UNIT 8 FOOD ADULTERATION

Structure

8.1 INTRODUCTION

In the previous units, we have studied about food additives that have been in use in different food items. We learnt that food additives are substances which are added to food by the manufacturers to facilitate processing or to improve appearance, texture, flavour and keeping quality. Besides, food is subjected to addition of undesirable substances naturally, accidentally or deliberately or removal of certain constituents which is called adulteration. What are the substances which can be termed as an adulterant? Do they have any potential harmful health effects? And if yes, are there any measures by which we can detect these and prevent the onset of a disease? This unit will focus on these aspects.

Further, the unit will describe in detail the foods commonly adulterated, the different classes of adulterants and reasons why adulterants are added to particular foods. Simple tests for the detection of these adulterants have also been outlined. The harmful effects of various adulterants on health have been discussed to understand the implications of consuming adulterated foods.

Objectives

After going through the unit, you will be able to:

- list foods commonly adulterated,
- identify some common adulterants added to different types of foods,
- classify the adulterants,
- discuss the reasons for adulteration,
- explain the harmful effects of these adulterants, and
- describe some simple tests for the detection of some common adulterants.

8.2 FOOD ADULTERATION

Let us first discuss what we mean by the term – 'adulteration'. Under the PFA Act, *the definition of food adulteration takes into account not only the intentional addition or substitution or abstraction of substances which adversely affects the nature, substance and quality of foods, but also their incidental contamination during the period of growth, harvesting, storage, processing, transportation and distribution.* To put it in simple terms, let us take an example of milk. Under

the PFA Act, a trader is guilty if he sells milk to which water has been added (intentional addition) or the cream of the milk has been replaced by cheap vegetable or animal fat (substitution) or simply the cream has been removed and the milk is sold as such, with a low fat content (abstraction). Unintentional contamination of the milk, due to carelessness on part of the trader is also considered as adulteration under the law. For instance, if the cans in which the trader is transporting or storing the milk, had been earlier treated with the chemicals like washing soda or boric acid or some detergent and not been washed thoroughly with water, residues of the chemicals may get mixed with the milk. Such milk would be considered adulterated. In addition, food is also considered to be adulterated, if it does not conform to the basic quality standards. For instance, the maximum amount of moisture allowed in a milk powder sample is 4%. If a sample is found to have greater moisture levels, it is considered to be adulterated.

The malpractice of food adulteration is still widely prevalent in our country. There are very few studies on the extent and nature of food adulteration in the country. Whatever studies are available, are restricted to a select few cities and hence are not adequate to give a true picture for the country as a whole. The only data that are available are the reports from the food testing laboratories of the Central and State Government. According to these official reports, the extent of food adulteration in India has been gradually diminishing from 31% in 1960s to less than 10% in the 1990s.

Food is a basic need for all. A food should not only be available in sufficient quantity, you would agree, it should also be nutritious, safe and wholesome. Pure food is essential for the maintenance of health. Food adulteration, therefore, not just lowers the quality of the food but also poses a serious health hazard. Consumption of poor quality or unwholesome food by the citizens of a nation can lead to ill-health and thus poor work efficiency. Providing good quality food is thus of considerable importance for public health and the national economy. Several laws have been enacted and implemented by the Central and State Governments to help maintain food quality at various stages from production through storage, processing, internal and external trade and consumption. *The Prevention of Food Adulteration (PFA) Act, 1954* and the *Prevention of Food Adulteration Rules, 1955* are the main statutes which protect the consumer and aim to provide him safe food. We will be learning more about these laws and regulations later in Unit 14 of this Course. Now, let us dwell on why is the food adulterated, i.e. the reasons for adulteration. Particularly in the light of the ill-consequences of food adulteration, why do individuals practice food adulteration.

Reasons for adulteration

The practice of adulterating food is as old as the art of buying and selling food for cash or commodities. The question that might arise in your mind is, why do people practise adulteration of food when they know that it adversely affects the health of fellow human beings? The answer is straight forward – 'the possibility of making greater profits', which has always been the lure for people indulging in the adulteration of food. Increasing the bulk or quantity of a food item by adding cheaper substitutes is the most common way of increasing profit margins. Adding water to milk or stones to food grains is perhaps the oldest form of adulteration. Similarly, to save money, a sweetmeat maker may place aluminium foil instead of silver foil on the sweets he makes. Apart from this, the other reasons include masking food spoilage and ignorance of the people handling food. Let us study about these.

Traders of perishable food commodities sometimes try to mask food spoilage by using various adulterants. For instance, the insect infested dry ginger may be coated with ultramarine blue to cover the holes. Poor quality fruits, vegetables and pulses are sometimes artificially coloured to give them the fresh look. Adulterants like artificial colours are also added to foods to improve their consumer appeal. Thus several prepared food items being sold in restaurants and eateries such as rice and meat preparations, sweets etc. have added colour because the consumer prefers it.

Preservation of food for supply to distant places and to avoid its wastage during the glut season has resulted in the use of food additives and chemicals. Ignorance about their proper use is probably a major factor responsible for people adding non-permitted additives to foods or adding excess of an additive. For instance, by law, you cannot add any chemical to preserve milk. However, milk vendors very commonly add chemicals like sodium bicarbonate to neutralise developed acidity in the milk and increase the shelf life. Others might add more than the permissible level of a preservative to a food item, like a juice, to make it last longer.

However, it cannot be denied that many cases of adulteration occur simply due to the negligence and lack of awareness on the part of manufacturers, distributors or retailers. As such, the grain lying exposed to rodents and insects in warehouses can get adulterated by faecal matter and insect larvae merely due to negligence rather than any profiteering motive. Similarly, if the ambient moisture level is not controlled, the food grains may absorb excess moisture, making them susceptible to mould growth.

How can then, we, as a consumer work towards this age-old problem? Well, one of the most effective ways could be by raising the standard of public morals and spreading awareness among manufacturers, traders and consumers. This would essentially root out the menace of adulteration. It is also necessary that those who infringe the food laws must be hunted out, prosecuted and suitably punished. This will serve as a deterrent to others who may be tempted to make a fast buck at the cost of human life.

