UNIT IV. Food Processing and Value Addition

1. Principals and Methods of Preservation of Fruits and Vegetables

Preservation means just protect the foods against the spoilage, but scientifically it may be defined as a science which deals with the process for prevention of decay or spoilage of the food is called preservation.

In other words, just controlling the physical, chemical or microbial changes in the foods is called preservation.

1. Physical Changes: Colour, flavour, texture and taste *etc.*

2. Chemical Changes: Carbohydrate, fats, proteins, vitamins and minerals.

3. Microbial Changes: Mould, yeasts and bacteria

Why do preserve the food?

1. To supply to increase the shelf life of the food for increasing the supply.
2. To make the seasonal fruits available throughout the year.
3. To add the variety to the diet.
4. To save time by reducing preparation, time and energy by fire.
5. To stabilize the prices of the food in the market.
6. To improve the health of the population.

Principles of Preservation: There are three main principles:

A. Prevention / delay the microbial decomposition of the food.

B. Prevention / delay the shelf decomposition of the food.

C. Prevention of damage by insects, animals, mechanical causes *etc.*

A. Prevention / delay the microbial decomposition of the food

1. By keeping out the micro organisms -Asepsis
2. By Removal of micro organisms -Filtration
3. By Hindering the growth and activity of micro organisms -Anaerobic condition
4. By killing the micro organisms -Exposing at high temperature

1. Asepsis: It means preventing the entry of micro organisms by maintaining of general cleanliness, while picking, grading, packing and transporting of fruits and vegetables, increase their keeping quality and the product prepared from them will be superior quality.

2. Filtration: Fruits juice, bear, soft drinks, wines *etc.* enter through bacteria proof filters which are made of Asbestos pad or unglazed porcelain type of materials. These filters contain the micro organisms and allow the water or juice to percolate though with or without pressure.

3. Anaerobic conditions: It can be maintained by:

(i) Replacing the O_2 by CO_2 carbonation

(ii) Evacuating the sealed container (fruit juice)

(iii) Use of oils from top of the food (pickles)

4. Exposing at high temperature: Fruits can be exposed by high temperature such as:

(i) Canning: Food is exposing to a high temperature (> 100^0C) which prevents spoilage and inactivate the enzyme present in the food.

(ii) Irradiation: In case of irradiation, the food is exposed to the radiations to kill the micro organism by ionizing and non-ionizing radiation like α, β and gamma rays. Her, food is exposed to electromagnetic or ionizing radiation or various frequencies ranging from low frequency electromagnetic to high frequency *i.e.*, gamma rays which destroy the micro-organism present in the food.

B. Prevention/delay the shelf decomposition
(i) By destruction or inactivate the enzyme – Blanching.
(ii) Prevention / delay the non-enzymatic chemical reactions – Antioxident

Blanching
1. It is primary treatments which have to soften the tissues to facilitate packaging.
2. To preserve the original colour and flavour

3. To destroy the certain enzyme which are undersirable

4. Elimination of the air

5. Mostly for vegetables

6. Remove micro-organisms

7. Remove astringent taste and toxins

Anti-oxidant

Anti-oxidant are substances which are used to protect the food gamma deterioration caused by exposure to the air.

1. BHA – Butylactic Hydroxy Anisole Vegetable oils

   BHT – Butylactic Hydroxy Toluene

2. Gellales: Animal fat, Vegetalbe oil

3. Tocopherols: Animal fat

4. Ascorbic acid: Fruit juices, Citrus oil, Wine, Bears *etc.*

5. Lactic acid: Processed fruits and vegetables, canned fruits,

6. Phosphoric acid: Vegetable oils, Animal fat and cola drinks

Methods of preservation of fruit and vegetable
There are two main basic methods:
a. Bacteriostatic methods

b. Bactericidal methods

a. Bacteriostatic Methods
1. Drying of foods

2. Use of chemical preservatives

3. Use of food additive

4. Use of low temperature

b. Bactericidal Methods

1. Pasteurization
2. Cooking
3. Canning
4. Irradiation

a. Bacteriostatic Methods

In this method, the environmental conditions are change to prevent the growth of micro organisms, such conditions are called
bacteriostic. These are:

1. Drying of Foods

Drying is just removal of moisture from the food to a certain level at which micro organisms cannot grow is called drying, it can be done by two methods:

(i) Application of heat

(a) Sun drying (b) Mechanical drying

(c) Vacuum drying (d) Freeze drying

(ii) Binding the moisture in the food

(a) Use of Sugar (b) Use of Salt

(i) Application of Heat

a) Sun Drying: Sun drying is the method in which food is directly exposed to sunlight. It is generally done in the places where plenty sunshine is available for long period e.g., Rajasthan. The dried product in this method is inferior in quality.

b) Mechanical drying: This is a method of drying where application of heat is applied by a mechanical dryer under the controlled conditions of temperature, humidity and air flow.

c) Vacuum drying: The temperature of the food and the rate of water removal are controlled by regulating the degree of vacuum and intensity of heat input.

d) Freeze drying: In this method, the food is dried by sublimation process, *i.e.*, just converting the food into ice without passing through the liquid form of water by means of vacuum plus heat applied in the drying chamber. In this method, product first frozen then water is removed by vacuum and application of heat which occurs simultaneously in same chamber.

(ii) Binding the Moisture

a) Use of Sugar: The use of high concentration of sugar bindup the moisture and make the food have a certain level of moisture at which micro organisms are not able to grow.

b) **Use of Salt:** The concentration of salt causes the high osmotic pressure and tie up the moisture which inhibit the growth of micro organisms. It dehydrates the food by drying out and tie up moisture as it dehydrate the micro organisms cells. Salt reduces the solubility of O_2

in the food by reducing the moisture. It interferes with the action of proteolytic enzyme. The effeteness of NaC1 is varied with the concentration of salt and temperature.

2. Use of Chemical Preservative

Chemical preservatives are substances which are added to food just to retard, inhibit or arrest the activity of micro organisms such as fermentation, pacification and decomposition of the food. Chemical preservatives are of two types:

Class-1 preservatives: Common salt, sugar, dextrose, spices, vinegar, ascorbic acid

Class-2 preservatives: Benzoic acid and its salt, SO_2 and the salts of sulphuric acid, nitrates, sorbic acid and its salts, propeonic acid and its salts, lactic acid and its salts.

Among the class-2 preservatives, only two chemical preservatives are used in fruits and vegetables Preservation:

(i) KMS

(1) It releases the SO2 and it is unstable.

(2) It is used for the fruit which have non water solvent pigment (colourless).

(3) It cannot be used in naturally coloured juices such as phalsa, jamun because they have the Anthocynin pigment.

(4) It cannot be used in the product which are packed in container because it acts on the tin containers and oil, Hydrogen Sulphide (H_2S) which has an unpleasant smell and also form a black compound with the base plate of containers.

(5) Best to control moulds than bacteria.

(6) 350 ppm KMS is mostly used in fruit juice products.

(ii) Sodium Benzoate

(1) It is salt of benzoic acid and soluble in water.

(2) It delays the fermentation in the juices.

(3) It is commonly used in the product which are having natural colour such as anthocynin pigment.

(4) It is more effective against the yeast.

(5) 750 ppm Sodium benzoate is mostly used in fruit juices, squashes and cordials.

3. Use of Food Additive

Food additives are substances or mixture of substances other than basic foodstuffs, which are present in the foods as reagent of any aspects of production, processing, storage, packaging *etc.* Food additives are:

(i) Sugar,
(ii) Salt,
(iii) Acids,
(iv) Spices

In case of sugar and salts, they exerts osmotic pressure by water is diffuses from the product through a semi-permeable membrane until the concentration reached equilibrium. They kills the micro organisms or do not allow them to multiplication.

(i) Sugar: The concentration of 68-70% is used for preparation of jam, jelly, marmalades *etc.* sugar act as a preservative by osmosis and not as a true poison for micro organisms. It

absorbs most of the available water, so little water available for the growth of micro organisms.

(ii) Salt: the concentration of salt 15-20% is used for the preparation such as pickles. Salt inhibits enzymatic browning and discolouration and also acts as an anti-oxidant.

It exerts its preservative action by:

1. Causing high osmotic pressure resulting in the plasmolysis of microbial cells.

2. Dehydrating food and micro organisms by tying up the moisture.

3. Ionizing to yield the chloride ion which is harmful to micro organisms, and

4. Reducing the solubility of oxygen in water, sensitizing the cells against CO_2.

(iii) Acids:

1. Many processed foods and beverages need the addition of acids to impart their characteristic flavour and taste in the final product because an acid provides desired flavour and taste.

2. They adjust the sugar and acid ratio in the food.

3. Proper balance flavour of the food.

4. They are also playing the role for controlling the pectin-gel formation.

Main acids are the following

1. Acetic acid (Vinegar)

2. Citric acid (Lime juice)

3. Lactic acid (Lactose)

1. Acetic acid: it is commonly used for pickles, chutney, sauce and ketchup, just to inhibit the growth of micro organisms.

2. Citric acid: It is used for preparation of jam, jelly, squash, nectar *etc.* just to increase the acidity.

3. Lactic acid: It is used for the formation of curd from milk, raw flavour, specific to pickles

(iv) Spices:

(1) Spices are plant products which are used in flavouring the foods and beverages to enhance the food flavour, colour and palatability.

(2) They act as antibacterial and antifungal activity.

(3) They impart as colour agent.

4. Use of Low Temperature

Low temperature retards the microbial growth and enzyme reaction because it retards the chemical reactions. This is not a permanent method because some micro organisms can also grow at low temperature.

