UNIT 7 FOOD ADDITIVES

Structure

7.1 INTRODUCTION

Have you ever wondered why butter available in the market has a pleasing yellow colour compared to the white butter we make at home? What prevents salt from becoming lumpy in its shaker? And what allows many foods to be available year-round? The answer to all these questions is – food additives!

Changes in our lifestyle have increased the demand for processed foods. Everyone is looking for convenient, easy-to-cook and ready-to-eat foods which require less time to prepare than the traditional home-cooked foods. Manufacturing of processed foods requires the addition of several chemicals. In this unit we will look at the chemicals which we intentionally put in our foods during processing. These chemicals are known as *food additives*. The unit will provide background information about food additives, why they are used in foods and how regulations govern their safe use in the food supply.

Objectives

After studying this unit, you will be able to:

- list the various types of food additives,
- explain the function of each type of food additive,
- recognize the type of additive added to a food by reading the label on the packaging of the food, and
- discuss some safety issues regarding intake of food additives.

7.2 WHAT IS A FOOD ADDITIVE?

A food additive may be defined as *any substance or a mixture of substances, other than basic foodstuff, which is present in food as a result of any aspect of production, processing, storage or packaging.* In simpler terms, food additives are the substances which are added to food by the manufacturers to facilitate processing or to improve appearance, texture, flavour and keeping quality. The term does not include chance contaminants which might unknowingly enter our food, or substances added to food for maintaining or improving nutritional qualities. Its usage is restricted to substances added intentionally to foods. Such substances include oxidizing agents, flavours, propionate sorbate, vitamins etc. Some foods likely to contain additives are illustrated in Figure 7.1.

Figure 7.1: Foods likely to contain additive

Why are Additives Used in Foods?

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. We can understand this better by looking at what goes in to producing good quality bread. A mild oxidizing agent is added to the flour to obtain whiteness, vitamins may be added to improve nutritional quality, salt, sugar and flavours are added to obtain desirable taste and flavour, glycerol monostearate for soft texture and propionates or sorbates are added for better keeping quality to suit long distance transportation and marketing. Figure 7.2 highlights the additive required to make good quality bread. Each additional component incorporated in bread manufacture has a positive impact on the desirable quality of the finished product which is so essential for its marketability or acceptance by the consumer.

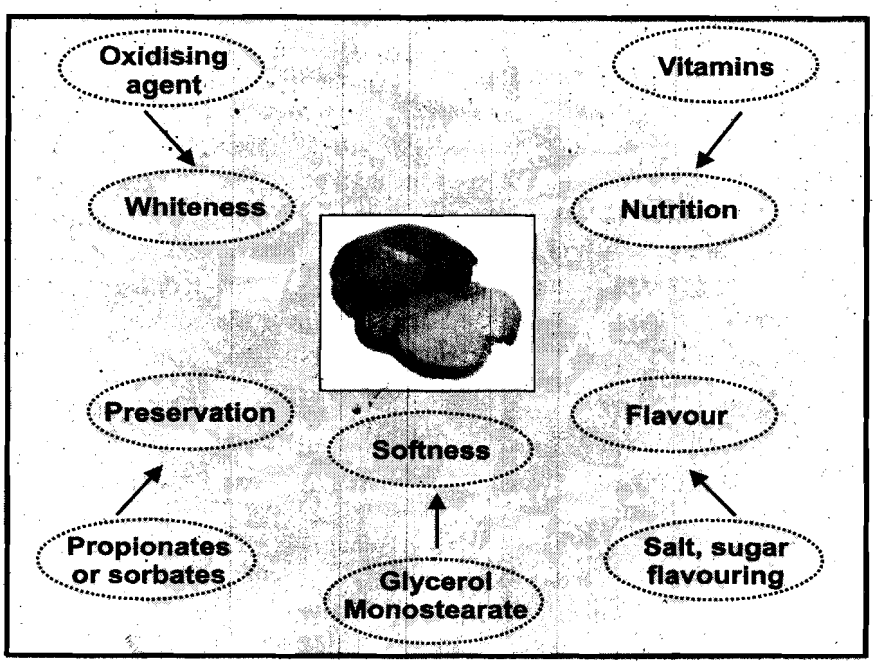

Figure 7.2: Additives required to make good quality bread

Having looked at the role of additives in making good quality bread, the different uses of additives in foods, in general, can be summarized as under:

- *To maintain product consistency* — Emulsifiers give products a consistent texture and prevent them from separating. Stabilizers and thickeners give a smooth uniform texture. Anti-caking agents help substances such as salt to flow freely.

- *To improve or maintain nutritional value* — Vitamins and minerals are added to many common foods such as milk, flour, cereal and margarine to make up for those likely to be lacking in a person's diet or lost in processing.

- *To maintain palatability and wholesomeness* — Preservatives retard product spoilage caused by mould, air, bacteria, fungi or yeast. Bacterial contamination can cause food borne illness which could be life-threatening. Antioxidants are *preservatives that prevent fats and oils in baked goods and other foods from becoming rancid or developing an off-flavour*. They also prevent cut fresh fruits such as apples from turning brown when exposed to air.

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

- *To enhance flavour or impart desired colour* — Many spices and natural and synthetic flavours enhance the taste of foods. Colours, likewise, enhance the appearance of certain foods to meet consumer expectations.

- *To enhance the keeping quality or stability of a food* — Use of certain preservatives, stabilizers, anti-caking agents etc. increases the shelf-life of food products.

Some of these functions are presented for your reference in Figure 7.3.

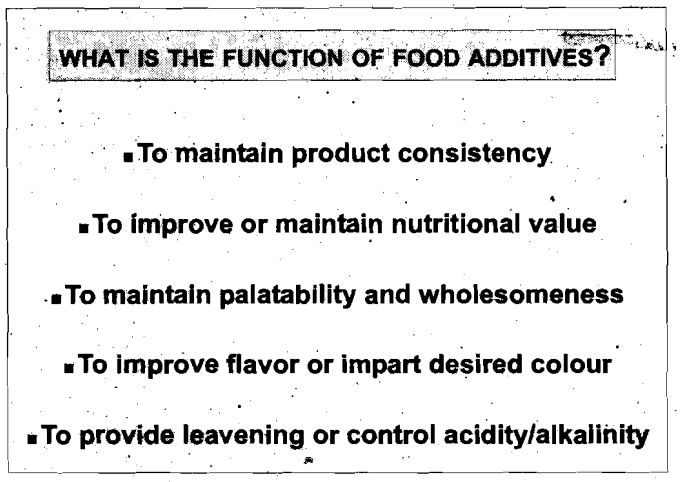

Figure 7.3: Functions of food additives

Different countries have different laws pertaining to which food additives can be used and in which foods. In India, the *Prevention of Food Adulteration (PFA) Act* and Rules specify the amounts and names of food additives which can be added to certain foods. You will learn more about this Act in Unit 14, later in this Course.

