Indian J.Sci.Res. 13 (2): 219-225, 2017 ISSN: 0976-2876 (Print)
ISSN: 2250-0138 (Online)

FOOD ADDITIVES AND PRESERVATION: A REVIEW

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ABSTRACT

Foods are substances or mixture of substances both solid and/or liquid, which are intended for human consumption or ingestion for their nutritional of pleasurable benefits. Food additives are natural or synthetic substances that can be added to foodstuff in small amounts to perform technological functions, namely colour, sweetness or to extend shelf life. This review is about Food additives and its effect, and significance of food preservatives and additives were also explained in this review.

KEYWORDS: Food, Additives and Preservation.

Food is any substance or material eaten or drunk to provide nutritional support for the body or for pleasure. It usually consists of plant or animal origin, which contains essential nutrients, such as carbohydrates, fats, proteins, vitamins, or minerals, and is ingested and assimilated by an organism to produce energy, stimulate growth and maintain life. Food chemistry is the study of chemical processes and interactions of all biological and non-biological components of foods. The biological substances include meat, poultry, lettuce, beer, and milk as examples (Francis F.J., 2000).

FOOD AND ITS SOURCES

Historically, people obtained food from hunting, farming, ranching, and fishing, known as agriculture. Today, most of the food energy consumed by the world population is supplied by the food industry operated by multinational corporations using intensive farming and industrial agriculture methods. Almost all foods are of plant or animal origin. Cereal grain is a staple food that provides more food energy worldwide than any other type of crop. Maize, wheat and rice together account for 87% of all grain production worldwide. Other foods not from animal or plant sources include various edible fungi, especially mushrooms: Fungi and ambient bacteria are used in the preparation of fermented and pickled foods such as leavened bread, alcoholic drinks, cheese, pickles, kombucha and yoghurt, Blue-green algae such as Spirulina. Inorganic substances, baking soda, cream of tartar are also used to chemically alter an ingredient.[2] Many plants or plant parts are eaten as food. There are around 2,000 plant species which are cultivated for food, and many have several distinct cultivars. Seeds of plants are good sources of food for animals, including humans because they contain nutrients necessary for the plant's initial growth, including many healthy fats, such as Omega fats. In fact, the majority of foods consumed by human beings are seed-based foods. Edible seeds include cereals (such as maize, wheat, and rice), legumes (such as beans, peas, and lentils), and nuts. Oilseeds are often pressed to produce rich oils, such as sunflower, flaxseed, rapeseed (including canola oil), and sesame (Mcgee H., 2004). One of the earliest food recipes made from ground chickpeas is called hummus, which can be traced back to Ancient Egypt times. Seeds are typically high in unsaturated fats and, in moderation, are considered a healthy food, although not all seeds are edible. Large seeds, such as those from a lemon pose a choking hazard, whereas seeds from apples and cherries contain poison cyanide. Fruits are the ripened ovaries of plants, including the seeds within. Many plants have evolved fruits that are attractive as a food source to animals, so that animals will eat the fruits and excrete the seeds some distance away. Fruits, therefore, make up a significant part of the diets of most cultures. Some botanical fruits, such as tomatoes, pumpkins and eggplants, are eaten as vegetables. Vegetables are second types of plant matter that are commonly eaten as food. These include root vegetables (such as potatoes and carrots), leaf vegetables (such as spinach and lettuce), stem vegetables (such as bamboo shoots and asparagus), and inflorescence vegetables (such as globe artichokes and broccoli). Many herbs and spices are highly flavorsome vegetables [Mcgee H., 2004 and Jean P.B., 1994].

FOOD ADDITIVES

Food additives are substances added intentionally to foodstuff, to increase the durability of the product and enhance or modify its properties, including its appearance, flavor or structure, provided it does not detract from its nutritional value. Substances can be of natural or synthetic origin, usually without appreciable

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nutritional value, that are added to food in small amounts during the manufacture (industrial change or during packaging) (Lidon F.C. and Silvestre M.M.A., 2007).