1. Cellar storage: (Above 15^0C)

2. Refrigerated storage: (0 to 5^0C)

3. Freezing storage: (-18 to -40^0C)

1. Cellar Storage: These are the underground room where surplus food can be stored for some time; only root crops such as potato, onion can be stored for a limited period.

2. Refrigeration: Fruits and vegetables can be stored for 2-7 days. Semi-perishable crops, such as potatoes, apples *etc*. can be stored, in the commercial cold storage with proper ventilation, automatic controlled temperature for one year.

3. Freezing: It tie up the moisture and increase the concentration of dissolved substances in the food. But, sometimes enzymes are active even below the 0^0C.

In this case before freezing, 'Blanching' is necessary for vegetable freezing.

B. Bactericidal Method

In this method, food material is exposed to higher temperature and high temperature helps to killing of the micro organisms due to coagulation of protein. It helps in inactivation of enzyme. Here moist heat is more effective than dry heat. At low pH high temperature is required than the high pH. High temperature can be employed by following methods:
(i) Pasteurization: Below 100^0C

(ii) Boiling/ Cooking: at 100^0C

(iii) Canning: Above 100^0C

(i) Pasteurization

There are three methods of pasteurization

a) Bottle or holding pasteurization

This method is commonly used for the preservation of fruit juices at home. The extracted juice is strained and filled in bottles, leaving sufficient head space for the expansion of the juice during heating. The bottles are then sealed air-tight and pasteurized.

b) Overflow method

Juice is heated to temperature of about 2.5^0C higher than the pasteurization temperature and then filled in hot sterilized bottles up to the brim, during filling and sealing the temperature of juice should not fall below the pasteurization temperature.

c) Flash pasteurization

The juice is heated rapidly to a temperature of about 5.5^0C higher than the pasteurization temperature and kept at this temperature for about a minute. This method commonly used for canning of natural orange juice, grape and apple juices. It is a mild heat treatment; by pasteurization milk is pasteurized by HTST at 72^0C for 15 sec. Fruit juices are pasteurized at such temperature and for such periods as would render them sterile, without impairing their flavour. Usually, the juices are pasteurized at about 85^0C for 25-30 min., according to the nature of the juice and the size of container. Acid fruit juices require lower temperature and less time for pasteurization than the less acid ones.

Juices can be pasteurized in two ways

(1) By heating the juice at a low temperature for a High time (LTHT) and

(2) By heating the juice at high temperature for a short time (HTST).

(ii) Boiling/Cooking

The primary objective of cooking is to produce a palatable food. Cooking results in:
1. Destruction or reduction of micro organisms and inactivation of undesirable enzymes.

2. Destruction of potential hazard in the foods which are present naturally through micro-organism.

3. Improvement of colour, flavour and texture of the food.

4. It improves the digestibility of food component.

5. Putting the temperature about 1000C. by this method, food can be preserved for 10-24 hours at low temperature.

(iii) Canning

Canning is done at or above 100^0C. In case of fruits which are acidic, they are canned at 100^0C, while in case of vegetable those are nonacidic, they are canned at above 100^0C. Here, high temperature can be obtained by using steam pressure; time is varying according to the type of foods. Due to anaerobic condition any survivable organism will not grow.

On the basis of Acid, foods are divided into four different groups:

1. Low Acid Foods (pH 5.3 and above): Peas, Corn, Lime beans, Meat, fish, Poultry and Milk.

2. Medium Acid Foods (pH 5.3-4.5): Spinach, Asparagus, Beets and Pumpkin.

3. Acid Foods (pH 4.5-3.7): Tomatoes, Pears and Pineapple, Sauce.

4. High Acid Foods (pH below 3.7): Berries and Sauer kraut, Pickle.

Other methods of Preservation

Preservation by filtration

In this method juices are clarified by settling or by using ordinary filters, and then passed through special filters which are capable of retaining yeasts and bacteria. Various types of germ-proof filters are used for this purpose.

Preservation by carbonation

Carbonation is the process of dissolving sufficient CO_2 in water or beverage so that the product when served gives off the gas as fine bubbles and has a characteristic taste, carbonation life of beverage. Fruit juice beverages are generally bottled with CO_2 content varying from 1-8 g/lit though carbon should be avoided as it destroys the flavour of the juice. The keeping quality of carbonated fruit beverages is enhanced by adding about 0.005% sodium benzoate. The level of carbonation is required according to the type of fruit juice and type of flavour.

Preservation by fermentation

This is one of the oldest methods of preservation. By this method the foods are preserved by the alcohol or organic acid formed by microbial action. The keeping quality of alcoholic beverages vinegars and fermented pickles depends on the presence of alcohol acetic acid and lactic acid respectively. Wines, beers, vinegar, fermented drinks, fermented pickles are prepared by these processes. Fermentation is carried out by using acetic acid, lactic acid and alcohol *etc.*

Preservation by Antibiotics

Certain metabolic products of micro-organisms which are found to have a germicidal effect those are:

Nissin: - is an antibiotic produced by *Streptococcus lactis* an organism found in milk, curd, cheese and other fermented milk products. It is non toxic and it is widely used in food industry especially for preservation of acid foods.

It is commonly used in canning of mushroom tomatoes and milk products. Nisin suppress the growth of spoilage organisms.

Subtilin: - an antibiotic obtained from *Bacillus subtilis* is used in preservation of asparagus, corn and peas.

Pimaricin: - an antifungal antibiotic used for treating fruits and fruit juices.

Preservation by irradiation

It is a process of preservation of food by exposing them to ionizing energy radiation which kills most of the spoilage causing organism and also inactivates the enzymes responsible for browning *etc.* This method prevents the sprouting in storage condition (onion, potato *etc.*).

The irradiation of food can be considered to be a method of "Cold sterilization". Irradiation measured in rads.

Point to Remember

- The oxicity of SO_2 is increased at hight temperature.
- SO_2 content in pure KMS is 57.7%.
- Commercial effect of KMS is due to H_2SO_4.
- Germicidal effect of KMS is due to H_2SO_3.
- Dehydration and drying is permanent method of preservation.
- Sterilization by Ultera-high temperature (UHT) is done at temperature of 149^oC for 2 second.
- In carbonated fruit juice beverages CO_2 content is 1-8g/liter.
- Cold process is also known as Ultrafiltration.

Importance and Scope of Fruit and Vegetable Preservation in India

Fruits and vegetables are an important supplement to the human diet as they provide the essential minerals, vitamins and fibre (roughage) required for maintaining health.

India with a great diversity in climatic conditions and soil types is ideal for growing a large variety of fruits and vegetables, both indigenous and introduced.

Most fruits and vegetables are seasonal and perishable in nature. In a good season there may be a glut but because of insufficient transport facilities, lack of good roads and poor availability of packaging materials, the surplus cannot be taken quickly enough to markets in urban areas.

Moreover the surplus often cannot be stored for sale in off-season because of inadequate local cold storage facilities. Thus, the cultivator do not get a good price for their produce.

Although, the R and D efforts on the development of post-harvest handling has helped in reducing the spoilage, considerable losses continue to occur.

Two approaches are possible for solving this problem.

(i) One is the creation/expansion of cold storage facilities in the fruit and vegetable producing regions, as also in the major urban consumption centres, to ensure supply of fruit and vegetable throughout year.

(ii) Another approach is to process the fruits and vegetable into various products which could be preserved for a long time and add value to the product.

With increasing in purchasing power of middle class, there is increasing demand for factory made jams, gullies, pickles.

In spite of all these, the fruit and vegetable preservation industry of present is able to utilise less than 2% of the total production for conversion into products like canned fruits, juices and their beverage squashes etc. as against 40% in developed countries. Thus there is considerable scope for expansion of the industry, which in turn would give a fillip to development of horticulture, specially in hilly areas and through export of value-added products, earn more foreign exchange.

India is one of the cheapest producer of horticultural produce. If the Government addresses some of the gaps in processing industry, Indian economy will get a boost up.

(i) Most of the varieties grown in India are not suitable for processing.

(ii) Seeds of processble varieties can be imported and multiplied using tissue culture technique.

(iii) Lowering sales tax on agriculture produce may help the industry to grow.

(v)In New Exim Policy of Union Government, setting of Agriculture Export Zones (AEZ) to identify each state's competitive advantage and to promote the cultivation and processing of fruit and vegetable accordingly.

2. Important Value Added Product of Fruits and Vegetables

Jam, Jelly and Marmalade

Jam is prepared by boiling the fruit pulp with sufficient quantity of sugar to a reasonably thick consistency, firm enough to hold fruit tissues in position. It should contain not less than 68 per cent soluble solids. Jam may be made from a single fruit (apple, strawberry, banana, pineapple etc.) or from combination of two or more fruits. Jam contains 0.5-0.6% acid and invert sugar should not be more than 40%.

Components of Jam

- **Fruit Pulp:-** 45%
- **TSS:-** 68%
- **Acidity:-** 0.5-0.6%
- **Water:-** 33-38%

Processing of Jam

1. **Selection of fruit:-** Fully ripe fruit should be harvested for Jam making. Jam is best fruit for Jam making. Pineapple, carrot, strawberry, banana, peach, pear also used for jam making.
2. **Washing/Cleaning of fruit:-** Fruit shoul be cleaned by clean water.
3. **Preparation of Fruit:-** Fruit should be peeled and remove of core material for Jam making.
4. **Blanching:-** Blanching is the heating of fruit or vegetables for a short time with either steam or water, and is an essential step before canning, drying or freezing of food.

