CONTENTS

INTRODUCTION TO FOOD PROCESSING

1

Learning Outcomes

- To know the importance, need and meaning of food processing.
- To understand the role and contribution of different subsectors of food processing.
- To identify the scope of food processing.

1.1.0. Introduction

In prehistoric period, food processing methods include slaughtering, fermenting, sun drying, preserving with salt and various means of cooking such as roasting, smoking, steaming and oven baking. Modern food processing technology was largely developed in the nineteenth and twentieth century.

Food processing as a scientific and technological activity covers a broader area than food preparation and cooking. It involves the application of scientific principles to slow down the natural processes of food decay caused by micro-organisms, enzymes in the food or environmental factors such as air, heat, moisture and sunlight.

Figure 1.1 Food Processing Unit

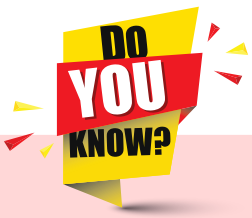
In India, agriculture sector has come a long way since the time of independence, with the emergence of green revolution. India's agriculture industries have transformed itself from country shortages to a land of surpluses. With the rapid growth of the

Indian economy, consumption pattern of the country is also being changed, from cereals to more varied and nutritious diet of fruits and vegetables, milk, fish, meat and poultry products. All these effects have resulted in the development of food processing industries. The accomplishments and achievements of the green and white revolutions have contributed to the development of Indian Processing Industry.

1.1.1. Meaning of Food Processing

Food processing takes clean, harvested crops or butchered animal products and use these to produce attractive, marketable and often long shelf-life food products.

It includes process under which the raw product of agriculture, dairy, animal husbandry, meat, poultry or fish is transformed through a process involving employees, power, machines or money. Its original physical properties undergo a change and the transformed product has commercial value as well as suitable for human consumption.



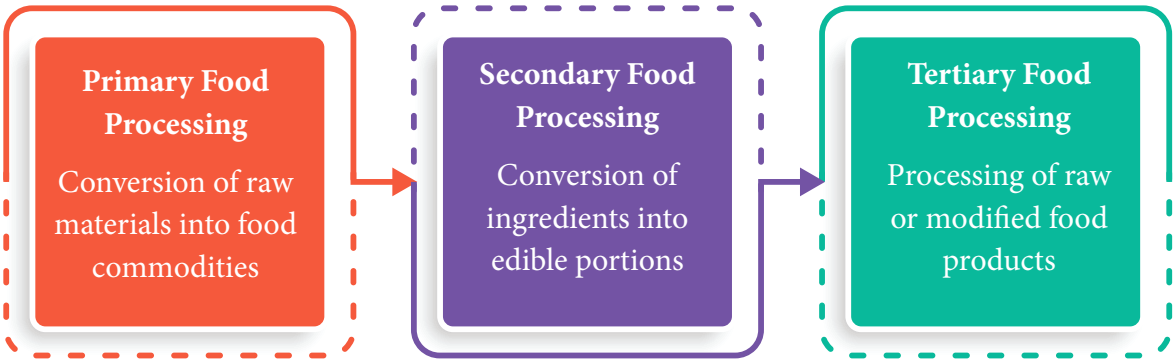
The Indian food processing market cost ₹ 24,665 Billion in 2018. The market is projected to reach ₹ 50,571 Billion by 2024 exhibiting a CAGR of 12.4% during 2019-2024.

Definition

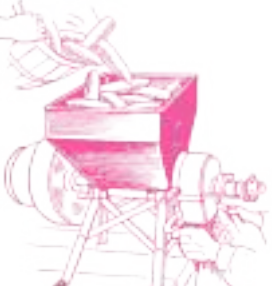
Food Processing is a series of operations by which unprocessed foods are converted into food stuffs to prolong their duration, enable storage and reduce time / effort spent in culinary procedures.

Classification

Food Processing is classified into primary, secondary and tertiary as shown in Flowchart 1.1.



Flowchart 1.1: Classification of Food Processing



Notes

1. Primary food processing

Primary processing relates to conversion of raw agricultural produce, milk, meat and fish into a commodity that is fit for human consumption. It involves steps such as cleaning, grading, sorting and milling of grains, shelling nuts and butchering animal meats.

Figure 1.2 Primary Food Processing (Sorting)

2. Secondary Food Processing

Secondary food processing involves creating food from ingredients that are ready to use. Baking bread, fermenting fish and sausages, making wine, beer and other alcoholic products are traditional forms of secondary food processing.

Figure 1.3 Secondary Food Processing (Malting)

3. Tertiary Food Processing

Tertiary food processing is the commercial production of what is commonly called processed foods. They are ready-to-eat and serve foods

Figure 1.4 Tertiary Food Processing (Sunflower oil)

Primary, secondary and tertiary food processing of various food elements are given in Table 1.1

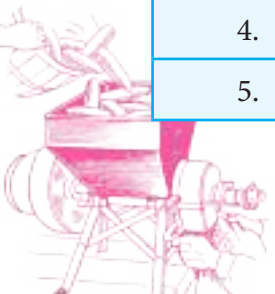
Table 1.1: Primary, Secondary and Tertiary Food Processing of Various Food Elements

S. No.	Food	Primary Processing	Secondary Processing	Tertiary Processing
1.	Fruits and vegetables	Cleaning, sorting, grading and cutting	Slices, pulp, flakes, paste, preserved and flavoured	Ketchups, jam, juices, pickles, preserves, candies, chips
2.	Cereals and grains	Sorting and grading	Flour, broken rice, puffed, malted and milled	Biscuits, noodles, flakes, cakes
3.	Oil seeds	Sorting and grading	Oil cakes	Sunflower oil, groundnut oil, mustard oil, olive oil
4.	Beverages	Sorting, bleaching and grading	Leaf, dust and powder	Tea bags, flavoured coffee, soft drinks, alcoholic beverages
5.	Milk	Grading and refrigerating	Cottage cheese, cream, simmered and dried milk	Processed milk, spreadable fats, yogurt (butter and cheese)
6.	Meat and poultry	Sorting and refrigerating	Cut, fried, frozen and chilled	Ready-to-eat meals
7.	Marine products	Chilling and freezing	Cut, fried, frozen and chilled	Ready-to-eat meals

Activity – 1

Identify the given processed foods and classify accordingly.

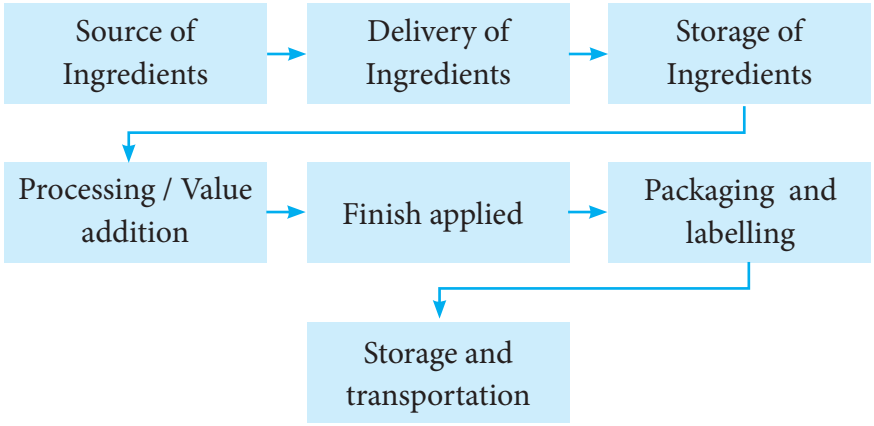
S. No.	Food items	Classification
1.	Flour	
2.	Noodles	
3.	Tea bags	
4.	Cottage cheese	
5.	Yogurt	



Notes

Food Processing Supply Chain

Most foods which are manufactured goes through a number of common steps. The sequence of unit operations in food processing from delivery of raw materials to distribution of finished product is given in Flowchart 1.2.



Flowchart 1.2 Delivery of Raw Materials from Source to End Products in Food Processing

Figure 1.5 Food Supply Chain

1.1.2. Significance of Food Processing

Foods are preserved for the following major reasons.

- Preservation for later consumption or sale to fetch better price.
- Removal of inedible portions
- Destruction of harmful substances
- Conversion to various forms desired by the consumer
- Reduce malnutrition and food wastage
- Boosts trade and earns foreign exchange
- Bridge between agriculture and manufacturing.

- Preserves the nutritive quality of food and prolongs shelf-life
- Provide employment opportunities in local places and so reduce migration.
- Controls food inflation. eg: Frozen peas are available throughout the year.
- Creates incentive for the farmers to grow and diversify crops.

Figure 1.6
Sorting Vegetables

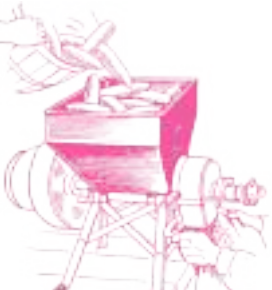
Need of food processing and preservation

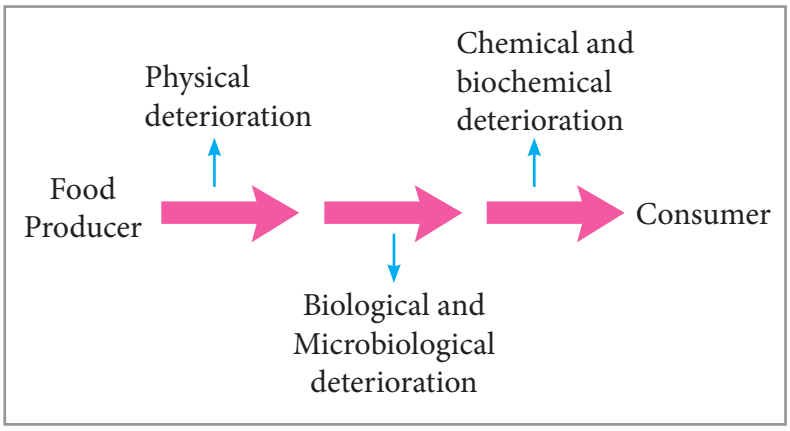
Food processing is a process of transformation of raw ingredients into food by means of physical and chemical treatments. But food preservation is to stop or slow down the spoilage of food, loss of quality and edibility of food for longer time. It involves preventing the growth of bacteria, fungi and microorganisms. Food processing involves both packaging and preservation and it turns food into more palatable and convenient to eat. So both processing and preservation is important in food industry. Food processing maintains a nutritious and safe food supply for the millions of people in urban and rural areas. Improvement in processing efficiency by increased yield of usable product is a tangible means of reducing food loss and increase in food supply.

Figure 1.7
Food Processing Industry

Food preservation is to keep food longer, reduce waste, and allow for food to be transported for refrigeration and other method of preservation. Preserving food allows for a stacked pantry as well as emergency stores of food. Food preservation consists of application of science based knowledge through a variety of available technologies and procedures, to prevent deterioration and spoilage of food products and extend their shelf-life. Shelf-life may be defined as the time it takes a product to decline to an unacceptable level. Deterioration of foods will result in loss of quality attributes, including flavour, texture, colour and other sensory properties. Nutritional quality is also affected during food deterioration. Physical, biological, microbiological, chemical and biochemical factors may cause food deterioration.

Preservation methods should be applied as early as possible in the food production supply chain and therefore include appropriate post-harvest handling before processing of both plant and animal foods. Processing techniques usually rely on appropriate packaging methods and materials to assure continuity of preservation. Handling of processed foods during storage, transportation, retail and by the consumer also influences the preservation of processed foods.





Flowchart 1.3 Losses in the food production supply chain

Selection of technology and procedures for food preservation depends on factors inherent to the product, common pathogenic and spoilage microorganisms and cost. Product-inherent factors include customary ways of consuming the particular food, sensitivity to heat or other principle used to inactivate microorganisms and other physical and chemical characteristics of the food.

Advantages of Food Processing and Preservation

- To destroy, inhibit or remove microorganisms
- To retard or prevent deleterious, biochemical, chemical and physiochemical changes.
- To maintain and generate acceptable organoleptic properties.
- To preserve and enhance the nutritive value by retaining natural colour, structure and flavour
- To store foods for future use.
- To increase shelf-life
- To minimize the wastage.

Figure 1.8 Food Processing Technology

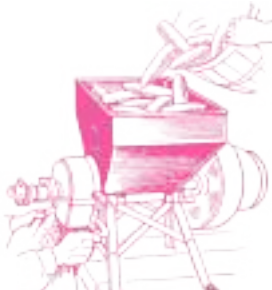
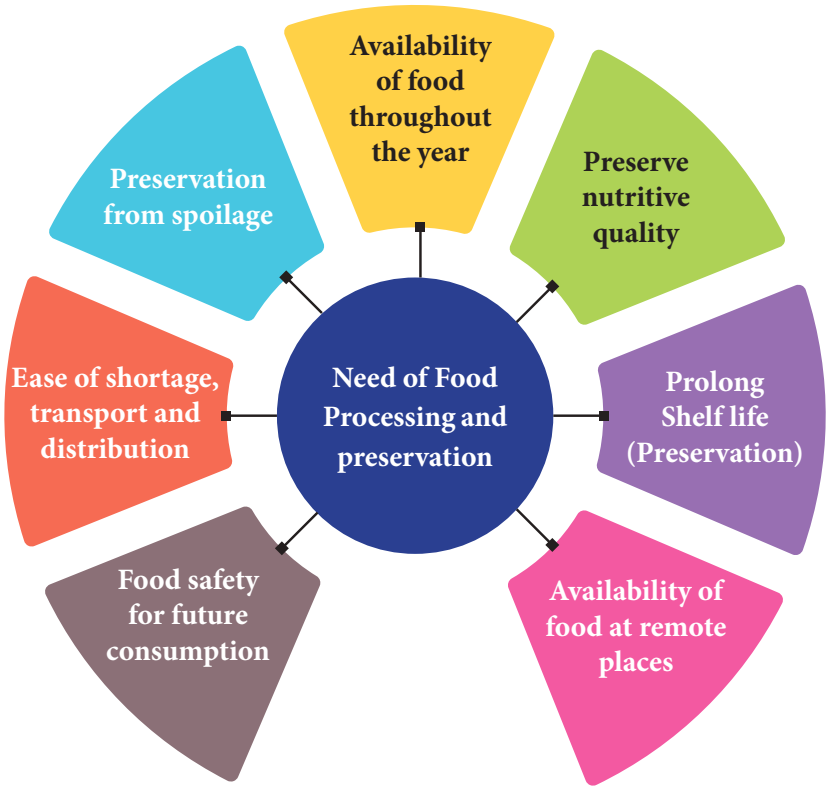


Figure 1.9 Drying

Technologies used in food industry : Processing and preservation technologies used in food industry are given below:

- Heating
- Drying
- Irradiation
- Concentration
- Freezing
- Using chemical preservatives
- Chilling
- Fermentation
- A combination of the above technologies

The need of food processing and preservation is shown in Flowchart 1.4.



Flowchart 1.4 Need of Food Processing and Preservation

Figure 1.10
Fruits and Vegetables

1.1.3. Fruits and Vegetables in Human Nutrition

Fruits and vegetables are important source of vitamins, minerals, fibre, disease fighting phytochemicals and antioxidants. Fruits and vegetables are good for health and are associated with decreased risk of cardiovascular disease and certain types of cancer. They are low in fat and recommended to make larger parts in diet. The benefits of fruits and vegetables are given in Table 1.2.

Table 1.2: Effects of Fruits and Vegetables on Human Health

S.No.	Sources	Nutrients	Effect on human health
1.	**Fruits:** Pineapple, Strawberry, Tomato, Watermelon, Citrus fruits, Guava **Vegetables:** Broccoli, Cabbage, Leafy Greens, Pepper, Potato	Vitamin C (Ascorbic acid)	• Prevents scurvy and cardiovascular diseases • Aids wound healing • Healthy immune system
2.	**Fruits:** Apricot, Mango, Orange, Papaya, Peach, Pineapple, Tomato **Vegetables:** Dark green leafy vegetables: Spinach and Turnip greens. Orange vegetables: Carrot, Pumpkin and Sweet potato	Vitamin A (Carotenoids)	• Prevents night blindness, chronic fatigue, psoriasis, heart disease, stroke and cataracts
3.	Lentils, Onions, Crucifers (Cabbage, Broccoli), Leafy greens and Nuts	Vitamin K	• Essential for the synthesis of pro-coagulant factors. • Prevents osteoporosis
4.	Dark green vegetables, Lentils, Corn, Dry beans **Nuts:** Almonds, Cashew nuts, Peanuts and walnuts	Vitamin E (Tochopherols)	• Prevents cancer, heart disease and diabetes • Boosting immune system
5.	Most of the fruits and vegetables	Fibre	• Control blood sugar level • Maintain bowel health • Lower cholesterol level
6.	**Dark green leafy vegetables:** Spinach, mustard greens, Broccoli and Asparagus	Folate (Folic acid)	• Prevents birth defects, cancer and heart disease • Helps tissues growth • Prevents and controls disorders of nervous system

7.	**Green leafy vegetables:** Broccoli, Cabbage, Pumpkin, Cauliflower **Fruits:** Papaya, Orange	Calcium	• Prevents osteoporosis • Proper function of skeletal muscle system • Development of teeth and regulate blood pressure
8.	**Fruits:** Dried Figs, Avocados, Guavas, Banana, Kiwi fruit, Papaya, Blackberries, Raspberries **Vegetables:** Potato, Spinach	Magnesium	• Prevents osteoporosis • Regulate blood glucose level and blood pressure • Teeth development and immune system
9.	**Fruits**: Banana, Dry fruits (Prunes and Apricots) **Vegetables:** Baked potato, Cooked greens	Potassium	• Prevent stroke and arteriosclerosis • Regulate blood pressure

Figure 1.11 Fruit Salad

Figure 1.12 Meal Plate

Activity – 2

List any five vitamin C rich fruits and their processed foods.

How to add fruits and vegetables in our daily diet?

- Fresh fruits are nutritionally superior to fruit juices. They have more micronutrients and tasty.
- Eat as much of other vegetables as possible daily.
- Add vegetable and fruits in every day meal in various forms like curry, soups, mixed with curd and rice.
- Consume raw and fresh vegetable as salads.
- Different varieties of vegetables and fruits add colour to meal plate.
- Vegetables and fruits can be added both for weight loss and obesity. Roots and tubers and banana help to increase weight and at the same time some vegetables like bottle gourd, ridge gourd and greens provide very low calories which helps in reducing weight.
- Proper methods of cooking and cutting help in reducing nutrient loss of fruits and vegetables.