Next, let us get to know about some of the commonly adulterated foods.

8.3 FOODS COMMONLY ADULTERATED

Which foods are commonly implicated in the malpractice of adulteration? What leads to adulteration of a particular food? Which adulterant is used and why? We will learn about these aspects in this section.

If we analyze the data on adulteration collected during surveys across the country, we will notice that almost all kinds of foodstuffs have been found to be adulterated. No food is spared. However, the nature of food adulteration may vary from State to State or region to region. In one region, one type of food commodity may be more prone to adulteration, simply because sales of the commodity are high in that region. A type of adulterant may be more common in a particular area because it is cheap and readily available. Taking the example of edible oil, if for instance, groundnut oil is the most widely consumed oil in a State and then it would be obvious that the adulteration of this oil would be most common. And if cottonseed oil is the cheapest and most readily available oil in that area, then it would be used to adulterate the more expensive groundnut oil. Listed herewith are some of the foods that have been commonly found to be adulterated. You will find that these are the ones which we consume on a daily basis. These foods include:

- Food grains like wheat, rice, pulses and their products like wheat flour, semolina (*suji*), gram flour (*besan*) etc.
- Edible oils and fats like groundnut oil, safflower oil, sunflower oil, mustard oil, vanaspati etc.
- Spices, both whole and ground, like red chilli powder, turmeric and coriander powder, asafoetida (*hing*), saffron etc.
- Milk and milk products like milk powder, butter, ghee, khoa, sweets
- Coffee, tea
- Sweetening agents like sugar, honey, gur

- Non-alcoholic beverages like aerated drinks, squashes, juices, sherbets, and
- Miscellaneous items like confectionery, jams, sauces, ice creams and prepared food items like sweets *(laddoo, burfi, jalebi)*, curries, rice preparations like biryani, tandoori meat dishes.

It is important to understand that adulteration of a food can take place at any of the stages in the supply chain of the foodstuff as highlighted in Figure 8.1. The food chain could be as follows: Primary production → primary food processing → secondary food processing → food distribution → food retailing food catering. Agricultural inputs during primary food production such as pesticides and veterinary drug residues, whose residue could be found in foods, are also considered as adulterants. Both during primary and secondary food processing, adulterants may enter the food chain. Besides, adulterants may also find their way during food distribution, food retailing and food catering.

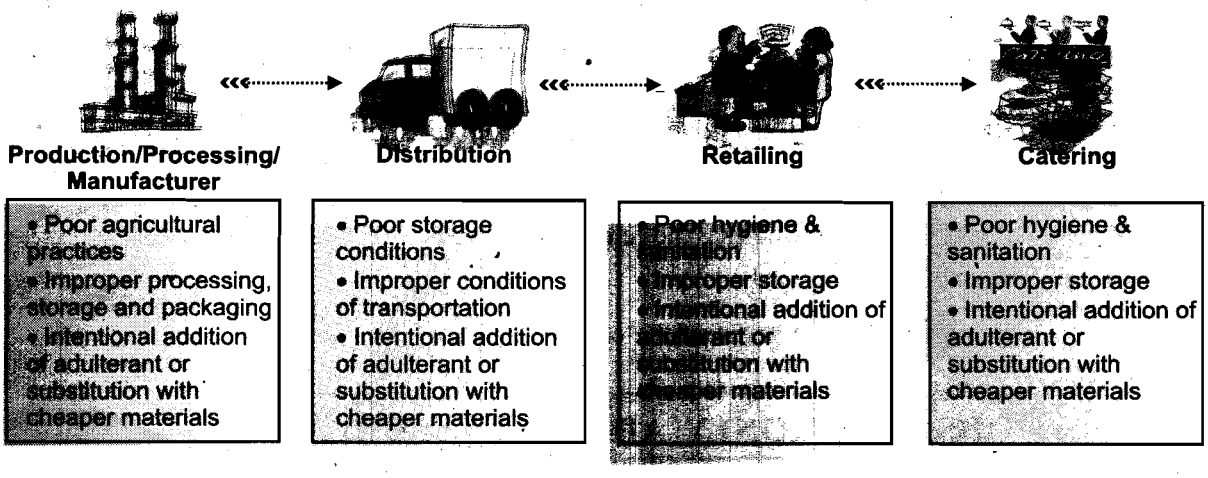

Figure 8.1: Typical supply chain for a food commodity

The manufacturer may intentionally adulterate the food to increase his profit margin or he may contaminate the food due to faulty processing technology. Either way, the adulterant enters the supply chain at the source. In most of the cases, however, the distributor (the link between the producer and the seller of the food) or the retailer introduces the adulterant into the food. Inappropriate storage and transportation conditions may also contaminate the food at this stage.

In fact, *any commodity that commands a premium in the market, and is either expensive or has a high volume sales, is a target for adulteration.* Surveys on the current trends in food adulteration reveal that adulteration of milk and milk products, edible oils and fats and spices is most common. This is because the total sales value of these foods is high.

You would have observed that the foods *which are in a powder, minced or paste form are more susceptible to adulteration.* This is because it is more difficult for the naked eye to detect adulteration in these foodstuffs. For instance, when buying minced mutton, it is difficult to tell whether the goat meat has been mixed with meat from other animals or that green coloured sawdust has been added to coriander powder.

Adulteration of foods sold loose by the retailer is also more common as compared to the packaged foods. This is simply because in the latter case, the adulterated food can be traced back to the manufacturer or distributor. It can be bad for business if the brand name gets a negative publicity with accusations of adulteration. A trader selling foodstuffs viz. oil, wheat flour, sugar, spices, tea etc. in loose form can easily adulterate them and, if caught, shift the blame on the manufacturer or distributor. It becomes difficult to fix the responsibility in such a case and the culprit often escapes punishment. So, what can be done to overcome this situation? Well, it could be that the manufacturers willing to curb this malpractice should discourage their products

from being sold loose to the extent practicable. The package also needs to have a suitable message indicating that the product is not to be sold loose.