   This heating process is not meant to cook the food but to inactivate substances that would otherwise adversely affect the nutrient content, colour, flavour or texture during subsequent processing and storage.
5. **Cooking with Sugar**:- Fruit pulp start cooking with 1/3 quantity with sugar. After some time add remaining sugar.
6. **Adding of Citric Acid**:- For enhancement of test citric acid should be added at 103^{o}C temperature.
7. **Judging of End-Point:-**
   a. **Sheet or Flake test:-**A small portion of jam is taken out during boiling, in a spoon or wooden ladle and cooled slightly, it is then allowed to drop. If the product falls off in the form of a sheet or flakes instead of flowing and a continuous stream or syrup, it means that the end-point has been reached and product is ready, boiling is continued till the sheet is positive.
   b. **Temperature:-** 105^{0}C.
   c. **TSS:-** 68-70%
   d. **Weight Test:-** If total weight of jam is 1.5 time is more than sugar weight, jam is prepared.
8. **Packing:-** Jam should be fill in glass jar.
9. **Storage:-** Jam should be stored at dry and cool place.

Important Point:-

- The jam should be containing 30-50% invert sugar.
- Crystallization of jam occurs due to the less than 30% invert sugar, it can be prevent by adding of corn syrup or glucose along with cane sugar.
- Sticky and gummy jam is due to high percentage of total soluble solid (more sugar). This problem can be solved by addition of pectin or citric acid or both.
- Premature setting is due to low total soluble solid and high pectin content in the jam and it can be prevent by adding more sugar.
- Surface graining and shrinkage is caused by evaporation of moisture during storage of jam, it can be avoid by storing in a cooling place.
- Jam should be stored at 80% humidity for avoid the mould growth.

Jelly

Jelly is a semi-solid product prepared by boiling a clear, strained solution of pectin containing fruit extract with sufficient quantity of sugar and measured quantity of acid.

Character of Ideal Jelly:-

- A perfect jelly should be transparent, well set, but not too stiff and should have the original flavour of the fruit.
- It should be firm enough to retain a sharp edge but should be tender enough to resist the applied pressure.
- It should not be gummy, sticky or syrupy or have crystallized sugar.
  - ✓ Guava is most suitable fruit for jelly making.
  - ✓ Fruits rich in pectin and acid: Sure apple, grape, lemon, orange, jamun, goose berry, cranberry, etc.
  - ✓ Fruits rich in pectin low acid: Apple, unripe banana, guava, sour cherry, fig, pear, loquat, etc.
  - ✓ Fruits low in pectin rich acid: Sweet cherry, pineapple, rhubarb, etc.
  - ✓ Fruits low in pectin and acid: Apricot, peach, pomegranate, raspberry, strawberry, overripe fruits, etc.
  - ✓ Tartaric acid is best for jelly preparation.
  - ✓ Pectin is most important constitute of jelly, it is present in fruits form of calcium pectate are responsible for the firmness of fruits.

Components of Jelly

- **Fruit Juice:- 45%**
- **TSS:- 65%**
- **Pectin:-** 0.5-1.0%
- **Acid:-** 0.75%
- **Water:-** 33-38%
- **pH:-** 3.2.

Preparation of Jelly:-

1. **Selection of fruit:-** Fruit should be harvested at half-ripe stage for jelly making because maximum pectin content in fruit at half ripe stage. If fruits are ripe when pectin change in pectic acid.

   Guava, sour apple, plum, karonda, wood apple, loquat, papaya and goose-berry are generally used for preparation of jelly. Apricot, pineapple, strawberry, raspberry, etc. can be used but only after addition of pectin powder, because these fruits have low pectin content.
2. **Washing/Cleaning of fruit:**- Fruit shoul be cleaned by clean water.
3. **Blanching:**- Blanching is the heating of fruit or vegetables for a short time with either steam or water, and is an essential step before canning, drying or freezing of food.

   This heating process is not meant to cook the food but to inactivate substances that would otherwise adversely affect the nutrient content, colour, flavour or texture during subsequent processing and storage.
4. **Extraction of fruit juice:**- For jelly making juice is excreted after blanching.
5. **Pectin Test:**-
   a. **Jelmeter test:-** A jelmeter is a graduated glass tube with an opening at each end. It is used to determine the amount of pectin in fruit juice. The rate of flow of the juice through this tube is used as a measure of the jellying power of the juice. Therefore, it is an index to the amount of sugar to be used. Jelmeters were once commonly available, but are not easy to find today, most likely because the alcohol test is more reliable.
   b. **Alcohol Test:**- his is a proven standard test for pectin content and luckily it's hard to go wrong with.
      - Take one teaspoon of clear boiling fruit juice and drop into a cold glass or cup, allow it to cool for a minute and then add three teaspoons of methylated spirit and swirl it around or gently shake.
      - If a large clot forms from the juice, adequate pectin for a good set has been extracted and the sugar may be added to the fruit and juice
      - If 2-3 clot formed means pectin content in juice is medium.
      - If 3-4 clot formed means pectin content in juice is low.
      - If there is only a very low amount of pectin, several small clots will form. It is probably going to be worth adding some additional pectin to ensure a good set.

Jelmeter Reading	Alcohol Test	Adding sugar quantity (Kg)
1.25	One large Clot	1.250
1.0	2-3 Clots	1.000
0.75	3-5 Clots	0.750
0.50	Several small clots	Jelly shouldn't make or Adding some synthetic pectin

6. **Cooking juice with sugar:-** Start heating with 1/3 quantity with sugar. After some time add remaining sugar.
7. **Adding of Citric Acid**:- For enhancement of test citric acid should be added at 103^{o}C temperature.
8. **Judging of End-Point:-**

- **Drop test:-** A drop of the concentrated mass is poured into a glass containing water. Settling down of the drop without disintegration denotes the end-point
- **Temperature:-** 105.5^0C.
- **TSS:-** 65%
- **Weight Test:-** If total weight of jam is 1.5 time is more than sugar weight, jam is prepared.

9. **Packing:-** Jam should be fill in glass jar.
10. **Storage:-** Jam should be stored at dry and cool place.

Problems of Jelly making

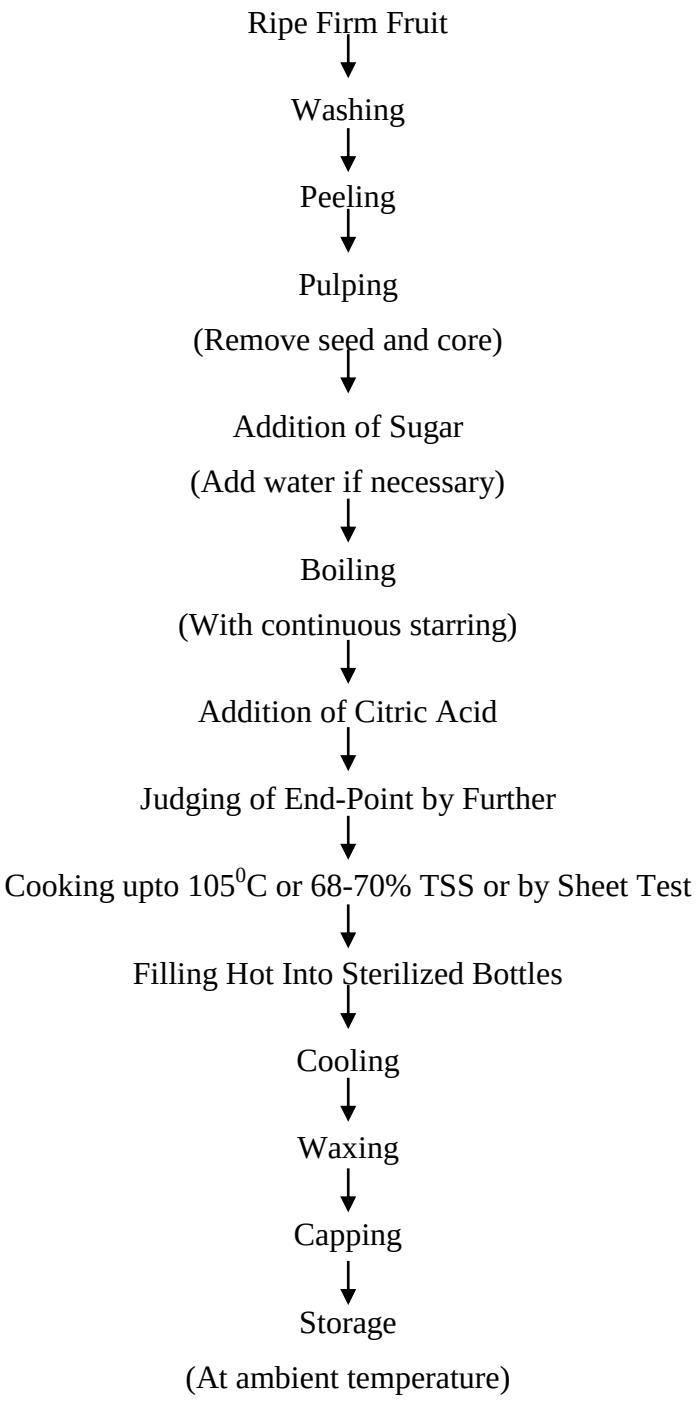
- **Jelly is failed to set:-** Jelly is failed to set due to addition of too much sugar, lake of acid the end-point, cooking below the end-point, cooking beyond the end-point and prolonged cooking.
- **Cloudy or foggy jelly:-** Cloudy or foggy jelly due to use of non-clarified juice or extract, use of immature fruits, over-cooking, non-removal of scum, faulty pouring and premature gelation.
- **Formation of crystals in jelly:-** Formation of crystals in jelly due to addition of excess sugar and also to over-concentration of jelly.
- **Syneresis or weeping of jelly:-** Syneresis or weeping of jelly is the phenomenon of spontaneous exudation of fluid from a gel is called syneresis and weeping and is caused by excess of acid, too low concentration of sugar, insufficient pectin, premature gelation and fermentation.
- Jelly pasteurized at 82-85^0C for 30 minutes.