Notes

- ICMR recommends intake of 100g of fruits and 300g of vegetables every day to make a diet balanced. This includes 125g of leafy vegetables, 75g of other vegetables and 100g of roots and tubers.

1.2.0. Different Sub-sectors under Food Processing

Indian food processing industry is the world's second largest producer of food next to China and has a powerful influence on food and agriculture sector. The total food production in India is likely to double in next ten years and there is great opportunity for large investments in food processing technologies.

Figure 1.13 Packaged Fruits and Vegetables

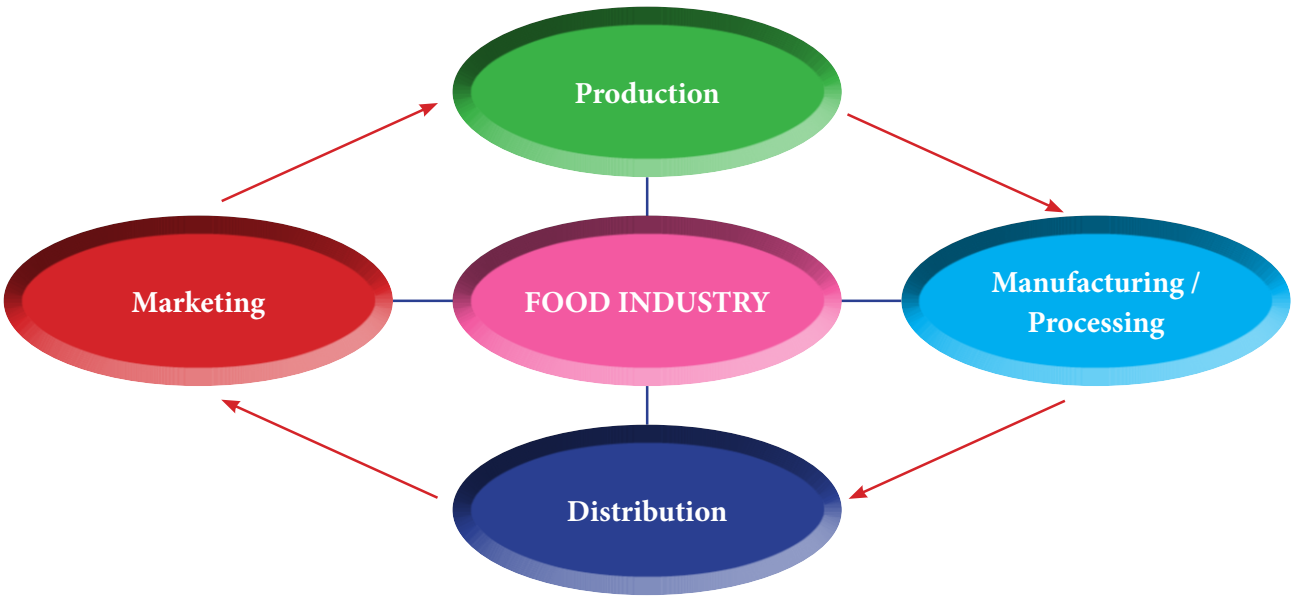
Food processing industry includes establishment of post-harvest infrastructure for processing of various food items like cold storage facilities, food parks, packaging centres, value added centres and irradiation facilities.

Food processing is a technique of manufacturing and preserving food substances in an effective manner by enhancing their shelf-life, quantity as well as makes them functionally more useful. The food processing sectors in India consist of two different segments as **"Primary Processed Foods"** and **"Value Added Foods"**. Primary processed foods are packaged fruits and vegetables, milk, flour, rice and spices. Value added foods are processed fruits and vegetables like juices, jam, jelly, vegetable or fruit powders (ginger or mango), pickles, fruit bars and desiccated coconut powder.

Figure 1.14 Small Food Processing Industry

The food processing industries in India includes millions of Small and Medium Enterprises (SMES) worldwide and some largest companies in the world and helps to increase the economic level of the country.

The food industry is divided into four major segments are shown in Flowchart 1.5.



Flowchart 1.5 Major Segments of Food Industry

1. Production

Activities as farming, ranching, orchard management, fishing and aquaculture are included in this segment. Selection of animal varieties, cultivation, growth, harvest and handling of the raw materials are done with various technologies.

2. Manufacturing / Processing

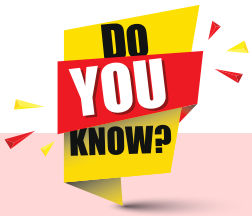
Manufacturing converts raw agricultural products to more refined and finished products. It requires many unit operations and processes.

3. Distribution

Distribution deals with product sales. This includes product form, weight and bulk, transportation, storage requirements and storage stability.

4. Marketing

Marketing is selling of foods as raw or processed which involves wholesale or retail to institutions or restaurants.



Allied industries

Specific examples include cans, food colour and flavuor, paper products, and plastic products. Chemical manufacturers represent another group of allied industries. They supply the acidulants, preservatives, enzymes, stabilizers, and other chemicals used in foods. Monitoring and regulatory agencies such as the BIS, APEDA, FPO, Food & Drug Administration (FDA), lawyers, consumer action and information agencies, and other regulatory agencies are also part of allied industries.

1.2.1.0. Sub sectors in Indian Food Processing Industries

Indian Food Processing Industries cover various subsectors like agriculture, horticulture, plantation, animal husbandry and fisheries. The different subsectors are shown in Flowchart 1.6.

1. Fruits and Vegetables

2. Milk and Dairy

3. Fisheries

4. Meat and Poultry

5. Cereals and Grains

6. Plantation and Spices

7. Consumer Industry and Others

Flowchart 1.6 Different Subsectors of Food Processing Industry

1. Fruits and Vegetables

India yields the widest variety of fruits and vegetables across the world, and is the second major vegetable and third major fruit producer accounting for 8.4 percent of the world's entire fruit and vegetable yield. Fruits production is estimated to be around 97.97 million tonnes (2018-19) compared to 96.45 million tonnes of 2017-18. Vegetables production is 183.17 million tonnes in fiscal year 2019. In India fruits and vegetables have been shown to earn 20-30 times more foreign exchange permit area than cereals due to higher yields and higher price available in the international market. The major processed items in the fruits and vegetables segments are as follows:

- Fruit juices, concentrates and fruit based ready-to-serve beverages

Figure 1.15 Vegetable processing

Figure 1.16 Jam

Figure 1.17 Jelly

Notes

- Canned fruits and vegetables
- Jams, jellies, squashes
- Pickles, chutneys and dehydrated vegetables
- Vegetable curries in restorable pouches
- Canned mushrooms and its products
- Dried fruits and vegetables.

2. Milk and Dairy

The Indian dairy market is the largest and fastest growing markets in the world. Increasing percapita income, health consciousness and change of lifestyle are the key factor for milk and milk products consumption in India. The total milk production in the country amounted to about 187 million metric tonnes in fiscal year 2019. The milk production in the country has an increase of 6.5 percent over the previous year.

Figure 1.18 Milk Processing Unit

Processed dairy segments are as follows:

- Skimmed milk powder, whole milk powder
- Ghee, flavoured yogurt, butter
- Flavoured milk, cheese
- Custard, smoothies

Figure 1.19 Processed Cheese

3. Fisheries

India is the third largest fish producing country in the world and ranks second in inland fish production. The total fish production during 2017-18 is estimated to be 12.60 million metric tonnes, of which nearly 65% is from inland sector and about 50 percent of the total production is from culture fisheries and constitutes about 6.3% of the global fish production.

The country's geographical advantage, in terms of a long coastline, abundant rivers and canals, reservoirs and ponds contributes 10 percent of the global biodiversity.

The Indian seafood fish processing industry is quite well developed. Because of the large scale processing facilities and skilled manpower, value addition, import of raw material for processing and export hold good prospects for India. Modern technology helps to export dried products to canned and frozen farms. The processed items in fisheries segment are as follows:

- Extruded products, battered and breaded products
- Surimi and derivatives
- Pickles and curried products

4. Meat and Poultry

Processing of meat is licensed under the Meat Food Products Order 1973. In India there are 2600 slaughter houses, 9 modern abattoirs and 171 meat processing units licensed under the Meat Food Products Order.

Meat and poultry production in India helps to create employment to millions of rural people. This requires large investment in infrastructure mainly in cold storages and modern meat processing plants like cold chain. In local markets, the growing number of fast food outlets in the country has a significant impact on the meat processing industry. There are eight integrated poultry processing units in the country, which holds the significant share in the industry. The processed items in meat and poultry segment are as follows:

- Sausages and canned meat
- Homogenized meat preparations
- Preserved meat and poultry
- Bacon, Ham, curries, meat loafs and cutlet mix

Figure 1.20: Fish Processing

Figure 1.21 Processed Sea-food

Figure 1.22 Meat Processing Unit

Figure 1.23 Processed Meat

Figure 1.24 Poultry

Figure 1.25 Cereal Grains

Figure 1.26 Biscuits

Figure 1.27 Tea

Figure 1.28 Coffee

5. Cereals and Grains

Processing of cereals includes milling of wheat, rice and various types of pulses. Primary milling helps to add shelf life, wastage control and value addition. Apart from the large flour mills, there are small mills operating in an unorganized manner. Rice occupies the major share in India's cereals export and it includes Basmati and non-basmati rice. The total food grain production in the county is estimated to 291.95 million tonnes (2019-20) which is higher by 6.74 million tonnes than the production of food grain of 285.21 million tonnes achieved during 2018-19.

Oil seed processing is another major segment, an activity largely concentrated in the cottage industry. Branded grains as well as grain processing is now gaining popularity due to hygienic packaging.

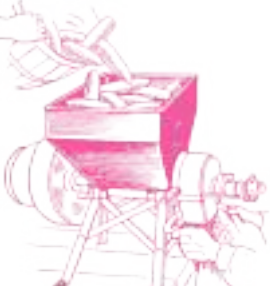
The different segments are as follows:

- Flour, bakery products
- Biscuits, pasta
- Cornflakes, malted foods
- Beer and malt
- Palm oil, sunflower oil

6. Plantations and Spices

Plantation crops in the country include coconut, oil palm, cashew, tea, coffee and rubber. Besides spice crops, cocoa are also considered as plantation crops. This sector contributes a significant amount to the foreign exchange, employment opportunities and for overall economic development.

During the fiscal year 2018, volume of coconut production in India amounted to 16.4 million tonnes. India was the second largest tea producer in the world with production of 1339.70 million kilograms (2019). Coffee production in India is accounting for 71 percent from Karnataka, followed by Kerala with 21 percent and Tamilnadu as 5 percent. India is one of the largest producers of coffee representing 3.5 percent of world coffee production.



Notes

7. Consumer Industry and Others

This includes chocolates, confectionaries, soft drinks and aerated beverages. Flavour innovation is a new trend in chocolate confectionary with manufacturers experimenting with new flavours such as coffee, cinnamon, fruit flavours like strawberry and orange peel. Dark chocolate which has lower sugar content with reasonable amount of antioxidants also favoured rising demand in the sector.

Natural health beverages continued to be significant value growth because of its flavours and nutrient contents. Fruits such as orange, mango and apple are remaining the most popular.

Figure 1.29 Chocolate

Figure 1.30 Confectionary

Figure 1.31 Fruit Juices

Ayurveda based juices such as aloevera, amla and vegetable juices, organic beverages, organic tea and sports drinks (fortified with nutrients) also have strong value sales performance.

India's significant production strength and the application of new processing technologies opens a gateway for the growth of the food processing industry.

Activity – 3

Draw a flow chart of different food processing subsectors and their processed foods.

1.2.2. Role and Contribution of Different Subsectors in Indian Economy

The Indian food processing industry, one of the largest industries in India, accounts for 32 percent of the country's total food market and is ranked fifth in terms of production, consumption, export and expected growth.

The significant benefits for different stakeholders involved in food processing are as follows:

Figure 1.32 Indian Farmer

* **Agronomist / Farmers**	:	Higher yield, better farm realization, lower risk
* **Consumer**	:	Greater variety, low prices, new products
* **Firm / Establishment**	:	New business opportunities, growth
* **Economy and Government**	:	New employments, decreasing rural migration

Food Processing Industry in India is a potential source for elevating rural economy as it brings synergy between industry and agriculture. A developed food processing industry must increase rural incomes, reduce wastages, ensure value addition, promote crop diversification and generate employment opportunities.

A continuous growth in urban population and an increase in employment rates results in busy lifestyle. Time available for cooking and meal preparation is limited. So processed foods such as ready-to-eat products and snacks have become quite popular. India has the largest working population in the world. So with increasing income flow, the subsectors in food industries have the biggest consumer turnover.

Food processing has numerous advantages in Indian economy. It has capacity to lift millions out of poverty and malnutrition. The production advantages of different subsectors in food processing industry are shown in Table 1.3.

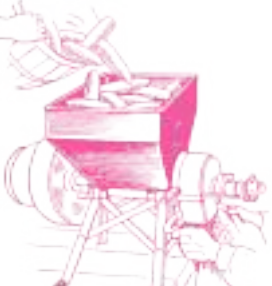


Table 1.3: Production Advantages of Subsectors in Food Processing Industry

S.No.	Food items	Production (Qty.)	Processing level (%)	Processed Foods
1.	Cereals and Grains	284.95 Million Tonnes	7	Brown rice, Basmati rice, Multi-grain flour, Bakery snacks, Ready-to-cook, Ready-to-eat
2.	Fruits and Vegetables	311.7 Million Tonnes	2	Pulp, Puree, Paste, Sauces, Snacks, Dressings, Slices, Flakes, Jam, Jelly
3.	Milk and Dairy Products	176.35 Million Metric Tonnes	35	Value added products, Ghee, Flavoured yogurt, Butter, Flavoured milk, Cheese
4.	Meat	7.7 Million Tonnes	21	Sausages, Canned meat, Ham, Bacon
5.	Poultry	95.2 Billion eggs	6	Preserved poultry, nuggets, burgers
6.	Marine Products	12.60 Million Metric Tonnes	23	Canned and Frozen items
7.	Consumer foods (Packaged foods)	-	-	Aerated soft drinks, Packaged food and drinking water, Alcoholic beverages, Sauces, Soups, Noodles, Chocolates, Confectionary

(Source: Food Processing Report 2019 cdr.cII-FACE)

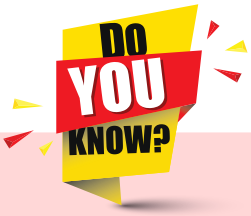
1.3.0. Scope of Food Processing

Food processing has an important role to play in linking Indian farmers to consumers in the domestic and international markets. The Ministry of Food Processing Industries (MoFPI) is making all effort to encourage investments across the value chain. The industry engages approximately 1.85 million people in around 39,748 registered units with fixed capital of $32.75 billion and aggregate output of around $158.69 billion.

Major industries constituting the food processing industry are grains, sugar, edible oils, beverages and dairy products. The increase in the incomes of the working class has lead to be spent on processed foods. The change in the food habits of the working class who prefer readily available convenient is another important factor.

In India there is an opportunity for large investments in food and food processing technologies, skills and equipment

Figure 1.33
Ready-to-Eat Foods



GDP-Gross Domestic Product.

GDP is the monetary value of all finished goods and services made within a counting during specific period. GDP provides an economic snapshot of a country, used to estimate the size of an economy and growth rate.

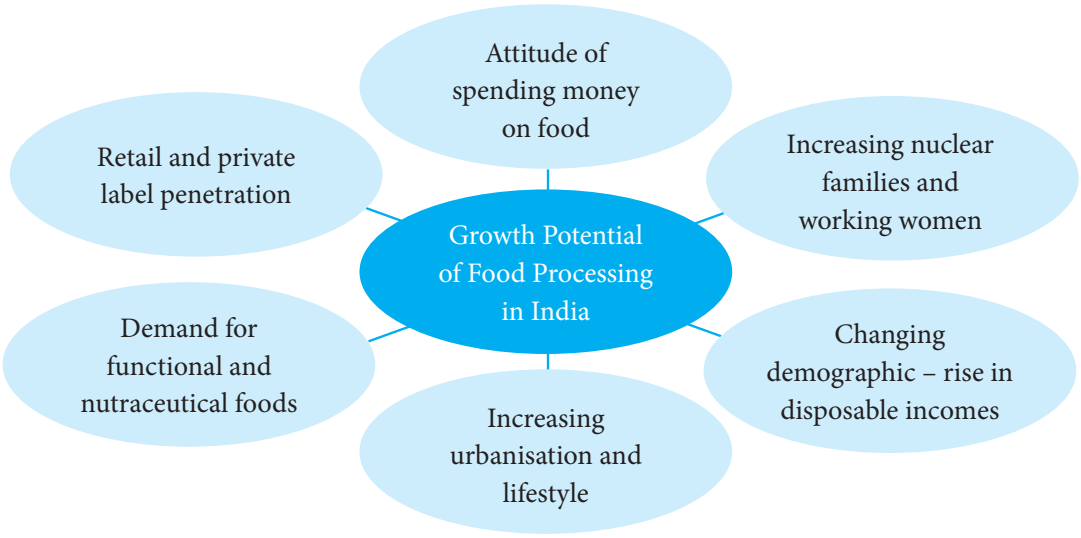
especially in areas of canning, dairy processing, packaging, frozen food or refrigeration and thermal processing.

India is one of the largest agricultural producers, producing 16 percent of the world's total food grains. In India, by 2030, there is an expected population of 1.51 billion. So, the demand for processed food also increases other than the exports.

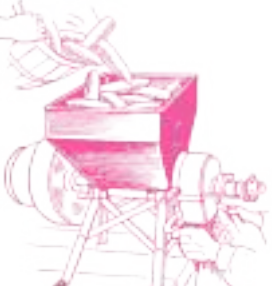
Factors that increase the demand for processed food and processing industry in upcoming years are as follows:

- Due to the rising disposable income levels of the middle class, the domestic market value increases.
- The surplus production of cereals, fruits, vegetables, milk, fish, meat and poultry must be processed and marketed well, so there will be greater opportunities for the growth of the sector.
- Rapid urbanization and food habits of the people are changing towards value added foods. So the demand for processed food increases.
- India is among the fastest growing economies in the world. Conducive business climate in the country attract foreign investment in food processing sector.
- Around 40 percent of total food production is wasted due to the inadequate facilities for transportation, storage, processing and marketing. So this must be rectified.