Even if the product is not sold loose, it may be a target for adulteration if the package is easy to tamper with. Manufacturers can curb this by implementing more effective tamper-proof or tamper-evident packaging. This would make it quite uneconomical for the wrong-doers to attempt adulteration by tampering with the packaging.

By now, you must have understood the social, as well as, economic aspects associated with the adulteration process. Let us now, in the next section, have a look at the various common adulterants used in food items.

8.4 COMMON ADULTERANTS

The adulteration of food has progressed from being a simple means of fraud to a highly sophisticated and lucrative business. Although simple forms of adulteration like addition of water to milk and coloured starch to turmeric or red chilli powder are still prevalent, newer forms and types of adulteration are emerging. Pesticide residues in vegetables, fruits, food grains, bottled water and antibiotic residues in milk and meat are now more in evidence. Use of newer adulterants like ultramarine blue in dry ginger to hide holes and other damage done by insects, urea in puffed rice to improve its texture and aluminium foil in *betelnut* or *supari* instead of silver foil has been observed. What do we mean by the word adulterant? *Any substance which is used to adulterate a particular item of food is called an adulterant. It is any substance that lessens the purity of effectiveness of a substance.*

Let us have a look at the different types of adulterants that are being added to our food. Table 8.1 gives a compilation of the types of adulterants (excluding microbial contaminants) detected in different food items. This list has been compiled based on several independent surveys conducted in the various parts of the country.

Table 8.1: Types of adulterants detected in different food items

Food items	Adulterants detected
Milk	Antibiotic residues, formalin, boric acid, pesticide residues, neutralizers like sodium bicarbonate, urea, water, sugar, starch, foreign fat, ammonium sulphate, cellulose.
Milk powder	Pesticide residues, sugar, starch, fat deficiency, excessive moisture.
Ghee and vanaspati	Extraneous colours, animal body fat, hydrogenated vegetable oils, excessive moisture.
Edible oils	Castor oil, mineral oil, argemone oil, triorthocresyl phosphate, oil – soluble colours, aflatoxin, pesticide residues, cheaper vegetable oils.
Spices	Non-permitted colours, mineral oil coating, husk, starch, foreign seeds/resins, extraneous matter, exhausted spices.
Non alcoholic beverages	Saccharin, dulcin, brominated vegetable oils, non-permitted colours, excess permitted colour.
Confectionery, sweets and savouries	Non-permitted colours, aluminium foil, permitted colour more than prescribed limit.
Coffee	Date or tamarind seeds, artificial colour.
Tea	Colour, iron filings, foreign leaves, exhausted leaves.
Pulses and their products like *besan*	*Lathyrus sativus, Vicia sativa*, artificial colours, talc, foreign starch, extraneous matter.
Cereals and their products like *maida, suji*, flour	Fungal infestation, pesticide residues, sand, dirt, foreign starch, powdered chalk, iron filings, aflatoxins, insect damage.

Let us now discuss about the adulterants found in each of these commonly consumed food items separately. We shall start with milk.

- *Milk:* In milk, the most widely used adulterant is *water*. Not only do the milk vendors add water to the milk sold loose but there also exists a racket of removing a portion of the milk from plastic pouches of well known companies and diluting the remaining milk with water. Such addition of water is very easily detected by measuring the specific gravity or relative density of the milk. Sometimes, to avoid detection, the vendors increase the specific gravity of diluted milk by adding *sugar, starch or urea*. Addition of preservatives like formalin, boric acid, hydrogen peroxide and neutralizers like sodium bicarbonate and caustic soda is also prevalent to increase the shelf life of the milk. This is especially done in summer months when milk spoils easily and by vendors who have to transport the milk over long distances. Contaminants usually found in milk are the *pesticide residues* (from pesticides sprayed in cattle sheds), *antibiotic residues* (from medications given to the cattle) and *aflatoxin* (from aflatoxin contaminated feed given to the cattle).

- *Edible fats and oils:* The most common adulterant in edible oils is a *cheaper oil*, which may or may not be edible. The cheaper oils generally used to adulterate expensive cooking oils are castor oil, mineral oil, argemone oil, palmolein, cottonseed oil and rapeseed oil. *Ghee* is usually found to be adulterated with *vanaspati* or hydrogenated oils. *Lard*, a cheaply available animal body fat, may also be added. Contaminants which have been detected in oils are the *pesticide residues* (from the pesticides which had been sprayed on the oil seed crops before harvesting) and *aflatoxin* especially in unrefined groundnut oil (from use of poor quality, fungus infested groundnuts). The process of refining the oil destroys the aflatoxin and hence it is safer to consume refined oils.

- *Spices:* Cheaper agricultural produce like *wheat starch, jowar, rice, corn and arrowroot starch* are used in a number of expensive foods like ground spices (red chilli powder, turmeric, coriander powder, *garam masala* etc.). The starch which is white in colour is usually dyed to the colour of the spice to which it is being added. Sometimes essential oils derived from expensive spices like cloves are extracted and the exhausted spice is sold as such. Cinnamon bark may be mixed with the bark of another similar looking tree, asafoetida may be mixed with a foreign resin, seeds of black pepper may be mixed with papaya seeds and mustard seeds may be mixed with argemone seeds which look similar.

- *Miscellaneous food items: Colour* seems to be an adulterant, which is added to a large variety of foods viz. non-alcoholic beverages, confectionery, sweets and savouries, to improve their appeal to the consumer. According to the PFA Act, you may recall reading in Unit 7, only some artificial or synthetic colours are permitted for use in foodstuffs. Colours other than the ones prescribed by law are referred to as *non-permitted colours*. The most commonly used *non-permitted synthetic colours* reported in various studies are *Orange II, Sudan dyes, Metanil Yellow, Auramine, Malachite Green and Rhodamine B.* In addition, extraneous matter like *sand, husk, sawdust, wood pieces, stones, straw* etc. are also used as adulterants especially in cereals and pulses to increase the bulk. Similar looking foreign pulse grains, which are mostly toxic, may be used to adulterate popular *toor* or *arhar dhal. Metal adulterants include iron filings (in suji) and nickel (in vanaspati)* which are present mainly as a result of poor processing techniques and aluminium foils used instead of silver foils in several products like sweets. Intense or artificial sweeteners like saccharin may be added in excess to non-alcoholic beverages or to foods in which it is not permitted like confectionery and sweets. Non-permitted sweeteners like dulcin and several other chemicals like urea, acetic acid, sodium hydroxide, sodium bicarbonate are also used as adulterants.

