UNIT 6: FOOD ADDITIVES

6.1 FOOD ADDITIVES

"A food additive is a substance or mixture of substances, other than the basic food stuff, which is present in food as a result of any aspect of production, processing, storage or packaging. The term does not include chance contamination" (WHO). This definition emphasizes one interpretation of a food additive; i.e., it is an intentional additive. Those food additives which are specifically added to prevent the deterioration or decomposition of a food have been referred to a chemical preservatives. These deteriorations may be caused by microorganisms, by food enzymes, or by purely chemical reactions. The inhibition of the growth and activity of microorganisms is one of the main purposes of the use of chemical preservatives. Preservatives may inhibit microorganisms by interfering with their cell membranes, their enzyme activity, or their genetic mechanisms. Other preservatives may be used as antioxidants to hinder the oxidation of unsaturated fats, as neutralizers of acidity, as stabilizers to prevent physical changes, as firming agents, and as coatings on wrappers to keep out microorganisms, prevent loss of water, or hinder undesirable microbial, enzymatic and chemical reactions.

Factors that influence the effectiveness of chemical preservatives in killing microorganisms or inhibiting their growth and activity are: (1) concentration of the chemical; (2) kind, number, age, and previous history of the organism; (3) temperature; (4) time; and (5) the chemical and physical characteristics of the substrate in which the organism is found (moisture content, pH, kinds and amounts of solutes, surface tension, and colloids and other protective substances). A chemical agent may be bactericidal at a certain concentration, only inhibitory at a lower level, and ineffective at still greater dilutions.

The various grouping of additives added to food are as follows :

1. Those added preservatives not defined as such by law : natural organic acids (lactic, malic, citric, etc.) and their salts, vinegar (acetic acid is a natural acid), sodium chloride, sugars, spices and their oils, woodsmoke, carbon dioxide, and nitrogen.
2. Substances generally recognized as safe (GRAS) for addition to foods: propionic acid, sodium and calcium propionates, caprylic acid, sorbic acid and potassium, sodium and calcium sorbates, benzoic acid and benzoates and derivatives of benzoic acid such as methylparaben and propylparaben, sodium diacetate, sulfur dioxide and sulfites, potassium and sodium bisulfite and metabisulfite, and sodium nitrite. (Although, there are some limitations on their use.)
3. Chemicals considered to be food additives, which would include all not listed in the first two categories. They can be used only when proved safefor man or animals, and they then fall into group 4.
4. Chemicals proved safe and approved by the Food and Drug Administration.

Preservatives added to inhibit or kill microorganisms may be classified on various other bases, such as their chemical composition, mode of action, specificity, effectiveness, and legality. Some, e.g., sugars are effective becauseof their physical action, others, e.g., sodium benzoate because of their chemical action, and others e.g., sodium chloride, because of a combinations of these effects. Some preservatives are incorporated into food and usually are antiseptic rather than germicidal, while others are used only to treat outer surfaces and may kill organisms as well as inhibit them. Some are employed to treat wrappers or containers for foods, while others are used as gases or vapours about the food. Some have been incorporated in ice used to chill foods, such as fish. Preservatives may be fairly specific against molds or yeasts and less so against bacteria, or vice versa, and may act against definite groups or species of bacteria or other organisms.

6.2 BROAD CLASSES OF INTENTIONAL FOOD ADDITIVES

There are approximately 3000 intentional food additives in 12 major groups. Afew representative types from each group are listed below.

6.2.1 Preservatives

These are substances added to foods to inhibit the growth of bacteria, yeasts, and/ or moulds. Examples include sodium bezoate used in soft drinks and acidic foods, sodium and calcium propionate used in breads and cakes as mold inhibitor, and sorbic acid used on cheese and in moist dog foods to controls mold. Substances such as sulfur dioxide, that control browning of fruits and vegetables caused by enzymes, also are considered preservatives.

6.2.2 Antioxidants

These substances are used to prevent oxidation of fats by molecular oxygen. Without them, potato chips, breakfast cereals, salted nuts, fat-containing dehydrated foods, crackers, and many other fat-containing foods could not be stored very long without developing rancidity. Principal among these antioxidants are butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), tertiary butylated hydroquinone (TBQH), and propyl gallate. The antioxidants also include such diverse materials as ascorbic acid, stannous chloride, and tocopherol (vitamin E). Sulfur dioxide, listed as a preservative, is further listed as an antioxidant. Many other food chemicals also exhibit dual roles.