CATEGORIES OF FOOD ADDITIVES

According to the technological function, twenty five categories of food additives have been defined (Silvestre M.M.A., 2007): Preservatives, also known as antimicrobial agents, used to extend the shelf-life of foods by protecting them against deterioration caused by microorganisms; Antioxidants, which extend the shelf-life of foods by protecting them against oxidation; Carriers, used to disperse, dilute, dissolve or otherwise physically modify a food additive, without altering its technological function and without the very substances exerting any technological effect, in order to facilitate its handling, application or use; Acidifying substances, used to increase the acidity of a foodstuff or confer them a sour taste and is widely used in beverages to give them an acid or sour taste similar to the taste of the fruit; Acidity regulators, which alter or control the pH of foodstuffs; Anti-caking agents, used to reduce the tendency of particles of food to agglomerate; Anti-foaming agents, used to prevent or reduce the formation of foams; Sparkling, substances that enable homogenous dispersion of a gaseous phase in food, liquids or solids; Emulsifiers, that allow the formation or maintenance of homogeneous mixtures of two or more immiscible phases (like oil and water) in food products; Thickeners, used for increasing the viscosity of foodstuffs, (e.g. they condense and thicken); Stabilizers, which maintain the physicochemical state of food and include substances that allow a homogenous dispersion of two or more immiscible substances (additionally, also might have the ability to retain or enhance the natural color of food - color stabilizers); Emulsifying salts, which disperse proteins (namely these contained in cheese), allowing a homogenous distribution of fat and other components; Gelling agents, used to impart texture to food products with the formation of a gel; Bulking agents, which contribute to the volume of food products; Firming agents, which make foodstuff (namely vegetables and fruits) crispy or interact with gelling agents to produce or strengthen a gel; Glazing agents, that applied to the external surface of the food products gives them a shiny appearance or a protective coating; Flavor enhancers, used to enhance the taste or smell of the food (have a broad spectrum of uses and are especially used in pre-cooked meals); Humectants, which prevent foods from drying (widely used in candy with fillings, chocolates and biscuits); Modified starches, substances obtained after one or more chemical treatments of edible starches, but may also have undergone physical, or enzymatic treatments; Packaging gases, gases introduced into the packaging container before, during or after placing the food products (yet, the air is not considered a packaging gas); Propellant gases, which expel foodstuff from containers (air is not a propellant gas); Raising agents, isolated substances or mixtures, which increase the gas release volume, namely from pasta flour or purées; Sequestrants, which form chemical complexes with metallic ions and thus sequester metal ions, thus preventing them to catalyze decomposition reactions; Colorants, which add or enhance the natural color of food products (can be natural colorants extracted from fruit, vegetable or minerals, or of synthetic origin); Sweeteners, sweet-tasting substances that replace sugar (commonly used in the production of energy-reduced food, therefore light products, foodstuff that do not cause tooth decay and food without added sugars, as well as in the production of dietetic foods).

ADVANTAGES OF FOOD ADDITIVES

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 convenience 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 (Pressinger, 1997).

Additives are used in foods for five main reasons:

i) 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.

ii) 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.

iii) To maintain palatability and wholesomeness. Preservatives retard product spoilage caused by mold, air, bacteria, fungi or yeast. Bacterial contamination can cause foodborne 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-flavor. They also prevent cut fresh fruits such as apples from turning brown when exposed to air.

iv) 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 flavor, taste and color.

v) To enhance flavor or impact desired color. Many spices, natural and synthetic flavors enhance the taste of foods. Colors, likewise, enhance the appearance of certain foods to meet consumer expectations (Pressinger R.W., 1997).

DISADVANTAGES OF FOOD ADDITIVES

Although additives and preservatives are essential for food storage, they can give rise to certain health problems. They can cause different allergies and conditions such as hyperactivity and Attention Deficit Disorder in some people who are sensitive to specific chemicals[5]. The foods containing additives can cause asthma, hay fever and certain reactions such as rashes, vomiting, headache, tight chest, hives and worsening of eczema. Some of the known dangers of food additives and preservatives are as follows:

- Benzoates can trigger the allergies such as skin rashes and asthma as well as believed to be causing brain damage.
- Bromates destroy the nutrients in the foods. It can give rise to nausea and diarrhea.
- Butylates are responsible for high blood cholesterol levels as well as impaired liver and kidney function.
- Caffeine is a colorant and flavorant that has diuretic, stimulant properties. It can cause nervousness, heart palpitations and occasionally heart defects.
- Saccharin causes toxic reactions and allergic response, affecting skin, gastrointestinal tract and heart. It may also cause tumors and bladder cancer.