Food processing sector has emerged as an important segment of the Indian economy in terms of its contribution to GDP, employment and investment. Growth potential of food processing in India is shown in Flowchart 1.7.



Flowchart 1.7 Growth Potential of Food Processing in India



Notes

1.3.1. Present Scenarios of Food Processing in India

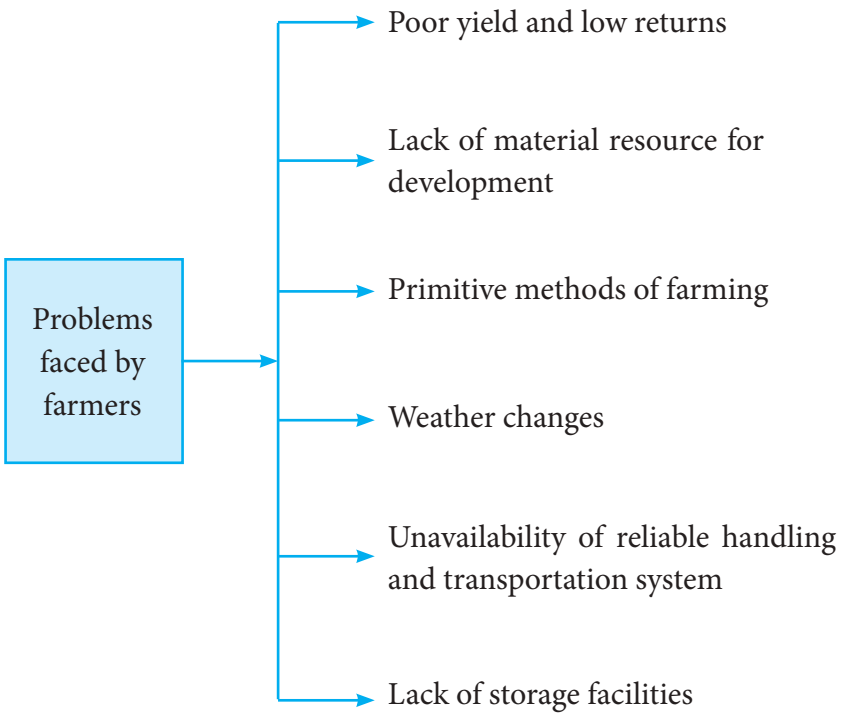
India ranks first in the world in production of milk, ghee, pulses, ginger, bananas, guava, wheat and several other vegetables and fruits but hardly two percent of the produce is processed.

India's livestock population is largest in the world with 50 percent of world's buffaloes and 20 percent of cattle, but only about one percent of total meat production is converted to value added products.

Though India has become a surplus producer of food grains, it does not figure significantly in the world trade. During the last five years ending 2017-18, Food Processing sector has been growing at an Average Annual Growth Rate (AAGR) of around 8.41 percent as compared to around 3.45 percent in Agriculture at 2011-12 prices. The online food ordering business in India witnessing exponential growth so, it has a huge potential and a promising future.

Obstacles in Food Processing Industries

In India at present most of the industries are in unorganized sector. So there are many problems arising from different sectors. The basic problems encountered by Indian food industries are shown in Flowchart 1.8.



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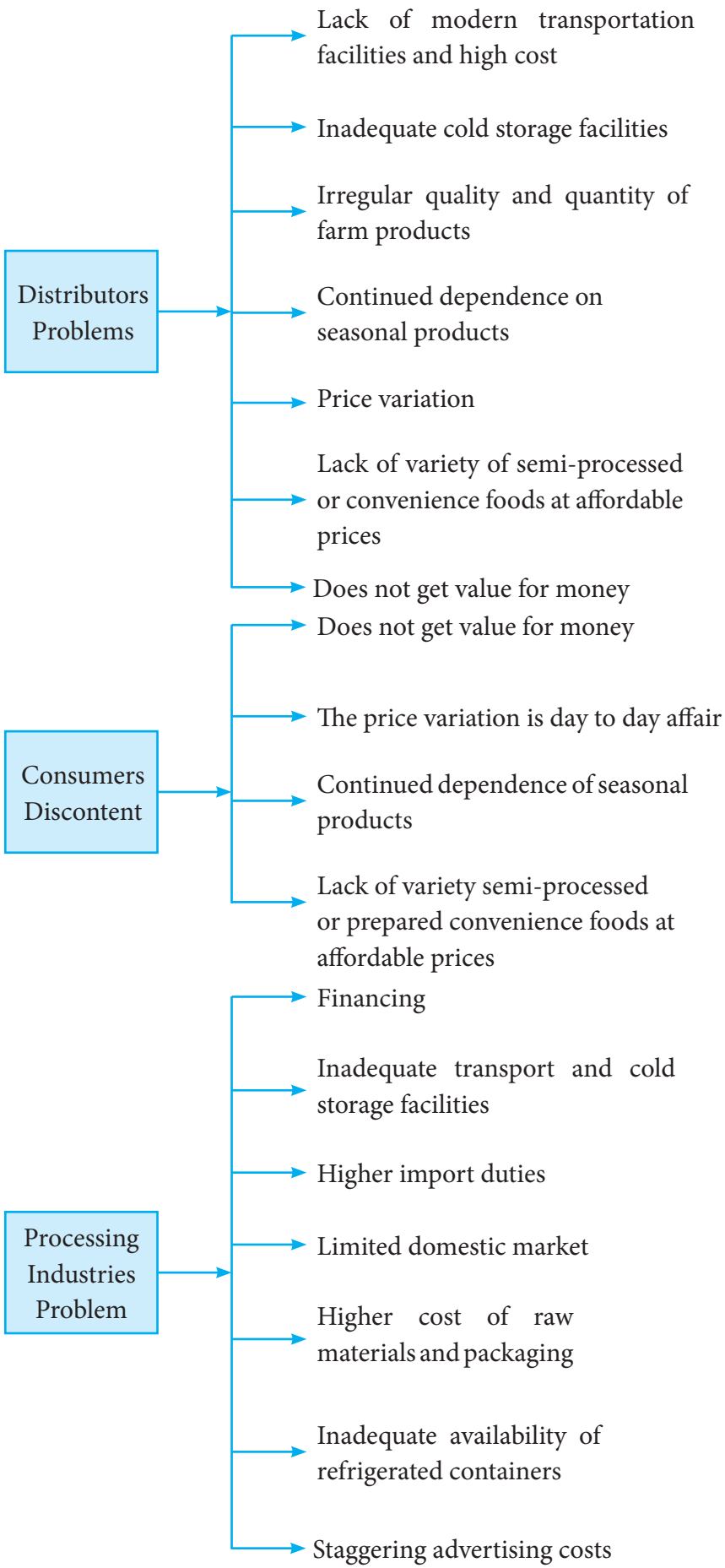
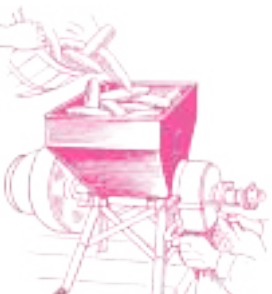


Flowchart 1.8 Problems in Food Processing Industries



Notes

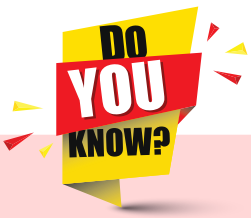
Reasons for Slow growth of Processed Foods in India

- Low income level population cannot afford processed foods.
- High cost of packaging increase the cost of the processed items and so it is out of reach for common man.
- Indians prefer freshly prepared foods rather than packed or preserved foods.

Figure 1.34 Value Added Food- Ginger Powder

- There is no national character for food habits and these keep changing from region to region.
- Transporting facilities are poor for perishable products.
- There are no reliable cold chains which are necessary for temperature sensitive foods like fruits, vegetables and ice cream.
- Modernization is unaffordable for small scale manufacturer, but the large companies do not find investment justifiable due to small size of market.
- Supermarkets are popular only in urban areas, but in rural areas supermarkets are rare. So reach of processed food is meager.
- Poor infrastructure for storing raw food materials. Farmers need warehouses to protect the raw materials from pest infestation. Proper use of pesticide and ventilation is necessary in warehouses.
- Poor quality standards and control methods for implementing the quality standards for processing and packaging the processed foods. For example, vegetables may not be worked properly and processed into either **'ready to eat food"** or packaged as **"cut and ready to cook"** vegetables.

- Extensive use of fertilizers, pesticides and other chemical substances has raised concerns about the quality of food. Protection is needed from unfair and hazardous practices.
- Processed foods may not be nutritionally balanced and may pose a health risk. This could trigger a negative perception regarding processed foods among people.
- Limited production of value added foods is followed by farmers around the country. This results in lower value addition at the processing stage.
- Limited ability to control quality and safety. Implementing quality and safety norms among large unorganized segment is very difficult. This has led to practices such as milk adulteration and use of carbide for fruit ripening.
- **Lack of food testing facilities:** The number of laboratories in the country is insufficient and lack in facilities and infrastructure.
- **Lack of manpower:** Food processing units require skilled manpower like food engineers, microbiologists, research technicians and so on. But at present the availability of man power is low. Very few universities offer graduation or Post Graduate courses for Food Science and Technology



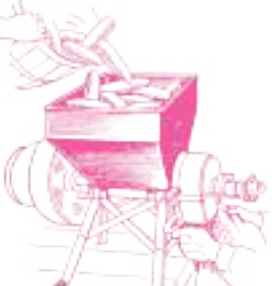
Terminal Markets

A terminal market is a central site, often in a metropolitan area, that serves as an assembly and tending place for agricultural commodities. It can be either be sold to the end consumer or to the processor, or packed for export, or even stored for disposal at a future date. It thus offers different opinions to farmers under a single roof.

Figure 1.35 Terminal Markets

1.3.2. Scope and Future Prospects of Food Processing in India

Food is a global commodity so processing industries will play an important role in economy of any country. Food processing in India is mainly done by unorganized sectors. The government, industry, academia and the framing community need to work together to lift the supply of quality raw materials.



Future Prospects of Food Processing in India

The present trends in the Indian food processing sector are encouraging. These are shown in Table 1.4.

Table 1.4: Present Trends in the Indian Food Processing Sector

S.No.	Criteria	Key Features
1.	Higher consumption of horticulture crop	• Hike in consumption of fruits and vegetables • Indian farmers are shifting production towards horticulture crops to cash in on growing demand
2.	Change of consumer tastes	• Wide variety of products with increasing global connectivity has led to a change in the tastes and preferences of domestic consumers • Rising incomes, increase in urbanization and nuclear families change consumers eating habits.
3.	Entry of International companies	• Liberalization and growth of organized retail have under the Indian market more attractive for globe players. • With a large agriculture sector, abundant livestock and cost competitiveness, India is fast emerging for processed foods.
4.	Rising demand of Indian product in International market	• Strategic geographic location and continuous increase in raw material production help India to supply cheaper products to other countries.
5.	Emphasis on healthier ingredient	• Food processing companies produce low carbohydrate and low cholesterol snacks to health conscious customers. Example: Low fat snacks and biscuits, slim milk, whole wheat products.
6.	A shift from usefulness in processing to usefulness to consumer	• Product innovation is always needed for safe ingredients and additives. • Consumers are willing to pay a higher price for health and convenience foods. • Greater opportunities mainly in product innovation and specialized products.
7.	Frozen processed foods	• Frozen processed foods offer both convenience and nutrition such as chicken, fish and meat products are the concurrent processed foods.

8.	Product innovation	• New innovations add value to food products. • Degree of newness of a product can be creative, innovative or new forms of existing products (ex: Milk shake, green tea)
9.	Strengthening procurement via direct farmer firm linkages	• Contract farming has been operational in India for a long time, it has helped both the processing companies, by increasing sales, augmenting their incomes, providing access to better technology and fetching better price by sewing an assured market for Indian farmers.

Source: Grant Thornton / global assets / Food Processing Sector, 2017

Activity – 4

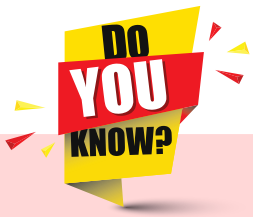
List any five ready-to-eat meals / foods and its effects on human health.

Scope of Food Processing Industries

1. Lending loans by banks will promote better growth of the industry.
2. Developing agricultural facility with good agricultural practice which leads to the transition from staple food crops to diversification of crops.

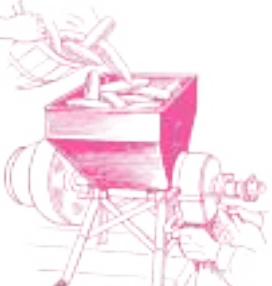
Figure 1.36 Ready-to-eat Meal

3. Development of hybrid varieties result in greater availability of quality raw materials to the industry resulting in better capacity utilization and producing a wide range of products and of international quality.



Contract Farming

It is a production and marketing or procurement system wherein producers agree to grow a crop at a pre agreed market price for procurement by another party usually a public or private company or corporation.



Notes

4. Storage capacities and infrastructure should be increased through proper storage on food grains, cold chain, value addition and mega food parks.

   a. **Storage of food grains and horticulture products:** In India, the surplus grains are stored with government agencies like Food Corporation of India, Control and State Warehousing Corporations. Storage structure should be properly repaired, cleaned and disinfected.

Figure 1.37 Warehouse

   b. **Cold chain facilities:** The objective of the scheme of cold chain, value addition and preservation infrastructure is to provide integrated cold chain and preservation infrastructure facilities without any break, from the farm gate to the customer. It covers creation facility, along the entire supply chain through pre-cooling, weighing, sorting, grading, waxing facilities at farm level, multi-temperature cold storage and mobile cooling. Van and mobile cooling units are used for facilitating distribution of horticulture, organic produce, marine, dairy, meat and poultry.

Figure 1.38 Cold Chain Storage

Notes

c. Value addition

Forward backward integration (in supply chain)

Suppliers to a producer or trader lie on upstream side, whereas customers lie on downstream side. For a farmer supplier of seeds and fertilizers lie on upstream, while cold store owners, farm contractors, mill owners, traders in agro output lies on downstream.

Forward and backward integration is also called vertical integration. For this a farmer needs financial and technical support. Integrated Pack-houses with mechanized sorting, grading and cold storage for the backward linkage and retail chain of outlets including facilities such as frozen storage and chillers for forward linkage are needed. The facility of refrigerated or insulated transport connects backward and forward linkages.

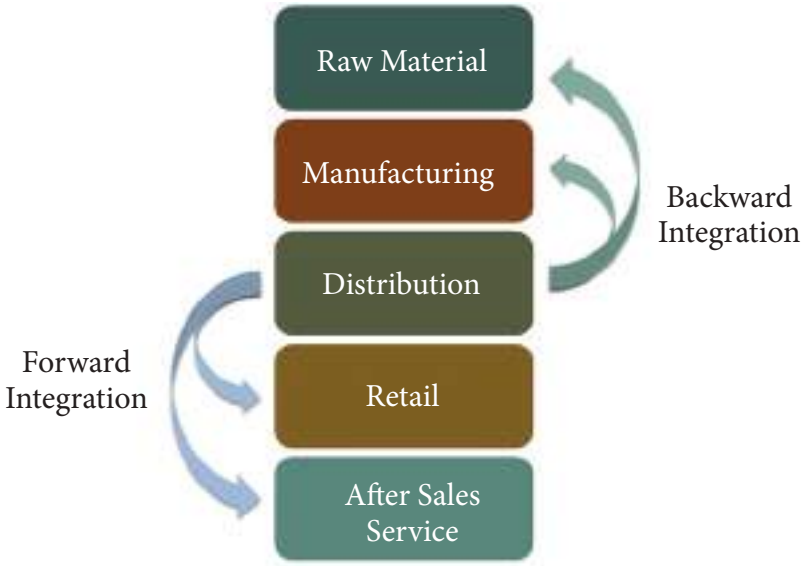
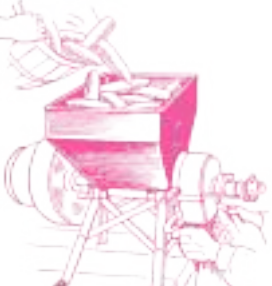


Figure 1.39 Vertical integration

d. Mega Food Park

Mega Food Park is linking agricultural production to the market by bringing farmers, processors and retailers together so as to ensure maximizing value addition, minimizing wastage, increasing farmer's income and creating employment opportunities particularly. In India, there are regional horticultural crops and in that region there is generally cluster of similar farmers, factories and traders are seen and who deals with same



agro product scheme aims to strengthen such clusters by providing world class infrastructure facilities.

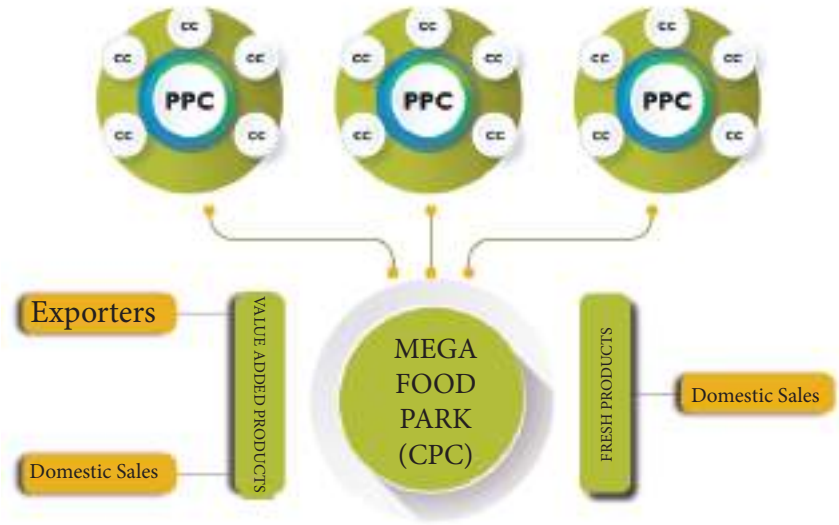


Figure 1.40 Mega Food Park (CC-Collection Centre, PPC-Primary Processing Centre)

e. Modernization of abattoirs

The major goal of the scheme is to improve processing and preservation capacities and modernization and growth of food processing units. The scheme offers facilities for scientific and less painful slaughtering, chilling, waste treatment plant, by-product utilization, water and power with required sanitary or phyto-sanitary conditions for modernization of abattoirs. Modernization of abattoirs will enhance essential supply of hygienic raw material to the meat processing industry, both for domestic consumption and exports, besides discouraging illegal slaughtering.