Marmalade

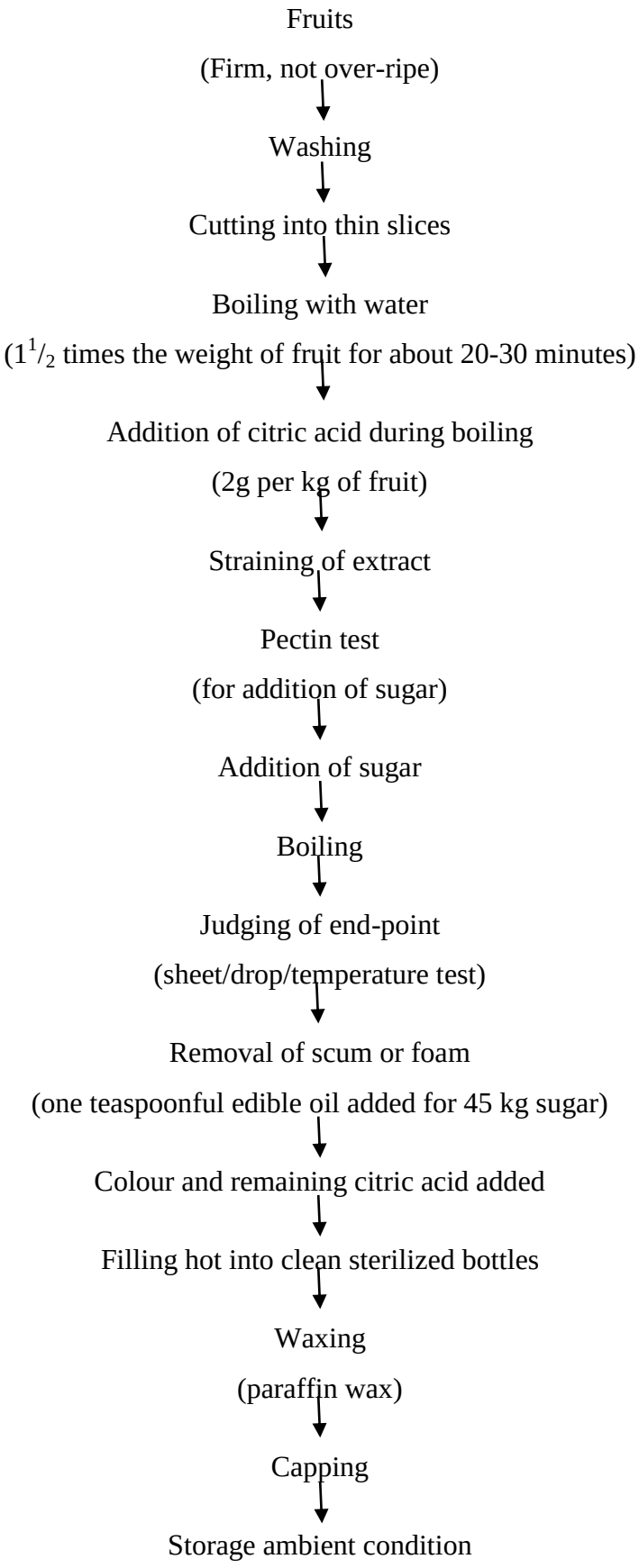
Marmalade is a fruit jelly in which slices of the citrus fruit or its peels are suspended. Marmalades are generally made from citrus fruits like oranges and lemons in which shredded peels are suspended.

- Browning during storage of marmalade is very common which can be prevented by addition of 0.09g of KMS per kg of marmalade and not using tin container.

Flow-Sheet for Processing of Fruits Jam



Flow-Sheet for Processing of Fruits Jelly



Flow-Sheet for Processing of Marmalade

Ripe Fruits

↓

Washing

↓

Peeling outer yellow portion (Flavedo) thinly

↓

Cutting yellow portion into fine shreds

(1.9-2.5cm long and 0.08-0.12cm thick)

↓

Boiling

(In 2-3 times weight of water for 40 to 60 minutes)

↓

Straining the extract

↓

Testing for pectin content

(Alcohol test)

↓

Adding of sugar

(as required)

↓

Cooking to 103-105^{0}C

(continuous stirring)

↓

Adding of prepared shreds

(Shredded peel boiled for 10-15 minutes in several changes of water for softening and removing bitterness and added @about 62g per kg of extract)

↓

Boiling till jellying point

(continuous stirring)

↓

Testing for end point

(Sheet/drop/temperature test)

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Cooking

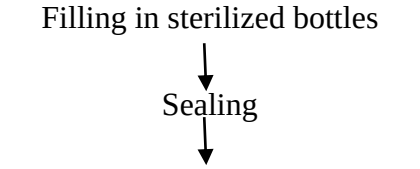
(to 82-88^{0}C with continues stirring)

↓

Flavoring

(orange oil)

↓



Preserves, Candied, Crystallized and Glazed fruits and vegetables

Preserves (*Murabbas*) are prepared from whole fruits and vegetables or their segments by addition of sugar followed by evaporation to a point where microbial spoilage cannot occur. The final soluble solids concentration is reached to about 70 per cent. The finished product can be stored without hermetic sealing and refrigeration.

- In preserves fruits can be cooked in syrup by three processes that are: 1) Rapid process, 2) Slow process and 3) Vacuum process.
- Preserves made by vacuum process retain the flavour and colour of the fruit better other methods.
- Most suitable fruits for preserves making are Aonla, beal, apple, pear, mango, cherry, karonda, strawberry, pineapple, papaya, etc.

Candied fruits

Fruits/vegetables impregnated with cane sugar or glucose syrup, and subsequently drained free of syrup and dried, is known as candied fruit/vegetable.

- Most suitable fruits for candied making are Aonla, karonda, pineapple, cherry, papaya, apple, peach and peel of lemon, grapefruit and citron, ginger etc.
- The difference between candied and preserves is that the fruit impregnated with syrup having a higher percentage of sugar or glucose.
- For best candied total sugar content of the impregnated fruit is kept at about 75 per cent to prevent fermentation.

Crystallized fruits/vegetables

Candied fruit/ vegetable when covered or coated with crystals of sugar, either by rolling in finely powdered sugar or by allowing sugar crystals to deposit on them from dense syrup are called crystallized fruits.

Glazed fruits/vegetables

Covering of candied fruits/vegetables with a thin transparent coating of sugar, which impart them a glossy appearance, is known as glazing.

Problems in preparation of preservation and candied fruits

1. Fermentation: It is due to concentration of sugar used in the initial stage of preparation of preserves. Sometime fermentation also occurs during storage due to low concentration of sugar and insufficient cooking. This can be prevented by boiling the product at suitable intervals, by adding the required quantity of sugar and by storage in a cool and dry place.

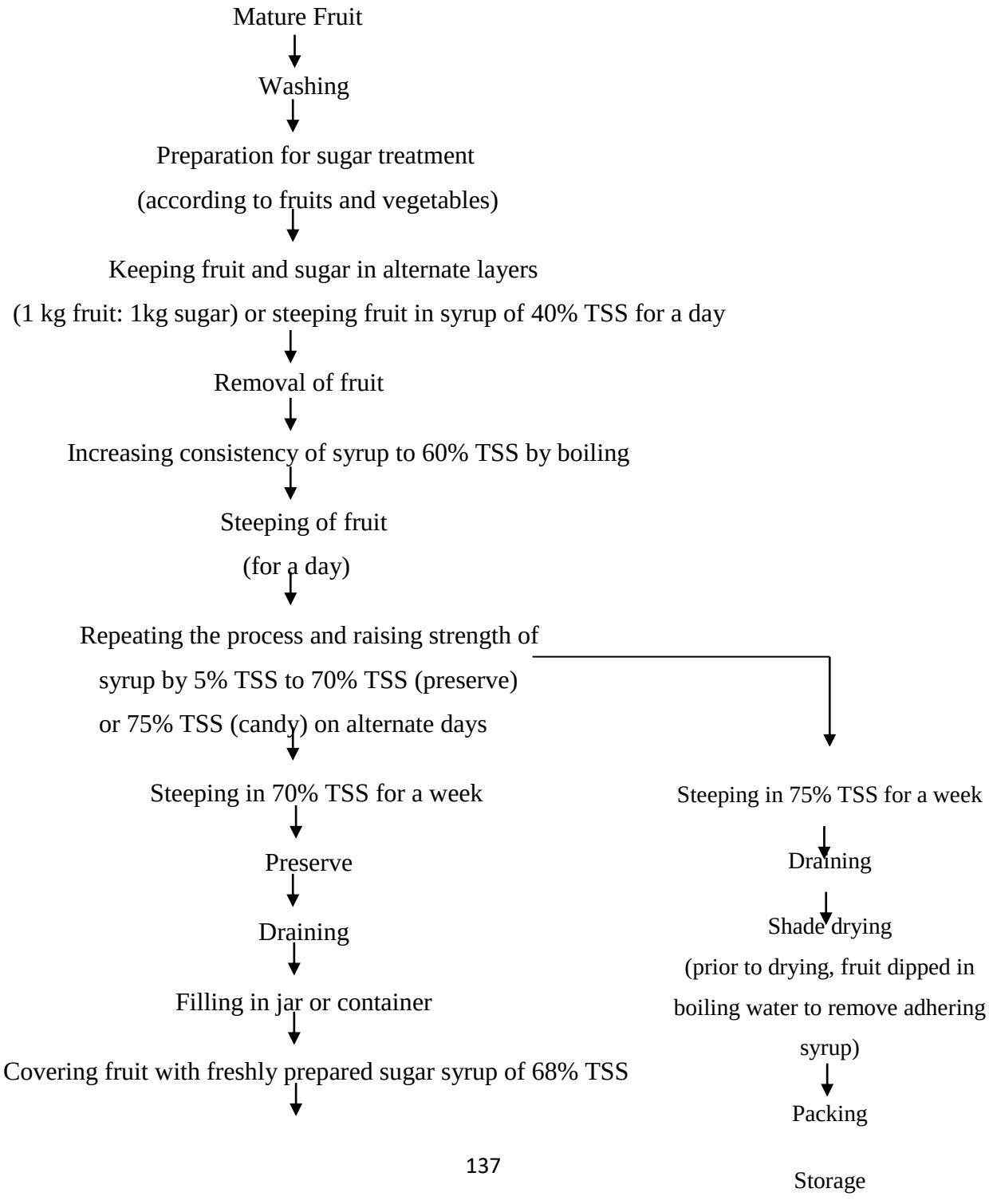
2. **Floating of fruit in jar:** It is mainly due to filling the preserve without cooling and can be avoided by cooling the preserve prior to filling.

