient, leading to high calorie, but low nutritional intake. This type of diet, due to its high calorie and low nutrient content, can lead to

malnutrition and result in less than optimum nutrition and therefore marginal malnutrition.

Effects of food additives and preservatives

For many people, supplements are not a problem in the short term. However, 50 of the 400 approved now in Australia have been linked to adverse reactions from some people. Some dietary supplements are more likely to cause allergic reactions than others. Often additives are used to provide marketable quality food, such as color, which often causes allergies. Some of these hypersensitive conditions include:

Digestive disorders

Diarrhea and fainting spells

Emotional disorders

Hyperactivity, insomnia and irritability

Respiratory problems

Asthma, rhinitis and sinusitis

Skin problems

Constipation, itching, rashes and swelling.

The effects of food additives may be immediate or potentially dangerous over time if person have constant exposure or accumulation. Some effects may include change in the energy level, headaches and change in behaviour or immune response. Long term effects can increase risk of cancer, cardiovascular disease. Some modern artificial preservatives have become an issue because they have been shown to cause respiratory and other health problems. Immune deficiency in food can cause anaphylactic shock in affected people, a condition that is often fatal within minutes without emergency treatment. There are two main source of dangerous additives. The first are the ones that are included as part of the processing work. These include colors, preservatives, flavors and flavor enhancers, sugars, texture agents and processing agents. Details of this should be included on the labeling and can be seen with a little information and some attention to the information provided by the manufacturer. The second source of food additives comes from the packaging, storage and handling of food and this information is rarely included in the food label. Foods that has no additives is to be preferred to feed children. Many foods that are available in the market contain different types of Preservatives. All these chemicals give rise to certain health problems.

Additives helps to maintain the high quality of foods. Food preservatives are the additives that are used to prevent the growth of bacteria, molds and yeasts. Many people are allergic to certain food ingredients or colors. If someone responds after eating a certain food, it is suspected that they are allergic. Unfortunately, some people do not respond until a day or two later, so it is difficult to know what is causing the problem. When a food additive is believed to cause allergies, the blood is mixed with substances known to cause allergies. It is best to eat a preservative free diet because the reactions from these additives can be mild to life-threatening.

Side effects of food additives and preservatives

Tartrazine: Tartrazine is also known as FD and C Yellow no.5 and E 102. Tartrazine is an artificially synthesized azo

pigment. Its use is allowed as a colorant in many food products and cosmetics. Excessive use of tartrazine can cause adverse effects. Tartrazine had genotoxic potential towards human lymphocytes and bind to DNA directly.

Boric acid: It is a boron compound that is soluble and flow in plasma. It is colorless and water soluble white color powder which is used as pesticides to kill insects, algae, fungi, mites, cockroach and termites. It is mostly used as a food preservatives in food items like caviar. For preservation of meats, dairy products and caviar. It is mostly used in almost every food products like pickles, ice cream, sweets, candies and soft drinks.

Curcumin: Clinical trials in man have been used to study the effects of various curcumin, including multiple myeloma, pancreatic cancer, myelodysplastic syndromes, colon cancer, psoriasis and alzheimer's disease. Various studies suggest that curcumin have carcinogenic effect.

Nitrites and Nitrates: Nitrate binds to hemoglobin (a compound that carries oxygen to the bloodstream to the body), and causes a chemically-altered hemoglobin (methemoglobin) that impairs oxygen delivery to tissues which may result in the blue color of the skin. Higher levels of nitrates and nitrites has increased the incidence of cancer in adults, brain tumors and leukemia. Decreased oxygenation of hemoglobin (methemoglobinemia) has been reported after exposure to nitrate and contaminated drinking water of nitrite; also called "blue baby syndrome" because of the cyanotic (Oxygen deficient) symptoms caused by a decrease in oxygen in the blood.

Butylated Hydroxytoluene (BHT) and Butylated Hydroxyanisole (BHA): They are artificial monocyclic phenolic compounds. They are mostly used in many foods as a food preservative because of their anti-oxidant properties. Many health risks such as child hyperactivity, damage of lungs, liver, kidneys and also cause cancer. Studies have shown that BHA and BHT can cause cancer in high doses and concentrations greater than 3000 ppm, it was known to cause forestomach squamous cell carcinomas in mice while BHT at 250 mg / kg / day increases spontaneous neoplasms and tumor promoting activity.

Vinegar: Long term ingestion of vinegar can cause hypokalemia, hyperreninemia and osteoporosis. Excessive use of vinegar can cause harmful side effects such as tooth enamel erosion and potential drug interactions. It can cause low potassium level, bone loss, throat burns, skin burns and cause feelings of nausea.

Artificial sweeteners-This contributes to one of the many side effects of food ingredients due to their sweet nature that makes them indiscriminately used by food manufacturers and individuals. The artificial sweeteners considered in this review include Saccharin, Aspartame, Sucralose and Neotame.

Saccharin: Consumption of saccharin can lead to obesity, diabetes, renal and liver impairment. Saccharin found in some infant formulas can cause irritability and muscle dysfunction. Use of saccharin should be limited in infants, children and pregnant women. Bladder Cancer was also found to be specific to rodent physiology.