Now, let us examine in detail the different types of additives permitted in foods in India and the role each one plays to make the food product more appealing or acceptable to us as consumers. We will also get to know how safe it is to consume these chemicals as a part of our daily diet in the next section.

7.3 CLASSIFICATION OF FOOD ADDITIVES

You would realize, of the many ways the food additives have been classified, the functional classification has received the widest acceptance. According to this, the food additives are classified based on their function in food, i.e. the purpose for which the additive has been incorporated in the food. You have studied about the uses/ purpose of additives in section 7.2. Based on this, the various classes of food additives can be identified as:

- antioxidants
- preservatives
- food colours
- food flavours
- emulsifiers and stabilizers
- anti-caking agents
- sequestrants
- acid, bases and buffers
- anti-foaming agents
- sweeteners
- enzymes, and
- leavening agents.

Visit your local grocery store or supermarket and note down the label information on the ingredients of processed food items like jam, tomato sauce, biscuits, bread, soup powder, health drinks (like bournvita, horlicks, etc.), cheese, cheese spread, butter,

breakfast cereals, sherbets, squashes, pickles, chocolates and canned fruits, vegetables and meat products. Figure 7.4 shows the typical label which you might see on a packet of biscuits.

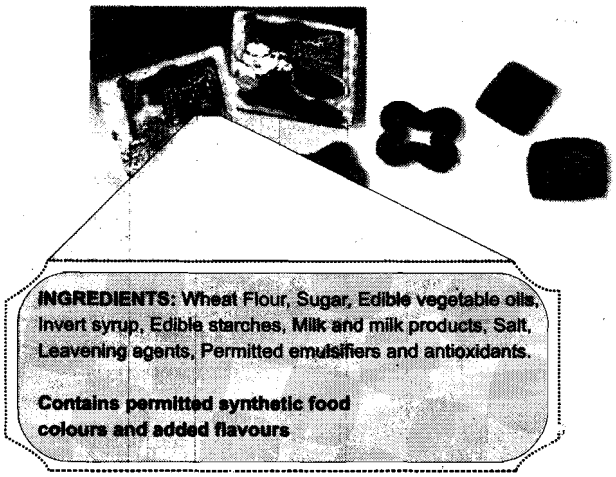

Figure 7.4: Typical label on a packet of biscuit

What information related to additives did you find on the label? Yes, a list of the ingredients, along with the other substances such as synthetic food colours, flavours present in the food item is listed. These other substances are the *additives*.

In the coming section, we will learn more about the functional role of some of these additives. But, while on the topic of classification of additives, note additives may also be classified as *direct* or *indirect*.

If a substance is added to a food for a specific purpose in that food, it is referred to as a *direct additive*. For example, the low-calorie sweetener aspartame, which is used in beverages, is considered a direct additive. Many direct additives are identified on the ingredient label of foods.

Indirect food additives are those that become a part of the food in trace amounts due to its packaging, storage or other handling. For instance, minute amounts of additives coated on packaging substances may find their way into foods during storage. That is why it is essential to make sure that all materials coming in contact with food are safe, before they are permitted for use. Also additives used in raw materials or ingredients may find their way in to the finished food product. For example, antioxidants used in edible oil may also be found in chips or any food item prepared with this oil. This is known as the "*Carry over*" principle.

Before moving on to the functional role of additives, let us recapitulate what we have learnt till now.

Check Your Progress Exercise 1

1) Define food additives.

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2) List five reasons why additives are added to foods.

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3) Distinguish between direct and indirect food additives.

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4) What do you mean by 'carry over' principle?

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7.4 FUNCTIONAL ROLE OF DIFFERENT ADDITIVES

Here, what do we mean by the term functional role? You may recall reading about the functional role of substances in the Principles of Food Science Course. Functionality (as implied to food ingredients), generally refers to *any property aside from the nutritional attributes that influences usefulness of ingredients in the food.* Most of the functional properties affect the sensory characteristics (especially textural attributes) of foods, but also can play a major role in the physical behaviour of food and food ingredients during their preparation. The functional role of different food additives classified, as per Codex Alimentarius, is presented in Table 7.1.

Table 7.1: The functional role of food additives classified, as per Codex Alimentarius

Functional classes (for labelling purposes)	Definition	Sub-classes (Technological functions)
1) Acid	Increases the acidity and/or alkalinity of a food.	Acidifer
2) Acidity Regulator	Alters or controls the acidity or alkalinity of a food.	Acid, alkali, base, buffer, buffering agent, pH adjusting agent
3) Anticaking agent	Reduces the tendency of particles of food to adhere to one another.	Anticaking agent, antistick agent, drying agent, dusting powder, release agent
4) Antifoaming agent	Prevents or reduces foaming antioxidant, antioxidant synergist.	Antifoaming agent
5) Antioxidant	Prolongs the shelf-life of foods by protecting against deterioration caused by oxidation, such as fat rancidity and colour changes.	Antioxidant, antioxidant synergist, sequestrant
6) Bulking agent	A substance, other than air or water, which contributes to the bulk of a food without contributing significantly to its available energy value.	Bulking agent, filler
7) Colour	Adds or restores colour in a food.	Colour
8) Colour retention agent	Stabilizes, retains or intensifies the colour of a food.	Colour fixative, colour stabilizer
9) Emulsifier	Forms or maintains a uniform mixture of two or more immiscible phases which surface as oil and water in a food.	Emulsifier, plasticizer, dispersing agent, surface active agent, surfactant, wetting agent
10) Emulsifying salt	Rearranges cheese proteins in the manufacture of a processed cheese, in order to prevent fat separation.	Melding salt, sequestrant
11) Firming agent	Makes or keeps tissues of fruit or vegetables firm and crisp, or interacts with gelling agents to produce or strengthen a gel.	Firming agent
12) Flavour enchancer	Enchances the existing taste and/or odour of a food.	Flavour enhancer, flavour modifier, tenderizer
13) Flour treatment agent	A substance added to flour to improve its baking quality or colour.	Bleaching agent, dough improver, flour improver
14) Foaming agent	Makes it possible to form or maintain a uniform dispersion of a gaseous phase in a liquid or solid food.	Whipping agent, aerating agent
15) Gelling agent	Gives a food texture through formation of a gel.	Gelling agent
16) Glazing agent	A substance which, when applied to the external surface of a food, imparts a shiny appearance or provides a protective coating	Coating, sealing agent, polish
17) Humectant	Prevents food from drying out by counteracting the effect of an wetting agent atmosphere having a low degree of humidity.	Moisture/water retention agent, wetting
18) Preservative	Prolongs the shelf-life of a food by protecting against deterioration caused by agent, bacteriophage control agent, microorganisms.	Antimicrobial preservative, antimycotic
19) Propellant	A gas, other than air, which expels a food from a container.	Propellant
20) Raising agent	A substance or combination of substances which liberate gas and thereby increase the volume of a dough.	Leavening, raising agent
21) Stabilizer	Makes it possible to maintain a uniform dispersion of two or more immiscible retention agent, foam stabilizer substances in a food.	Binder/firming agent moisture/water
22) Sweetner	A non-sugar substance which imparts a sweet taste to a food sweetner	Sweetener, artificial sweetner, nutritive
23) Thickener	Increases the viscosity of a food.	Thickening agent, texturizer, bodying agent.