3. Toughening of fruit skin or peel: It may be due to inadequate blanching or cooking of fruit hence blanching till tender is necessary.

4. Fruit shrinkage: Cooking of fruit in heavy syrup greatly reduces absorption of sugar and causes shrinkage. Therefore, fruit should be blanched first or cooked in low-sugar syrup.

5. Stickiness: It may develop after drying or during storage due to insufficient consistency of the syrup, poor quality packing and damp storage conditions.

Flow-Sheet for Processing of Preserve and Candy



Pickle

The preservation of food in common salt or in vinegar is known as pickling. It is one of the most ancient methods of preserving fruits and vegetables. Pickles are good appetizers and add to the palatability of a meal. They stimulate the flow of gastric juice and thus help in digestion. They are prepared with salt, vinegar, oil or with a mixture of salt, oil, spices and vinegar.

Method of pickle preparation

1. Preservation with salt: Salt improves the taste and flavour and hardness the tissues of vegetables and controls fermentation. Salt content of 15 per cent or above prevents microbial spoilage. This method of preservation is generally used only for vegetables and some fruits like lime, mango etc. which contain very little sugar and hence sufficient lactic acid cannot be formed by fermentation to act as preservation.

2. Preservation with vinegar: The fruits and vegetables preserved in vinegar whose final concentration, in terms of acetic acid in the finished pickle should not be less than 2 per cent.

3. Preservation with oil: The fruits and vegetables should be completely immersed in the edible oil. Cauliflower, lime mango and turnip pickles are the most important oil pickles.

4. Preservation with mixture of salt, oil, spices and vinegar: The fruits and vegetables can preserve in mixture of salt, oil, spices and vinegar. Cauliflower, carrot, turnip, red chilli, jackfruit and tomato most important pickle those are prepared by this method.

Problems in pickle making

1. Bitter taste: Use of strong vinegar or excess spice or prolonged cooking of spices imparts a taste to the pickle.

2. Blackening: It is due to the iron in the brine or in the process equipment reacting with the ingredient used in pickling. Certain microorganisms also cause blackening.

3. Cloudiness: Cloudiness caused by the use of inferior quality vinegar or chemical reaction between vinegar and minerals.

4. Dull and faded product: This is due to use of inferior quality materials or insufficient curing.

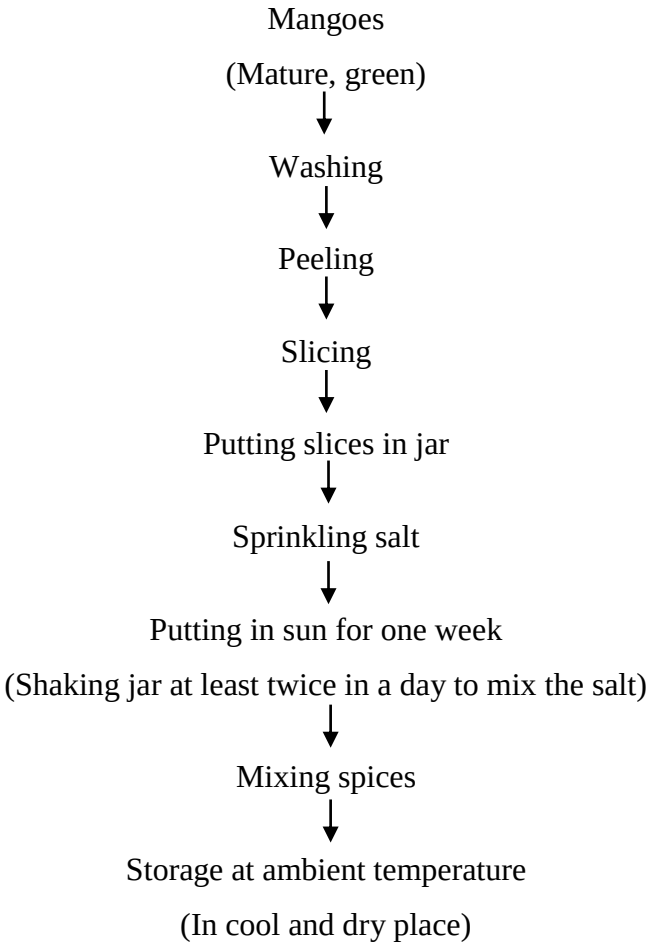
5. Shrivelling: It occurs when vegetables are placed directly in a very strong solution of salt or sugar or vinegar.

6. Scum formation: When vegetables are cured in brine, a white scum always from on the surface due to the growth of wild yeast. This delays the formation of lactic acid and also helps the growth of putrefactive bacteria which cause softness and slipperiness. Addition of 1 per cent acetic acid helps to prevent the growth of wild yeast in brine, without affecting lactic acid formation.

7. Softness and slipperiness: This very common problem is due to inadequate covering with brine or the use of weak brine. The problem can be solved by using a brine of proper strength and keeping the pickles well below the surface of the brine.

FLOW-CHART FOR MANGO PICKLE

Mango (peeled and sliced) -1 kg, salt - 200 g, red chilli powder 10 g, asafetida -5 g, fenugreek, black pepper, cardamom (large), cumin and cinnamon (powdered) each 10 g, clove (headless) 6 numbers.



FLOW-CHART FOR LIME PICKLE

Select ripe (but not overripe) healthy lime fruits.

↓

Washing

↓

Heat Dip in hot water (60-65^{0}C)

for about five minutes

↓

Cut into four pieces or alternatively cut into smaller, uniform-sized pieces

↓

Brine Ensure that the surface is covered with juice

↓

Dry in the sun for 2-3 days

↓

Mix spices

(To local preference)

↓

Packaging

↓

Storage

(In a cool place, away from sunlight)

FLOW-CHART FOR CUCUMBER PICKLE

Cucumber 1 kg, salt 200 g, red chilli powder 15 g, cardamom (large), cumin, black pepper (powdered) each 10 g, clove (headless) 6 numbers, vinegar 750 ml.

Cucumber

↓

Washing

↓

Peeling

↓

Cutting into 5 cm pieces

↓

Mixing with salt

↓

Filling in jar

↓

Standing for 6-8 hours

↓

Draining off water

↓

Adding spices and vinegar

↓

Keeping in sun for a week

↓

Storage

(In a cool place, away from sunlight)

FLOW-CHART FOR GREEN CHILLI PICKLEPICKLE

Green chillies – 1 kg, salt – 150 gm, mustard (ground) – 100 gm lime juice – 200 ml (or) amchur – 200 gm, fenugreek cardamom (large), turmeric, cumin (powdered) each – 15 gm, mustard oil – 400 ml.

Green chillies

↓

Washing

↓

Drying

↓

Making incision

↓

Mixing all spices in a little lime juice

↓

Mixing with chillies

↓

Filling into jar

↓

Adding lime juice and oil

↓

Keeping in sun for a week

↓

Storage

(In a cool place, away from sunlight)

Sauce

Sauce is a product similar to ketchup, prepared from pulps of tomato or other fruit/vegetable, having TSS not less than 15% and cooked to a suitable consistency with

added sugar, salt, spices and vinegar. Sugar, salt, spices, acetic acid all act as partial preservatives. According to FPO specification fruit sauce should have minimum of 15% TSS and 1.2% acidity. Preservatives and colours may also be added for increasing of appearance and storability.

Tomato Ketchup

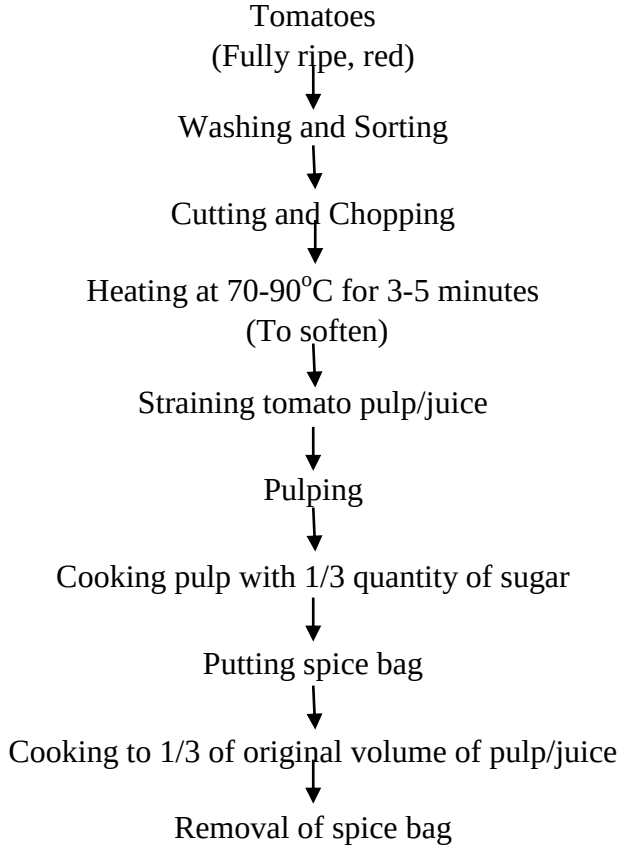
Ketchup is a product made by concentrating tomato juice or pulp without seeds and skin, with added spices, salt, vinegar, onion, garlic etc. so that it content not less than 12% tomato solids and generally 28% or more total solid (not less than 25% TSS as per FPO specificartion).