To minimize the risk of developing health problems due to food additives and preservatives, one should avoid the foods containing additives and preservatives. Before purchasing the canned food, you must check its ingredients. You should buy organic foods, which are free from artificial additives. Try to eat the freshly prepared foods as much as possible rather than processed or canned foods (Pressinger R.W., 1997).

PRESERVATION OF FOOD

Preservation of Food is the process of treating and handling food to stop or greatly slow down spoilage (loss of quality, edibility or nutritive value) caused or accelerated by micro-organisms. Some methods, however, use benign bacteria, yeasts or fungi to add specific qualities and to preserve food (e.g. cheese, wine). Maintaining or creating nutritional value, texture and flavour is important in preserving its value as food. This is culturally dependent, as what qualifies as food fit for humans in one culture may not qualify in another culture. Preservation usually involves preventing the growth of bacteria, fungi, and other micro-organisms, as well as retarding the oxidation of fats which cause rancidity. It also includes processes used to inhibit natural ageing and discolouration that can occur during food preparation such as the enzymatic browning reaction in apples after they are cut (Jean P.B., 1994).

Classification of Food Preservation

Some preservation methods require the food to be sealed after treatment to prevent recontamination with microbes; others, such as drying, allow food to be stored without any special containment for long periods. Common methods of applying these processes include drying, spray drying, freeze drying, freezing, vacuum-packing, canning, and preserving in syrup, sugar crystallization, food irradiation, and adding preservatives or inert gases such as carbon dioxide. Other methods that not only help to preserve food, but also add flavour, include pickling, salting, smoking, preserving in syrup or alcohol, sugar crystallization and curing.

Preservation processes include:

- Heating to kill or denature micro-organisms (e.g. boiling)

- Oxidation (e.g. use of sulfur dioxide)
- Toxic inhibition (e.g. smoking, use of carbon dioxide, vinegar, alcohol etc)
- Dehydration (drying)
- Osmotic inhibition (e.g. use of syrups)
- Low temperature inactivation (e.g. freezing)
- Ultra high water pressure (e.g. fresherised, a kind of "cold" pasteurization, the pressure kills naturally occurring pathogens, which cause food deterioration and affect food safety). These methods include:

i. Drying: One of the oldest methods of food preservation is by drying, which reduces water activity sufficiently to prevent or delay bacterial growth. Drying also reduces weight.

ii. Freezing: Freezing is also one of the most commonly used processes commercially and domestically for preserving a very wide range of food including prepared food stuffs which would not have required freezing in their unprepared state. For example, potato waffles are stored in the freezer, but potatoes themselves require only a cool dark place to ensure many months' storage. Cold stores provide large volume, long-term storage for strategic food stocks held in case of national emergency in many countries (Deeley et.al., 2006).

iii. Vacuum packing: Vacuum-packing stores food in a vacuum environment, usually in an air-tight bag or bottle. The vacuum environment strips bacteria of oxygen needed for survival, slowing spoiling. Vacuum-packing is commonly used for storing nuts to reduce loss of flavour from oxidation.

iv. Salt: Salting or curing draws moisture from the meat through a process of osmosis. Meat is cured with salt or sugar, or a combination of the two. Nitrates and nitrites are also often used to cure meat and contribute the characteristic pink color, as well as inhibition of *Clostridium botulinum.*

v. Sugar: Sugar is used to preserve fruits, either in syrup with fruit such as apples, pears, peaches, apricots, plums or in crystallized form where the preserved material is cooked in sugar to the point of crystallization and the resultant product is then stored dry. This method is used for the skins of citrus fruit (candied peel), angelica and ginger. A modification of this process produces glace fruit such as glace cherries where the fruit is preserved in sugar but is then extracted from the syrup and sold, the preservation being maintained by the sugar content of the fruit and the superficial coating of syrup. The use of sugar is often combined with alcohol for preservation of luxury products such as fruit in brandy or other spirits (Louis S.T. and Botulism M.E., 1991).

vi. Pickling: Pickling is a method of preserving food in an edible anti-microbial liquid. Pickling can be broadly categorized as chemical pickling for example, in chemical pickling, the food is placed in an edible liquid that inhibits or kills bacteria and other micro-organisms. Typical pickling agents include brine (high in salt), vinegar, alcohol, and vegetable oil, especially olive oil but also many other oils. Many chemical pickling processes also involve heating or boiling so that the food being preserved becomes saturated with the pickling agent. Common chemically pickled foods include cucumbers, peppers, corned beef, herring, and eggs, as well mixed vegetables such as piccalilli. In fermentation pickling, the food itself produces the preservation agent, typically by a process that produces lactic acid. Fermented pickles include sauerkraut, nukazuke, kimchi, surstromming, and curtido. Some pickled cucumbers are also fermented.