Aspartame: It is also an artificial sweetener. It is one of the most important artificial sweeteners which is used in the manufacturing of cheese, chocolate, hot dog, fatty foods, ice creams, beer and red wines. It is restricted for people with phenylketonuria. It can't be consumed with people who are suffering from metabolism disorder phenylketonuria.

Annatto: Annatto is safe when it is used in small quantity. It can cause some allergic reactions for those who are sensitive to it. Symptoms include swelling, itching, stomach pain and low blood pressure. Pregnant women should not consume it in more amount. It may trigger symptoms of irritable bowel syndrome.

Sucralose: Presence of chlorine in sucralose is the most harmful component of sucralose. Chlorine has been used in poisonous gases, disinfectant, pesticides and plastics and is considered as a carcinogen. Symptoms such as gastrointestinal problems (bloating gas, nausea), skin irritations (rashes, redness, swelling), cough, chest pains, anxiety, anger, depression and itchy eyes. Sucralose does not contain any calories but it is 600 times sweeter than sugar so it is used in small quantity to achieve the desired sweetness.

Acesulfame K: It contains carcinogen methylene chloride. Long term effects of methylene chloride can cause problems such as headaches, nausea, liver effects, kidney effects, depression and cancer in humans.

Aspartame disease: The term "aspartame disease" was coined by Roberts, H.J. MD. It includes the health effects of ingesting aspartame. Dr. Roberts reported in 1998 that aspartame products were the main cause of 80% of complaints to the FDA about food additives. Symptoms such as headache, change in mood, vomiting, nausea, abdominal pain, cramps, diarrhea, memory loss, dizziness and fatigue.

Table 6: Some food additives and Preservatives that should be avoided

Colour	Source	Negative impact	References
Erythrosine FD and C Red No.3	Fruit salads, dairy products, ice cream, soft drinks, cocktail	Can cause cancer	The Washington Post, February7, 1990CBS News, June 3,2008
Sunset yellow (E110)*Yellow FCF Orange Yellow	Yogurt, sweets, ice cream, drinks, snack foods.	Can cause allergy and asthma, damage DNA and increase tumours in animals	091113 efsa.europa.eu doi:10.1016/S0140- 6736(07)
Ponceau 4R(E124)* Cochineal	Deserts, alcoholic drinks, ice cream, cold drinks	Can cause cancer and asthma, damage DNA	Food And Drug Administration Compliance Program Guidance Manual p.10
Carnosine (E122)*	Found in sweets and yogurts	Can damage DNA and cause	Food additives CBC News. 29 September 2008

		cancer	
Amrantha (E123)	Alcoholic drinks	Can cause allergy and hives	FDA/CFSAN Food Compliance Program: Domestic Food Safety Program
Brilliant blue(E133)*	Found in dairy products, drinks and sweet products	Can cause skin rashes and hyper activity	FDA, 1993
Sodium benzoate (E211)*	Found in pickles, sauces, carbonated drinks,	Can cause neurotoxin and carcinogen and also cause fetal abnormalities	Food Standards Agency issues revised advice on certain artificial colours, 2007
Sulphur dioxide (E220)*	Found in dried fruit juices, potato products and carbonated drinks	Can cause gastric, diarrhea, asthma and skin rashes.	International Chemical Safety Card 0074
Potassium Nitrate (E249)	Canned meat and meat products	Can lower the oxygen carrying ability of blood, can affect the adrenal gland	International Chemical Safety Card 1069
Calcium sulphite(E226)	It is used to make old food products to look fresh.	Can cause bronchial problem, lower down blood pressure.	http://www.fedupwithfoodadditives.info/factsheets/Factsafeadditives.htm
Calcium Benzoate (E213)	Found in low sugar products, cereals, drinks and meat	Can cause allergies, asthma and hives.	http://www.fedupwithfoodadditives.info/factsheets/Factsafeadditives.htm
Aspartame (E951)*	Used in sweeteners and it is 200 times sweeter than sugar	Can cause phenylketonuria	FDA Consumer Magazine, 1999
Saccharin (E954)*	It is 350 times sweeter than sugar.	Bladder Cancer, can lead to obesity, diabetes, renal and liver impairment.	USDA, 1972
High Fructose Corn syrup (HFCS)	Found in cold drinks, juices, jams, jellies, dairy products and baked foods	Can cause obesity and diabetes	The American Medical Association, 2007

Safety evaluation of food additives

Two groups of ingredients are exempted from regulation under food additives Amendment:

Group 1: Earlier approved substances that FDA or USDA has determined safe for use in food prior to 1958 amendment. Examples- Potassium nitrate and Sodium nitrate.

Group 2: This includes GRAS (Generally Recognized as Safe). Substances approved by experts as safe based on published scientific evidence. Examples- Salt, sugar and MSG (Monosodium Glutamate).