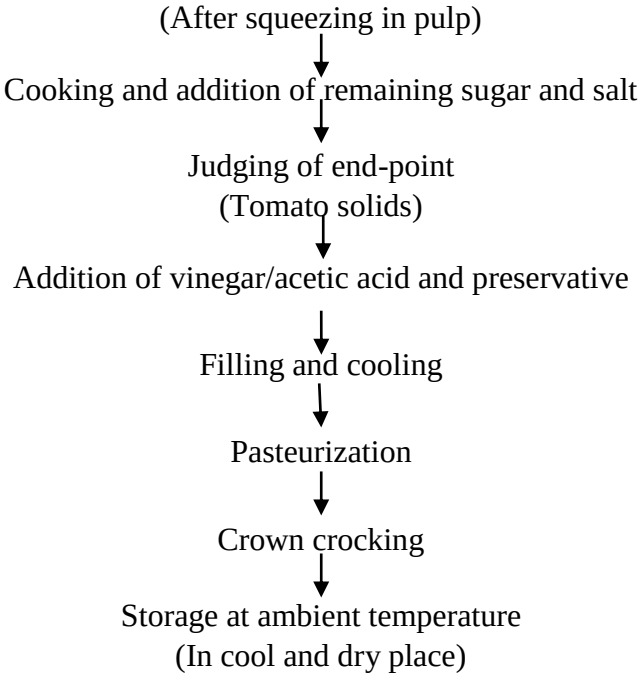
Sauce and ketchup are similar products but ketchup is only prepared from tomato while sauce may be made by another fruit and vegetable pulp.

Difference between Ketchup and Sauce

Ketchup	Sauce
1. Prepared from tomato only.	1. Prepared from tomato as well as other fruits and vegetables such as pumpkin, chilli, etc.
2. Minimum TSS is 25%.	2. Minimum TSS is 15%.
3. Minimum acidity is 1.0%.	3. Minimum acidity is 1.2%.
4. Thicker in consistency.	4. Thinner in consistency.
5. Costly	5. Cheep as compared to ketchup.
6. Only red in colour.	6. May have red, green or other colours.

Flowchart for Processing of Tomato Ketchup/Sauce




(After squeezing in pulp)
Cooking and addition of remaining sugar and salt
Judging of end-point
(Tomato solids)
Addition of vinegar/acetic acid and preservative
Filling and cooling
Pasteurization
Crown crocking
Storage at ambient temperature
(In cool and dry place)

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3 Packaging, Quality Slandered and Their Marketing Including Export

Packaging is an important consideration in vegetable and fruit market. The use of properly designed containers for transporting and marketing of vegetables is significantly reduce losses and maintain their freshness succulence and quality for longer period. Packaging also provides protection from mechanical damage and undesirable physiological changes and pathological deterioration during storage, transportation and marketing.

Many vegetables are transported in gunny bags and bamboo baskets. Packaging material such as polythene films, paper boars, and boxes lived with polythene and other materials can effectively prolong the shelf life of vegetables. By using plastic films vegetables can be protected from dry air. Polythene packaging provides modified atmosphere and consequently reduces decay, softening, and loss of solids. The thickness and permeability to CO_2, O_2 and water vapour of films needs to be standardized for each vegetable.

The Function of Packaging or Why package Produce?

A significant percentage of produce buyer and consumer complaints may be traced to container failure because of poor design or inappropriate selection and use. A properly designed produce container should contain, protect, and identify the produce, satisfying everyone from grower to consumer.

The main objective of packaging is to keep the fruits, vegetable and root crops in good condition until it is sold and consumed.

Characteristics of packaging

The characteristics of packaging are to contain, to protect, to communicate and to market the product.

A. To contain produce

- As an efficient handling unit, easy to be handled by one person.
- As a marketable unit. e.g. units with the same content and weight.

B. To protect produce against

- Rough handling during loading, unloading and transport - rigid crate.
- Pressure during stacking.
- Moisture or water loss with consequent weight and appearance loss.
- Heat: air flow through crate or box via ventilation holes.
- Fumigation possible through ventilation holes.

C. To communicate

- Identification: a label with country of origin, volume, type or variety of product, manufacturing and expiry date, etc. printed on it.
- Marketing, advertising: recognizable trade name and trademark.

D. To market the product

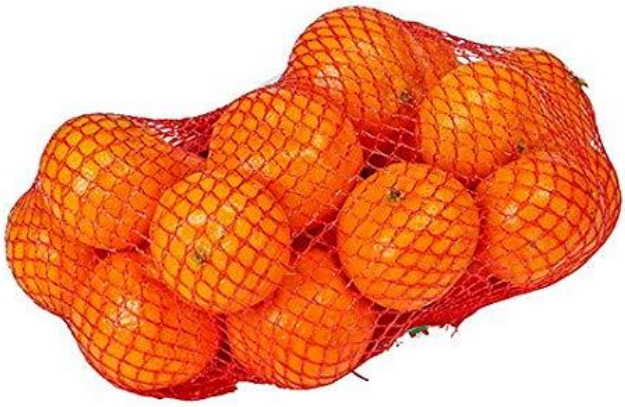
- Proper packaging will lead to reduced injuries of fruits and vegetables and subsequently to improvement of appearance.
- Standard units (weight, count) of a certain produce will increase speed and efficiency of marketing.
- With reduced costs of transport and handling, stacking and combining of packages into layer units like pallets is possible. A more efficient use of space and reduced losses will lower the marketing costs.
- Labels and slots facilitate inspection.

Type of packaging

1) Plastic film bags: – Widely used for consumer size packs in fruit and vegetables marketing.

2) Plastic boxes: – They are rigid containers most suited for packaging soft and delicate commodities.

3) Net / mesh bags: – Widely used for packing fruits like apple, citrus, guava, sapota *etc.*



4) **Sleeve packs: –** Immobilization of packed fruits, superior visibility that gives a good sales appeal.

5) Cling film: – Ideal packaging for low water vapour transmission rate, high gas permeability.

6) Shrink film or stretch film: – Among the specialised plastic packaging systems, shrink packaging or commonly known as shrink wrapping and stretch wrapping are very common and widely used. ey are considered to be totally different in terms of material and operation.

In the case of shrink wrapping, shrink film is used as the basic material and heat forms an important part of the operation, whereas, in the case of stretch wrapping, stretch

film is used as the basic material and no heat is applied during the operation. Shrink Wrapping is done in 3 or 4 stages, namely:

• Wrapping (sleeve wrapping or over-wrapping)

• Sealing (necessary only for over-wrapping)

• Shrinking (with application of hot air), and

• Cooling

Stretch wrapping is done only in two stages, namely, wrapping and sealing (most of the time even without a sealer).

7) Antimicrobial packaging: – Incorporating antimicrobial agents into polymer surface coating sand surface attachments.

8) Wooden packaging: – used for packing fruits and vegetable.

The advantages of wooden crates are:

- The crates can be manufactured and repaired locally.
- Wood is relatively resistant to different weather conditions and (sea) water.
- Wooden crates are often used on more than one journey and have a higher efficiency for larger fruits, e.g. watermelons.
- Most crates have good ventilation and fast pre-cooling is possible.

Disadvantages of wooden crates are:

- Untreated wood can easily become contaminated with fungi and bacteria.
- Treatment of wooden crates with paint or other chemicals may cause produce deterioration.
- The material may be too hard or rough for produce like soft fruits, and therefore liners of a soft material may be needed.
- Disposal of the crates after use.
- Manufacturing of wooden crates puts an extra claim on the natural forest resources.

9) Modified atmosphere packaging

It is the packaging of perishable products. Modified atmosphere packaging (MAP) of fresh fruits and vegetables is based on modifying the levels of O_2 and CO_2 in the atmosphere produced inside a package sealed with some type of polymer film. It is desirable that the natural interaction that occurs between the respiration of the product and the packaging generates an atmosphere with low levels of O_2 and / or a high concentration of CO_2. The growth of organisms that cause decay is thereby reduced and the life of the product is extended. Additionally, the desired atmosphere can reduce the respiration rate, and ethylene production, physiological changes. For example, it can inhibit chemical, enzymatic and microbiological mechanisms associated with the decay of fresh products, thus avoiding the use of other chemical or thermal process such as freezing, dehydration, and sterilization. Modified atmosphere packaging is two types:-

Passive Modified atmosphere packaging

Modified atmospheres can be obtained passively between plant material and sealed package or intentionally using determined concentrations of gases. Modified atmosphere is formed as a result of vegetable respiration, which consumes CO_2 and releases O_2 in sealed package. In passive modification, the respiring product is placed in a polymeric package and sealed hermetically. Only the respiration of the product and the gas permeability of the film influence the change in gaseous composition of the environment surrounding the product. If the product's respiration characteristics are properly matched to the film permeability values, then a beneficial modified atmosphere can be passively created within a package. The polymer itself variably restricts gas exchange between the internal and external environments due to its selective permeability to O_2 and CO_2. After a period of time, the Modified Atmosphere Packaging for Perishable Plant Products system reaches an equilibrium atmosphere containing of lower concentrations of O_2 and higher concentrations of CO_2 than in atmospheric air.

