FOOD ADULTERATION

A food article is said to be adulterated in the following situations :

1. When it contains other substances, wholly or in part, whose presence affects its quality injuriously or renders it harmful; e.g. inferior or cheaper substances, decomposed animal or vegetable matter, insect infestation, other poisonous substances, non-permitted additives.
2. If it lacks in quality which it should represent or does not meet prescribed standards.
3. If some ingredient, partly or wholly is abstracted.
4. If made or stored under unhygienic conditions.

A food article is said to be misbranded in following situations :

1. It is an imitation or has a deceiving resemblance to another article.
2. Any damage is concealed by polishing, coating, flavouring etc..
3. If the labelling is wrong with respect to manufacture, place of origin, contents, special dietary use.

Misbranding and adulteration are two significant aspects of food commerce which have legal consequences. The PFA list of common instances of food adulteration is given in Table 3.1.

Table 3.1 Common instances of food adulteration

	Food Article	Nature of Adulteration
1.	Ajwain (vamu)	Presence of sandy matter of foreign seeds.
2.	Asafoetida (hing)	Presence of sand, chalk, excess ash, or starch, foreign resins and gums, coal tar dyes.
3.	Atta, maida	Presence of sand, dirt; excess bran, foreign starch, chalk powder.
4.	Besan	Presence of pea flour, kesari pulse flour, maize flour, sand, excess ash.
5.	Biscuits	Presence of talc, other foreign matter.
6.	Black pepper	Presence of light berries, foreign berries and dried papaya seeds.
7.	Butter and ghee	Presence of vanaspati, animal fat, starch, Prohibited colours, deficiency in milk fat.
8.	Cream	Presence of foreign fat and fat deficiency.
9.	Chana dal and moong dal	Presence of kesari dal, prohibited colours such as metanil yellow.
10.	Chilly powder	Presence of powdered bran, mineral oil and prohibited colour, insect infestation.

(Cont.)

Table 3.1 *(Cont.)*

Food Article	Nature of Adulteration
11. Coffee powder	Presence of powder of roasted dates and tamarind seeds, husk, presence of chicory without declaration.
12. Cumin (Jeera)	Presence of foreign seeds, synthetic jeera prepared from mud.
13. Food grains	Presence of excess foreign matter like sand, gravel, dirt, stones, pebbles, straw, Stems, chaff damaged grain or insect infested grains, beyond permissible limits.
14. Honey	Presence of cane sugar, commercial invert sugar, dirt, and excess of moisture.
15. Milk	Presence of extraneous water and starch, fat and deficiency in fat and non-fat solids.
16. Mustard	Presence of a argemone seeds.
17. Supari	Presence of foreign matter such as stones, seeds, nuts and added colour.
18. Sweetmeats	Presence of prohibited colours, flavours, sweeteners, other foreign matter, vanaspati or vegetable oil used in place of ghee and labelled 'Made in pure ghee'.
19. Tea (Dust/Leaves)	Presence of foreign and exhausted leaves, dust, excess wood stalks, black gram husk, sawdust, cashew husk, excess ash or wood fibre.
20. Vanaspati	Presence of animal fat, prohibited colour and flavour, excess fatty acids and deficiency in sesame oil.
21. Turmeric powder	Presence of prohibited colour, yellow earth, sand or talc.

Food articles are meant for consumption by human beings, and the quality ar safety aspects are of paramount significance. A wide variation exists in foods, eve within foods of the same class, due to a variety of factors like soil, species, climati condition etc. In view of this, in order to have an unbiased judgment and criteria for quality and uniformity, to assure safety of food, to avoid adulteration of food and to make commerce possible and practicable, irrespective of variation in quality, a set of uniform guidelines is required and such a set is called food standards.

These standards are devised by various statutory bodies and committees formed by the government. While devising these standards all the factors and variables like climatic conditions, technological advancement etc. are taken into consideration and accordingly, standards for minimum attainable quality under local country conditions are evolved. Certain standards are evolved to define a product of very high quality. These standards, which are suitably modified whenever necessary, act as a watch body in ascertaining the quality of the manufacturer. The manufacturer is required to strictly adhere to these standards and comply with the provisions therein, failing which he has to face legal consequences.