Figure 1.41 Abattoir

Notes

5. Multinational companies are entering the Indian food industry and this will open a way for Indian products reach all over the world.
6. Encouraging the domestic startups and industry than the International companies.
7. More training institutes for upcoming entrepreneurs in all stages help in introducing new technology and skill development.

With the government initiative the **Ministry of Food Processing Industries (MoFPI)** is implementing **PMKSY (Pradan Mantri Kisan SAMPADA Yojana)**(July, 2015).

Main Features

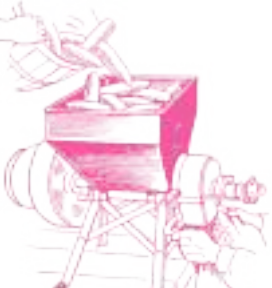
- Creation of modern infrastructure with efficient supply chain management from farm gate to retail outlet.
- Support farmers to get better returns, doubling their income and also give a big boost to food processing sector.
- Creating employment opportunities in rural areas.
- Reducing wastage of agricultural products, increasing the processing level and enhancing the export of the processed foods.

The following schemes will be implemented under **Pradan Mantri Kisan SAMPADA Yojana:**

- Mega Food Parks
- Integrated Cold Chain and Value Addition Infrastructure
- Creation / Expansion of Food Processing / Preservation Capacities.
- Infrastructure for Agro-processing clusters.
- Creation of Backward and Forward Linkages
- Food Safety and Quality Assurance Infrastructure
- Human Resources and Institutions
- Operation Greens.

Objectives of Draft National Food Processing Policy, 2019

- Reducing wastage at the farmer level to increase their incomes.
- Supporting the food processing industry to create employment opportunities.
- Ensuring a higher deployment of credit in the sector.



Notes

- Enhancing the availability of safer, affordable and higher quality products to consumer.
- Infrastructure and skill-building to meet the demands of the sector.

Food Processing has numerous advantages to lift millions out of poverty and malnutrition. Government should take initiatives to develop small scale industries along with domestic and foreign investments. The entire food value chain in India is controlled by multiple ministries, departments and law. A comprehensive policy will ensure the coordination of all the departments to achieve the overall goal of availability, awareness, affordability, access, quality and safety of food.

Glossary

Abattoir	:	A slaughter house, where animals are slaughtered to supply meat
APEDA	:	Agricultural and Processed Food Products Export Development Authority
BIS	:	Bureau of Indian Standards
CAGR	:	Compound Annual Growth Rate
FPO	:	Food Products Order
INR	:	Indian Rupee
Mega Food Park	:	A direct linkage from farm to processing and then to consumer markets through a network of collection centres and primary processing centres.
Nuggets	:	A chicken product made from chicken meat, breaded or battered, deep fried or baked.
Sausage	:	A meat product made from ground meat, often pork or poultry along with salt, spices and other flavourings.
Surimi	:	Washed and minced fish meat paste, mixed with sugar and sorbitol.
Warehouse	:	A warehouse is a building for storing goods used by manufacturers and wholesalers

Notes

Evaluation

I. Choose the correct answer (1 Mark)

1. …….. is a process of converting food stuffs to prolong their duration, storage and reduce time in culinary procedure.

   a. Food preservation b. Food processing

   c. Food contamination d. Food adulteration

2. Conversion of ingredients into edible portions is classified under ……

   a. Primary Food Processing b. Tertiary Food Processing

   c. Secondary Food Processing d. Value Added Foods

3. Hygienic meat raw materials are supplied from …….. to the processing industries.

   a. Mega Food Parks b. Abattoirs

   c. Value addition d. Cold chain

4. The processing level of milk and dairy products in Indian food processing industry is …… percent.

   a. 2 b. 7 c. 35 d. 21

5. The processed food surimi and derivatives comes under ……. subsector.

   a. Fisheries b. Milk and dairy

   c. Cereals and grains d. Meat and poultry

6. …….. facilities helps in preservation of foods without any break, from the farm gate to the customer.

   a, Integrated cold chain b. Mega Park

   c. Warehouse d. Supply Chain

7. Selling of food as raw or processed to institutions as whole sale or retail is the …….. segment of food industry.

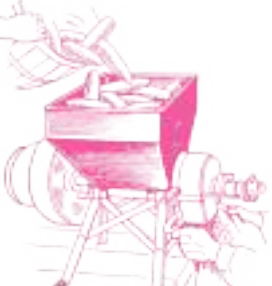
   a. Manufacturing b. Marketing

   c. Production d. Distribution

8. India is the world's …….. largest producer of fruits and vegetables.

   a. First b. Third

   c. Second d. Fourth



Notes

9. Find out the correct statement given below:
   a. Fruit juices are superior to fresh fruits
   b. Consumption of vegetables and fruits increase the risk of cardiovascular disease
   c. Carrots and green potatoes are rich source of vitamin E
   d. Fruits and vegetables aid in healthy immune system and prevent cancer
10. Match the different processed foods with the subsectors.
   1) Cereals and grain - (i) Chocolates and confectionaries
   2) Meat and poultry - (ii) Corn flakes
   3) Milk and dairy - (iii) Bacon and Ham
   4) Consumer Industry - (iv) Cheese and Yogurt
   a) 1-(ii), 2-(iii), 3-(iv), 4-(i)
   b) 1-(i), 2-(ii), 3-(iii), 4-(iv)
   c) 1-(iv), 2(iii), 3-(ii), 4, (i)
   d) 1-(iii), 2-(i), 3-(ii), 4-(iv)

II. Write in two lines (2 Mark)

1. Define food processing.
2. Why foods need to be preserved? Give two reasons.
3. Give few technologies used for food processing and preservation.
4. Write the recommended allowances of fruits and vegetables given by ICMR.
5. List the major segments of food industry.
6. Enumerate the obstacles faced by the distributors in Indian food processing industry.
7. Expand PMKSY.
8. What is forward backward integration?
9. Lack of manpower affects Indian food processing industry. Explain.
10. Change in consumer taste – How this trend helps in future development of food processing industry?
11. Write the significant benefits for different stakeholders involved in food processing.
12. List any five dairy processed products.

Notes

III. Write in three lines **(3 Mark)**

1. Bring out the meaning of food processing.
2. Classify food processing and explain.
3. Draw the sequence of unit operations in supply chain.
4. Draw the need of food processing.
5. Write any five reasons to add fruits and vegetables in our daily diet.
6. Write on meat and poultry subsector.
7. Growth potential of food processing in India contributes to GDP-Explain.
8. List any five reasons for the slow growth of processed foods in India.
9. What is the significance of cold chain facilities in Indian food processing industry?
10. How PMKSY helps in the development of Indian food processing industry?

Practical

Identification of Processed Products and their Ingredients

Aim: To identify the ingredients in processed products

Apparatus: Tomato ketchup, Jam, Fruit squash, Jelly, Fruit candy

Procedure: Place the specimens for students to view

Specimen 1

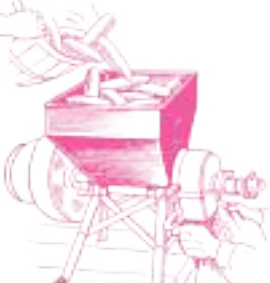
Specimen 2

Specimen 3

Specimen 4

Specimen 5

Tabulate the following findings.



1. Ingredients in each product
2. Method of preservation
3. Nutritive value
4. Shelf life
5. Preservative used

Results and discussion

Project

Visit to a food processing unit and reporting it.

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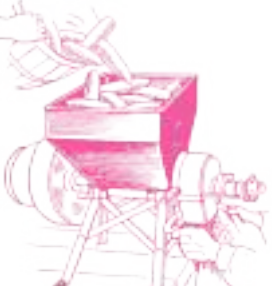


FRUITS AND VEGETABLES PROCESSING

2

Learning Outcomes

- To understand the basic principles of Food Preservation
- To gain knowledge about Food Processing Technology
- To obtain the skill of different types of processing pertaining to Fruits and Vegetables

2.1.0. Introduction

Processing of foods is an important step in assuring adequate food supply for any country. Both animal and plant food products can be processed. Processing of food helps in extending shelf life and preventing spoilage.

Fruits and vegetables are both major food products in their own right and key ingredients in many processed foods. There has been growing research on their importance to health and techniques to preserve the nutritional and sensory qualities desired by consumers.

2.1.1. Importance of fruits and vegetables in human nutrition

Vegetables and fruits are very important and should be included in our daily diet. They are termed protective foods. A balanced diet which helps in maintenance of good health can be obtained by including 5 servings of fruits and vegetables per day.

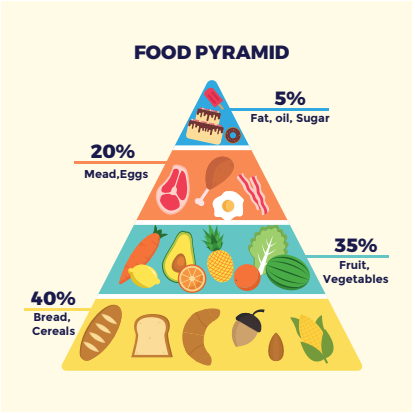


Figure 2.1: Food Pyramid

Notes

- Fruits and vegetables add colour and variety to the diet.
- They also provide carbohydrates, vitamins, minerals and roughage which is essential for body functions.
- Vegetables being low in fat and calories can be utilised for weight reduction.
- Flavouring substances are available in them.
- They act as therapeutic agents in healing sickness and preventing diseases.
- Fibrous fruits and vegetables give satiety, help in bowel movement, reduce blood cholesterol, promote chewing and decrease the rate of ingestion.

2.1.2. Definition for fruit and vegetable processing

Processing of fruits and vegetables is very important to produce products for direct consumption and as food ingredients. During processing, the main objectives are to preserve the odour, flavours, texture and nutrition while extending the shelf life of perishable fruits and vegetables.

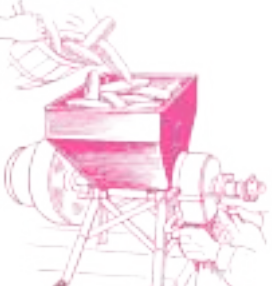
2.1.3. Selection and Purchase Criteria for Vegetables

Standards for selection of vegetables vary with the specific commodity. In general, freshness, uniformity of size, variety, colour, degree of ripeness and freedom from defects are the qualities most frequently sought.

- Each vegetable has the highest nutrient content, flavour and is available at a reasonable price during peak season. Therefore, seasonal vegetables are preferred.
- Fresh vegetables which are firm, crisp, bright in colour, with no visible bruises or signs of decay and wilting should be selected.
- Vegetables will usually wither when kept in the sun or kept for too long. So, fresh vegetables should be bought.

Leafy vegetables

- Clean, young, tender, firm, crisp, brightly green coloured leafy vegetables which are free from flowers, insects, mud and spots or holes in the leaves should be selected.
- Wilted or insect eaten or the ones with white insect eggs on the leaves, which are found on the underside of the leaves should be discarded.
- Leaves with coarse, fibrous stems, yellowish-green colour, softness (a sign of decay), or wilted condition should be



avoided. Greens with evidence of insects especially aphid should be avoided because it is not easy to wash it away.

Figure 2.2 Leafy Vegetables

Cabbage: Cabbage with hard, heavy and compact heads, free from bruises and worm injury should be selected.

Roots and tubers

- When buying roots and tubers, one should be sure that they are of one variety, well-shaped, smooth and roughly of one size.
- In general, roots and tubers should be firm, heavy, and free from spots, dirt and discolouration.

Figure 2.3 Roots and Tubers

- Roots and tubers should be free from bruises/ cuts since this makes them rot quickly and the skin should be unbroken and should cling tightly.
- Softness, excessive dirt, scabbiness, sunburn, hollow or black heart, and decay are all undesirable qualities in roots and tubers crops.

Onions: Onions that are hard or firm with dry and small necks, reasonably free from green sunburn spots or other blemishes should be selected.

Potatoes: Potatoes which are clean, firm, heavy in relation to size, with shallow eyes and are free from sprouts, blemishes, decay and green discolouration should be selected.

Carrots: Carrots which are well formed, smooth, well coloured, and firm with their green coloured tops should be selected.

Other Vegetables:

- They should be generally tender, firm, crisp, bright coloured vegetables, free from worm injury.
- Small or medium sized vegetables are likely to be tender and less fibrous in texture than large and too mature ones.
- Those which are too mature, dry, wilted, shrunken, shrivelled, discoloured should be avoided.

Figure 2.4: Other vegetables

Cauliflower: Cauliflower should have white to creamy-white, compact, solid, and clean curds. A smudgy or speckled appearance of the curd is a sign of insect injury, mould growth, or decay. Hence, it should be avoided.

Mushrooms: Mushrooms that are small to medium in size should be selected. The surface of the cap should be white or creamy, or uniform light brown if it is brown type.

Ladies finger: Ladies finger with bright green colour and free from blemishes should be selected.

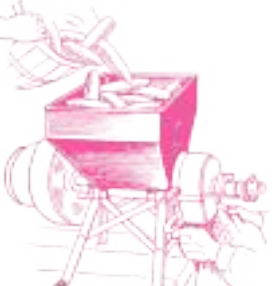
Tomatoes: Tomatoes which are smooth, well ripened, with an overall rich, red colour and a slight softness and free from blemishes should be selected.

2.1.4. Selection Criteria for Fruits

In order to select fruits for processing, knowledge of ripening process in fruits is essential. When the ripened fruit develops to its full size, the pulpy edible tissue becomes soft and tender, the colour of fruit changes, and the starch content changes to sugar giving a mild sweet flavour. Thus, the full characteristic aroma of the fruit develops. Changes beyond this point cause spoilage and deterioration of texture and flavour.

Efficient selection of fruit involves consideration of size, grade and variety. Size and grade of fruit are major determinants of the economic value of preserved food product. Fruits of lower grade are less expensive but the waste may compensate the price advantage. Each fruit has different varieties and each variety has its special characteristics. Some varieties are good for preservation while some are good only for eating. Fruit price is not always indicative of quality or its nutritive value.

Climacteric fruits are those which ripen after being picked whereas non-climacteric ones do not. Climacteric fruits



include apples, apricots, bananas, kiwi, peaches, pears, plums, watermelon, mangoes, figs and tomatoes. These can be purchased when unripe. But non- climacteric fruits like cherries, grapefruit, grapes, oranges, pineapple and strawberries should be purchased when they are fully ripe.

- The quality of fresh fruits can be judged reasonably well by their external appearance. In purchasing fruits, the appropriate size and colour for the kind and variety of fruit, are indicators of the high quality of the fruit and its maturity.
- Most fresh vegetables and fruits retain their freshness for a short time under ideal conditions of storage. Nutritive value of fruits and vegetables decreases over a period after harvest. Hence they should be bought when they are fresh.
- Good quality fruits are the ones that are just ripe, crisp, fine and free from bruises. They should not show any signs of spoilage like presence of mould, wilting and limpness, discolouration and mushy texture, presence of insects and worms.
- The fruit at its peak of maturity for its sweet preserved preparations should be selected. Fruits selected in unripe state are used when salty preserved products are to be made.
- Fruits in season are generally cheaper than when not in season and are of better quality than the fruit sold out of season. So, fruits which are in season, as the quality is high and the price low should be bought.
- Since the fruits deteriorate more rapidly after they have ripened, it should be bought in bulk only when there is adequate facilities for storage of the surplus fruit. Few fruits like apples can be kept for long period of time but the duration involved in transportation from the place of growing to the market should also be kept in mind.

Figure 2.5: Fruits

Bananas: Bananas should not have black spots on the skin and be free from bruises and slightly hard when purchased. They should be then allowed to ripen at room temperature. Shelf-life of green bananas is very short after ripening. Ripe fruit does not store well in the refrigerator, as the sugar to starch conversion is favoured at low temperature.

Apples: Good apples are firm, crisp, well coloured and heavy. Each variety has its own characteristic colour and shape. Apples have less flavour and taste, when stored too long. Hence, apples should be bought only in season. Small,

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tart fruits are suitable for making jelly, sauce and similar preserved foods.

Grapes: Grapes should be plump, shiny, well coloured, firmly attached to stem, free from discolouration and bruises. If they leak then it is a sign of spoilage.

Citrus fruits: These include oranges, sweet limes (mausambi), grape fruits and lemons. These are sorted according to size and the price decreases with the size. Citrus fruits which are bright and thin skinned, firm, rich in colour and heavy in relation to size are to be selected, as these contain more juice.

Pears: Pears should be selected when it is firm and already begun to soften to be reasonably sure that they will ripen satisfactorily. They should not be wilted or shrivelled with dull-appearing skin and slight weakening of the flesh near the stem, which indicates immaturity and such pears will not ripen. Pears with spots on the sides or blossom ends should be avoided, because it means that corky tissue may be underneath.

Pineapple: Pineapple with bright golden yellow, orange-yellow, or reddish-brown colour, depending on the variety, which is spread to 15 or 20 per cent of the fruit and are firm, plump, and heavy for their size, with fragrant aroma, and a very slight separation of the eyes or pips should be selected. The larger the fruit, the greater the proportion of edible flesh. They should be free from discoloured or soft spots, bruises and mouldiness.

Plums and prunes: They should be selected with a good colour for the variety, in a fairly firm to slightly soft stage of ripeness.

Peaches: Peaches which are fairly firm, not too soft, having skin colour yellowish or at least creamy between the red areas should be selected.

Activity 1

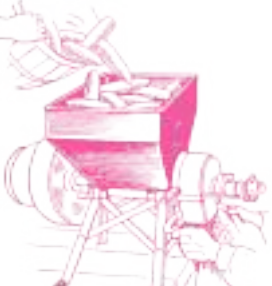
List the fruits and vegetables that can be used for preparing the following:

Jam, Jelly, Squash, Pickle, Ketchup

2.2.0.Principles of Food Preservation and Food Processing

Need for Food Preservation

1. Elimination of microbes



2. Increasing shelf life of food
3. Making seasonal fruits available to them throughout the year
4. Adding variety to the diet
5. Saving time and energy
6. Improving nutritional value of foods
7. Controlling prices

2.2.1. Principles of Food Preservation

A. Preventing entry microbes can be done by

1. Asepsis - packaging the food in cans or airtight containers prevent the entry of microbes.
2. Filtration - Used to filter liquids like juices water and alcoholic beverage and removes bacteria.
3. Freezing, drying in these conditions the microbes in the food do not grow.
4. Heating and Radiation in which microorganisms are killed.

B. Prevention or delay of self-decomposition of food

Blanching – destruction or inactivation of food enzymes.