Next, let us review the applicability of different types of food additives permitted for use in our country. We start with the antioxidants.

7.4.1 Antioxidants

You must have at some point of time tasted a stale deep fried snack prepared at home or bought from a local sweet shop. Do you remember its foul flavour and how you probably had to spit it out? What do you think may have been responsible for the foul flavour? The culprit are the unsaturated organic molecules in foods mostly fats, pigments, vitamins and other nutrients, which are highly unstable towards atmospheric oxidation. These undergo a variety of chemical and physical changes and form obnoxious taints and odours in stored foods. Also the products based on meat, fish, milk and egg which are rich in fats, especially the polyunsaturated fatty acids, are more prone to spoilage and need protection. Auto-oxidation in stored foods not only spoils the flavour but also depletes them of essential fatty acids and vitamins. Secondly, products of oxidation react with the proteins of the food leading to the loss of essential amino acids, digestibility, flavour, aroma, texture and basically a lowered nutritional value of the food.

What then are antioxidants? What is their role as an additive? Antioxidant means *a substance which when added to food retards or prevents oxidative deterioration of food.* According to the PFA Rules, this does not include substances like sugar, cereal, oils, flours, herbs and spices. Under Rule 59, no antioxidant other than lecithin, ascorbic acid and tocopherol shall be added to any food. However the following antioxidants, not exceeding in concentration mentioned against each, may be added to edible oils and fats except ghee and butter, namely:

1)	Ethyl gallate	or mixture thereof	0.01 per cent
2)	Propyl gallate		
3)	Octyl gallate		
4)	Dodecyl gallate		
5)	Ascorbyl palmitate		0.02 per cent
6)	Butylated hydroxyanisole (BHA)		0.02 per cent
7)	Citric acid		
8)	Tartaric acid		
9)	Gallic acid		0.01 per cent
10)	Resin Guiace		0.05 per cent
11)	Tertiary butyl hydro quinone (TBHQ)		0.02 per cent

Dry mixes of *rasgollas* and *vadas* may contain butylated hydroxyanisole (BHA) not exceeding 0.02 per cent calculated on the basis of fat content. Flavouring agents also may contain the permitted antioxidants in concentration not exceeding 0.01 per cent. Ghee and butter may contain BHA in a concentration not exceeding 0.02 per cent. Fat spread may contain BHA or Tertiary-butyl-hydroquinone (TBHQ) in a concentration not exceeding 0.02 per cent by weight on fat basis. Ready-to-eat dry breakfast cereals may contain BHA not exceeding 0.005 per cent (50 ppm). In ready-to-drink infant milk substitute, lecithin and ascrobyl palmitate may be used up to a maximum limit of 0.5 g / 100 ml and 1 mg /100 ml respectively. Wherever BHA is used in conjunction with the antioxidants mentioned as items Nos. 1 to 4 above, the quantity of the mixture shall not exceed the limit of 0.02 per cent.

7.4.2 Preservatives

Preservatives are *substances which when added to food, retard, inhibit or arrest the activity of microorganisms such as fermentation, acidification and*

decomposition of foods. In India, the preservatives have been grouped into two classes – Class I and Class II preservatives.

Included under Class I preservatives are items of common use such as:

a) Common salt
b) Sugar
c) Dextrose
d) Glucose Syrup
e) Spices
f) Vinegar or acetic acid
g) Honey
h) Edible vegetable oils

Most of these preservatives you will find in food items like pickles, relishes, *chutneys* and pastes which we make at home. There is no restriction as such on the addition of these preservatives in any food item unless otherwise specified under the PFA Rules.

Under Class II preservatives are included:

a) Benzoic acid including salts thereof
b) Sulphurous acid including salts thereof
c) Nitrates or nitrites of sodium or potassium
d) Sorbic acid including its sodium, potassium and calcium salts
e) Propionic acid including its calcium or sodium salts and its esters
f) Lactic acid including its sodium, potassium or calcium salts
g) Acid calcium phosphate
h) Nisin
i) Sodium diacetate, and
j) Methyl or propyl parahydroxy-benzoate

The use of Class II preservatives is restricted to only certain foods and the amount of the preservative which can be added to these foods is also specified under the PFA Rules. Also the presence of a Class II preservative in any food has to be declared on the packaging of the food as illustrated in Figure 7.5. Use of more than one Class II preservative in a food is prohibited unless specified under the Rules. For instance, sulphur dioxide or benzoic acid can be added in the proportion of 40 parts per million or 200 parts per million respectively in some foods like jams, marmalades and preserves. If both preservatives are used in combination and the proportion of sulphur dioxide is 20 parts per million, the proportion of benzoic acid shall not exceed 100 parts per million.

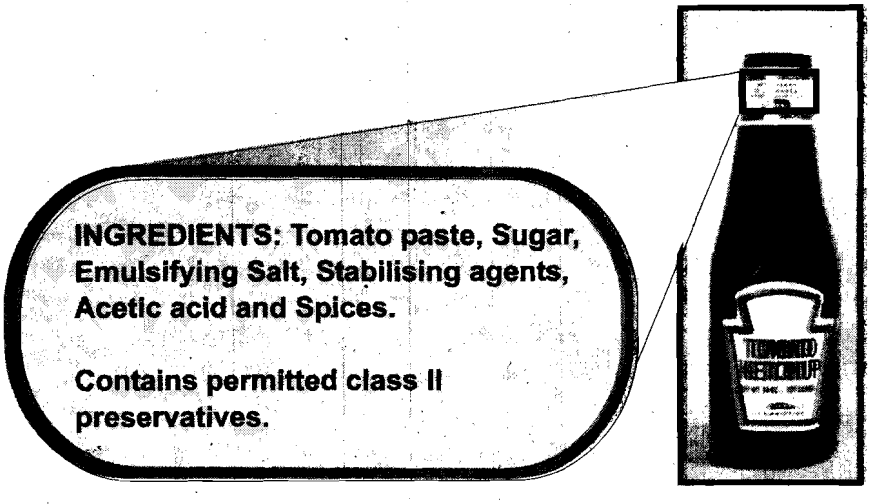

Figure 7.5: Label showing use of class II preservatives

Let us get to learn a little more about the commonly used Class II preservatives, next.

i) *Sulphur dioxide, bisulphites and sulphites:* Sulphites, as a source of sulphur dioxide, has been extensively used as preservatives in foods for quite sometime now. They are effective, versatile and economical additives which are used as antimicrobials in the preservation of a number of food items viz. jam, jelly, marmalade, fruit, fruit pulp and juices, syrups and sherbets, alcoholic beverages, confectionery, dry fruits and meat products. They are also used as bleaching agents in the refining of sugar as antimicrobial agents, to control enzymatic and non-enzymatic browning reactions in dehydrated fruits and vegetables and to provide protection against oxidative reactions.