The food standards which are available are,

1. International standards.
2. Indian standards.

Codex Alimentarius is the international standard constituted by the United Nation's organisations FAO/WHO. These standards are available for processed and raw foods. These standards can be adopted in totality or in a suitably modified form to suit local conditions, by any country. They provide specifications for food additives, contaminants, sampling, methods of analysis, labelling and hygienic requirements for foods. A codex commission is constituted to evolve and implement these standards.

In India, mandatory standards which define minimum attainable quality and optional standards which assure a very high quality product are available. The PFA standards and FPO standards are called mandatory standards while Agmark and ISI standards are called optional standards.

PFA ACT

The PFA act (prevention of food adulteration act) was incorporated in 1955, and since then has been amended from time to time (1968,1973). A central committee for food standards is the parent body responsible for it. The enforcement of the act is left to the state governments e.g. in Maharashtra, FDA is the body responsible for ensuring enforcement of the act. The PFA act contains the following :

1. The definition, title, statement and scope of the act.
2. Definition of food, its adulteration and misbranding.
3. Constitution, guidelines and functions of central food laboratory
4. Definition and quality standards for food articles.
5. Requirements, duties and responsibilities of public analysts and food inspectors.
6. Guidelines for collection of samples for analysis i.e. sealing, fastening, despatch etc..
7. Packaging and labelling specifications for food articles.
8. Prohibitory and regulatory controls over the sale of certain food articles.
9. Issue of licences for trade in food articles.
10. Requirements and use of food additives and a list of permitted substances.
11. Limits for amounts of poisonous metals, crop contaminants, natural toxicants, insecticides and pesticide residues etc..

Under the PFA act, solvent extracted oil, deoiled meal and edible flour order 1967 and meat product order are issued. The oil order pertains to :

1. Manufacturing procedure, specifications, and requirements for solvents.
2. Varieties and grades for storage.
3. Packaging and labelling requirements.
4. Sale or movement of oil

The meat products order specifies requirements for manufacturing and distribution of raw and processed meat and its quality.

FPO (FRUIT PRODUCT ORDER)

The fruit products order pertains to the following :

1. Names of the articles under the order.
2. License requirements.
3. Constitution of advisory committee and members.
4. Packaging, marking, container and labelling requirements.
5. Categories of factories i.e. large, small and cottage scale.
6. Hygiene requirements during manufacture.
7. Equipment specifications.
8. Specifications and standards for different articles under order.
9. Limits for poisonous metals Pb, Cu, As, and Zn for preservatives and list of permissible colours.

The order was issued in 1946 and revised in 1955. A product not meeting the order requirements is treated as sub standard, while under the PFA act, it is termed as adulterated.

Under the PFA act provisions, establishments involved in food trading can be inspected to ascertain that the act requirements are met with. Adulterated or misbranded items can be seized by inspectors, destroyed or relabelled, and legal action including a fine, imprisonment or both can be taken, depending upon the nature of the offence. The PFA standards define the minimum attainable quality level under local conditions and do not represent products of the highest quality.

Agmark (Agricultural Markings) standards pertain to agricultural and related products. The products are graded as Grade One, Two, Three and Four or are marked as special, good, fair and ordinary quality. This system takes into account physico-chemical properties, native or acquired during processing or storage etc. The product is labelled as "Agmark", and then the quality of excellence is assured. This system makes trade easy from both the buyer's and seller's point of view, since there is no ambiguity.

ISI (Indian Bureau of Standards), a central government body, has formulated a set of standards. It includes specifications for hygiene in manufacture, process specifications, standards for organoleptic testing, standards for processing chemicals and additives, standard methods of analysis, equipment specifications, standards for foods and food products etc. When all the requirements under these standards are met, the product can be sold with an ISI stamp on it, which stands for the mark of excellence and which is a useful parametre in purchase of goods. Compliance with ISI and Agmark Standards is not essential, unless it is claimed.

TESTS FOR ADULTERANTS

TEA

Spent tea leaves, which are dyed, are added as an adulterant in a sample of pure tea.

Spread tea leaves on a wet filter paper. Add a few drops of ether or alcohol. The filter paper gets coloured, if dyed leaves are present (yellow, pink or red spots appear).

COFFEE

Chicory is added as an adulterant in pure coffee.

Mix a little sample with cold water. Chicory, when present, will sink in water while coffee will float. Chicory will stain the water brownish red.

Add the coffee sample to a saturated solution of sodium chloride. When the sample is pure all the material floats, while the liquid becomes pale amber in colour.