In 1969, President Nixon instructed the FDA to review the safety features of all GRAS items on the basis of current scientific research. In 1972 a committee from the Federation of American societies for experimental biology reviewed the safety of all GRAS items on the basis of published and other available information. The committee placed all evaluated substances in five categories:

Category 1: It contains all those additives whose GRAS status was reaffirmed. This means that the information available does not provide evidence of toxic hazards for the substance in question. These items are usually used in accordance with GMP.

Category 2: It contains those substances whose GRAS status was reaffirmed at the current level of use. This means that the information available does not provide evidence of toxic hazards at the level of practice and current use.

Category 3: It contains those substances whose safety is reaffirmed at the level of current use and practice.

Category 4: It contains those substances whose information is incomplete to “reaffirm safety”. This means the level of toxicity has been reported, yet the level and manner of current use the information is insufficient to determine the impact on public health.

Category 5: Those that do not have biological studies available to judge their safety.

Some of the permitted GRAS (Generally Recognized as Safe) food additives and tolerance level

Table 7: Some of the permitted GRAS (Generally Recognized as Safe) food additives and tolerance level

Additive	Food in which it is used	Roles	Tolerance Level
Butylated hydroxyanisole (BHA)	Used in butter, cereals, chewing gum and beer	Antioxidants	<0.02%
Butylated Hydroxytoluene (BHT)	Used in snack food, chewing gum and animal feed	Antioxidants	<0.02%
Ca, silicate	Cashew nuts, baking powder and Table salt	Fumigants Flavoring agent	5%
Caffeine	Used in cola type beverages	Multipurpose	0.02%
KMS	Used as a general Preservative	Antimicrobial	GMP
Gelatin	Used in filling pudding	Flavouring agent	0.03%
Sodium sulphite	Used in various foods	Antimicrobial properties	GMP
Sodium bisulphate	Used in various foods	Antimicrobial properties	GMP
Thiodipropionic acid	Used in Fat containing foods	Antioxidants	0.02%

Source: Sunitha and Preethi, (2000)

Regulations of food and preservatives

There are various regulating agencies that decide what have to be added to food and food supplements and their quality and quantities that should be added so they will not have harmful effects on the health of consumers. These substances are known as generally recognized as Safe (GRAS). Every country of the world has its own regulatory concern though there must be similarities among them. In Nigeria, before adding anything it must be approved by the National Agency for Food and Drug Administration and Control (NAFDAC). The drug and related products act (1996) in Nigeria gave many regulations that every food and drug companies must adhere to or face penalty. Those regulations include: Label declaration for substances that are used as food additives, Labeling of artificial colours and mixture of colours in the food, Food additives should contain certain information, carry-over of food additives and processing aids.

U.S Food safety and Regulation

In the U.S, food ingredients must be approved by FDA or generally recognized as safe (GRAS). Manufacturers of food packaging must prove to the U.S. Food and Drug Administration (FDA, 1993) [56] states that all food additives are safe, before they are approved for use in that way. Food additives first became legal in the United States under the Food and Drug Administration of 1906. The law states that food will be considered unclean: "If it contains any toxic or deleterious substance, which could cause harm to health; but if the item is not an additional item, that food will not be considered adulterous under this clause if the quantity of substance in food does not ordinarily render it injurious to health" (Food and Drug Act, 1906) [13].

Recommendations

In order to improve the current condition, the following recommendations are suggested

- The food additives which are not essential should be banned.
- Various regulatory concern should make sure that food additives that are Generally Recognized as Safe (GRAS) should be added to foods.
- All foods consisting of additives with carcinogenic, mutagenic and teratogenic properties should be clearly labeled with appropriate warning.
- All food additives should be prohibited from foods that are consumed by infants and young children.
- All food Additives which are not generally recognized as safe (GRAS) should not increase the acceptable daily Intakes (ADIs).
- All the food items that have very less or no nutritional value should be removed from all promotions.
- Regulatory agencies must ensure that Good Manufacturing Practices (GMP) are followed by various food and processing industries.
- The government should also introduce free nutritious school meals, preferably using natural foods, which will be available to all school children to discourage them from patronizing these colourant food additives.

Conclusion

This review paper has surveyed the numerous effects of food preservatives and additives on man's life. They have been used for many years and are used to preserve foods,

flavour, thicken, blend and have played an important role in maintaining the nutritional values. Additives help to maintain the availability of healthy, tasty and affordable food that meets the needs of consumers from season to season and also helps to protect food from getting spoiled by microorganisms. Food additives play an important role in food processing industries but the adverse effects caused by them remain a problem. Artificial food additives respond to the cellular portion of the body leading to various food effects. If we want to use food additives they should be natural ones that have minimum effect and should be Generally Recognized as Safe (GRAS). For those that are not generally recognized as safe (Non GRAS), the acceptable daily intakes (ADIs) should be reduced. In order to reduce the risk of health problems due to various food preservatives and additives, we must avoid that type of food which contain these additives and preservatives. Before buying the canned food items its ingredients and composition should be checked. Always try to buy that type of product which are organic and free from synthetic additives. Before buying any food product, we should check regulatory bodies of food.

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