ii) *Nitrates and nitrites:* These are added as preservatives to particularly meat products like ham, bacon and pickled meat. They are especially effective against bacteria like *Clostridium botulinum* and *Staphylococcus aureus* which have a long history of causing lethal food poisoning. Its preservative action is mainly due to the formation of nitric acid and other oxides of nitrogen and their action increases with decreasing pH value. Nitrates are more effective when they are used in combination with common salt. The presence of nitrites imparts the characteristic pink colour to meat apart from protecting its flavour. It also delays the development of off-flavours during storage. Note, nitrates and nitrites are, however, not permitted to be added to any infant food.

iii) *Benzoic acid and salts:* These are mainly used to protect foods against yeasts and moulds. They are not very effective against bacteria and have to be used in combination with sulphur dioxide in foods prone to spoilage by bacteria. Benzoic acid is used in squashes, fruit syrups, cordials, juices, jams, marmalades, preserves, sweetened ready-to-serve beverages, pickles, *chutneys*, sauces, tomato puree and paste and fat spread. Its effectiveness increases with the lowering of pH and is most effective below of pH 4.5.

iv) *Sorbic acid and its salts:* These are effective against moulds, yeasts and many bacteria. It is more effective as a preservative than propionates and benzoates at higher pH values and, therefore, it is widely used for bakery and confectionery products like cakes, fillings for chocolates and various types of cheese, cheese spreads and fat spread, *paneer* and ready-to-eat preserved *chapatis*. These are also used in the preservation of fermented vegetable products and vegetables pickled in vinegar. Its presence inhibits lactic acid fermentation slightly but supresses the growth of film-forming yeasts and moulds.

Having learnt about preservatives, let us now get to know about colours as food additives.

7.4.3 Food Colours

You will agree that the colour of a food product plays a very important part in its acceptance by the consumer. Many of the food processing operations like drying, canning, roasting, frying etc. lead to loss of the attractive natural colour of foods. This makes the addition of synthetic colour to the processed food essential. You would, for example, surely reject a can of cherries which were brown in colour instead of a bright red or a can of peas which are a dirty greenish-yellow instead of bright green. Colour additives are also used in foods to correct natural variations in food colour. A manufacturer would want, for instance, that every batch of his orange marmalade is the same shade of orange. A few other reasons of adding colours to foods include:

- to enhance colours that occur naturally but at levels weaker than those usually associated with a given food.
- to provide a colourful identity to foods that would otherwise be virtually colourless.

- to protect nutrients such as vitamins and flavours that may be affected by sunlight.
- to provide an appealing variety of foods to consumers.
- to compensate for natural or seasonal variations in food, raw material or the effects of processing and storage to meet consumer expectations.

The addition of colouring matter is, however, restricted to only specified items of food. Any extraneous addition of colouring matter has to be written on the label attached to any package of food. So next time you purchase a packet of cream biscuits, candy or a tetrapack of fruit juice, check the label for any of the following declarations in capital letters:

CONTAINS PERMITTED NATURAL COLOUR(S)

or

CONTAINS PERMITTED SYNTHETIC FOOD COLOUR(S)

or

CONTAINS PERMITTED NATURAL AND SYNTHETIC FOOD COLOUR(S)

The colouring matter in foods can be broadly classified into two groups – *natural and synthetic colours*. Natural food colours have been in use from prehistoric times. Among the natural colouring matters which may be used, caramel may be used without label declaration. The other natural colouring matter which are permitted are listed herewith. Addition of these has to be declared on the label. These colours may be isolated from natural sources or may be synthesized. These may be used in any article of food, and are listed as:

a) i) Beta-carotene
   ii) Beta-apo-8' carotenal
   iii) Methylester of Beta-apo-8' carotenoic acid
   iv) Ethylester of Beta-apo-8'carotenoic acid
   v) Canthaxanthin
b) Chlorophyll
c) Riboflavin (Lactoflavin)
d) Caramel
e) Annatto
f) Saffron, and
g) Curcumin or turmeric

Inorganic colouring matter and pigments are not allowed to be added to any food except titanium dioxide (food grade) is permitted to be added to chewing gum up to a maximum limit of 1 per cent. No synthetic food colours or a mixture, thereof, except the ones shown in Table 7.2, are permitted for use in food.

Table 7.2: Synthetic food colours permitted for use in India

Colour	Common name	Colour index (1956)	Chemical class
(1)	(2)	(3)	(4)
1. Red	Ponceau 4R	16255	Azo
	Carmoisine	14720	Azo
	Erythrosine	45430	Xanthene
2. Yellow	Tartrazine	19140	Pyrazolone
	Sunset yellow FCF	15985	Azo
3. Blue	Indigo Carmine	73015	Indigoid
	Brilliant blue FCF	42090	Triarylmethane
4. Green	Fast green FCF	42053	Triarylmethane

These synthetic food colours are permitted for use only in certain foods, which include:

a) Ice cream, milk lollies, frozen dessert, flavoured milk, yoghurt, ice-cream mix powder

b) Biscuits including biscuit wafer, pastries, cakes, confectionery, thread candies, sweets, savouries (*dal moth, mongia, phulgulab, sago papad, dal biji* only)

c) Peas, strawberries and cherries in hermatically sealed containers, preserved or processed papaya, canned tomato juice, fruit syrup, fruit squash, fruit cordial, jellies, jam, marmalade, candied, crystallized or glazed fruits

d) Non- alcoholic carbonated and non-carbonated ready-to-serve synthetic beverages including synthetic syrups, sherbets, fruit beer, fruit beverages, fruit drinks, synthetic soft drink concentrates

e) Custard powder

f) Jelly crystal and ice candy, and

g) Flavour emulsion and flavour paste for use in carbonated or non-carbonated beverages only under label declaration.

The maximum limit of any permitted synthetic food colours or mixture, thereof, which may be added to any food article enumerated in the PFA Rules shall not exceed 100 parts per million of final food or beverage for consumption except in case of food articles mentioned in clause (c) where the maximum limit of permitted synthetic food colours shall not exceed 200 parts per million of the final food or beverage for consumption.

The misuse of non-permitted colours and usage of excess quantity of permitted colours have several health effects as given in Table 7.3.

Table 7.3: Adverse health effects of non-permitted colours

Colours	Adverse health effects
Metanil Yellow	Cancer, Stomach ache, testicular degeneration
Malachite Green	Tumours of lung, breast ovary and liver
Liver chromate	Anaemia, paralysis and abortion
Rhodamine B Sudan III Auramine	Pathological lesions in vital organs like kidney, spleen and liver.

So next time when you buy food which has food colour, check to be sure it is safe.

Now we move on to the study of flavouring substances which impart, as well as, enhance the flavour of different food preparations.

7.4.4 Flavouring Agents

Flavouring agents include flavour substances, flavour extracts or flavour preparations, which are capable of imparting flavouring properties, namely taste and odour to food. Flavouring agents may be of three types – *natural flavours*, *nature identical flavouring substances* and *artificial flavouring substances*.