MILK

ADDED SUCROSE

Take a 15ml milk sample. Add 1ml concentrated HCl and 1ml resorcinol. Heat the solution to boiling point in a water bath for 5 minutes. A red colour is obtained.

ADDED SALT

To 1ml milk add 5ml of 0.13% $AgNO_3$ and one drop of 1% K_2CrO_4. A yellow colour is obtained.

ADDED SODA

Take 5ml of milk. Add 5ml alcohol and 3 drops of rosanilic acid. A red colour is obtained.

ADDED STARCH

Take 3ml of milk sample. Heat to boiling and cool. Add a few drops of I_2 solution. A blue colour is obtained.

ADDED WATER

Measure the specific gravity with a lactometre, for normal milk the value is between 1.03 to 1.034.

HONEY

Invert sugar is commonly added to it.

Take 10g of honey. Add 10ml water and 20ml diethyl ether. Shake well and decant ether layer. Evaporate the ether layer. To the residue, add 10ml ether. To 2ml ether extract add 1ml concentrated HCl and 1ml of resorcinol. A pink colour is obtained at the junction of layers.

BURA SUGAR

Washing soda is added to it. When present it effervesces with HCl. Also when dissolved in water, washing soda turns red litmus blue.

ICING SUGAR

Marble powder, $NaHCO_3$, and starch are added as adulterants. When dissolved in water, a residue is obtained if marble powder is present. When dilute HCl and lime water are added effervescence is obtained if $NaHCO_3$ is present. When I_2 solution is added to an aqueous sugar solution, a blue colour is developed, if starch is present.

JAGGERY

Colour metanil yellow is added to it. To gur solution add concentrated HCl. The solution turns magenta coloured.

Grit is also added to sugar and salt. When the sample is dissolved in water, grit remains as such.

SOFT DRINKS

Mineral acids are added to them.

Add 2 drops of the drink to be tested over a prepared metanil yellow colour paper. A stable violet colour is obtained.

SEMOLINA (RAWA)

Iron filings are added to increase weight. When a magnet is passed through it, the iron filings cling to the magnet.

SUPARI

Sawdust and artificial colour are added.

Sprinkle a sample in water, wood shavings float, and the water becomes coloured.

SAGO

Sand and talcum are added to it

If present, they give a gritty feel in the mouth. Pure sago burns with swelling and no residue is left.

PULSES AND CEREALS

1. Metanil yellow is added to it - Add concentrated HCl to the sample. A magenta colour is obtained.
2. Kesari dal is added to other dals - Kesari dal has a typical wedge shape and is of two types, smaller and larger with triangular dirty grey dark spots on the surface. The smaller variety resembles masoor dal and the larger is of tur dal size. It can be identified visually.
3. Ergot is added in bajra - Place a small amount of the seeds in water. Ergot seeds being lighter than bajra, float on the surface.

Foreign matter and kesari dal are commonly found as adulterants. Foreign matter is found by cleaning by hand. Weigh about 5g of the sample on glazed or butter paper. Pick up foreign matter with the hand or forceps, weigh and calculate the percentage. Use the same method if kesari dal is added. Bajri grains, if ergot infected, become black, swollen, and float on water.

SAFFRON

It readily colours water and gives a characteristic aroma. Maize fibres which are dried, coloured and scented are added to it. Genuine saffron is tough; spurious saffron is brittle and breaks easily. Dry the water extract and streak H_2SO_4 across the sample. Blue colour - turning purple to reddish brown indicates a pure sample.

ASAFOETIDA (HING)

Resin or gum which is coloured and scented is added to it. Pure asafoetida dissolves in water and forms a milky white solution. When ignited, a pure sample burns with a bright flame.

SPICES

HALDI POWDER

Metanil yellow is added to it.

Add concentrated HCl solution to the powder. It turns a magenta red colour. Dilute with water. Red colour persists if metanil yellow is present. Mud is added to the powder. Burn powder on a glass rod. A white residue is obtained when mud is present. Lead oxide may also have been added to haldi powder. To the sample add 1ml concentrated HCl. Mix well and add KI solution to the supernatent liquid. A yellow colour is obtained. Added starch is detected by iodine solution test. When heated, talc, geru, brick powder remains behind as ash.

WHOLE TURMERIC

Lead chromate or metanil yellow are used to polish the extracted whole turmeric to give a genuine appearance. Ash about 2g of whole turmeric. Add 10ml of (1:7) H_2SO_4. Boil for 5 minutes and filter.