From the discussion above, it must be obvious to you that a wide variety of adulterants are present. To help us get to know them better, these have been classified into different categories based on their nature. Let us next look at the classification of these different types of adulterants, used so commonly in our food.

8.4.1 Classification of Adulterants

If you look at the definition of adulteration carefully, you would realize that the definition of food adulteration according to the PFA Act clearly distinguishes the types of adulterants as those *added intentionally* and those present as *contaminants* due to improper storage, handling, transportation or processing of the foodstuff. In this unit we have mostly discussed the former type as food adulterants, the contaminants have been described earlier in detail in Unit 6. We will, however, briefly summarize here the different types of contaminants which can be present in the foods. These are:

- antibiotic residues – for e.g. milk and milk products, meat and meat products.
- pesticide residues – like milk, grains, oil, bottled water, vegetables and fruits.
- metallic contaminants – e.g. Nickel due to the improper processing of *vanaspati*, iron filings in tea, *suji*, from rollers used in processing
- microbial contaminants – like fungi and fungal toxins, bacteria and their toxins due to improper storage or processing of the food products

Adulterants, which are added intentionally, can be further classified based on their nature. Table 8.2 illustrates the different categories of these adulterants.

Table 8.2: Classification of adulterants

Categories	Adulterants
Coal tar dyes	Orange II, Sudan, Metanil Yellow, Auramine, Malachite Green, Rhodamine B
Cheaper oils	Castor oil, sesame oil, rapeseed oil, palmolein, mineral oil, turpentine, soyabean oil
Cheaper agricultural produce	Wheat starch, maize starch, jowar starch, rice starch, arrowroot starch, date seeds, amaranth seeds
Chemicals/Additives	Saccharin, sodium bicarbonate, sodium carbonate, acetic acid, ammonium sulphate, copper sulphate, urea, dulcin, brominated vegetable oil, monosodium stearate, ammonia, calcium oxide, benzoic acid, diazepam, ammonium chloride, chloral hydrate, triorthocresyl phosphate
Extraneous matter	Wooden pieces, chalk, cashew husk, yeram husk, coffee husk, silver oak leaf, sand, sawdust, stones, fenugreek, cellulose, resin, tamarind husk, grass.
Metals	Aluminium, iron filings, lead chromate, nickel
Fungi	Fungal toxin, ergot, aflatoxin
Insect infestation	Weevilled grains
Residues	Pesticides residues, veterinary drug residues, acetylene

It is evident from the Table 8.2 that a majority of the adulterants are chemicals. Some of these chemicals are nothing but additives which are permitted under the PFA Act for use in specific foods. So, if they are additives, why are we categorizing them as

adulterants now? *Remember, they are categorized as adulterants only when they are added to foods in which they are not permitted.* For instance, saccharin is not permitted to be used in confectionery, but it can be used in non alcoholic beverages. In some cases, these chemicals are being used in excess of the permitted levels. For example, benzoic acid is permitted in pickles at 250 ppm, but may be found at much higher levels in some samples. Similarly, certain permitted synthetic colours may be added in excess of the permissible limit of 100 ppm or may be added to foods in which they are not permitted. Non-permitted colours, which are mostly coal tar dyes are also widely used in different foodstuffs.

Cheaper edible and inedible oils are used to dilute the more expensive oils just like starches from different sources may be used to adulterate expensive spice powders. Substances in the extraneous matter category are added to increase the bulk of the food. Metals form an important class of adulterants because of the harmful effects due to their ingestion. Aluminium foil used instead of silver foils and lead chromate used as a colourant, are some of the examples.

There are a few new adulterants which are being used now. Let us learn about them next.

New Adulterants

In the fast-changing food scenario in India, along with increased food production and availability and stringent international food trade laws and norms, the traders try new ways and means of cheating the consumers and food control authorities by adulterants which are not likely to be detected by analysts. The newer adulterants identified are included in Table 8.3.

Table 8.3: Newer food adulterants

Sr. No.	Food	Adulterant
1.	Legumes/pulse	Toxic lentils (imported), *Leucaena leucocephala* seeds
2.	Milk	Veterinary drug residues
3.	Flours	Mouldy wheat flour
4.	Bakery products	Animal fat
5.	Vanaspati	Industrial contaminants like orthonitroaniline

Before moving on to the understanding of the harmful effects of food adulteration, let us quickly review what we have learnt so far.

Check Your Progress Exercise 1

1) Define food adulteration.

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2) Which foods are more likely to be adulterated? List some foods which are commonly found adulterated.

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3) Name a few adulterants which are commonly added to:

a) Milk

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b) Cooking oil

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c) Ground spices

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4) Name two non-permitted colouring agents which are still added to lots of foods.

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5) How would you classify food adulterants?

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6) List some common reasons for food adulteration.

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In the past few sections, you have seen what is meant by food adulteration, what are the reasons for adulteration and which are the foods that are most commonly implicated in this malpractice. Next, let us get to know about the harmful effects of adulterants.

8.5 HARMFUL EFFECTS OF ADULTERANTS

There are a wide range of potentially toxic adulterants which might be present in our food. Very few studies are available on the health consequences of consuming adulterated food. Investigations into causes of food borne disease outbreaks help us to appreciate the health implications of food adulteration. In the developing countries, food borne diseases continue to be a serious health hazard and an important cause of illness and death. At present, the reporting of food borne diseases in our country is very poor. You would remember studying about this aspect in a greater detail in Unit 5, where we saw that reporting of a food borne disease outbreak is not done systematically. In fact, how many times do we actually report diarrhoea or vomiting from which we suffered after eating at a restaurant or a roadside vendor, to the proper health authorities? Most of us don't even complain to the food vendor about

the poor quality of his food. Even the health authorities sit up and take notice only when a large number of people are taken ill or die as a result of food poisoning. Let us look at some of the ill-effects of consuming adulterated foods including well publicised instances of acute poisoning outbreaks.