Natural flavours are those exclusively obtained by physical processes from vegetable, sometimes animal raw materials. *Nature identical flavouring substances* are the substances chemically isolated from aromatic raw materials or obtained synthetically. They are chemically identical to the substances present in natural products. On the other hand, *artificial flavouring substances* are those which have not been identified in natural products and are hence chemically synthesized.

The use of the following flavouring agents are prohibited in any article of food in India, namely:

a) Coumarin and dihydrocoumarin

b) Tonkabean (Dipteryl Odorat) and

c) *B* asarone and cinamyl anthracilate

d) Estragole

e) Ethyl Methyl Ketone

f) Ethyl-3-Phenylglycidate

g) Eugenyl methyl ether

h) Methyl α napthyl Ketone

i) P.Propyl anisole

j) Saffrole and Isosaffrole

k) Thujone and Isothujone α and β thujone

Also, diethylene glycol and monoethyl ether may not be used as solvent ID flavours.

Monosodium glutamate, popularly known as *ajinomoto* is used chiefly in Chinese cooking to enhance flavour. It is permitted to be added to foods in restricted amounts (so that the total glutamate content of the food is not more than one per cent). Its addition needs to be declared on the label of the food product along with a warning that the food is unsuitable for children below twelve months of age. This is because the safety of this flavour has not been conclusively shown in infants. In fact, addition of any extraneous flavour to a food has to be declared on the label attached to any package of food in capital letters as – "CONTAINS ADDED FLAVOUR".

Having learnt about flavouring agents, let us move on to the other category of additives i.e, emulsifying and stabilizing agents.

7.4.5 Emulsifying and Stabilizing Agents

It is a well known fact that oil and water are immiscible liquids i.e. they can not be dissolved in one another. So how do you mix the two liquids in a food product in which both are essential ingredients? Well, with the use of emulsifying and stabilizing agents. What are these substances? Let's find out.

Substances which are capable of facilitating a uniform dispersion of oils and fats in aqueous media, or vice versa, and / or stabilizing such emulsions are known as emulsifying and stabilizing agents. Such substances are widely used in the commercial production of bread, confectionery, ice cream, chocolate and soft drinks. A long list of these substances is permitted to be added to food products in India. These substances include:

Agar, alginic acid, calcium and sodium alginates, carrageenan, edible gums (such as *guar*, karaya, arabic, carobean, furcellaran, tragacanth, gum ghatti), dextrin, sorbitol, pectin, sodium and calcium pectate, sodium citrate, sodium phosphates, sodium tartrate, calcium lactate, lecithin, albumin, gelatin, quillaila, modified starches, hydrolysed proteins, monoglycerides or diglycerides of fatty acids, synthetic lecithin, propylene glycol stearate, propylene glycol alginate, methyl ethyl cellulose, methyl cellulose, sodium carboxy- methyl cellulose, stearyl tartaric acid, esters of monoglycerides and diglycerides of fatty acids, monostearin sodium sulphoacetate, sorbitan esters of fatty acids or in combination, poly-oxy-ethylene sorbitan monostearate sodium stearoyl-2-lactylate and calcium stearoyl-2-lactylate, polyglycerol esters of fatty acids and polyglycerol ester of interesterified ricinoleic acid, glycerol esters of wood resins (Ester Gum).

No emulsifying or stabilizing agent can be used in any food except where the use of emulsifying or stabilizing agent is specifically permitted under the PFA Rules. Polyglycerol esters of fatty acids and polyglycerol ester of interesterified ricinoleic acid may be used in bakery products and in chocolate to the extent of 0.2 per cent by weight. Diacetyl tartaric acid, esters of mono and diglycerides may be used in bread and cakes.

The following emulsifying or stabilizing agents are not permitted for use in milk and cream, viz. monoglycerides or diglycerides of fatty acids, synthetic lecithin, propylene glycol stearate, propylene glycol alginate, methyl ethyl cellulose, methyl cellulose, sodium carboxymethyl cellulose, stearyl tartaric acid, esters of monoglycerides and diglycerides of fatty acids, monostearin sodium sulphoacetate, sorbitan esters of fatty acids or in combination.

Let us know more about some of the commonly used stabilizers. *Modified starches* are being used the world over by the food processing industry as thickeners, binders and stabilizers. These starches contribute in making our sauces thick in consistency, potato chips crisp and giving that special smooth texture to the puddings. According to the PFA Rules, these starches are permitted in baked foods, confectionery, snacks, flavours, some dairy products, glazes, icings, gravies, sauces, soups and fruit beverages up to a maximum concentration of 0.5 per cent by weight.

Gums derived from plants and seaweeds have been in use for thousands of years. You may recall reading about these gums in the Principles of Food Science Course Unit 2. In India gums have traditionally been used in the preparation of *ladoos*, a sweet preparation. Gums, you may recall reading, are obtained from various sources. Gum arabica, karaya and ghatti are tree exudates, guar gum, cassia gum and konjac mannan are seed and root gums, pectin is obtained from the peel of fruits, sodium carboxymethyl cellulose are obtained from cellulose pulp, gellan gum and xanthan gums are microbial gums, whereas, agar, alginate are seaweed extracts. Gums are widely used in various food products owing to the different properties they possess. They are used as a thickening agent in jams, gravies and sauces, and as a gelling agent in pudding desserts, as an encapsulating agent in stabilizing flavours. Pectin, sodium alginate, calcium alginate, alginic acid and propylene glycol alginate are permitted as additives in fruit products.

Next, let us move on to anti-caking agents. What are these and what is their role as additives? Let's find out.

7.4.6 Anti-caking Agents

We have all faced the problem of trying to take salt out of the salt shaker on the dining table. Moisture in the air tends to make the salt lumpy and then no matter how vigorously you shake, the salt simply refuses to flow out. How can we prevent this? Yes, with the use of anti-caking substances. Anti-caking substances are *anhydrous substances that can pick up moisture without themselves becoming wet and these are added to products such as table salt and dry mixes (soup powder, garlic and onion powder, fruit powder) to a maximum level of 2 per cent.* You must have seen advertisements of *free flowing* salt where the manufacturers claim that their salt does not form lumps. Such salt has anti-caking agents added to it in order to have this "free flowing" property. The anti-caking agents permitted for use in India include:

a) carbonates of calcium and magnesium
b) phosphates of calcium and magnesium
c) silicates of calcium, magnesium, aluminium or sodium or silicon dioxide
d) myristates, palmitates or stearates of aluminium, ammonium, and
e) calcium, potassium or sodium.

In addition, calcium, potassium or sodium ferrocyanide may also be used as anti-caking agents in common salt, iodized salt and iron fortified salt in quantity not exceeding 10 mg/kg singly or in combination expressed as ferrocyanide.

Another class of food additive that is commonly used in variety of foods is sequestrants. Let us get to know about them.