Take 5ml of the filtrate and add 0.5ml of diphenyl carbazide solution (2% in alcohol) A dark pink colour is obtained if added lead chromate is present.

CHILIES

Chillies are contaminated with Rhodamine B colour.

Add ether or alcohol to the sample and extract the colour. Take 5ml of the extract and add 5ml concentrated HCl. If added dyes are present a dark pink colour is obtained. Coal tar dyes are also added to it. Grind a 5g sample with 25ml of 2% NH_4OH and 70% alcohol. Keep for 2 hours, filter and evaporate to dryness on a water bath. Dissolve the residue in 15ml water containing 4ml acetic acid Add a 20cm piece of neutral wool, boil for 15 minutes and wash with tap water. Transfer to 100ml beaker and boil with 20ml dilute ammonia solution. When coal tar dyes are present, a coloured solution is obtained.

CHILLI POWDER

Saw dust, brick powder, coloured powdered bran, Rhodamine B colour, foreign starch and geru are added to it.

Mix the sample with water, the sawdust will float. If brick powder is present, a residue is obtained when mixed with water. Take chilli powder on a wet filter paper. Add a few drops of ether or alcohol. A red colour is obtained on filter paper if Rhodamine B is present. When heated, a large quantity of ash is left behind if talc or brick powder is added.

CARDAMOM

The oil is removed from it and pods are coated with talcum powder. On rubbing, talcum sticks to the fingers. On testing no aromatic flavour is felt, indicating pre extraction.

CORIANDER POWDER

Horsedung powder is added to it. Soak the sample in water. Hoarsedung, which floats, can be visually detected.

CLOVES

Oil is extracted from them. Such a sample appears shrunken.

CUMIN SEEDS

Grass seeds coloured with charcoal dust are added to them. If such a sample is rubbed in the hand, the fingers turn black. Also husk or grass seeds are added. In such a case there is no taste.

CINNAMON

Coloured casia bark is added to it. When added to water, the water becomes coloured due to extraction of added colour.

MUSTARD

Aregmone seeds are added to it. Argemone seeds are not uniformly smooth and round, but are of the same colour as mustard. They can be visually identified.

PEPPER

Dried papaya seeds are added to it. Add pepper seeds to water. Papaya seeds float on water, while pepper seeds do not. In alcohol only pepper seeds sink, while papaya seeds float. Pepper seeds on hydrolysis with HCl give a pale red colour.

OILS AND FATS

GHEE

Vanaspati and vegetable oils are added to it.

Take 5ml of melted ghee. Add 5ml concentrated HCl and 1g glucose. Shake well for 1 minute and keep aside for 10 minutes. Aqueous layer turns reddish orange if vanaspati is added to it.

COCONUT OIL

Mineral oil or any other oil may be added to it.

Keep the oil sample at 0°C for 1/2 hour. Coconut oil solidifies leaving other adulterants in a separate layer.

EDIBLE OILS

1. Tea seed oil is added.
   Mix 0.8ml acetic anhydride, 1.5ml $CHCl_3$ and 0.2ml H_2SO_4. Cool in an ice bath for 2 minutes. Add 2 drops of edible oil to it. Cool in an ice bath for 5 minutes, add 10ml ether and shake well. A green colour is obtained.
2. Mineral oil is added.
   Cool oil sample at 0°C for 1/2 hour. No solidification occurs.
3. Argemone oil is added.
   To 5ml edible oil add 1ml concentrated HNO_3. A red colour is obtained. To the oil add $FeCl_3$ and HCl. A reddish brown precipitate is formed.
4. Rancid oil is added.
   Add 5ml HCl to a 5ml oil sample, shake vigorously for 1/2 minute. Add 5ml of 0.1% phloroglucinol in ether. Shake for 1/2 minute and keep for 1/2 hour. Pink or red colour is formed in the acid layer.
5. Cottonseed oil is added.
   To 2ml of oil add 2.5ml Halphen reagent. Heat in boiling water for 30 minutes. Rose colour is obtained.

CONTAMINATION OF FOOD

Starting from harvesting of food to food processing, storage and distribution, at every stage there is a potent danger of the food article getting contaminated, unintentionally, with other substances. It may be due to lack of proper knowledge,

negligence in handling, lack of appropriate facilities and food processing hazards. The various groups of substances contributing to this contamination are microbial contamination, natural toxic substances in food, processing contamination, metallic contamination, agricultural and environmental contamination. The PFA mentions upper permissable limits for some of these categories.