vii. Lye: Sodium hydroxide (lye) makes food too alkaline for bacterial growth. Lye will saponify fats in the food, which will change its flavour and texture. Lutefisk uses lye in its preparation, as do some olive recipes. Modern recipes for century eggs also call for lye. Masa harina and hominy use agricultural lime in their preparation and this is often misheard as 'lye'.

viii. Canning and bottling: Canning involves cooking food, sealing it in sterile cans or jars, and boiling the containers to kill or weaken any remaining bacteria as a form of sterilization. It was invented by Nicolas Appert (Deeley et.al., 2006). Foods have varying degrees of natural protection against spoilage and may require that the final step occur in a pressure cooker. High-acid fruits like strawberries require no preservatives to can and only a short boiling cycle, whereas marginal fruits such as tomatoes require longer boiling and addition of other acidic elements. Low acid foods, such as vegetables and meats require pressure canning. Food preserved by canning or bottling is at immediate risk of spoilage once the can or bottle has been opened. Lack of quality control in the canning process may allow ingress of water or micro-organisms. Most such failures are rapidly detected as decomposition within the can causing gas production

and the can will swell or burst. However, there have been examples of poor manufacture (underprocessing) and poor hygiene allowing contamination of canned food by the obligate anaerobe *Clostridium botulinum*, which produces an acute toxin within the food, leading to severe illness or death. This organism produces no gas or obvious taste and remains undetected by taste or smell. Its toxin is denatured by cooking, though, cooked mushrooms, handled poorly and then canned, can support the growth of Staphylococcus aureus, which produces a toxin that is not destroyed by canning or subsequent reheating (Saulo A.A., 2005).

ix. Jellying: Food may be preserved by cooking in a material that solidifies to form a gel. Such materials include gelatine, agar, maize flour and arrowroot flour. Some foods naturally form a protein gel when cooked such as eels and elvers, and sipunculid worms which are a delicacy in the town of Xiamen in Fujian province of the People's Republic of China. Jellied eels are a delicacy in the East End of London where they are eaten with mashed potatoes. Potted meats in aspic, (a gel made from gelatine and clarified meat broth) were a common way of serving meat off-cuts in the UK until the 1950s. Many jugged meats are also jellied. Fruit preserved by jellying is known as jelly, marmalade, or fruit preserves. In this case, the jellying agent is usually pectin, either added during cooking or arising naturally from the fruit. Most preserved fruit is also sugared in jars. Heating, packaging and acid and sugar provide the preservation.

x. Potting: A traditional British way of preserving meat (particularly shrimp) is by setting it in a pot and sealing it with a layer of fat. Also common is potted chicken liver.

xi. Jugging: Meat can be preserved by jugging, the process of stewing the meat (commonly game or fish) in a covered earthenware jug or casserole. The animal to be jugged is usually cut into pieces, placed into a tightly-sealed jug with brine or gravy, and stewed. Red wine and/or the animal's own blood is sometimes added to the cooking liquid. Jugging was a popular method of preserving meat up until the middle of the 20th century.

xii. Irradiation: Irradiation of food (Lopez A., 1987) is the exposure of food to ionizing radiation; either high-energy electron X-rays from accelerators, or by gamma rays (emitted from radioactive sources as Cobalt-60 or Caesium-137). The treatment has a range of effects, including killing of bacteria, molds and insect pests, reducing the ripening and spoiling of fruits, and at higher doses including sterility. The technology may be compared to pasteurization; it is sometimes called 'cold pasteurization', as the product is not heated. Irradiation is not effective against viruses or prions; it cannot eliminate toxins already formed by microorganisms, and is only useful for food of high initial quality. The radiation process is unrelated to nuclear energy, but it may use the radiation emitted from radioactive nuclides produced in nuclear reactors. Ionizing radiation is hazardous to life (hence its usefulness in sterilization); for this reason irradiation facilities have a heavily shielded irradiation room where the process takes place. Radiation safety procedures ensure that neither the workers in such facility nor the environment receive any radiation dose from the facility. Irradiated food does not become radioactive, and national and international expert bodies have declared food irradiation as wholesome. However, the wholesomeness of consuming such food is disputed by opponents (Anon M.I., 1991) and consumer organizations[14]. National and International expert bodies have declared food irradiation as 'wholesome', UN-organisations as WHO and FAO are endorsing to use food irradiation. International legislations on whether food may be irradiated or not varies worldwide from no regulation to full banning (Hauther W.W., 2008). It is estimated that about 500,000 tons of food items are irradiated per year worldwide in over 40 countries. These are mainly spices and condiments with an increasing segment of fresh fruit irradiated for fruit fly quarantine (Deeley et. al., 2006 and Food Irradiation, 2000).