7.4.7 Sequestrants

Sequestrants are substances that complex with transition metal ions like copper, iron, cobalt and nickel. These metals are powerful catalysts in the auto-oxidation processes and their binding helps in eliminating/ retarding the oxidative breakdown of foods which would otherwise result in decolourisation, rancidity and production of an off taste in the food product. Addition of sequestering agents is permitted in a specified list of foods only. Some examples of commonly used sequestering agents are citric acid, phosphoric acid, tartaric acid, ethylene diamine tetra acetate (EDTA) etc.

Next, we shall have a book at the buffering agents.

7.4.8 Buffering Agents (Acids, Bases and Salts)

Buffering agents are *materials used to counter acidic and alkaline changes during storage or processing of the food, thus improving the flavour and increasing the stability of foods.* These agents are also permitted to be added in limited quantities to only specific foods in India. Some examples of buffering agents include – acetic acid used in beverages and soft drinks, calcium oxide in specified dairy products, ammonium phosphate monobasic added as a bread improver in flour, ammonium carbonate as a leavening agent for baked foods and confectioneries, citric acid, malic acid, DL lactic acid and L (+) tartaric acid as acidulants in miscellaneous foods.

Anti-foaming agents are the next type of food additives about which we shall study. As the name suggests, these are the agents which retard foam formation. Let us get to know about them.

7.4.9 Anti-foaming Agents

While deep fat frying you must have noticed that some oils, especially, unrefined oils like mustard oil tend to produce a lot of foam. The anti-foaming agents are added to retard deteriorative changes and foaming height during heating of edible oils and fats. In India, dimethyl polysiloxane may be used as anti-foaming agent in edible oils and fats for deep fat frying upto a maximum limit of 10 ppm.

The last category in food additives is sweetening agents. We all are aware of what these are. Let us get to know little more about them.

7.4.10 Sweetening Agents

Sweeteners are such a common ingredient of different dishes and food items that you may find it surprising to see them listed as a food additive. There are three types of sweeteners based on the calorific value (the number of calories obtained per gram of the sweetener). They can be classified as *caloric sweeteners, low calorie sweeteners and non-caloric sweeteners* (which contain little or no calories). Let us have a look at each of these.

Caloric sweeteners

These sweeteners are substances which provide not only sweet taste but also contribute 4 calories per gram of substance. Common natural sweeteners that are used in foods

are *cane sugar, glucose syrup, jaggery, honey, khandsari* sugar, *dextrose, invert sugar or golden syrup and icing sugar.* From the nutritional point of view, the increasing incidence of diabetes and obesity among population groups should caution us against excessive use of caloric sweeteners. These sweeteners have also been associated with dental problems like caries and gum disorders.

Low-caloric sweeteners

These substances are relatively less sweet than sucrose (sugar) and provide energy between 1 and 3 calories per gram. Examples of these sweeteners include sugar alcohols, also known as *polyols* (xylitol, sorbitol, mannitol, etc.) These are known to occur naturally in a number of fruits and vegetables but are more often manufactured for use on a commercial scale. Use of polyols not only aids diet control by reducing the calorie intake, but also these do not cause dental caries. In food processing, they impart special properties to products, improving their texture and stability.

Non-caloric sweeteners

These may be natural in origin or synthetic (artificially prepared). Natural non- caloric sweeteners include a variety of proteins which are found in some tropical plants and fruits viz. miraculin, monellin and thaumatin. These sweeteners have yet to be thoroughly evaluated for their safety. Besides, it has to be economically viable to produce these commercially. Synthetic high intensity sweeteners are more popular. Some are also permitted for use in India. They are called intense because they are required in very small quantities. You must have seen diabetics or those on a weight reducing diet consuming these artificial/intense sweeteners as they provide sweetness to the food to which they are added but do not give any calories. These sweeteners also do not cause dental caries. Saccharin, aspartame and acesulfame potassium are the commonly used artificial/intense sweeteners in India. They are also sold as table-top sweeteners for you to add to tea, coffee, milk etc. instead of sugar. In addition, the use of these artificial sweeteners is permitted in a limited number of foods as highlighted in Table 7.4.

Table 7.4: Food items to which the artificial sweeteners can be added

Sl No	Name of Artificial Sweetener	Article of Food	Maximum Limit of Artificial Sweetener
(1)	(2)	(3)	(4)
1.	Saccharin Sodium	Carbonated Water	100 ppm
	-do-	Soft Drink Concentrate	* 100 ppm
	-do-	*Supari*	4000 ppm
	-do-	*Pan Masala*	8000 ppm
	-do-	*Pan* Flavouring Material	8 Per cent
2.	Aspartame (methyl ester)	Carbonated water Soft drink concentrate	700 ppm *700 ppm
3.	Acesulfame potassium	Carbonated water Soft drink concentrate	300 ppm *300 ppm

Note: *Pan flavouring material refers to the flavouring agents permitted for human consumption to be used for pan.*

**Maximum limit of artificial sweetener in soft drink concentrate shall be as in reconstituted beverage or in final beverage for consumption. Soft drink concentrate label shall give clear instruction for reconstitution of products for making final beverage.*

Both aspartame and acesulfame K are about 200 times sweeter than sucrose, while saccharin is 300 times sweeter. Acesulfame K is heat resistant and, therefore, suitable for cooking. Saccharin is one of the oldest sweeteners in use today. It was at one time implicated as a cancer-causing chemical, however, scientific studies have now shown it to be safe.

Addition of artificial sweeteners to foods has to be declared on the label. Every package of aspartame (methyl ester), acesulfame-K and saccharin sodium marketed as table-top sweetener and every package of carbonated water/synthetic soft drink concentrate containing either of these artificial sweeteners and every advertisement for such table top sweetener or such carbonated water / synthetic soft drink concentrate shall carry the following label:

Contains..... (name of artificial sweetener)
Not recommended for children

Packages of aspartame (methyl ester) marketed as table-top sweeteners and every package of food containing aspartame, and the advertisement for such table-top sweetener and food shall also carry the following label:

Not for Phenylketonurics

Look at Figure 7.6, which illustrates such a label. You may be wondering, why the label should caution not for phenylketonurics. This is because aspartame upon digestion breaks down into its constituent amino acids – aspartic acid and phenylalanine. Phenylketonuria is a hereditary defect which affects the way in which the body breaks down phenylalanine, which in turn leads to concentration of toxic metabolites in the nervous system causing brain damage. Hence, it is dangerous for people suffering from this disease to consume this sweetener.