C. Prevention of damage caused by insects, animals and mechanical causes

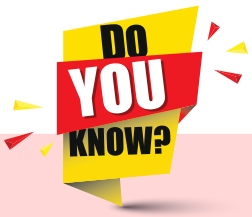
The basic concepts in food processing methods to prevent food spoilage are:

- Application of heat
- Removal of water or moisture
- Lowering of temperature during storage
- Reduction of pH
- Controlling the availability of oxygen

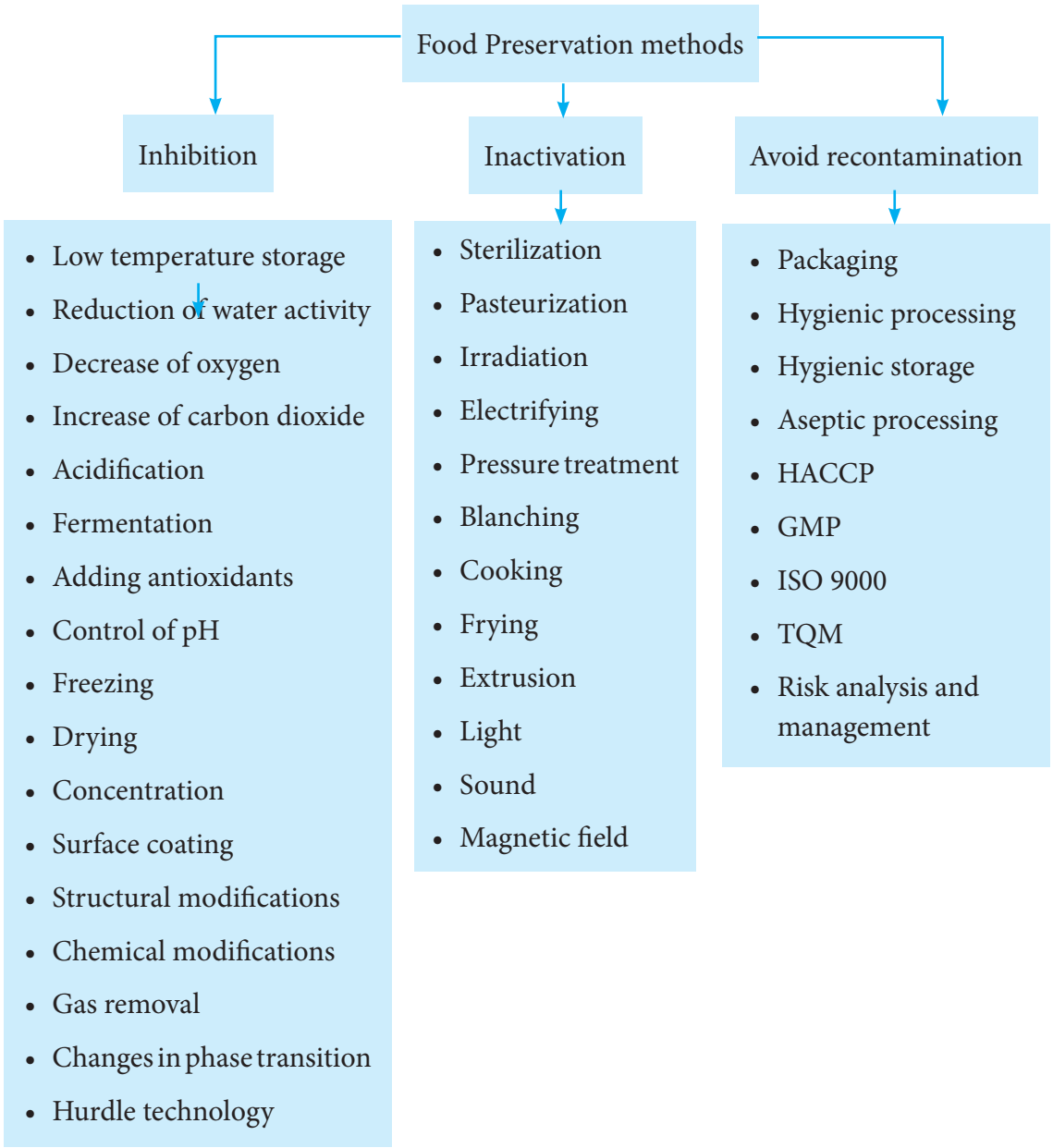
2.2.2. Methods of Food Preservation

Based on the mode of action, the major food preservation techniques can be categorized as

- Slowing down or inhibiting chemical deterioration and microbial growth,
- Directly inactivating bacteria, yeasts, moulds, or enzymes
- Avoiding recontamination before and after processing.



- Bacteria prefer protein rich foods (Eg: meat, fish, poultry, eggs and dairy products. These are known as High Risk Foods)
- Bacteria grow at any temperature between 5°–60°C. This temperature range is known as the Danger Zone.

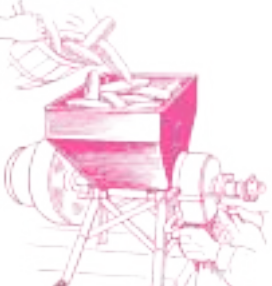


Flowchart 2.1 Food Preservation Methods

Some of the frequently used methods of preserving or food processing are shown in Flowchart 2.1. These methods are performed under strict guidelines and regulations so as to achieve maximum efficiency and preservation. Some of the food processing methods are explained below:

a. Drying

This is perhaps the oldest method used to preserve or process food. Drying reduces the water content in the product, which in turn reduces the likelihood of bacterial growth. When it comes to process cereal grains like wheat, maize, oats, rice, barley, grams and rye, drying process is used.



b. Pasteurization

Figure 2.6 Drying

Pasteurization or pasteurisation is a process in which packaged and non-packaged foods (such as milk and fruit juice) are treated with mild heat, usually to less than 100°C (212°F), to eliminate pathogens and extend shelf life.

Pasteurization has several important benefits when used to prepare foods and semi-solids for distribution.

1. Prolonged shelf life

Keeping product fresh long enough for it to make it to market and then on to consumers' pantries is key. Some bacteria and other microorganisms can cause food products to deteriorate faster than it takes for the end consumer to purchase it, so pasteurization is vital to making the food products viable.

2. Preventing disease

Diseases are found in many food products, and removing the organisms that cause those diseases is critical to ensure the product safe for general consumption. For example, eggs are known to spread salmonella and avian flu, and pasteurization kills the organisms that cause those diseases.

Some food products are breeding grounds for microbes, which means that as sterile as your processing plant may be, there may be a chance your product would cause disease later on if it's not pasteurized.

3. Quick and safe sanitation

There are many ways to sanitize food products, but few are as quick or as safe as pasteurization. With pasteurization, the temperature of the product is simply raised enough to destroy any microorganisms that may be present. Other methods may involve chemical treatments or radiation, and may not be the safest to use.

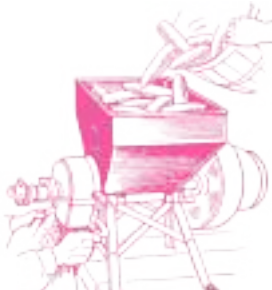
Pasteurization is also faster than most methods that rely on filtration or other means.

4. Consistent product quality

By eliminating volatile contaminants, the product becomes more stable, therefore the quality of the product is more consistent. A more consistent product means, customers know what to expect from the production lines, and it's easier to provide reliable results.

5. Potential improvements in flavour and scent

In some cases, the pasteurization process can improve the smell and taste of the product. Often, foods and other products



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may have bacteria that produce unpleasant smells over time but do not necessarily impact the product's quality besides. Removing those bacteria can create a more consistently pleasant experience for the consumer.

c. Fermentation

The term fermentation refers specifically to the chemical conversion of sugars into ethanol, producing alcoholic drinks such as wine, beer, and cider. However, similar processes take place in the leavening of bread (CO_2 produced by yeast activity), and in the preservation of sour foods with the production of lactic acid, such as in sauerkraut and yogurt.

Other widely consumed fermented foods include vinegar, olives, and cheese. More localised foods prepared by fermentation may also be based on beans, grain, vegetables, fruit, honey, dairy products, and fish.

d. Blanching

Blanching is a cooking process in which a food, usually a vegetable or fruit, is scalded in boiling water, removed after a brief, timed interval, and finally plunged into iced water or placed under cold running water (shocking or refreshing) to halt the cooking process.

Blanching loosens the skin on fruits such as tomatoes and peaches to assist in peeling, which is required for certain recipes. Before freezing, drying, and canning, blanching is often called for. So the produce is a pleasant texture and colour when used later on.

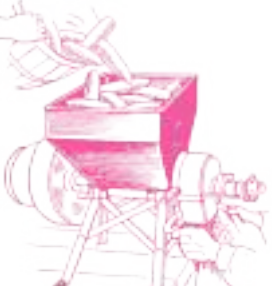
e. Extrusion

Food extrusion is a form of extrusion used in food processing. It is a process by which a set of mixed ingredients are forced through an opening in a perforated plate or die with a design specific to the food, and are then cut into a specific size by blades.

Extrusion technique is a process in food processing technology which combines several unit operations including mixing, cooking, kneading, shearing, shaping and forming. Food extrusion is a form of extrusion used in food processing. Eg. Macaroni is an extruded hollow pasta.

f. Irradiation

Food irradiation is the process of exposing food and food packaging to ionizing radiation. Ionizing radiation, such



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as gamma rays, x-rays or electron beams, is the energy that can be transmitted without direct contact to the source of the energy (radiation) capable of freeing electrons from their atomic bonds (ionization) in the targeted food. The radiation can be emitted by a radioactive substance or generated electrically. This treatment is used to improve food safety by extending product shelf-life (preservation), reducing the risk of foodborne illness, delaying or eliminating sprouting or ripening, by sterilization of foods and as a means of controlling insects and invasive pests.

Gamma rays are ionizing radiation, the kind of radiation that kills living cells. Ionizing radiation can sterilize food or at least prolong its shelf life by killing microbes and insects on plants (wheat, wheat powder, spices, dry vegetable seasonings). Preventing potatoes and onions from sprouting during storage slowing the rate at which some fruits ripen.

g. Sterilization

Sterilization refers to any process that removes, kills, or deactivates all forms of life (in particular referring to microorganisms such as fungi, bacteria, viruses, spores, unicellular eukaryotic organisms such as Plasmodium, etc.) and other biological agents like prions present in a specific surface, object or fluid, for example food or biological culture media. Sterilization can be achieved through various means, including heat, chemicals, irradiation, high pressure and filtration. Sterilization is distinct from disinfection, sanitization and pasteurization, in that those methods reduce rather than eliminate all forms of life and biological agents present. After sterilization, an object is referred to as being sterile or aseptic.

h. Canning

It is one of the most widely used method of preserving food, in which the food contents are processed (using heat to appropriate temperature and for a prescribed time to destroy micro-organisms, including Clostridium botulinum spores) and sealed in an airtight container.

i. Smoking

Many foods such as meat, fish and others are processed, preserved and flavoured by the use of smoke mostly in big smoke houses. The food processing technique is quite simple, and the combination of smoke with the aroma of hydro-carbons generated from the smoke processes the food and enhances the taste.

j. Freezing

This is the most common technique used in modern world to preserve or process the food both on commercial and domestic basis. A wide range of products can be frozen to process at the same time with the help of huge cold storage facilities.

k. Salting

Figure 2.7 Salting

Salt sucks out the moisture from the food, hence is used in food processing. Meat is the best example of the food processed by salting as nitrates are used very frequently to treat meat. Vegetables are salted before pickling.

l. Vacuum packs

Here, the food is packed in airtight bags and bottles in a vacuum area. An air-tight environment doesn't provide oxygen needed by germs especially bacteria to survive. This method is very commonly used for preserving processed nuts.

m. Sugaring

In this method fruits such as apples, peaches and plums are cooked with sugar until they are crystallized and then it is stored dry.

Figure 2.8 Pickling

n. Pickling

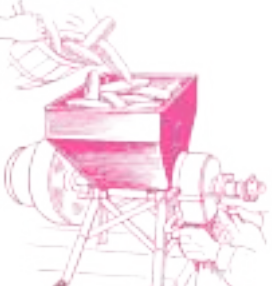
In this method of food processing, the food is cooked in chemicals and materials (which are fit for human and animal consumption) which destroy micro-organisms. These include brine, vinegar, ethanol, vegetable oil and many other types of oils. Pickling is very commonly seen in vegetables such as cabbage and peppers.

Activity 2

- List the foods that are preserved in your region/ community and identify the method and preservatives used for preservation.
- Identify the artificial sweeteners that are available in your area.

Importance of Food Processing

- Prevent the loss of excess /surplus produce.
- Increase use of by-products.
- Extend the shelf life of a food or beverage.
- Remove health hazards associated with microbial pathogens.



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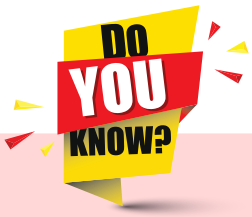
- Ensure the delivery of foods of the highest quality to the consumer.
- Ensure that the consumer has access to a wide variety of foods.
- Reduce postharvest losses.
- Require limited amounts of preparation for consumers.
- Enhance the nutritional value of foods.

Classification of Processed Foods

Processed Foods can be classified on the basis of extent and type of processing as follows:

1. **Minimally processed foods:** These are processed as little as possible in order to retain the quality of fresh foods. Generally, the processes used are cleaning, trimming, shelling, cutting, slicing and storage at low refrigeration temperatures.
2. **Preserved foods:** The methods of preservation used do not change the character of the product substantially E.g., frozen peas and frozen vegetables, dehydrated peas, dehydrated vegetables, canned fruits and vegetables.
3. **Manufactured foods:** In such products, the original characteristics of the raw products are lost and some basic methods of preservation are used, often using various ingredients such as salt, sugar, oil or even chemical preservatives. Eg. are pickles, jams, marmalades, squashes, papads.
4. **Formulated foods:** These are products prepared by mixing and processing of individual ingredients to result in relatively shelf stable food products such as bread, biscuits, ice cream, cakes, kulfi.
5. **Food derivatives:** In food industry, components of foods may be obtained from the raw product through purification, E.g., sugar from sugarcane or oil from oil seeds. In some cases, the derivative or the component may be processed further, E.g., conversion of oil to vanaspati (hydrogenation).
6. **Functional foods:** These are foods that can have a beneficial effect on human health, E.g., probiotics, lycopene.
7. **Medical foods:** These are used in dietary management of diseases, for example, low sodium salt, lactose–free milk for persons with lactose intolerance.



Processing according to needs

Processing	Examples of food
For easy distribution	Washed and packaged fruits or vegetables, bagged salads, roasted nuts and ground coffee beans
To preserve food	Canned tuna, canned beans, frozen fruits and vegetables, porridge and baby foods in jars
To improve security, taste or visual appeal	Packaged foods such as potato, rice, cake flour, tomato sauce, spice mix, dressing, sauces and gelatine.
To facilitate its consumption	Breakfast cereals, biscuits, jam, ice cream, yogurt, granola bars, sausages, cheese spread, carbonated drinks, fruit drinks.
Food to save time	Frozen meals, pizza

2.2.3. Advantages of processed foods

1) Preservation

The preservation of food is very useful to preserve them for a long period of time. If these methods are not used, the food could not be available for a long time and most likely would have to be discarded.

2) Health benefit

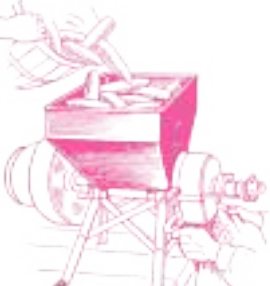
The processing confers benefits to health, as is the case of pasteurization, since by heating foods at a certain temperature for a certain period; bacteria harmful to human health are eliminated.

3) Value added

There are products that have added vitamins or minerals that help cover the recommended daily intake.

4) Nutritional value

In foods with minimal processes there is no effect to the nutritional content.



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5) Durable

When there is no urgency to consume the food before a certain time, it can be left for several days. Frozen, canned or similar food is necessary in cases of emergency such as earthquakes or floods, since its duration and storage make it available for a longer period.

6) Ready for busy people

When there is no time to cook or do not know how to do it, there is a great variety of packages that are sold with processed food that is already cut or that only needs to be heated.

7) Always available

The modifications that are applied on fruits or vegetables that normally would not grow in certain seasons can be obtained practically all the year. This is possible because they can be better preserved and in good condition.

8) Fortification

Apart from the chemicals used to encourage the decomposition of food, substances that protect food from bacteria are also added, they are reinforced with a larger variety of vitamins and even supplements are created for people who cannot take certain things, as in case of vegetarians.

2.3.0. Preservatives

Preservatives are commonly used to preserve food that is susceptible to damage. This substance is an ingredient that is added to the foods to prevent or inhibit the growth of fungi, bacteria, or microorganisms. Thus, the process of fermentation (decomposition), acidification or decomposition due to microorganism activity can be prevented, so that the shelf life is relatively longer.

2.3.1. Need for preservatives

Food preservatives play a vital role in preventing deterioration of food, protecting against spoilage from mould, yeast, life-threatening botulinum and other organisms that can cause food poisoning. Preservatives reduce food cost, improve convenience, lengthen shelf life and reduce food waste. They also improve the appearance of the product.

2.3.2. Natural food preservatives

There are plenty of foods preservatives in nature and one can use according to the need.

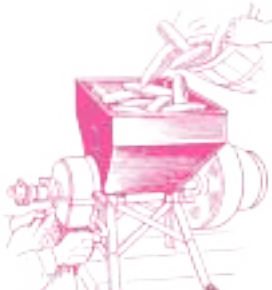


Figure 2.9
Natural Food Preservatives

a) Oil

Oil is a natural food preservative. It has an ability to stop the moisture from entering the food and thus it acts as a barrier for moisture. It is a natural antioxidant that stops the process of oxidation. Oil forms a layer on the surface of the food and as the nature of the oil are oleophilic it prevents the oxidation of food. In pickling oil plays a vital role as pickles have to have a shelf life of several years.

b) Sugar

Sugar is another very powerful naturally occurring preservative. Sugar locks the moisture in the food thus making it impossible for the food to spoil. Sugar is added in the canned foods to preserve them for long.

c) Salt

Salt is a natural antioxidant and it also traps the water content in the food. Salt is added in the pickled food to stop the process of spoilage in it. Many of the dried vegetables are stored after applying sufficient amount of salt. When salt is applied to apple it does not get brown even after cutting; since salt is an antioxidant and it stops the oxygen from reacting with the food. Oxidation does not occur if salt has been applied to food.

d) Vinegar

Vinegar and all other citric juices can be used as an antioxidant as a preservative. Vinegar has been in use since antiquity. Vinegar results from the fermentation of different food like apple, grapes or dates.

e) Spice

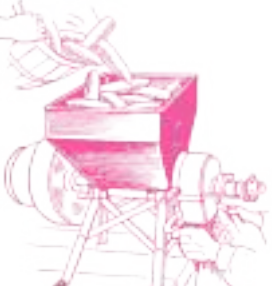
Spices like red chillies, rosemary, thyme and oregano are great preservatives. Spices also contain antioxidants that help in preventing food oxidation.

f) Pectin

Pectin performs two functions in canning. It thickens fruits and acts as a preservative when used in combination with sugar. There is a choice between sugar-activated pectin and calcium-activated pectin when canning fruit, such as jams, confitures, preserves and jellies, depending on the amount of sugar to be used.