xiii. Modified atmosphere: Modifying atmosphere is a way to preserve food by operating on the atmosphere around it. Salad crops which are notoriously difficult to preserve are now being packaged in sealed bags with an atmosphere modified to reduce the oxygen (O2) concentration and increase the carbon dioxide (CO2) concentration. There is concern that although salad vegetables retain their appearance and texture in such conditions, this method of preservation may not retain nutrients, especially vitamins. Grains may be preserved using carbon dioxide. A block of dry ice is placed in the bottom and the can is filled with grain. The can is then "burped" of excess gas. The carbon dioxide from the sublimation of the dry ice prevents insects, mold, and oxidation from damaging the grain. Grain stored in this way can remain edible for five years. Nitrogen gas (N2) at concentrations of 98% or higher is also used effectively to kill insects in grain through hypoxia. However, carbon

dioxide has an advantage in this respect as it kills organisms through both hypoxia and hypercarbia, requiring concentrations of only 80%, or so. This makes carbon dioxide preferable for fumigation in situations where a hermetic seal cannot be maintained (Deeley et.al., 2006).

xiv. Burial in the ground: Burial of food can preserve food due to a variety of factors: lack of light, lack of oxygen, cool temperatures, pH level, or desiccants in the soil. Burial may be combined with other methods such as salting or fermentation. Many root vegetables are very resistant to spoilage and require no other preservation other than storage in cool dark conditions, for example by burial in the ground, such as in a storage clamp. Century eggs are created by placing eggs in alkaline mud (or other alkaline substance) resulting in their "inorganic" fermentation through raised pH instead of spoiling. The fermentation preserves them and breaks down some of the complex, less flavourful proteins and fats into simpler more flavourful ones. Most foods can be preserved in soil that is very dry and salty (thus a desiccant), or soil that is frozen.

xv. Controlled use of micro-organism: Some foods, such as many cheeses, wines, and beers will keep for a long time because their production uses specific micro-organisms that combat spoilage from other less benign organisms. These micro-organisms keep pathogens in check by creating an environment toxic for themselves and other micro-organisms by producing acid or alcohol. Starter micro-organisms, salt, hops, controlled (usually cool) temperatures, controlled (usually low) levels of oxygen and/or other methods are used to create the specific controlled conditions that will support the desirable organisms that produce food fit for human consumption.

xvi. High Pressure Food Preservation: High pressure food preservation refers to high pressure used for food preservation. "Pressed inside a vessel exerting 70,000 pounds per square inch or more, food can be processed so that it retains its fresh appearance, flavour, texture and nutrients while disabling harmful microorganism and slowing spoilage". By 2001, adequate commercial equipment was developed so that by 2005 the process was being used for products ranging from orange juice to guacamole to deli meats and widely sold (Church J.J., and Parson A.L., 1995).

EFFECTS OF FOOD PRESERVATIVES

Many foods available in the market contain different types of preservatives. These chemicals can give rise to certain health problems. 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 colors. When someone has a reaction after eating certain foods, such 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 (Riddervold A., 2008).

CONCLUSION

Most food products require protection against microbial spoilage during storage. Consumers demand safe natural products. This drives the search of food authorities and researchers for mild preservation techniques to improve microbial quality and safety without causing nutritional and organoleptic losses. Additives have been used for many years to preserve, flavor, blend, thicken and color foods, and have played an important and essential role in reducing serious nutritional deficiencies. Additives help to assure the availability of wholesome, appetizing and affordable foods that meet consumer's demands from season to season.. This review relies on the techniques used for preservation that protect foodstuff against the action of microorganisms (fungi and/or bacteria) and thereby extend the shelf life emphasizing that food preservatives have an incontestable importance in food technology.

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