Most of the examples are instances of food borne illness due to the consumption of poor quality or stale food contaminated with harmful bacteria or their toxins. You might have read in the newspaper reports about marriage parties taking ill after consuming the food served or groups of people suffering vomiting and diarrhoea after consuming some sweet preparation after a religious or social function, which are very common especially during summer months. Unhygienic handling of foodstuffs and non-refrigeration of cooked food especially in hot and moist weather encourages the growth of bacteria in the food. Mouldy food can also lead to ill-health, although there have been a few recorded outbreaks as a result of fungal contamination in India. Ergot *bajra* has been implicated in an outbreak where the disease was characterized by symptoms of nausea, vomiting, giddiness and drowsiness.

Aflatoxicosis (liver damage), which is caused by the consumption of foodstuffs contaminated with aflatoxins, was first reported in 1974 among tribals in Western India. An outbreak associated with the consumption of bread made from mould-damaged wheat containing trichothecene mycotoxins was reported in the Kashmir valley. People who consumed the contaminated wheat flour, developed symptoms of abdominal pain and vomiting. These outbreaks have already been discussed in detail earlier in the unit entitled 'Food Contaminants' i.e. Unit 6 and you can refer back to the unit for details of these outbreaks, as well as, toxic effects of other contaminants like veterinary drug residues, heavy metals, pesticide residues etc. You will recall that selling unintentionally contaminated food is also an offence under the PFA Act and such food is called *adulterated.*

Let us learn about the harmful effects of adulterants in different foods.

Toxic adulterants in milk and their ill-effects

Milk, as you would have realized, is a highly perishable food item which is prone to microbial spoilage. You might have observed that if you leave milk at room temperature in summers, it begins to sour in a matter of few hours. If this milk is heated, it curdles or splits. Bacteria naturally present in the milk or those which enter the milk due to improper handling, multiply in number on keeping the milk at room temperature. You might recall reading about this in Unit 4. In the process, they produce acid which makes the milk sour and ultimately curdles it. Milk vendors who have to transport milk to long distances, especially in hot weather, *add chemicals like carbonates or alkalis* for neutralizing developed acidity in milk. Such addition of chemicals is not permitted by law. Chemicals like *sodium carbonate* (washing soda) can be harmful when ingested with milk and can have deleterious effects on the intestinal lining by irritating it. *Sodium hydroxide* (caustic soda) is also used for neutralizing acidity in milk. It is strongly alkaline and corrosive. It rapidly destroys organic tissues. *Formaldehyde* is another adulterant used to increase the shelf life of milk by killing the bacteria. It is a disinfectant against bacteria, fungi and many viruses and actually used in the preparation of lotions, soaps and mouthwash. Ingestion of formaldehyde solution causes an intense pain with inflammation, ulceration and necrosis of mucous membranes.

Hydrogen peroxide is another preservative which may be used to inhibit microbial growth and prevent milk spoilage. Strong solutions of this chemical produces irritating burns on the skin and mucous membranes and its continuous use even as a mouthwash has been known to cause damage to the papillae of the tongue. *Urea*, which may be added to increase the specific gravity of milk diluted with water, can cause gastrointestinal irritation. It may also cause loss of appetite, nausea and vomiting when taken in excess.

Let us next see what are the consequences of consuming adulterated oil.

Toxic adulterants in oil and their ill-effects

Mustard and other vegetable oils have been found to be adulterated with *argemone oil*. Epidemic dropsy, first reported from Kolkata in 1877, we learnt is the disease resulting from the ingestion of toxic alkaloids like *sanguinarine*, present in *Argemone mexicana* seeds. The disease is characterized by oedema or swelling over ankles, gastrointestinal disturbances, blood vessel changes, changes in the eyes and cardiac insufficiency. Outbreaks of epidemic dropsy have been reported from Itarsi, Madhya Pradesh, Delhi, Rajasthan and Andhra Pradesh in India. A massive outbreak of the disease was reported in Delhi in 1998, which resulted in several deaths.

In May 1982, there was an epidemic outbreak in Spain because of the ingestion of adulterated oil containing various proportions of *rapeseed oil denatured with aniline*. This was known as *'Toxic Oil Syndrome'* (TOS) which affected about 25,000 people and resulted in the death of about 2.5 % of the people. *Pentachlorophenol* was also detected in the oils, which along with *anilides*, contributed to the toxic effect seen. An outbreak of *tricresyl phosphate poisoning* in Kolkata has also been reported. About 600 people were affected with paralysis of the hands and feet due to the consumption of rapeseed oil adulterated with tricresyl phosphate.

Mineral oil (liquid paraffin), a cheap inedible oil used as an adulterant, may result in anal seepage and irritation, if consumed in excessive amounts. Prolonged ingestion may interfere with the absorption of fat-soluble vitamin like vitamins A, D, E and K. The administration of castor oil by mouth as a laxative was widely practised earlier. Such an intake, particularly in large doses, may produce nausea, vomiting, colic pain and a severe laxative effect. Similar effects may be seen after consumption of cooking oil adulterated with *castor oil*. Castor oil in doses that exert a laxative effect is reported to inhibit the absorption of fat-soluble vitamins, notably vitamin A and vitamin D.

Next, let us learn about the toxicity of food colours.

Toxicity of food colours

The relevance of colours in foods, undoubtedly, cannot be denied. It is colour which makes a food appealing, attractive and desirable to the consumers. Though, you would wonder that the use of certain colours has been banned in foods. Why is it so? This is because they are well known for their toxicity in experimental animals. *Auramine* was found to inhibit growth and lead to dysfunction of the liver and kidney. *Rhodamine B* was shown to cause retardation of growth, haemolysis of red blood cells and degenerative changes in the liver and kidney. It also adversely affected the immune system. *Sudan dyes* were found to be toxic to the liver and produced kidney lesions. *Malachite green* caused a decrease in food intake, growth rate and fertility rate. It also caused damage to organs like liver, kidney, heart and spleen, as well as, lesions of skin, eyes, lungs and bones. *Orange II* led to retardation of growth, increased mortality and haematological changes. *Metanil yellow* consumption could lead to degenerative changes in the stomach, ileum, rectum, liver, kidney, ovary and testis. Metanil yellow is one of the most commonly used water soluble non-permitted dye to colour foodstuffs including pulses with a false presumption that it could be washed out in pre-cooking washings of the pulse.