2.3.3. Artificial Preservatives

Artificial preservatives are chemical substances added to foods. The exact definition of an artificial preservative is



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problematic, however, as many artificial preservatives are in fact derivatives of natural compounds. Most common chemical preservatives are derived from acids and their main preservative function is that they raise the acidity of foods which kills micro-organisms.

Artificial preservatives may be organic (derived from a living organism, E.g. a plant) such as benzoates, propionates and sorbates or inorganic (derived from non-living things, E.g. rocks) such as sulfites (sulphites) and nitrites/nitrates.

Artificial food preservatives are subdivided into antimicrobial agents, antioxidants and chelating agents.

A. Antimicrobial agents

Antimicrobial agents are added to foods to destroy bacteria or inhibit the growth of mould on food, these can improve the safety of the food as well as increasing its shelf life. These include benzoates, sorbates, propionates and nitrates.

1. Benzoates

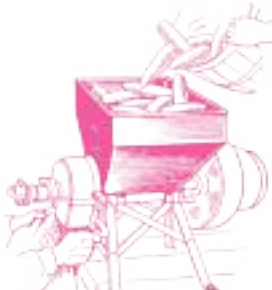
Benzoates are compounds based on benzoic acid, that are frequently used in the preservation of soft drinks such as carbonated drinks and squashes, Benzoates are seen in pickles and flour. Most commonly used benzoate is potassium benzoate - the potassium salt of benzoic acid, which inhibits the growth of mould, yeast and bacteria. Sodium benzoate is also very widely used as a food preservative in the preservation of fruit juices, pickles, salads, margarine, jams and jellies.

- Possible health considerations - When combined with ascorbic acid (vitamin C) benzoates can form benzenes which are known to be carcinogenic (cancer causing). Benzoates have also been suggested to effect hyperactivity in children.

2. Sorbates

Sorbates are compounds based on sorbic acid, they are frequently used to prevent food decay in products such as bread, dairy products, salad, fruit products and smoked fish. Potassium sorbate is the most commonly used food preservative in the world.

- Possible health considerations - Some people develop an allergy to sorbates. Sorbates have also been associated with the development of migraines and potassium sorbate can cause raised potassium levels in the blood (hyperkalemia) in patients with kidney disease.



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3. Propionates

Propionates are compounds of propionic acid, they are most frequently used to prevent the formation of mould in baked goods. The most commonly used propionates is calcium propionate. It is used to inhibit the growth of mould on bread. Sodium propionate is also widely used in the preservation of bread, chocolate, cheese and pastry.

- Possible health considerations - Health effects can range from symptoms of irritable bowel syndrome to nasal congestion, restlessness, difficulty sleeping and attention deficit disorders.

4. Nitrates

Nitrates are salts of nitrous acid, the most commonly used nitrate being sodium nitrate which is added to meat and smoked fish where it helps prevent the growth of bacteria such as clostridium botulinum and also helps to give meat a more appealing dark red appearance.

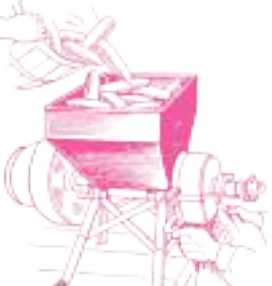
- Health considerations - Nitrates have some health implications which have made them less appealing as a food preservative. Nitrates are toxic in large quantities and are potentially carcinogenic.

B. Antioxidant preservatives

These are a group of artificial preservatives which help to prevent food spoilage by slowing down the reaction of food with oxygen in the atmosphere. Some antioxidants are natural including retinoids (vitamin A) and ascorbic acid (vitamin C) which is found in fruits and vegetables. Artificial antioxidants include butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA) which are used in bakery products, fats and oils. Both natural and artificial antioxidants are used to preserve a variety of foods including vegetable oils and spreads, nuts, cheese and bread.

Sulphites

Sulphites are a group of compounds consisting of charged molecules of sulphur combined with oxygen. Sulphites have a long history in food preservation as they occur naturally in most wines. It helps to preserve taste and colour E.g. preserving the pink colour of meat and fish. The main sulphite preservatives include sodium suphite, sodium bisulphite, sodium metabisulphite, potassium bisulphite, potassium metabisulphite and sulphur dioxide. Sulphites are generally applied to foods in a dipping solution through a spray.



- Health considerations - Sulphites can cause allergies, shortness of breath, wheezing, coughing, increased symptoms of asthma as well as skin rashes and nausea.

C. Chelating agents

Chelating agents are chemicals added to foods in order to bind metal ions such as iron, cobalt and copper which would otherwise exert detrimental effects on the colour, texture, and aroma of food. The most commonly used chelating agent is EDTA (Ethylene diamine tetraacetic acid) which helps to prevent colour deterioration. EDTA is used in soft fats such as in mayonnaise, spreadable fats and sauces where it helps keep these products from going rancid preserving their taste and flavour. EDTA also helps to protect foods from bacteria by removing the metal cofactors that the bacterial enzymes require to grow and is added to canned foods to eliminate any metal taste from the can.

- Health considerations - EDTA is safe to health in the quantities used in foods. Side effects are generally only seen where EDTA is used as a medicine.

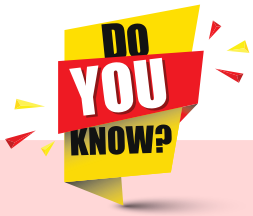
Activity 3

Find the name of preservatives used in the following and classify then under natural or artificial preservative

- Pickles
- Jams
- Squashes
- Jellies
- Tomato ketchup
- Juices in bottles and cartons

2.4.0. Minimal processing of Fruits and Vegetables

One of the major growth segments in the food retail industry is minimally processed foods. Minimally processed foods are natural foods altered by processes such as removal of inedible or unwanted parts, drying, crushing, grinding, fractioning, filtering, roasting, boiling, pasteurization,



Class 1 Preservatives

Saltish - Common Salt

Sweet - sucrose, dextrose, glucose or its syrup and honey

Pungent - spices, vinegar (natural & synthetic)

Oily - vegetable oils

Class 2 Preservatives

Benzoic acids and its salt

Sulphurous acid and its salt

Nitrates / nitrites of sodium and potassium

Sorbic acid, propionic acid, lactic acid and its Sodium, pottacium and calcium salt and its acetates

Nisin etc.

refrigeration, freezing, placing in containers, vacuum packaging or non-alcoholic fermentation.

Fresh fruits and vegetables are minimally processed to increase their functionality without greatly changing their freshness and appearance. It can also be defined as "any fruit or vegetable, or any combination thereof, which has been physically altered from its original form, but has remained in its fresh condition".

The purposes of Minimal processing of fruits and vegetables are (Huxsoll and Bolin, 1989).

- Keeping the produce fresh, without losing its nutritional quality.
- Maintaining food taste fresh
- Ensuring product shelf life sufficient to make distribution feasible within a region of consumption.

2.4.1 Foods that are minimally processed

According to the Academy of Nutrition and Dietetics, processed food falls on a spectrum from minimally processed, to heavily processed foods. Foods such as sliced fruits and vegetables, bagged salads and leafy greens and roasted nuts are all examples of minimally processed foods (figure 2.10).

Figure 2.10 Minimally Processed Foods

Activity 4

List the fruits that are minimally processed and what they are processed into.

2.4.2 Preparation of fruits and vegetables for minimal processing

- Good quality of raw materials (variety, correct cultivation, harvesting and storage condition)
- Strict hygiene and good manufacturing practices, use of hazard and critical control point principles
- Correct temperature and humidity during distribution and retailing.
- Low temperature during processing
- Use of mild additives in washing water for disinfection or the prevention of browning
- Careful cleaning and/or washing before and after peeling
- Good quality water (sensory, microbiology, pH) for washing.
- Gentle spin-drying following washing
- Gentle peeling
- Gentle cutting, slicing and shredding
- Correct packaging materials and packaging methods


Washing


peeling


husking


slicing


chopping


blanching


Packing


refrigeration

Figure 2.11 Minimal Processing

Table1: Manufacturing of Pre-peeled and/or Sliced, Grated or Shredded Vegetables

Working principle	Demands for processing	Shelf-life (days)	Customer	Examples of suitable vegetables
Preparation today consumption tomorrow	• Normal kitchen hygiene and tools • No heavy washings, except for potato • Packages may be returnable containers	1-2	Catering Restaurants Schools and Industry	carrot, cabbages, onion potato, iceberg lettuce, green lettuce, cucumber, tomato, red beet.
Preparation today a customer uses during 3-4 days	• Permeable packages, except for potato • Disinfection At least washing with water	3-5	Catering Restaurants Schools and Industry	carrot, cabbages, iceberg lettuce, potato, red beet, berries.
Products are intended for retailing	• Good Disinfection • Chlorine or acid washing • Permeable packages, except for potato • Additives	5-7	Retail shops	Carrot, Chinese cabbage, red cabbage, potato, red beet, fruits, berries.

2.4.3 Machinery needed for minimal processing

Figure 2.12 Wash Machine

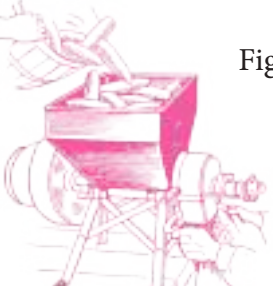
Figure 2.13 Sorting Machine

Figure 2.14 Peeling Machine

Figure 2.15 Chopping Machine

Figure 2.16 Shrink Wrapping Machine

Figure 2.17 Refrigerator



Notes

2.5.0. Drying

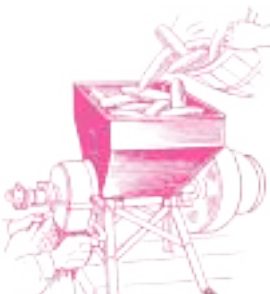
Food drying is a method of food preservation in which food is dried (dehydrated or desiccated). Drying inhibits the growth of bacteria, yeasts and mould through the removal of water. Dehydration has been used widely for this purpose since ancient times.

Water is traditionally removed through evaporation using methods like air drying, sun drying, smoking or wind drying. Today electric food dehydrators or freeze-drying are used to speed the drying process and ensure more consistent results.

Plate 2.18 Drying Method

2.5.1. Benefits of drying and dehydration

- Inhibits the growth of micro-organisms- Stops the growth of bacteria, yeast and mould by removing moisture. Slowdown enzymatic activity.
- Nutritious and Healthy- A food dehydrator helps in retaining the original vitamins, minerals, and natural enzymes of foods far better than other forms of food preservation or cooking. A study in Journal of the American College of Nutrition in 2005 showed dried fruits like dried cranberries, grapes, and plums had twice the amount of antioxidants as their fresh versions.
- No Preservatives or Chemicals- Dehydrated food contains only the food that is dehydrated. No chemicals or ingredients are added to it.
- Easy Storage and Preservation- By removing all of the food's moisture, the growth of microorganism is inhibited. So, the food stays preserved and safe much longer and by shrinking the size of the food, it can be stored easily.



Notes

- Portable- It is easy to carry dried foodstuffs especially while camping.
- Reduces waste- Dehydration extends shelf life. Having to throw out extra food and eliminating unnecessary waste can be avoided.

2.5.2. What can be dehydrated?

Fruits like apples, grapes, figs, berries, plums, banana, mango, and vegetables like onions, potatoes, tomatoes, corn, beets, and carrots can be dehydrated as whole or thin slices or its puree can be dried. They require pre-treatments before keeping it for drying. Different herbs which add flavour to food are dehydrated for long use.

Figure 2.19 Food Dehydrator

2.5.3. Types of drying

Dryers are classified according to drying process into:

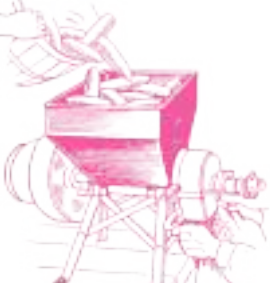
Adiabatic drying – Solids are dried by direct contact with hot air

Non-adiabatic drying – External medium is used to transfer heat.

Figure 2.20 Sun Drying

Based on the above two process different types of drying are:

a. **Sun drying** – Sun and solar drying have been practised extensively since ancient times. The grains are spread in thin layers on paved grounds and expose it to sun and wind



for drying. In addition to cereals, other products like fruits, spices, oilseeds, vegetables, and fish are naturally dried in the sun by spreading them. It is a slow and inexpensive process but environmental contamination, insect infestation, and microbial deterioration cause low quality food.

b. **Tray drying** – Food material is arranged in a thin layer in shallow mesh or perforated trays. Hot air is blown through a system of ducts and baffles to promote uniform air distribution. Generally, Heating may be by conduction from heated trays or by radiation from heated surfaces. It requires low capital and maintenance cost. But the poor quality of food near to heat source dries more rapidly.

c. **Drum drying** – In this food is spread over the heated drum surface. When the drum rotates, the food remains on the drum surface for the greater part of the rotation, during this time the drying takes place, and after the completion of drying process dried material is scraped off. Drum drying may be regarded as conduction drying.

Figure 2.21 Freeze Drying

d. **Fluidized bed drying** – In this drying heat is transferred to food material by convection. Hot air is blown upwards directly underneath the food, causing it to flow and remains suspended against gravity. There may also be a horizontal air flow helping to convey the food through the dryer.

e. **Freeze drying** – It's also called lyophilisation. It is based on sublimation principle. It freezes the material first, then reduces pressure and adds heat for frozen water in the food to sublimate. There are 4 stages in this: Pre-treatment, freezing, primary drying, and secondary drying. It is an excellent method for preserving heat-sensitive food material. Freeze-dried product is easy to reconstitute also. Its only drawback is its cost.

Figure 2.22 Spray Drying

f. **Spray drying** – Slurry of liquid or fine solid material is injected into a blast of hot air in the chamber, water evaporates and solid parts of product remain in powder form. Air and solids may move in parallel or counter current flow. It is an excellent method for products which are damaged by exposure to heat for a long time, as the process occurs very rapidly.

g. **Vacuum drying** – Here moisture is removed by means of creating a vacuum. It involves reducing pressure below the vapour pressure of water surrounding the product and increases drying rate. It is the wide application for hygroscopic, heat sensitive materials.

h. **Microwave drying** – In this electromagnetic radiation of frequency 915 and 2450MHz directly interact with food and generate heat. Pressure gradient and concentration gradient play an important role in moisture transfer. Mostly it is used in combination with other drying methods for better quality. This is not common in food industries due to technical problems.

i. **Osmotic dehydration**- It is an operation used for the partial removal of water from plant tissues by immersion in a hypertonic (osmotic) solution.

Sugar or salt solutions are used to reduce the moisture content of foods before actual drying process. This technique is used to give the product quality improvement over conventional drying process. Mild heat treatment after osmotic dehydration favours colour and flavour retention resulting in the product having superior organoleptic characteristics. It also increases resistance to heat treatment, prevents enzymatic browning and inhibits activities of polyphenol oxidase. The process is economical.

Osmotic dehydration depends on:

1) Temperature of osmotic solution

2) Concentration of the osmotic solution

3) Osmotic agent used

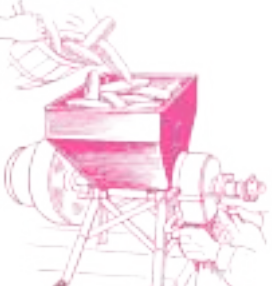
4) Process duration

5) Geometry of food material

Figure 2.23 Osmotically Dehydrated Fruits

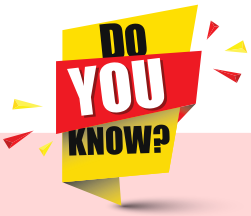
Process

Water removal is based on the natural and non-destructive phenomenon of osmosis across cell membranes. The driving force for the diffusion of water from the tissue into



the solution is provided by the higher osmotic pressure of the hyper-tonic solution. The diffusion of water is accompanied by the simultaneous counter diffusion of solutes from the osmotic solution into the tissue. Since the cell membrane responsible for osmotic transport is not perfectly selective, solutes present in the cells (organic acids, reducing sugars, minerals, flavours and pigment compounds) can also be leaked into the osmotic solution, which affects the organoleptic and nutritional characteristics of the product.

The rate of diffusion of water from any material made up of such tissues depends upon factors such as temperature and concentration of the osmotic solution, the size and geometry of the material, the solution-to-material mass ratio agitation of the solution.



Osmotic Dehydration

- It is a physiochemical phenomenon
- It makes reference to the passage of solvent but not solute through a semipermeable membrane

Activity 5

Collect recipes with dried fruits or vegetables as one of the ingredients and prepare it in class.

2.6.0. Canning

Canning is the process in which the foods are heated in hermetically sealed (airtight) jars or cans to a temperature that destroys microorganisms and inactivates enzymes that can cause food spoilage. The general steps to be adopted for canning foods are cleaning, blanching, filling, exhausting, sealing, sterilizing, cooling and labeling.

Canning process was invented after prolonged research by Nicolas Appert of France in 1809. Appert's method consisted of tightly sealing food inside a bottle or jar, heating it to a certain temperature, and maintaining the heat for a certain period, after which the container was kept sealed until use. Louis Pasteur explained that the food so treated with heat did not spoil because the heat killed the microorganisms in the food, and the sealing kept other microorganisms from entering the jar. In 1810 Peter Durand of England patented the use of tin-coated iron cans instead of bottles, and by 1820 he was supplying canned food to the Royal Navy in large quantities. In the late 19th century, Samuel C. Prescott and William Underwood of the United States set canning on a scientific basis by describing specific time-temperature heating requirements for sterilizing canned foods.