Active Modified atmosphere packaging

The concept of active packaging has been developed to adjust the deficiencies in passive packaging such as when a film is a good barrier to moisture, but not to oxygen, the film can still be used along with an oxygen scavenger to exclude oxygen from the pack. An intentionally or actively obtained modified atmosphere occurs when the desired gas mixture is introduced into the container before sealing. In this way, atmospheric balance inside the package is reached faster or almost immediately. Sometimes, certain additives are incorporated into the polymeric packaging film or within packaging containers to modify the headspace atmosphere and to extend shelf-life. Another process is the acceleration of atmospheric balance under partial vacuum packaging is the process of removing the air before sealing, reducing the free space. Although the active modification of the atmosphere within the package incurs additional costs, the advantage is that the desired atmosphere is securely achieved in considerably less time.

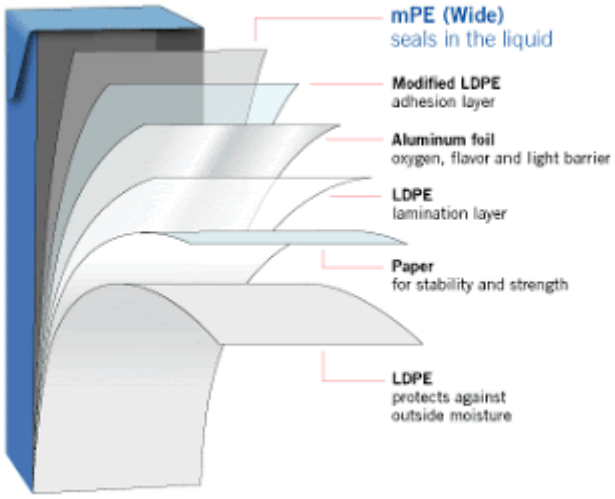
10) Vacuum packaging: – Where as MAP and CAP mostly operate in ambient pressure (101 kpa), storage at reduced atmosphere has been experimented and is known as vaccum packaging. Packaging the products in film of low oxygen permeability and sealing it after evacuating the air. Apple can be stored well in below pressure of 10 kpa.

12) Bamboo mat holed boxes: -Suitable for transportation of apple.

13) Polypropelene boxes: - Highly suitable for long markets it can be reused.

14) Corrugated fibre board: -Suitable for fruit and vegetable and most economical.

15) **Tetra-packaging:-** Tetra Pak aseptic cartons are made of three basic materials that together result in every efficient, safe and light-weight package. Each material provides a specific function:



1.Polyethylene: Protects against moisture

2. Paper: For stability & strength

3. Polyethylene: Adhesion

4. Aluminium: Barrier to oxygen, flavour & light

5. Polyethylene: Adhesion

6. Polyethylene: Seals in the liquid

It is used to store the fruit beverages and RTS beverages.

- Paper (80%): to provide strength and stiffness

- Polyethylene (15%): to make packages liquid tight and to provide a barrier to micro - organisms
- Aluminium foils (5%): to keep out air, light, and off-flavours-all the things that can cause food to deteriorate.

Combining each of these three materials has enabled Tetra Pak to produce a packaging material with optimal properties and excellent performance characteristics.

- Higher degree of safety, hygiene and nutrient retention in food
- Preserving taste and freshness
- Can be kept for months with no need for refrigeration or preservatives
- Efficient (a filled package weight is 97% product and only 3% packaging material), using a minimum quantity of materials necessary to achieve a given function
- A good example of resource efficiency is its light-weight (among the lightest packages available)

Type of packaging materials

1. Sacks: flexible, made of plastic or jute.
   i. Bags: small size sack
   ii. Nets: sacks made of open mesh
2. Wooden crates.
3. Carton or fiber-board boxes.
4. Plastic crates.
5. Pallet boxes and shipping containers.
6. Baskets: made of woven strips of leaves, bamboo, plastic, etc.

5 CONCEPT OF SAFE FOOD AND QUALITY STANDARD

Quality Standards and Laws

Quality is how well a product or service satisfies the needs of the customer. This includes all aspects related to the needs of the customer such as quality specifications, safetgy, delivery method or date, price etc. Quality can be interpreted in several ways as conformance to the standards, meeting customers' preference/ satisfaction for desired quality attributes, degree of excellence and zero defect products etc. Because of education and consequent greater understanding of implications of poor quality commodities in recent years, consumers have become quality conscious and this fact is also applicable to food and food products. In order to strengthen competitiveness, quality must be incorporated throughout the value added chains right from the harvesting, handling, manufacturing, processing, packaging, storage, marketing and distribution stages, especially in the case of food and food products.

Elements of Food Quality and Safety

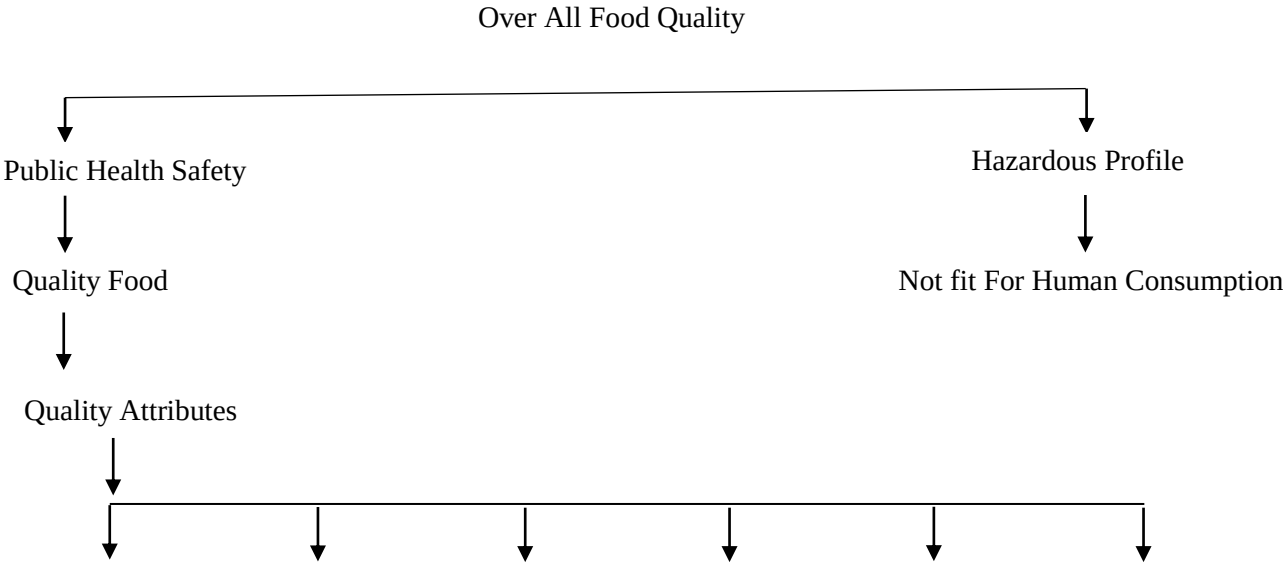
The basic functions of a quality control programme are:

- Physical and chemical evaluation of raw materials and processed products
- In-process control of :
  - ✓ Raw materials, ingredients and packaging supplies
  - ✓ Processing parameters
  - ✓ Finished products
- Microbiological analysis and their control in raw materials and finished products
- Control of storage and handling conditions
- Sanitation and waste products control
- Assurance that final products are within the legal and established marketing standards

Steps for ensuring food quality

Quality Control and Quality Assurance are the two steps for ensuring quality. Quality Control is the evaluation of a final product prior to its marketing i.e., it is based on quality checks at the end of production. Quality Assurance is similar to quality control, but has more to do with the process than the product. It is the implementation of quality checks and procedures to immediately correct any failure and mistake that is able to reduce the quality of the interim products at every production step.

The desired high quality of the final product is planned and obtained by conducting Standard Operating Procedures (SOP) that guarantee the desired quality of the interim products at every production step meeting the demands for Good Manufacturing Practices (GMPs). The management approach to long-term success through customer satisfaction is based on the participation of all members of an organization in improving processes, products, services and the working culture and is known as Total Quality Management (TQM). These are the systems that can demonstrate that the organization can meet the specifications and requirements of the customers. They also allow the management of the organization to know that the customer's requirements are being met. Food quality profile for any product is depicted under:



Physical	Chemical	Sensory	Nutritive	Convenience	Microbial
Size	Proximate composition	Appearance	Vitamins	Processing	Total load
Shape	Deteriorative parameters	Colour	Minerals	Shelf life	Yeasts
Viscosity		Smell	Dietary fiber	Packagin	Pathogens
Thickness		Texture	Energy content		Moulds
		Flavour	Antioxidants		

Good Manufacturing Practices (GMPs) are guidelines to assure that food for human consumption is safe and has been prepared, packed and held under sanitary conditions. These guidelines deal with personnel involved in food processing, building, premises as well as construction and design.