In humans, some of these colours have been shown to lead to acute food poisoning outbreaks. Metanil yellow has been reported to cause symptoms of giddiness, weakness, vomiting and cyanosis. The people who developed these symptoms had eaten *laddoo* coloured with this dye. In another incident, *biryani* coloured with metanil yellow caused similar symptoms 2 to 4 hours after consumption. Lead chromate added as a colourant to chilli powder caused lead poisoning among Gurkha soldiers with symptoms of stomach ache, nausea, constipation and anaemia.

All the above colours can also mutate genes (mutagenic) and most of them have been identified as potential cancer causing agents. Toxicity of permitted colours has already been discussed in Unit 7 on food additives. The most common harmful effect seen is an allergic response to these colours. *Tartrazine* is the food colour most frequently associated with allergic reactions. Asthmatic people are especially sensitive to this yellow colour and many have reported a worsening of their asthma attack after consuming food containing tartrazine.

To help you recapitulate the food adulterants used and their toxic effects, have a look at the Table 8.4 where a summary is presented.

Table 8.4: Adulterants and their ill-effects

S.No	Food	Chemical/Adulterant used	Ill-effects
1)	Milk	- Sodium carbonate or washing soda	Irritates the intestinal lining
		- Sodium hydroxide or caustic soda	Corrosive, destroys organic tissues
		- Formaldehyde	Intense pain with inflammation, ulceration and necrosis of mucous membranes.
		- Hydrogen Peroxide	Irritating burns on the skin and mucous membranes
		- Urea	Gastrointestinal irritation, loss of appetite, nausea and vomiting.
2)	Oil	- Argemone oil	Epidemic dropsy, characterized by oedema over ankles, gastrointestinal disurbances, blood vessel changes, changes in the eyes and cardiac insufficiency
		- Pentachlorophenol and Anilides	Toxic Oil Syndrome (TOS) and death
		- Tricresyl phosphate	Paralysis of hands and feet
		- Mineral oil (liquid paraffin)	Anal seepage and irritation, interfere with the absorption of fat soluble vitamins (A,D,E,K)
		- Castor oil	Nausea, vomiting, colic pain and a severe laxative effect, inhibits the absorption of fat-soluble vitamins, notably vitamins A and E
3)	Food Colours	- Auramine	Inhibits growth, dysfunction of the liver and kidney
		- Rhodamine B	Growth retardation, hemolysis of RBCs, degenerative changes in the liver and kidney, adversely affects the immune system
		- Sudan dye	Toxic to the liver and produced kidney lesions
		- Malachite green	Decreased food intake, growth rate and fertility rate, damage to organs like liver, kidney, heart and spleen as well as lesions of skin, eyes, lungs and bones.
		- Orange II	Growth retardation, increased mortality and haematological changes
		- Metanil Yellow	Degenerative changes in the stomach, ileum, rectum, liver, kidney, ovary and testes, giddiness, weakness, vomiting and cyanosis
		- Lead Chromate	Stomach ache, nausea, constipation and anaemia.
		- Tartrazine	Allergic reactions and worsening of asthma attack in case of asthmatic people.

In the light of the consequences of consuming adulterated food, it is crucial that we should be aware of these adulterants and more so have a basic knowledge on how to detect them in foods, using simple household techniques. The next section presents the methods for detection of some adulterants. We hope you will find this information useful and applicable.

8.6 METHODS FOR DETECTION OF SOME ADULTERANTS

Samples of food are regularly picked up by the food inspectors and analyzed in Food Laboratories under the PFA Act. However, the findings of the tests conducted are not made public. Traders found to be adulterating are prosecuted and sometimes the court cases take years to resolve. As consumers, we can not wait that long to know if the food we are eating is safe or not. So how can the consumers come to know if their food is adulterated (Figure 8.2).

Figure 8.2: How to know if the food is adulterated?

There is a provision under the PFA Act by which the general public can pick up samples of suspect food items and send them for analysis to the Food Laboratories. A minimum fee has to be paid for the analysis, which is refunded if the sample is found to be adulterated. The public can send these samples for testing to other private laboratories also. However, there are simple tests for detection of adulterants which can be done at home with the minimal number of chemicals required. Several home detection kits are available in the market for this purpose. Most of these kits have chemicals for the simple tests which have been described in Table 8.5. In addition, simple visual and physical tests can be undertaken to detect adulterants as highlighted in Figure 8.3.

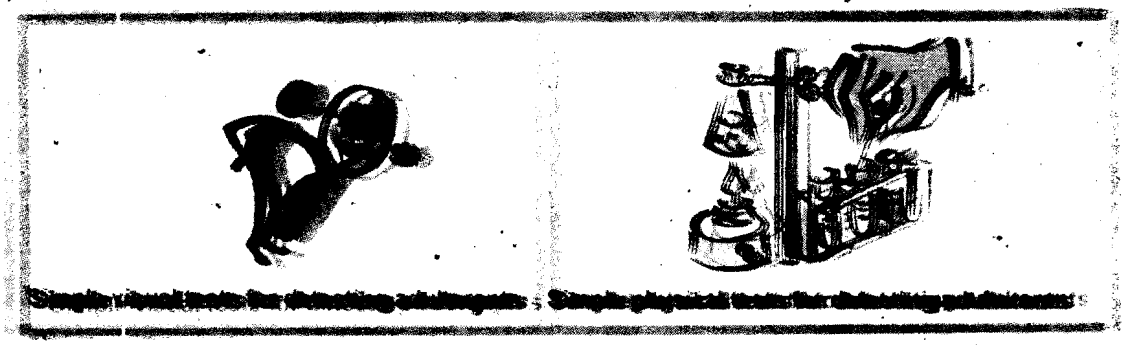

Figure 8.3: Detecting adulterants

You will also find information on simple physical detection methods for some of the adulterants in Table 8.5.