Principle and Process of Canning

Destruction of spoilage organisms within the sealed container by means of heat.

Notes

2.6.1 Advantages of canning

- Canning preserves most of the nutrients in foods. Proteins, carbohydrates, fats, vitamins A, C, D, and B2 are unaffected. The retention of vitamin B1 depends on the amount of heat used during canning. Some vitamins and minerals may dissolve into the brine or syrup in a can during processing, but they retain their nutritive value if those liquids are consumed.
- Canning has the advantage of making seasonal produces available year-round.
- Canning food helps reduce waste in times of abundance.
- Many recipes can be made and canned. This can be used during busy days.
- It is suitable for low and high acidic foods.
- It prevents contamination.
- It enhances shelf life.

Figure 2.24 Canning

Selection of fruits and vegetables

i. Fruits and vegetables should be absolutely fresh.

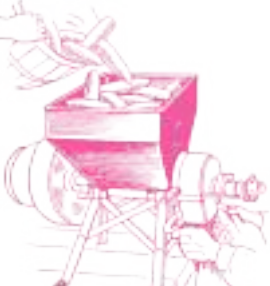
ii. Fruits should be ripe, but firm, and uniformly mature. Over-ripe fruits should be rejected because they are infected with microorganisms and give a poor-quality product. Unripe fruits should be rejected because they generally shrivel and toughen on canning.

iii. All vegetables except tomatoes should be tender.

iv. Tomatoes should be firm, fully ripe and of deep red colour.

v. Fruits and vegetables should be free from dirt.

vi. They should be free from blemishes, insect damage or mechanical injury



Notes

2.6.2. What can be canned?

Canning is a great method for preserving fruits and vegetables with a high water content.

Some vegetables suitable for canning

- Beans
- Carrots
- Peas
- Potatoes
- Asparagus
- Peppers
- Tomatoes
- Corn
- Winter squash
- Beets
- Pickled onions
- Pickled cucumbers
- Cabbage

Figure 2.25 Canned Vegetables

Figure 2.26 Pickled Vegetables

Some fruits that can be canned

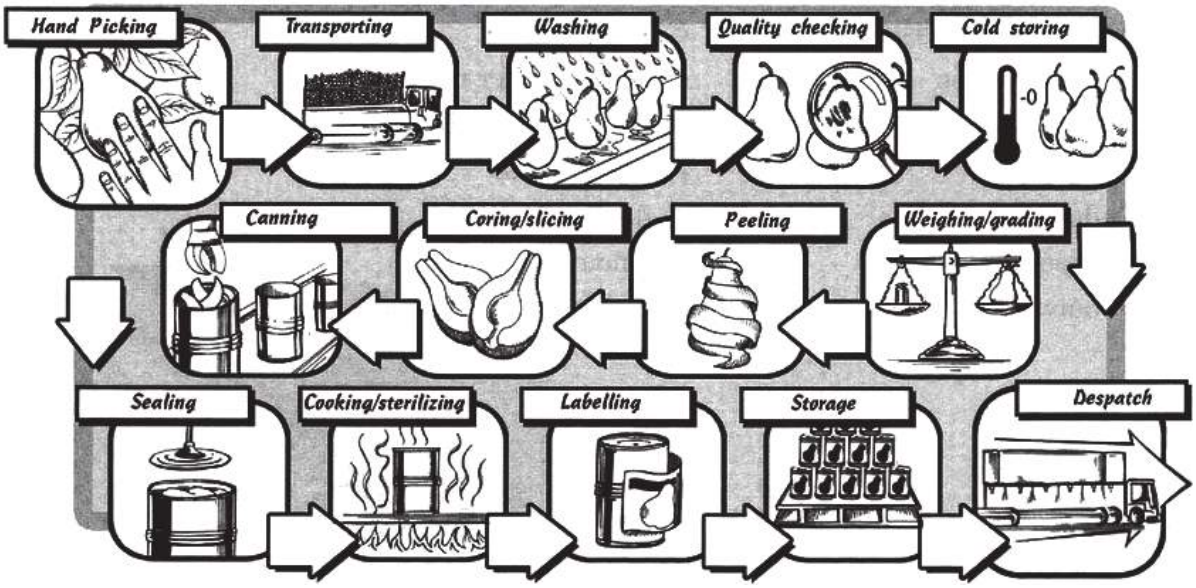
- Cherries
- Pineapple
- Plums
- Peaches
- Strawberries
- Apricots
- Goose berries
- Mangoes
- Apple
- Orange

Figure 2.27 Canned Fruits

Squashes, jams and jellies of fruits are also canned.

2.6.3. Canning Processes

Several stages involved in canning processes are depicted in Flowchart 2.2.



Flowchart 2.2 Canning Process

Several Stages involved in canning processes

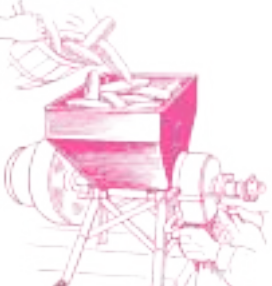
Cleaning usually involves passing the raw food through tanks of water or under high-pressure water sprays, after which the vegetables or fruits are peeled, cut, sliced, cubed or pureed.

Almost all vegetables and some fruits require blanching by immersion in hot water or steam; this process serves as an additional or final cleaning operation. Blanching softens the fruit and vegetable pliable enough to be packed tightly and also make the enzymes inactive which might cause undesirable changes in the food before canning.

The filling of cans is done automatically by machines. Cans are filled with the fruits or vegetables accompanied with sugar syrup or brine water in order to replace as much of the air in the can as possible.

The unfilled space above the food in a jar and below its lid is referred to as headspace. Directions for canning typically specify leaving $^{1}/_{4}$-inch for jams and jellies, $^{1}/_{2}$-inch for fruits and tomatoes to be processed in boiling water, and from 1 to 1¼ -inches in low acid foods to be processed in a pressure canner.

If too little headspace is allowed the food may expand and bubble out when air is being forced out from under the lid during processing. The bubbling food may leave a deposit on the rim of the jar or the seal of the lid and prevent the jar from sealing properly. If too much headspace is allowed, the food at the top is likely to discolour. Also, the jar may not seal properly because there will not be enough processing time to drive all the air out of the jar.



The filled cans are passed through a hot water or steam bath in an exhaust box. This heating expands the food and drives out the remaining air.

Immediately after the cans are exhausted, they are closed and sealed.

The sealed cans are sterilized. They are heated in temperatures high enough and long enough to destroy the micro-organisms. The cans are cooled in cold water or air and then labelled.

2.6.4. Two canning methods

Water-bath canning: This method sometimes referred to as hot water canning, uses a large kettle of boiling water. Filled jars are submerged in the water and heated to an internal temperature of 100°C for a specific period of time. This method is used for processing high-acid foods, such as fruit, items made from fruit, pickles, pickled food, and tomatoes.

Figure 2.28 Water Bath Canning

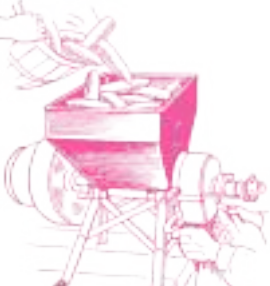
Pressure canning: Pressure canning uses a large kettle that produces steam in a locked compartment. The filled jars in the kettle reach an internal temperature of 115°C under a specific pressure (stated in pounds) that is measured with a dial gauge or weighted gauge on the pressure-canner cover. A pressure canner is used for processing vegetables and other low-acid foods, such as meat, poultry, and fish.

Notes

Figure 2.29 Pressure Canning

Canning Safety Guidelines

- When choosing food to can, always start with high quality, fresh ingredients. Ensure all foods to be canned are thoroughly washed and any seeds and stems are removed. For most recipes, instructions to peel certain ingredients such as carrots, potatoes, and fruits will be mandatory.
- A tightly sealed lid is a must for canning safety in order to preserve freshness, food must remain vacuum sealed. Once the jars have cooled to room temperature, the seal should be checked and the jars should be examined for any leakage.
- When choosing jars for canning, jars that are tall, thin, and hold a smaller volume should be chosen. As it is extremely important that all of the contents in the jar reach the desired temperature, taller, thinner and less voluminous jars will ensure uniform heating. If jars are too wide, the outer contents will overcook or the inner contents will not get properly sterilized, resulting in a loss of food and effort.
- Pay attention to can defects - Major defects -distorted, corroded and dented can and Minor defects - bent, rusty and minor buckles cans
- The time involved in processing while canning will depend on the type of food that is canned, as processing time is a function of the acidity of the food. Highly acidic foods (those with a pH of less than 4.6) will require a shorter processing period (anywhere from 5-85 minutes depending on the type of food) as they naturally inhibit bacteria. Low acid foods



(those with a pH of more than 4.6) will require a longer processing time that can range from 7-11 hours and must be at a temperature of 115°-120°C.

- After following proper canning safety guidelines, the temperature of the stockpile of canned foods should be kept at a steady temperature, somewhere between 50°-70°F. The humidity in the storage place should be low and away from sunlight because Ultra violet rays will degrade the nutrients and spoil the food.

Activity 6

* Find canned products in the local market and list them. Find the shelf life of each product.
* Identify the foods used for canning and find out the pH value for the same

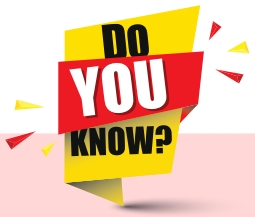
2.7.0. Fermentation

2.7.1. Definition

Fermentation is the process in which a substance breaks down into a simpler substance. Microorganisms like yeast and bacteria usually play a role in the fermentation process.

Figure 2.30 Fermentation (Kimchi)

Fermentation is a metabolic process in which an organism converts a carbohydrate, such as starch or a sugar, into an alcohol or an acid. For example, yeast performs fermentation to obtain energy by



Home Canning and Botulism

What is Botulism?

Botulism is an illness cast by Clostridium botulinum that can be deadly. It is found in the soil but can produce toxins in the right environment. Like, improperly canned foods.

Symptoms of Botulism:

- Double vision
- Difficulty swallowing
- Dry mouth
- Blurred vision
- Slurred speech
- Muscle weakness
- Thick feeling tongue

Take Proper Home Canning Steps:

- Use proper canning techniques
- Use the right canning equipment
- When in doubt, throw it out!
- If the container has any signs of contamination throw it away!
- Never taste food to see if it is safe
- Pressure canning is the only method of canning recommended for canning foods

converting sugar into alcohol. Bacteria perform fermentation, converting carbohydrates into lactic acid.

In microorganisms, fermentation is the primary means of producing adenosine triphosphate (ATP) by the degradation of organic nutrients anaerobically. Fermentation has been used to produce foodstuffs and beverages since the Neolithic age. For example, fermentation is used for preservation in a process that produces lactic acid found in sour foods like pickled cucumbers, kombucha, kimchi, and yogurt, as well as for producing alcoholic beverages such as wine and beer.

The following are some of the most reported fermented fruits and vegetables and they are classified as follows:

- **Root vegetables:** carrots, turnips, beetroot, radishes, celeriac, and sweet potato.
- **Vegetables**: cucumbers, olives, tomatoes, peppers, okra, and green peas.
- **Vegetable juices:** carrot, turnips, tomato pulp, onion, sweet potato, beet and horseradish.
- **Fruits:** apples, pears, immature mangoes, immature palms, lemons, and fruit pulps such as banana.

2.7.2. Types of fermentation

There are three types of fermentation

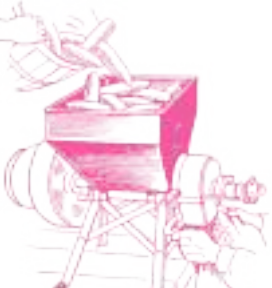
1. Lactic acid fermentation

A product prepared by lactic acid bacteria (LAB) fermentation of sugars present in the pieces of fruits and vegetables. Traditionally, non-iodized salt is introduced to the vegetables through a brine, which inhibits spoilage but allows the growth of lactobacillus. The prepared product is rich in lactic acid, and only the beneficial bacteria that can tolerate lactic acid pH survive. It not only assures good quality of nutrients, but it is also a good source of probiotics. Lactic acid bacteria (LAB) already exist as part of the natural flora in most vegetables. Lettuce and cabbage were examined to determine the types of lactic acid bacteria that exist in the leaves. Different types of LAB will produce different types of silage fermentation, which is the fermentation of the leafy foliage. Sauerkraut, fermented cucumbers, and kimchi (fermented Korean side dish) are lactic acid fermented products.

Figure 2.31
Lactic Acid Fermentation

2. Alcoholic fermentation

Alcoholic fermentation is the best known of the fermentation processes, and is involved in several important



transformation, stabilization, and conservation processes for sugar-rich substrates, such as fruits, and fruits and vegetables juices. Alcoholic fermentation is carried out by yeasts and some other fungi and bacteria. Alcoholic fermentation is the basis for the manufacturing of alcoholic beverages such as wine and beer.

3. Acetic acid fermentation

Starches and sugars from grains and fruit ferment into sour tasting vinegar and condiments. Examples include apple cider vinegar, wine vinegar, and kombucha (fermented, lightly effervescent, sweetened black or green tea drink).

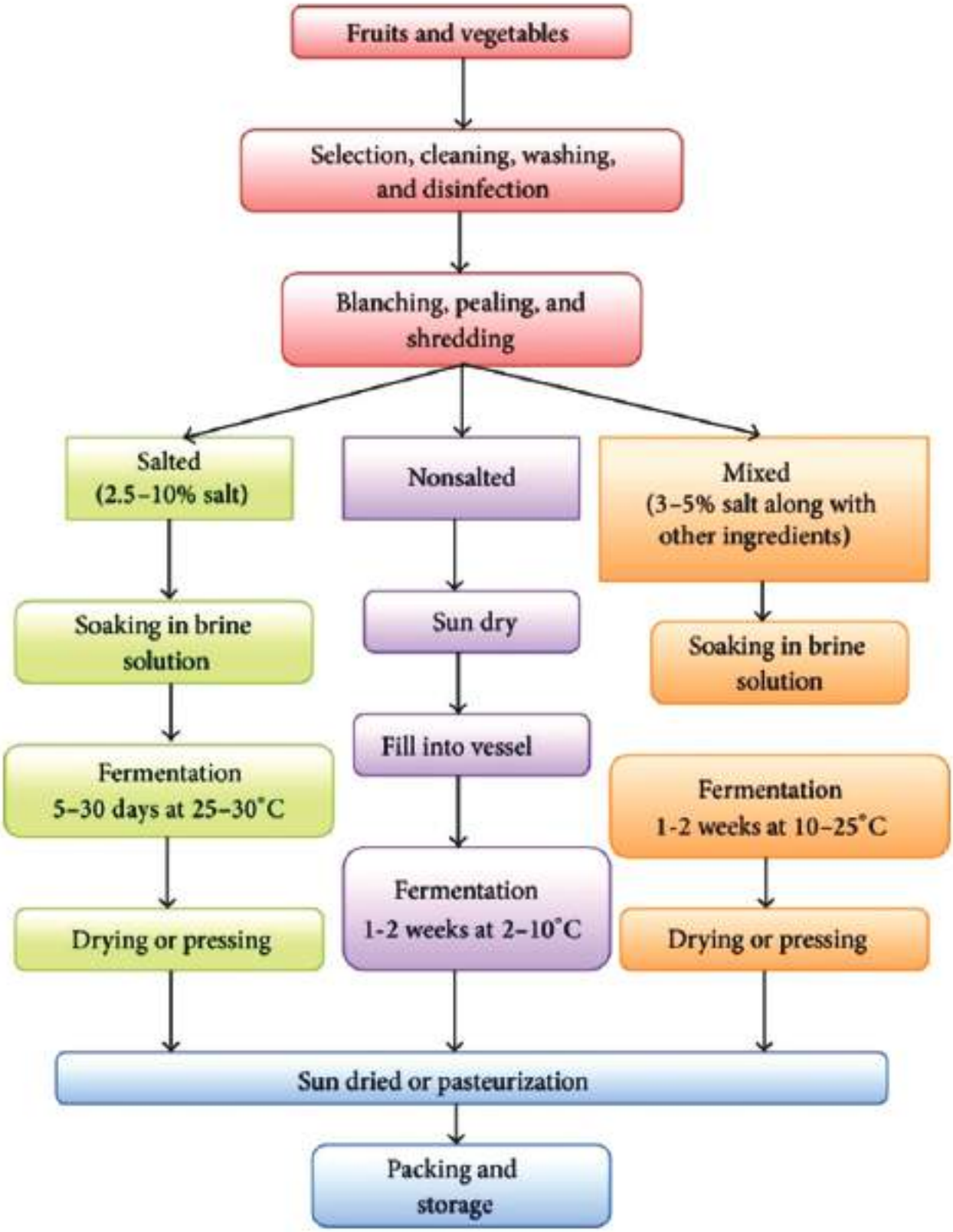
Figure 2.32
Alcoholic Fermentation

2.7.3 Six tips for starting fermentation

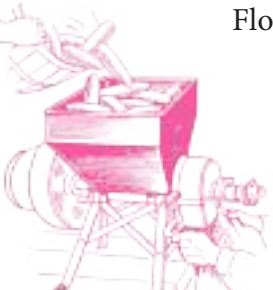
1. Establish "starter" cultures. Microbes are naturally present in the air but to begin fermentation you will often a "starter" is needed. Examples: whey (from yogurt), a Symbiotic Colony of Bacteria and Yeast, or SCOBY (for kombucha), or even liquid from a previous ferment.
2. Keep equipment clean. To prevent bad bacteria from leaching onto ferment, it is essential clean and sterilize kitchen equipment and the work surfaces.
3. Avoid exposure. Exposing ferment to air can prevent proper fermentation and increase the risk of spoilage and food poisoning.
4. To prevent fermenting food from coming into contact with air, submerge it in a salt solution (brine). This controls the pH of the fermentation.
5. Storage-In order to avoid air contamination, keep the fermenting product in a sealable storage container. Storage containers have a valve to vent carbon dioxide gas released during fermentation. (While making kombucha, wine, or other end products that benefit from carbonation, and can forego the CO_2 venting.)
6. Fermentation management-Typically, microbes work well when their environment is warm or room temperature, but the ideal temperature depends upon the type of microbes. Altering the temperature can impact the process greatly. But cooler environment, such as a basement or a refrigerator, will slow the rate of fermentation and, in some cases, halt it completely. Heating ferment, on the other hand, can kill essential microbes.