MICROBIAL CONTAMINATION

Micro-organisms like bacteria and fungi grow on food. The metabolites of these microbes are also of a toxic nature and get introduced into food. The toxic metabolites of fungal origin are known as mycotoxins. They are a group of chemical compounds with varying nature and biological effect. The origin of fungi may be in the field, storage or food decay. Some of the principal mycotoxins are as follows:

Aflatoxins of Aspergillus, in foods like groundnut and cottonseed - B1 and G1 series of these compounds occur alongwith their derivatives.

Ergot alkaloids of *claviceps P.* They are to be found in rye, jowar, bajra. The responsible alkaloids are ergotamine, ergotoxin and ergometine.

The other types of mycotoxins to be found in foods and animal feed are (1) Amanita (Amatoxin and Phallotoxins) toxins in mushrooms, (2) *Brevianamide A* from Penicillum, (3) Sterigmato cystins from *A. versicolour* and *A. flavus*, (4) Ochratoxins from penicilliums, (5) Patulin and citrinin from penicillum, (6) Zearalenone from fusarium etc.

Certain toxic principles, proteins in nature are bacterial metabolities. The commonly encountered bacteria are clostridium, staphylococus, salmonella, shigella and bacillus.

NATURAL TOXICANTS IN FOODS

Certain toxic substances may be present in foods of animal and plant origin, as natural constituents. These may be organic or inorganic in nature. Certain substances of this class are steroidal alkaloids in solanum genus plants like potato and eggplant; glucosinolates in brassica plants like cabbage and cauliflower; isoflavones in animal feed plants like clover and alfa alfa; cyanogenic glucosides in a variety of plants; phenolic substances in cottonseed; fluorides in tea; oxalic acid in spinach and beet; selenium in plants or other elements, like Cu, Pb, Ca, F etc. Toxic poisonous substances found in fish are ciquaters, tetradotoxin, sconbrotoxin, clupleotoxin and saxitoxin in shell fish.

METALLIC CONTAMINANTS

The commonly encountered metallic contaminants in foods are Pb, Hg, Cd, Sn, Co, Sb, Cr, As, Cu, and Zn. They get introduced due to metallic containers, metal containing pesticides, air, water, soil, industrial effluents etc. For each of them an upper permissible limit is prescribed by law.

AGRICULTURAL AND ENVIRONMENTAL CONTAMINATION

A variety of pesticides are used for crop protection against pests and insects. Their residues get introduced in small amounts in agricultural products like grains and vegetables, and in air and water, and ultimately into the living systems where the quantity gets accumulated with routine exposure. The PFA prescribes maximum permissible limits for them, to limit the extent of contamination.

When the crop is growing in the field or during storage and transportation, it invites attack by insects, mice and rats. Their body parts and secretions get introduced into the food, thus contaminating it. Certain antibiotics and synthetic growth hormones like DES are added in animal feed, and they ultimately find entry into the living systems.

PROCESSING CONTAMINATION

During processing of food, it comes in contact with a variety of substances, raising the chances of its contamination. e.g. (1) Solvent residues in foods (hexane in oil industry) (2) Chemical agents for sterilization of food packets (ethylene oxide) (3) Metallic residues due to use of containers, water, air etc. (4) Contamination due to packaging material used (ink, chemical residues within the materials etc.) and (5) Changes that get introduced into food because of improper and excessive heating of food during processing (food may undergo polymeric reactions).

The PFA limits the amounts of some of these categories by specifying the upper permissible limits for them. For example :

1. Limits for natural toxicants in foods: Agaric acid - 100ppm, Hydrocyanic acid - 5ppm, Hypericine - 1ppm. and Saffrole - 10ppm.
2. Limits for insecticide residue in certain agricultural food items e.g. Aldrin 0.01ppm in food grains, 0.15ppm in milk products, 0.1ppm in fruits and vegetables, 0.2ppm in meat and 0.1ppm in eggs.
3. Limits for metallic constituents in processed foods: lead in soft drink concentrate 0.5ppm, fruit and vegetable juices 1ppm, Cu in tea 150ppm, and in milk, 0.1ppm etc..

◆◆◆