Quality Systems

Food Laws: There are a number of food laws being implemented by various Ministries/Departments. These are primarily meant for two purposes namely, (1) Regulation of Specifications of Food and (2) Regulation of Hygienic Condition of Processing/Manufacturing. Some of these food laws are mandatory and some are voluntary. Food laws are set up and established by authorities as a rule for the measure of quantity, weight, value or quality. Food laws are essential to provide uniform units for weights and measures. The purpose/ benefits of food laws are helpful for farmers and other people engaged in harvesting and food production, those who are engaged in processing and marketing of food, for consumers and government agencies.

Legislations Governing Food Industry in India: With trade liberalization and globalization in the food industry after WTO we have to amend / make changes in our legislations to meet international requirements. In our country, standardization systems fall into two categories. Compulsory legislations are formulated by various Ministries whereas voluntary standards are framed by the organizations with the motto of serving the country. The details of

Acts/Orders, their mode of operation, regulations with special features are described in Table 3. Different voluntary legislations are made for the purpose to guarantee stated quality and sales promotion. A number of control orders have been formulated under the provisions of the Essential Commodities Act, which operate on the main objectives of regulating the manufacture, commerce and distribution of essential commodities. There are various commodity boards such as Spices Board, Tea Board, Coffee Board, National Horticulture Board operating in India which undertake research and development work for their respective fields**.**

International Organizations Governing Food Safety

- World Health Organization (WHO)
- World Trade Organization (WTO)
- Food and Agriculture Organization (FAO)
- Codex Alimentarius Commission (CAC) (Under FAO/ WHO)
- International Organization for Standardization (ISO)
- International Association of Milk, Food and Environmental Sanitarians (IAMFES)
- International Commission for Microbiological Specifications for Foods (ICMSF)
- National Advisory Committee for Microbiological Criteria for Foods (NACMCF)
- International Dairy Federation (IDF)
- Her Majesty's Stationary Office (HMSO)

International Organization for Standardization (ISO)

International Organization for Standardization (ISO) is based in Geneva, Switzerland. Founded in 1947 for the purpose of advancing standardization around the world, this non-government organization is now comprised of over 130 member countries. The ISO 9000 series of quality management standards were developed by the ISO/TC 176 (ISO Technical Committee 176) convened in 1979. It sets out to create a series of internationally recognized quality management standards that represent the essential requirements that every enterprise needs to address to ensure the consistent production and timely delivery of its goods and services to the marketplace. These requirements make up the standards that comprise the quality management system. The ISO 9000 series is able to provide these quality management benefits to any organization of any size, public or private, without dictating how the organization is to be run. The series contains four system standards of varying complexity and completeness which are: ISO 9001, ISO 9002, ISO 9003 and ISO 9004.

The ISO/TC 207 convened in 1993, developed the ISO 14000 series of environmental management standards. The ISO 14000 series of standards represent the essential requirements that every enterprise needs to address in order to control and minimize the impact that its operation, and resulting goods and services, has on the environment.

Codex Alimentarius Commission (CAC)

The Codex Alimentarius Commission (CAC) was created in 1963 by FAO and WHO to develop food standards, guidelines and related texts such as codes of practice under the Joint FAO/WHO Food Standards Programme. The main purpose of this programme is protecting health of the consumers, ensuring fair trade practices in the food trade and promoting coordination of all food standards work undertaken by international government and non-government organizations.

Hazard Analysis and Critical Control Point (HACCP)

Hazard Analysis and Critical Control Point (HACCP) is a food safety programme that was developed nearly 30 years ago for NASA to ensure the safety of food products that were to be used by the astronauts in the space programme. HACCP involves a systems approach for identification of hazards, assessment of chances of occurrence of hazards during each phase, raw material procurement, manufacturing, and distribution, usage of food products and in defining the measures for hazard control.

HACCP is comprised of seven principles

1) Analyze hazards – Potential hazards associated with a food and the measures required to control those hazards are identified that include biological, chemical and physical contaminants.
2) Identify critical control points (CCP). These are points in a food's production at which potential hazards can be controlled or eliminated.
3) Establish preventative measures with critical limits for each control point. These are minimum standards required for the safe preparation of food.
4) Establish procedures to monitor the critical control points. Such procedures include determining how and by whom processing standards are to be monitored.
5) Establish corrective actions to be taken when monitoring has shown that a critical limit has not been met. Therefore, either reprocess or dispose off foods if minimum processing standards have not been met.
6) Establish procedures to verify that the system is working properly for testing and calibrating equipment to ensure their proper functioning which is one typical requirement.
7) Establish effective record keeping in order to document the HACCP system. This would include records of hazards and their control methods, monitoring of safety requirements and corrective actions taken to either prevent problems or how non-conformances are to be prevented from reoccurring.

HACCP enables the producers, processors, distributors, exporters etc., of food products to utilize technical resources efficiently and in a cost effective manner for ensuring food safety. For food industry in India, adoption of HACCP is becoming imperative to reach global standards, demonstrate compliance to regulations/ customer requirements besides providing safer food at all times. HACCP helps in the reduction of contamination, reduction recalling/ product destruction, providing market protection, providing preferred supplier

status, demonstrating conformance to international standards, transforming commodities into branded products and facilitating international acceptance.

Standardization systems for quality control of foods

S.N	Act / Order	Mode of Operation	Regulations	Special Features
I. Compulsory legislations				
1.	Prevention of Food Adulteration (PFA) Act, 1954	i)Ministry of Health & Family Welfare ii)Directorate General of Health Services iii)Central Committee for Food Standards	Makes provisions for prevention of adulteration of food. Adulterated, misbranded, and not in accordance with the conditions of license shall be prohibited for selling. No such food shall be imported. Standards for the commodities have been specified in the rules. Proprietary foods shall specify the ingredients in the product in the descending order of their composition of the label.	Minimum quality standards. Ensure safety against harmful impurities, adulteration. Mandatory law Non-following of PFA Act lead to fine and imprisonment.
2.	Atomic Energy Rules, 1991 (Control of irradiation of food)	Department of Atomic Energy	Regulates the irradiation application in foods. Certificate with the dose and purpose is insisted upon.	Certificate of irradiation indicating the dose and the purpose shall be provided by the competent authority.
3.	Essential Commodity Act, 1954	Ministry of Food	Regulates the manufacture of commodities, commerce and distribution.	Formations of other suborders for easy implementation.
4	Fruit Products Order (FPO), 1955	Ministry of Food Processing Industry Central Food Products Advisory Committee	Regulates the manufacture and distribution of all fruit and vegetable products. Exempted from the provisions of the order to products prepared by Drug Control Act and Educational Institutions for training purposes. Quantity shall not exceed 10 kg. License shall be issued after the satisfaction of quality of product, sanitation, personnel hygiene, machinery, equipment and work area requirements as per the schedule specified.	Licensing authority 'FPO' standard mark shall be imprinted on the products
5	Vegetable Oil	Ministry of Food	Regulates the production and	Supersedes the Vegetable

	Products (Regulation) Order, 1998	and Consumer Affairs	distribution of all the edible oils. Specifications of the products provided.	Oil Products (Control) Order, 1947 and Vegetable Oil Products (Standards of Quality) Order, 1975. BIS Certification for the tin plates used for "*Vanaspati"* packing is deleted.
6.	Sugar (Control) Order, 1966	Ministry of Agriculture and Irrigation Department of Sugar	Regulates the manufacture, quality and sale of sugar.	
7.	Export (Quality Control & Inspection) Act, 1963	Ministry of Commerce Export Inspection Council 5 Regional Export Inspection Agencies Network of 50 Offices	Regulates compulsory, pre-shipment inspection. Exportable commodities list has been notified for pre-shipment inspection. Quality control of various export products is monitored.	AGMARK has been recognized as an agent for inspection and quality control of certain items. Voluntary inspection at the request of foreign buyers and advice of Export Inspection Council is also carried out.
8.	Standards on Weights and Measures Act, 1976	Ministry of Food and Civil Supplies Directorate of Weights and Measures	Prescribed the conditions for packed products with respect to quantity declaration, manufacturing date and sale price.	Providing relief to the weaker sections of society and protecting the consumer in general by guaranteeing the quantity for the amount paid.
9.	The Consumer Protection Act, 1986	Ministry of Food and Civil Supplies	Provision made for the establishment of consumer councils and other authorities for the settlement of consumer disputes.	Protection of the interest of Consumers.
10.	Environ-ment Protection Act, 1986	Ministry of Environment and Forestry	Regulates the manufacture, use and storage of hazardous microorganisms /substances/cells used as foodstuff.	Compulsory for every food plant discharging waste into mainstream to obtain a No Objection Certificate (NOC) from respective State Pollution Board.

11.	The Insecticide Act, 1968	Directorate of Plant Protection, Quarantine and Storage, Ministry of Agriculture	Describes the safe use of insecticides to ensure that residual level doesn't pose any health hazard.	
II. Voluntary Standards				
1.	Agricultural Produce (Grading & Marketing) Act, 1937	Directorate of Marketing and Inspection	Grade Standards are prescribed for Agricultural and Allied Commodities Grading, sorting as per quality attributes and inspection are included.	Activity is based on marketing and grading at producers' level. Non-following of rules leads to fine and imprisonment. AGMARK Certificate System available.
2.	Bureau of Indian Standards (BIS)	Indian Standards Institution	Prescribing of grade standards, formulation of standards, and specification for foods, prescribing standards for limits of toxic compounds as applicable. Implementation of regulation by promotion through its voluntary and third party certification system, specifying of packaging and labeling requirements.	General cover on hygienic conditions of manufacture, raw material quality and safety are given. Quality and Safety oriented standards. Enforces certification system.
3.	Certification Marks Scheme, BIS Act, 1986 (Rules and Regulations)	Bureau of Indian Standards	Regulates the certification scheme for various processed food products, ingredients and packaging containers.	Ensure the quality to the consumer by certification.