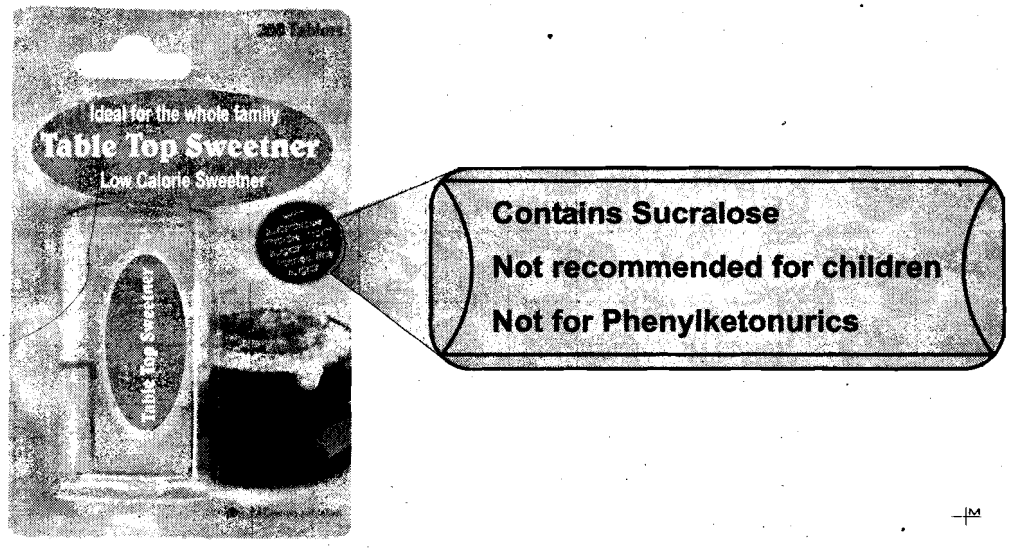

Figure 7.6: Label showing table-top sweetener

Sucralose is a relatively new synthetic intense sweetener. It is derived from ordinary sugar by selective treatment resulting in a product which is 600 times sweeter than sugar. Sucralose does not break down in the body and it is poorly absorbed in humans. Saccharine, on the other hand, is absorbed by the body and then excreted unchanged by the kidneys. Sucralose is yet to be approved under PFA Act for use in India.

Finally, let us look at some other additives also used.

7.4.11 Other Additives

Enzymes play important roles in various aspects of food processing. They are mainly used in the industry to split carbohydrates, proteins and lipids. A large number of food processing industries make use of enzymes namely for cheese production, making of bread, crackers, chocolates, soya sauce, tenderizing meat etc.

Leavening agents are what make fluffy pastries, spongy cakes and breads and crisp biscuits possible. The term leavening refers to *introduction of a gas (generally carbon dioxide) in the batter or dough leading to its expansion.* A variety of chemical leavening agents are in use today to improve the appearance, texture and taste of foods. Yeast was traditionally used as a leavening agent. The principle disadvantage in its use is that the fermentation process is slightly difficult to control and at times can lead to undesirable flavours. Chemical leavening agents like baking soda (sodium bicarbonate) do not have this problem. The vast majority of chemical leavening systems are based on the reaction of an acid with sodium bicarbonate to release the carbon dioxide. There are a number of acids which might be used and they differ in the speed at which they release the leavening gas. Examples include cream of tartar (rapid release), sodium aluminium phosphate or sulphate (slow release) and anhydrous monocalcium phosphate (for an intermediate speed of release).

Check Your Progress Exercise 2

1) What do you understand by the term 'functional role' of additives? Give any five functional roles of food additive.

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2) Give examples of the following:

a) any two antioxidants that can be added to edible oil in India.

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b) two classes of preservatives which can be added to prevent spoilage of foods.

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3) Why are artificial sweeteners also referred to as intense sweeteners? Name the intense sweeteners permitted for use in India.

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4) Which food additive can be added to salt to make it "free flowing"?

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In this unit we have so far learnt about the different additives and their uses in the food. How safe are these additives, particularly when we consume foods containing these additives regularly? Let us find out.

7.5 SAFETY ISSUES

Did you know that some of the foods that we (especially children) eat almost daily like biscuits, bread, sugar confectionery, chewing gum, carbonated beverages and fruit squashes and syrups have a large number of food additives? Biscuits may have up to 12 additives and bread up to 9. How safe is it to consume so many additives on a daily basis?

A large number of substances in use today as food additives are "generally recognized as safe" or GRAS substances. GRAS substances are those substances *whose use is generally recognized by experts as safe, based on their extensive history of use in food or based on published scientific evidence.* Salt, sugar, spices and vitamins are classified as GRAS substances, along with several hundred other substances. In deciding whether an additive should be approved for use, the regulatory authority considers the composition and properties of the substance, the amount likely to be consumed, its probable long-term effects and various safety factors. Absolute safety of any substance can never be proven. Therefore, it must be determined if the additive is safe under the proposed conditions of use, based on the best scientific knowledge available. If an additive is approved, regulations determine the types of foods in which it can be used, the maximum amounts to be used and how it should be identified on food labels.

Although most food additives are considered to be without any potential adverse effects, there have been problems concerning the safety of some of these chemicals. The safety of the antioxidant BHA, for instance, has been questioned in light of the fact that its consumption leads to cancer in rodents (rats, mice). The preservatives such as benzoic acid and sulphites have been associated with allergies. A small segment of the population has been found to develop hives, nausea, diarrhoea, shortness of breath or even fatal shock after consuming sulphites. This is true especially for the sensitive asthmatics, who may develop an allergic response at high levels of intake. Nitrites, on the other hand, can form cancer-causing nitrosamines in the foods in which they are added as preservatives. Monosodium glutamate (MSG) intake of 1.5 g or more can result in acute illness characterized by burning or tingling sensation on the face, neck and head, tightness, stiffness or pressure in the chest and facial muscles. This is known as the *"Chinese Restaurant Syndrome"* because these symptoms have been seen in people who had consumed Chinese food. In the 1970's, a theory linking additives to childhood hyperactivity was popularised. Well-controlled studies conducted since have however produced no evidence that food additives can cause hyperactivity or learning disabilities in children.

As we have seen earlier, the permitted colours are also not totally safe. High levels of erythrosine intake have been associated with thyroid tumours. Ponceau 4R, tartrazine and sunset yellow FCF have provoked allergic reactions in several individuals even at low levels of intake. The allergic responses vary from rashes to swelling and worsening of the condition of patients with asthma. The incidence of tartrazine sensitivity appears to be higher in asthmatics. Persons who are sensitive to aspirin may also be sensitive to tartrazine and hence should avoid foods and even medicines having this yellow dye. Among the permitted food colours, tartrazine is the most frequently reported to be associated with irritability, restlessness and sleep disturbance in some young children. Allergic reactions have also been seen in some people who consumed foods to which natural colours like annatto and carmine had been added. So, the general rule that all that is natural is safe, does not work.

The rule, therefore, is that one should choose foods that are free of additives or at least select those brands of processed foods which have a minimum number of additives. Foods with artificial or synthetic colours and class II preservatives should specially be avoided. We have learnt above that, the label of the food product

declares the presence of the additives used in the product. Hence only properly labelled foods should be selected. All additives should be subject to an ongoing safety review as scientific understanding and methods of testing continue to improve. In fact, a monitoring system should be set up which investigates all complaints by individuals or their physicians that are believed to be related to specific foods, food additives or vitamin and mineral supplements.