6.2.3 Sequestrants

These are the chelating agents or sequestering compounds which serve to scavenge metal ions. They do this by combining with trace metals such as iron and copper and remove them from solution. The trace metals are active catalysts of oxidation and also contribute to off-color reactions. Their removal by chelating additives such as ethylenediamine tetraacetic acid (EDTA), polyphosphates, and citric acid prevents these defects.

6.2.4 Surface Active Agents

These include the emulsifers used to stabilize oil-in-water and water-in-oil mixtures, gas-in-liquid mixtures, and gas-in solid mixtures. In addition to emulsifiers of natural origin such as lecithin and to emulsifires that can be prepared synthetically such as monoglycerides and digylcerides and their derivatives, other emulsifying agents include certain fatty acids and their derivatives and bile acids, which are important in digestion. Also included among the surface active agents are numerous defoaming compounds and detergent chemicals.

Table 6.1 : Some Functional Properties of Common Food Additives

I. Purpose: Maintain/improve nutritional quality

1. Class : Nutrients

Function : Fortify : add nutrients; enrich; replace nutrients

Examples	*Where found*
Vitamin C	Beverages
Iron	Baked goods

II. Purpose : Facilitate production, processing, or preparation

1. Class : Acidulants, alkalies, buffers

Function : Flavour, pH control, processing, antimicrobial

Examples	*Where found*
Acetic acid	Dressings
Sodium bicarbonate	Chocolate
Phosphoric acid	Soft drinks
Phosphates	Meats

2. Class : Anticaking agents

Function : Keep powders free-flowing

Examples	*where found*
Silicates	Salt, baking powder

3. **Class : Bleaching, maturing agents, dough conditioners**

Function : Accelerate dough aging, machinability

Examples	*Where found*
Peroxides	Flour
Gums	Bread dough

4. **Class : Bulking, bodying, thickening , firming agents**

Function : Change consistency, stabilize, mouthfeel

Examples	*Where found*
Pectin	Jams, jellies
Alginates	Dairy desserts
Carboxymethycellulose	Ice cream, bread
Modified food starch	Sauces, soups
Calcium lactate	Apple slices

5. **Class : Chelating agents**

Function : Sequester metal ions

Examples	*Where found*
EDTA	Beer, canned fish

6.2.5 Stabilizers and Thickeners

These substances include gums, starches, dextrins, protein derivatives, and other additives that stablize and thicken foods by combining with water to increase viscosity and to form gels. Gravies, pie fillings, cake toppings, chocolate milk drinks, jellies, puddings, and salad dressings are among the many foods that contain such stabilizers and thickeners as gum arabic, carboxymethyl cullulose (CMC), carrageenan, pectin, amylose, gelatin, and others.

6.2.6 Bleaching and Maturing Agents, Starch Modifiers

Freshly milled flour has a yellowish tint and suboptimum functional baking qualities. Both the color and baking properties improve slowly on normal storage. These improvements can be obtained more rapidly and with better

control through the use of certain oxidizing agents such as benzoyl peroxide which bleaches the yellow color. Oxides of nitrogen, chlorine dioxide, and other chlorine compounds both bleach color and mature the flour. Starch modifiers include compounds such as sodium hypochlorite, which oxidizes starches to a higher degree of water solubility.

6.2.7 Buffers, Acids, Alkalies

As pH-adjusting and pH-controlling chemicals, buffers, acids, and alkalies affect an endless number of food properties, many of which have been previously described. The acids in particular may be derived from natural sources, such as fruits, and from fermentation, or they may be chemically synthesized.