Table 8.5: Simple methods for detecting adulterants

Sl	Food	Adulterant	Method of detection
1	Milk, milk product, powdered spices	Starch	Mix sample in a test tube with water, add a few drops of iodine solution. A blue colour indicates the presence of starch.
2	Milk	Water	Measure the specific gravity with a lactometer by immersing it in milk kept in a deep vessel. The normal values lie between 1.028-1.032. But this is not a foolproof method, as, in addition to water, sugar or urea may have been added to the milk to increase its specific gravity.
3	Milk	Developed acidity	Place a test tube containing 5 ml of the milk sample in a boiling water bath and hold for about 5 minutes. Remove the tube and rotate in an almost horizontal position. The film of milk on the side of the test tube is examined for any precipitated particles. Formation of clots is indicative of developed acidity in the milk due to microbial spoilage. Such milk is unsuitable for consumption.
4	Milk, milk powder	Neutralizers like carbonates	To about 5 ml of milk in a test tube add 5 ml of alcohol and a few drops of rosalic acid solution and mix the contents of the test tube. A rose red colour is obtained in the presence of a carbonate, whereas, pure milk shows only a brownish colouration.
5	*Ghee*, butter	Margarine or *vanaspati*	In one tea spoonful of completely melted sample, add 5 ml concentrated hydrochloric acid. Shake for 5 minutes, add a pinch of sugar or furfural. Appearance of pink colour in the acid layer indicates added *vanaspati.*
6	Oils and fats, black pepper	Mineral oil	To 2 ml of oil sample taken in a flask, add 20 ml of 0.5 ml normal alcoholic potash. Heat for 30 minutes and add 20 ml hot water. If turbidity appears, mineral oil is present.
7	Sweetmeats, ice cream and beverages, *sella* rice pulses, spices	Metanil yellow	Extract colour with lukewarm water from food samples and add a few drops of concentrated hydrochloric acid. A magenta colour indicates the presence of metanil yellow.
8	Pulses, whole and split, *besan*	Kesari dal	*Kesari dal* is wedge shaped, with a slant on one side and a square face on the other side. Physical examination can detect the adulterant
		Metanil yellow	Put the sample in dilute hydrochloric acid. Pink colour develops indicating the presence of the adulterant.
9	Mustard seeds	Argemone seeds	Argemone seeds have a rough surface and mustard seeds are smooth. Upon pressing, mustard seeds are yellow inside while argemone seeds are white.
10	Black pepper	Papaya seed	Papaya seeds are comparatively shrunken, oval and greenish brown to brownish black in colour.
11	Tea leaves, sugar	Iron filings	Easily separated using a magnet.

Sl	Food	Adulterant	Method of detection
12	Silver foil	Aluminium foil	To metal foil add 2 drops of concentrated Nitric acid in a test tube. The silver foil will completely dissolve whereas the aluminium foil remains undissolved.
13	Honey	Sugar solution	A cotton wick dipped in pure honey, when lighted, burns smoothly. If water is present, it will not allow the honey to burn. Even if it does, a crackling sound is produced. (The test is for water which is there in the sugar solution added as an adulterant to honey).
14	Coffee	Chicory	Sprinkle coffee powder on the surface of water in a glass. Coffee floats while chicory starts sinking leaving a trail of colour, due to large amount of caramel.
15	Tea	Artificial colour (coal tar dyes)	Put the tea leaves on a moistened blotting paper. Artificially dyed tea will impart colour to the moistened blotting paper immediately.
16	Cardamom	Talc Powder	The sticking of talc on finger touch will indicate its presence. The talc powder sticking to the fingers when tasted will give an aromatic flavour which confirms extraction of essential oil.
17	Coffee powder	Tamarind powder	Sprinkle a little coffee powder on a bloating paper and spray a little potassium hydroxide solution. If adulterated with tamarind powder, a brown colour spreads around the particles.
18	Chilly or Turmeric powder	Colouring matter (e.g.metanil yellow)	To a little powder in a test tube, add little quantity of ether and shake well. Let it stand. Transfer the extract into another test tube and add a few drops of concentrated HCl. A dark pink colour confirms adulteration.
19	Jalebi	Metanil yellow	Put the sample in dilute hydrochloric acid. Pink colour develops indicating the presence of the adulterant.

With the information given in this section, we hope you find yourself equipped to deal with adulteration at the home level. However, remember it is also very important that you report any incidence of adulteration promptly.

Check Your Progress Exercise 2

1) How would you test if:

a) artificial colour has been added to tea leaves?

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b) silver foil has been replaced by aluminium foil?

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2) Concentrated hydrochloric acid was added to colour extracted from a food sample. What is the consequent development of magenta colour indicative of?

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3) Is a sample of *ghee* adulterated if, on addition of concentrated hydrochloric acid and a pinch of sugar, a pink colour develops?

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4) Name the adulterant and the harmful effects associated with the following:

a) Epidemic dropsy

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b) Toxic oil syndrome

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c) Aflatoxicosis

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d) Non-permitted colour used to dye pulse

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5) Why are only a few colours permitted for use in foodstuffs?

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8.7 LET US SUM UP

In this unit, we studied that an access to genuine and pure food commodities is of paramount importance for the social health and welfare of a community. Adulterants lower the quality of the food and also sometimes make it hazardous for our health. In this unit, we have discussed about the problem of adulteration of food, a practice still widely prevalent in our country. Any foodstuff that commands a premium in the

market can be adulterated. Foods sold loose or without proper packaging are easy to adulterate. Also foods sold in powder, paste or mince form are more likely to be adulterated. Surveys have indicated that milk and milk products, edible oils and fats and spices are the foods most commonly found adulterated.