The safety of food additives is evaluated at an international level through the Joint Expert Committee, from the Food and Agriculture Organization (FAO) and the World Health Organization (WHO), on Food Additives (JECFA). Assessments are based on reviews of all available toxicological data in both humans and animal models. From the available data, the maximum level of additive that has no demonstrable toxic effect is determined. This is called the *"no-observed-adverse-effect level" (NOAEL)* and is used to determine the *"Acceptable Daily Intake" (ADI)* for each food additive. The ADI provides a large safety margin and is the amount of a food additive that can be consumed daily over a lifetime without any adverse effect on health. We will learn more about the ADI later in Unit 12.

The Codex Alimentarius Commission, a joint FAO/WHO activity which develops guidelines for food safety globally, is also drawing up new "General Standards for Food Additives" (GSFA), with the aim of establishing a harmonized, workable and indisputable international standard for world trade. Only those additives that have been evaluated by the JECFA are included.

In the Indian context, a list of food products and additives which are under mandatory certification of Bureau of Indian Standards (BIS) through PFA Act, 1954 has been provided. This list is provided in Annexure 1, Table IV at the end of the course.

Thanks to strict regulation and thorough testing, food additives can be considered safe components in our diet that are contributing to the rapid evolution of the food supply in Europe and throughout the world

Check Your Progress Exercise 3

1) Which food additive is implicated in causing the classical symptoms of the "Chinese Restaurant Syndrome"? How will you know whether this food additive is present in a food item?

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2) Discuss the importance of reading the label of a processed food item before consuming it.

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7.6 LET US SUM UP

This unit focused on food additives and their utility in foods. The use of various food additives has increased with the growth in the food processing industry. Additives have been used for many years to preserve, flavour, blend, thicken and colour foods. We learnt that additives help assure the availability of wholesome, appetizing and affordable foods that meet consumer demands from season to season. However, it is important to make sure that each substance is safe at its intended levels of use before it may be added to foods.

We learnt that food additives are classified based on their function in food, i.e. the purpose for which the additive has been incorporated in the food. The various classes of food additives can thus be listed as – antioxidants, preservatives, food colours, food flavours, emulsifiers and stabilizers, anti-caking agents, sequestrants, acid, bases and buffers, anti-foaming agents, sweeteners, enzymes and leavening agents. Further, the functional role of each of these additives has been discussed in this unit. In India the Prevention of Adulteration (PFA) Act and Rules governs the food additive that can be used, the foods to which it can be added and the quantity in which it can be added.

Finally the unit highlighted the safety issues linked with additivies. Although most additives are generally regarded as safe for consumption, some of them may cause problems especially in sensitive individuals. Hence, in general, consumers should try to choose food products with a minimum number of additives. This can be achieved by reading the label of a processed food item before consuming it.

7.7 GLOSSARY

Aqueous	:	containing water
Anhydrous	:	without water or moisture, dry.
Anti-caking substances	:	anhydrous substances that can pick up moisture without themselves becoming wet and these are added to products to prevent the particles from forming lumps.
Anti-foaming agents	:	added to retard deteriorative changes and foaming height during heating of edible oils and fats.
Antioxidants	:	substances which when added to foods retard or inhibit oxidation reactions.
Buffering agents	:	materials used to counter acidic and alkaline changes during storage or processing of the food, thus improving the flavour and increasing the stability of foods.
Dispersion	:	to distribute uniformly in a medium.
Emulsifying and Stabilizing agents	:	substances which are capable of facilitating a uniform dispersion of oils and fats in aqueous media, or vice versa, and/ or stabilizing such emulsions.
Emulsion	:	a fine dispersion of one liquid in another.
Leavening Agent	:	substance added to dough to make it ferment and rise.
Preservatives	:	substances which when added to food retard, inhibit or arrest the activity of microorganisms.

Rancidity	:	having a disagreeable smell or taste from partial decomposition, especially of a fatty substance.
Residue	:	what is left over or remains.
Sensory quality	:	that which appeals to the senses, viz. taste, sight, smell, texture.
Sequestrants	:	substances that bind with transition metal ions and thus help in eliminating/retarding the oxidative breakdown of foods.
Taints	:	spots or traces of decay or decomposition.

7.8 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress Exercise 1

1) A food additive may be defined as any substance or a mixture of substances, other than basic foodstuff, which is present in food as a result of any aspect of production, processing, storage or packaging. The term does not include chance contaminants which might unknowingly enter our food; its usage is restricted to substances added intentionally to foods.

2) Additives are added to foods to maintain product consistency, improve or maintain nutritional value, maintain palatability and wholesomeness, provide leavening or control acidity/alkalinity and enhance flavour or impart desired colour.

3) If a substance is added to a food for a specific purpose in that food, it is referred to as a direct additive. For example, the low-calorie sweetener aspartame, which is used in beverages, is considered a direct additive. Indirect food additives are those that become part of the food in trace amounts due to its packaging, storage or other handling. For instance, minute amounts of additives coated on packaging substances may find their way into foods during storage.

4) Additives use in raw materials or ingredients may find their way into the finished food product. This is referred to as carry over principle.

Check Your Progress Exercise 2

1) Functional role of additives refers to any property aside from the nutritional attributes that influence usefulness of ingredients in the food. The functional role of food additives are tabulated as follows:

Functional classes (for labelling purposes)	Definition	Sub-classes (Technological functions)
1. Acid	Increases the acidity and/or alkalinity of a food	Acidifer
2. Acidity regulator	Alters or controls the acidity or alkalinity of a food	Acid, alkali, base, buffer, buffering agent, pH adjusting agent
3. Anticaking agent	Reduces the tendency of particles of food to adhere to one another	Anticacking agent, antistick agency, drying agent, dusting powder, release agent
4. Antifoaming agent	Prevents or reduces foaming antioxidant, antioxidant synergist	Antifoaming agent
5. Antioxidant	Prolongs the shelf-life of foods by protecting against deterioration caused by oxidation, such as fat rancidity and colour changes	Antioxidant, antioxidant synergist, sequestrant

2) a) Ethyl gallate and butylated hydroxyanisole (BHA) are the two antioxidants that can be added to edible oil in India.

b) Class I preservatives – salt, sugar, spices, vinegar.

Class II preservatives – benzoic acid and its salts, sulphur dioxide, nitrates and nitrites.

3) Artificial sweetness are called intense sweetness because they are required in very small quantities (say a drop or a small tablet) to produce the same sweetness as a larger quantity (say a teaspoonful) of a natural sweetener like sugar. Examples of artificial sweeteners are saccharine and aspartame.

4) Anti-caking agent can be added to salt to make it free flowing e.g. Silicon dioxide.

Check Your Progress Exercise 3

1) Monosodium glutamate is implicated in causing the classical symptoms of the Chinese Restaurant Syndrome. The label of the food product can be checked if it has been used as a food additive.

2) The label of the processed food item gives us important information about the kind of additives that have been used in the food product. Although most food additives are considered to be relatively safe, some can be problematic and cause allergic reactions. So if one is trying to avoid a particular food additive e.g. artificial food colours or class II preservatives, a thorough scrutiny of the food label is a good practice.