6.2.8 Food Colors

Colors are added to thousands of food items to produce appetizing and attractive qualities in foods. Both synthetic and naturally occurring colors are added to foods. Artificial colors, each batch of which must be tested and certified by the regulatory agency, must be labeled as artificial. Many natural coloring agents such as extract of annatto, caramel, carotene, and saffron are widely used in foods. Synthetic colors generally excel in coloring power, color uniformity, color stability, and lower cost. Carbonated beverages, candies and gelatin desserts are among items colored with certified synthetic dyes. In addition to the organic synthetic dyes and the natural organic coloring agents, food colors also include such inorganic materials as iron oxide to give redness and titanium dioxide to intensify whiteness. Organic coloring materials also can be coated onto metallic salts to produce suspensions of colored particles, known as lakes, as opposed to dissolved colored solutions.

Interest in the use of natural reds from grapes, beets, and cranberries has increased. Another natural red food color, cochineal, used to produce carmine, is extracted from females of the insect *Coccus cacti*.

6.2.9 Artificial Sweeteners

Chemicals which taste sweet but which contain few or no calories at the levels required for sweetness are considered non-nutritive or reduced-calorie sweeteners. Some compounds such as aspartame contain the same number of calories as sucrose (sugar) but are hundreds of times sweeter; hence, only a fraction of the amount is used compared to normal sugar. Thus, they are "reduced"-calorie sweeteners. Other compounds, such as saccharin, contain no calories and are truly non-nutritive. The largest group of users of non-nutritive and reduced-calorie sweeteners have been the low-calorie soft drink manufacturers. But such sweeteners also have been important in the manufacture of other low-calorie foods such as candies, frozen desserts, salad dressings, gelatin desserts, and some baked goods. Other non-nutritive sweeteners, which have sweetness ranges upto to 3000 times that of sucrose, are under study. Among them are neohesperidine dihydrochalcone from citrus rinds and L-isomers of common sugars, which have comparable sweetness to the naturally occurring D-isomers but are not metabolized and therefore do not contribute calories. Aspartame is currently the most widely used artificial sweetener and is a synthetic aspartic acid-phenylalanine dipeptide.

6.2.10 Nutritional Additives

Vitamins, minerals, and other nutrients are added as supplements and enrichment mixtures to a number of products. Major examples are the following: vitamin D added to milk; B vitamins and iron added to cereal products; iodine added to salt; vitamin A added to margarine; and vitamin C added to fruit juices and fruit-flavoured desserts. Several amino acids also are listed in this group. The amino acid lysine has received considerable study since it is the only essential amino acid absent from the protein of wheat flour in sufficient amount to prevent wheat flour from being a nutritionally complete protein source.

6.2.11 Flavouring Agents

Natural flavouring substance include spices, herbs, essential oils, and plant extracts. Typical of the synthetic flavour additives are benzaladehyde (wild cherry/almond),ethyl butyrate (pineapple), methyl anthranilate (grape), and methyl salicylate (wintergreen). Currently, there are over 1200 different flavouring materials used in foods, making this the largest single group of food additives. These are typically used in trace amounts and are similar group of food additives. These are typically used in trace amounts and are similar to the chemicals found in natural sources. Also included among the flavour additives are flavour enhancers or potentiators, which do not have flavour in themselves in the low levels used but intensify the flavour of other compounds present in foods. Monosodium glutamate (MSG) and the 5'-nucleotides (related tocomponents found in nucleic acids) are examples of the potentiators..

6.2.12 Miscellaneous Additives

Many additional food additives provide functions other than also already discussed. Included are substances to promote growth of baker's yeast such as ammonium sulfate, firming agents (for fruits and vegetables) such as calcium chloride, anticaking agents for salt and granular foods such as calcium phospate, antistickintg agents such as hydrogenated sperm oil, clarifying agents for wine such as bentonite, solvents such as ethanol, acetone, and hexane, machinery lubricants such as mineral oil, meat curing agents such as sodium nitrite and sodium nitrate, crystallization inhibitors such as oxystearin, plant growth stimulants used in malting barley such as gibberellic acid, enzymes for a wide variety of uses, and many more.

6.2.13 Macrocomponents and Foods Subsitutes

In recent years, a special type of additive known as a macrocomponents is being used with increasing frequency. Macrocomponents substitute a large portion of the food with another component. For example, there is interest in reducing the fat content of some food such as ice cream without changing

texture and flavour. This means substituting a less caloric fat replacer for all ormost of the fat in ice cream. This is a macrosubstitution.