Various types of adulterants can be intentionally added to foods and several others can be present as unintentional contaminants due to negligence on part of the food producers or traders. Adulterants can be classified based on their nature. The variety of adulterants which have been detected in different foods have been enumerated in this unit. Colour seems to be an adulterant which is added to a large variety of foods to improve their appeal to the consumer.

Economic gain is the primary motive behind adulteration. Profit margins are increased by using cheap substitutes, masking spoilage in foods and increasing the shelf life of the food by addition of preservatives. Such interference with foodstuff may potentially lead to food which is harmful to health. Harmful effects of consuming adulterated food were described in this unit. While the consumption of some of the adulterants has resulted in minor health problems like stomach upsets others have even resulted in the death of a large number of people. A few adulterants can be detected by simple tests at home while others require detailed laboratory analysis. Simple tests were highilighted in this unit for the detection of various adulterants in different foods.

8.8 GLOSSARY

Abstraction : removal.

Acute : severe, coming sharply to a crisis.

Adulterants : any substance that lessens the purity of effectiveness of a substance.

Anal seepage : oozing of fluids in the anal canal.

Cardiac insufficiency : inadequate cardiac output due to failure of the heart to function properly.

Colic : pain in the abdomen.

Cyanosis : a bluish discolouration of the skin due to the presence of oxygen-deficient blood.

Degenerative : characterized by progressive, often irreversible deterioration.

Distributor : the link between the seller and the distributor of food.

Dysfunction : an abnormality or impairment of function.

Edible oils : vegetable oils and fats; includes any margery, vanaspati, bakery shortening and fat – spread as specified in the PFA Act, 1954 and rules made there under, for human consumption.

Exhausted spices : spices from which essential oils and flavours have been extracted.

Extraneous : of external origin.

Food adulteration : intentional addition or substitution or abstraction of substances which adversely affects the nature, substance and quality of foods. Also incidental contamination during the period of growth, harvesting storage, processing, transportation and distribution.

Food borne : carried or transmitted by food.

Food-borne disease	:	disease caused due to the consumption of food which is contaminated by microorganisms.
Food-borne disease outbreaks	:	an incident in which two or more persons experience a similar illness, usually gastroenteritis, after ingestion of a common food which is identified as the source of food borne disease.
Haematological	:	to do with the physiology of blood.
Haemolysis	:	loss of haemoglobin from red blood cells.
Immune system	:	complex network of cells and cell products which protects the body from disease.
Lard	:	a cheaply available animal body fat.
Lesions	:	any damage to the body, wound, sore.
Laxative effect	:	increased bowel movement.
Malpractice	:	criminal wrongdoing or misconduct.
Mandatory	:	compulsory.
Mutagenic	:	an agent promoting a genetic change which is capable of being transmitted to the offspring.
Mycotoxin	:	toxin produced by fungi
Necrosis	:	death of a tissue caused by disease or injury.
Neutralizer	:	a substance which opposes and mitigates the effects of something by an action.
Non-permitted colours	:	colours other than the ones prescribed by law.
Papillae of the tongue	:	small nipple-like projections on the tongue.
Prevention of food Adulteration (PFA) Act, 1954	:	legislative measure that has been enacted to prevent adulteration of foodstuffs and the manufacture, storing and sale of adulterated foods for human consumption.
Preservative	:	a chemical substance added to increase the stuff life of food products.
Specific gravity	:	the ratio of the mass of a solid / liquid to the mass of an equal volume of distilled water at 4°C.
Statutes	:	written laws passed by a legislative body, e.g. Acts of Parliament.
Tamper	:	to interfere improperly or in violation of the law.
Wholesome	:	that which promotes health.

8.9 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress Exercise 1

1) Under the PFA Act, the definition of food adulteration takes into account not only the intentional addition or substitution or abstraction of substances which adversely affect the nature, substance and quality of foods, but also their incidental contamination during the period of growth, harvesting, storage, processing, transportation and distribution.

2) Foods which are expensive or have high volume sales, foods sold in a loose condition or in packages which are not labelled properly and easy to tamper with, foods sold in powder, mince or paste form are more likely to be adulterated. Milk, edible oils and fats, spices are the foods which are commonly found to be adulterated.

3) a) Preservatives like formalin, boric acid; neutralizers like sodium bicarbonate; urea, water, sugar, starch, foreign fat.

   b) Castor oil, mineral oil, argemone oil, triorthocresyl phosphate, oil soluble colours, aflatoxin, pesticide residues, cheaper vegetable oils.

   c) Non-permitted colours, husk, starch, powder of foreign seeds/resins, extraneous matter, exhausted spices.

4) Metanil Yellow and Orange II are the two non-permitted colouring agents which are still added to lots of foods.

5) Food adulterants can be classified as intentional or unintentional (contaminants). They can also be classified based on their nature as coal tar dyes, cheaper oils, cheaper agricultural produce, chemicals/additives, extraneous matter, metals.

6) Increase profit margin by increasing the bulk of the food or substituting with cheaper alternatives, better consumer appeal, mask spoilage in foods, increase shelf-life of the food product are some common reasons for food adulteration.

Check Your Progress Exercise 2

1) a) Artificial colour that has been added to tea leaves can be tested by putting the tea leaves on a moistened blotting paper. Artificially dyed tea will impart colour to the moistened blotting paper immediately.

   b) To metal foil add 2 drops of concentrated Nitric acid in a test tube. The silver foil will completely dissolve whereas the aluminium foil remains undissolved.

2) The development of magenta colour on additon of conc HCl in a food sample indicates adulteration of food sample with Metanil Yellow.

3) Yes, the *ghee* is adulterated with *vanaspati.*

4) a) argemone oil; the harmful effects include oedema over ankles, gastrointestinal disturbances, blood vessel changes, in the eyes and cardiac insufficiency.

   b) pentachlorophenol and anilides; the harmful effect being death.

   c) aflatoxin; its harmful effects include abdominal pain and vomiting.

   d) metanil yellow; the harmful effects being degenerative changes in stomach, ileum, rectum, liver, giddiness, weakness, vomiting and cyanosis.

5) Only few colours which are relatively safe are permitted for use in foodstuffs. Others are banned because of evidence of their toxicity.