Figure 2.33
Acetic Acid Fermentation

Fermentation process of Fruits and vegetables- Lactic Acid Fermentation



Flowchart 2.3 Fermentation Process of Fruits and Vegetables - Lactic Acid Fermentation



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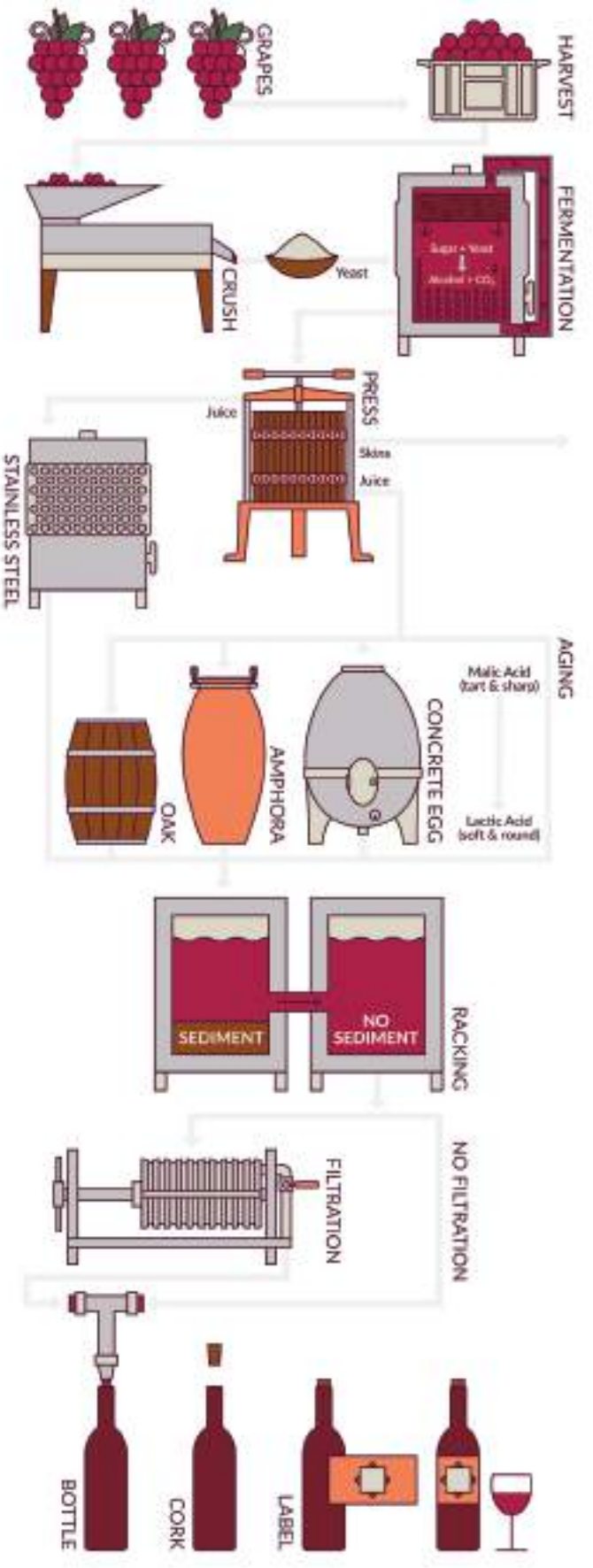
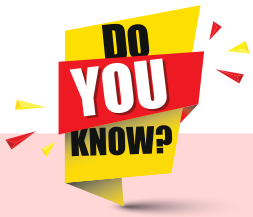


Flowchart 2.4 Alcoholic Fermentation- Production of Wine

2.7.4. Merits of Fermentation

- Food fermentation is often a preservation method. Vegetables or milk can be kept a little longer if fermented.
- The process often synthesizes vitamins, so a fermented vegetable, for instance, is more vitamin-rich than its raw or cooked counterparts.
- Fermented foods are generally more easily digestible.
- Minerals in fermented foods are more bio available.
- It is frequently less expensive than the store-bought option of similar quality.
- It is very easy to do many basic food fermentation processes.
- The flavours created by fermentation are pretty difficult, if not impossible, to replicate. These foods have distinctive flavour profiles that make them wonderful additions to the kitchen of the curious cook.
- Adding fermented foods in the diet will help ensure a healthy gut and improves the immune system
- Fermented milk products can mildly decrease high blood pressure
- There is currently some evidence that taking probiotics can prevent antibiotic-associated diarrhoea.



Fermentation Media

Major components

Carbon Source

Nitrogen Source

Minor components

Inorganic salts, vitamins, groth factors, anti-foaming agents, buffers, dissolved oxygen, other dissolved gases, growth inhibitors and enzymes

2.7.5. Demerits of Fermentation

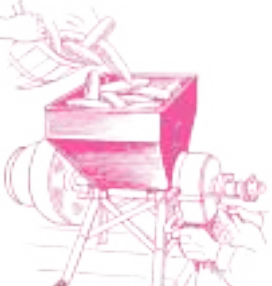
Fermented foods can cause the following in humans

- Gas and bloating
- Nausea and diarrhoea
- Dizziness and racing heart
- It increases the risk of developing gastric cancer.
- It is vulnerable to contamination.

Activity 7

List the components of the following. Mention the type of fermentation process.

Kimchi
Coffee
Beer
Sauerkraut
Vinegar



Notes

Glossary

Antioxidant	:	A substance (such as beta-carotene or vitamin C) that inhibits oxidation, especially one used to counteract the deterioration of stored food products.
Chelating Agent	:	A chemical compound that coordinates with a metal to form a chelae, often used to trap or remove heavy metal ions
Climacteric	:	It is a stage of fruit ripening associated with increased ethylene production and a rise in cellular respiration.
Effervescent	:	Giving off bubbles of gas; bubbling.
Shelf life	:	The length of time for which a food item remains usable, fit for consumption, or saleable.
Sublimation	:	To be transformed directly from the solid to the gaseous state or from the gaseous to the solid state without becoming a liquid.
Aphid	:	A small bug which feeds by sacking sap from plants.
HACCP	:	Hagard Analysis Critical Control Point.
GMP	:	Good Manufacturing Practice
TQM	:	Total Quality Managment
SCOBY	:	Symbotic culture of Bacteria and Yeast
Oleophile	:	Relating to a substance that has and affinity for oils and not for Water.

Notes

Evaluation

I. Choose the correct answer: (1 Mark)

1. A balanced diet which helps in the maintenance of good health can be obtained by including ……..servings of fruits and vegetables per day.

   a. 5 b. 7 c. 3 d. 2

2. ……. is a climacteric fruit.

   a. Strawberry b. peach c. jack fruit d. grapes

3. ……. helps in inactivation of food enzymes.

   a. Cutting b. Chopping

   c. Blanching d. Frying

4. The temperature zone at which bacteria grow is called ……

   a. Easy zone b. Secure zone

   c. Good zoned. d. Danger zone

5. ……..is an example of functional foods.

   a. Probiotics b. Boiled foods

   c. Aerated foods d. Fried foods

6. ……..stops moisture from entering food.

   a. Spice b. Oil

   c. Sugar d. Salt

7. …… helps in preparation of jams and jellies.

   a. Citric acid b. Vinegar

   c. Pectin d. MSG

8. The chemical preservative in juices is ……..

   a. MSG b. Vinegar

   c. Sodium chloride d. Sodium benzoate

9. In ……..solids are dried by direct contact with hot air

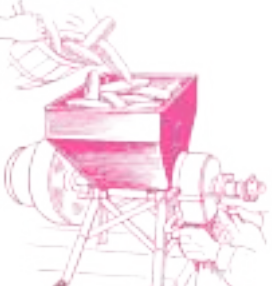
   a. Non-adiabatic drying b. Adiabatic drying

   c. Freeze drying d. Vacuum drying

10. ……is an example for lactic acid bacteria fermentation.

    a. Wine b. Beer

    c. Kimchi d. Whisky



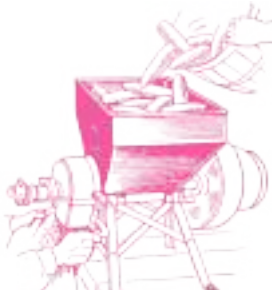
Notes

II. Write in two lines (2 Mark)

1. Define food processing.
2. How do you select roots and tubers?
3. Mention the methods of food preservation.
4. What do you mean by minimal food processing?
5. Name the natural preservatives.
6. Write on chelating agents.
7. Give a short note on osmotic dehydration.
8. List the fruits and vegetables that can be canned.
9. Define 'Starter Culture" with an example.
10. Bring out the demerits of fermentation.

III. Write in three lines (3 Mark)

1. How will you select fruits for preservation?
2. What are the principles of preservation?
3. List the importance of processing food.
4. Explain antioxidant preservatives.
5. Mention the techniques used to prepare fruits and vegetables for minimal food processing.
6. Enumerate the benefits of drying and dehydration.
7. What are the two methods of canning?
8. Explain the steps for starting fermentation.
9. List the advantages of fermentation.
10. Do you think processed food is good for health? Explain.



Notes

Practical

Experiment 1

Preparing Fruits and Vegetables

Aim: To obtain the skill of preparing vegetables for processing.

Apparatus: Cutting board, Knife and Food processor (if available)

Procedure:

Washing:

Cleaning

- Sanitize sink, wash hands, and use soap and water to clean all areas coming into contact with your fresh produce.
- Fill sink with either diluted wash or vinegar solution.
- Soak vegetables for at least 30 seconds.
- Place them in a colander and use hands to rub the produce while rinsing with cold water.
- Let produce air dry and enjoy.

figure 2.34 Washing

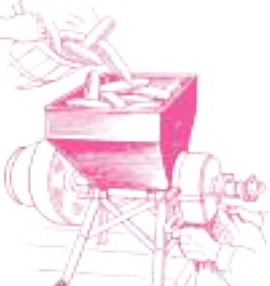
Peeling:

The skin of certain fruits and vegetables has to be peeled before cutting them. A knife or a peeler can be used to peel the outer skin. Now-a-days electric peelers are available in the market. Care should be taken to peel the skin very thin because most of the nutrients are under the skin of fruits and vegetables.

Figure 2.35 Peeler

Figure 2.36 Knife

Figure 2.37 Electric peeler



Notes

Cutting

Slicing:

Slicing is a technique in which fruits and vegetables are cut into thin slices that are relatively broad in comparison to the slice depth.

Brunoise (Fine Dice)

This particular technique is for finely diced vegetables and fruit. The food is cross cut and then sliced across the sticks in order to create fine cubes. Foods that are commonly brunoised include turnips, onions and carrots.

Chiffonade (Shredding)

The chiffonade technique is usually used on leafy vegetables and herbs. Some examples include, spinach, lettuce, basil herbs and cabbage. This is accomplished by first cutting the food into long strips, and then cross cutting them in the preferred thickness.

Julienne (Match Stick Cuts)

The Julienne technique is used to cut foods into long, thin match stick like pieces. This is a cutting style that is normally used for zucchini, carrots, celery and capsicum, but it can be used on virtually any type of vegetable.

Macedoine (Large Dice)

This particular technique is used to cut vegetables and fruit into large cubes, which is ideal for preparing vegetables that will be used in soups. Cooks also cut melons and other types of large fruit using this technique. When using this technique, it is important to have a flat surface to cut on.

Figure 2.38 Different types of cutting

Result and Discussion:

Notes

Experiment 2

Drying

Aim: To obtain the skill of drying vegetables and fruits

Apparatus: Vessels, ladles, drying mats, net cover for drying.

Procedure:

General procedure for drying fruits:

- Select firm ripe fruit
- Wash the fruits in clean water
- Peel and remove damaged and discoloured parts
- Slice/cut into thin uniform slices or cubes
- Pre-treat with lemon juice or sugar solution
- Spread on trays and dry under sunlight.
- Pack the dried product in moisture-proof packs
- Store in a cool, dark, dry, well-ventilated place.

Drying vegetables

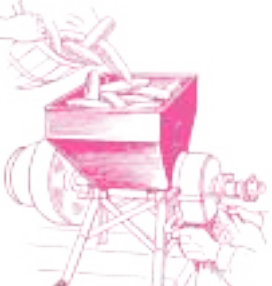
Vegetables like tomatoes, kales, cowpeas leaves, cabbages and pumpkin leaves can be dried. Tender healthy vegetables are selected for drying. To prepare the vegetables for drying, wash and remove old and damaged parts and then chop/slice for drying.

Blanching

A solution of water and salt is prepared (varying in strength depending on products) and boiled. The vegetables for drying are dipped into the hot boiled saline solution in a piece of clean cloth (or basket). Kale, other hard leafy vegetables and cabbages should be dipped in the hot boiling solution for 3 minutes while spinach and soft leafy vegetables require only 2 minutes. To avoid overcooking, boil the blanching water before dipping the vegetables. Dip the vegetables in cold water immediately after removing them from the boiled saline solution to prevent further cooking. After blanching the vegetables are spread on trays and dried, then parked and stored in dry, dark store. Blanching is carried out to improve the quality by inactivating the enzymes, reducing the microorganisms, softening the vegetables, and preserve the natural colour of the green vegetables when they are dried.

Drying

Spread on trays and dry under direct sunlight.



Basic hygiene requirements

Food products are prone to contamination, which can affect the health of consumers. To have a good processed product, standards of hygiene must be followed and maintained during preparation, processing and storage.

Personal hygiene

- Avoid rings, bangles and nail polish during processing.
- Wash hands carefully with soap and running water.
- Do not be involved in processing when you are sick and/or when having open wounds.
- Maintain personal cleanliness including body and clothes.
- Keep nails short and clean.

Cleanliness of equipment and utensils

The equipment and utensils should be properly cleaned before and after use:

- Scrub wooden equipment, e.g. tables and benches, with soap water and brushes and then rinse thoroughly.
- Dry the utensils on a dish rack or wipe them dry with a clean cloth and store them in a dust free place

Figure 2.39 Dried Mangoes

Recipe

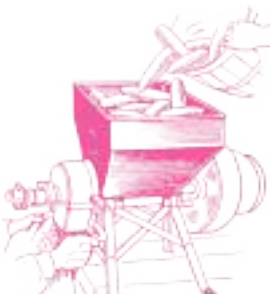
Dried mango slices

Ingredients:

- Mangoes
- Lemon juice
- Water

Method:

1. Select and weigh hard ripe fresh mangoes.
2. Wash the fruits thoroughly in clean water.
3. Peel the mangoes.
4. Slice the peeled fruits into thin uniform slices.
5. Prepare lemon juice/water solution in the ratio of 1 part lemon juice to 20 parts of water.
6. Keep the mango slices in this solution then arrange them on the trays (in single layers).
7. Load the trays and keep them facing the sun.
8. Shift the trays occasionally until the slices are dry.



Notes

9. Unload for sorting and packaging of the dried slices.
10. Pack the dried slices into moisture proof containers and store in a cool, dry dark place.

Result and Discussion

Experiment 3
Fermentation

Aim: To obtain the skill of preserving products through fermentation.

Apparatus: Vessels, spoons, glass bottle with wide mouth.

Procedure:

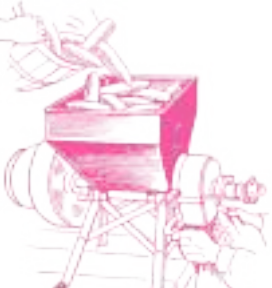
The process of fermentation is a segment of the food processing industry. Food processing is the transformation of raw ingredients into marketable food products. Fermentation in this context is a process that converts sugar to acids, gases, or alcohol which commonly occurs in yeast and bacteria.

Lacto-fermented means that the starches and sugars in vegetables and fruits are converted into lactic acid by the many species of lactic-acid-producing bacteria present on the surface of all living things. The "lacto" portion of the term refers to a specific species of bacteria, namely Lactobacillus.

Lactic acid is a natural preservative that inhibits putrefying bacteria. All you have to do is to add SALT. Bacteria that could be harmful to us can't tolerate much salt, but there are healthy bacteria that can. Lacto-fermentation wipes out the bad bacteria, then lets the good bacteria get to work. The product is a living food, full of enzymes and probiotics.

Benefits of Fermented Foods

- Fermented foods improve digestion.
- Fermented foods restore the proper balance of bacteria in the gut.
- Fermenting foods actually increase the vitamin content of the food.
- Eating fermented foods helps us absorb nutrients more efficiently.
- Fermenting foods helps preserve our food for longer periods of time.
- Fermenting foods is inexpensive.



Notes

Pickled Cucumber

Plate 2.40 Pickled Cucumber

Ingredients

- 2 tbsp sea salt
- 1 quart of filtered water (chlorine free)
- 3 large cucumbers

Optional

- 1/2 onion, sliced into thin rounds
- 2 tbsp fresh dill, finely chopped or 1/2 tsp dried dill
- 2–3 peeled and smashed cloves of garlic
- one bay leaf
- 4–5 black peppercorns
- 2–3 small hot peppers

Instructions

1. Make brine with 2 tablespoons salt and one quart of good quality water.
2. Cut cucumbers into ½ - inch slices (if you slice them too thin, they may get soggy.)
3. Place cucumbers and any optional add ins that desired into a 2 ltr. glass bottle.
4. Pour brine over top to cover cucumbers. Add a weight to keep the sliced cucumbers under the brine.
5. Place an airlock lid onto glass bottle, wrap jar with kitchen towel to block out light, and place on kitchen counter for 2-5 days then refrigerate.

Result and Discussion

Notes

Project

1. **Visit a food preservation unit and write a report.**
   a. Name of the unit with address
   b. Products in production and process of producing each
   c. Methods of preservation
   d. Preservatives used
   e. Shelf life of each product
2. **Visit a canning unit and write a report on it.**

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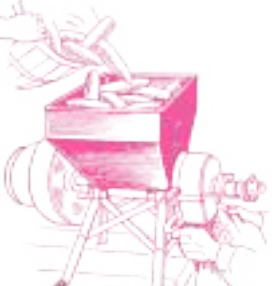


FOOD MICROBIOLOGY

3

Learning Outcomes

- To understand the importance of microbes in food industry
- To know the causes of food spoilage
- To identify the primary sources of microorganisms in food
- To Learn the important properties of enzymes in fruits and vegetables
- To acquire knowledge about factors affecting microbial growth in food

3.1.0. Introduction

Food microbiology is the scientific study of microorganisms, which have both beneficial and deleterious effects on the quality and safety of raw and processed food.

Figure 3.1 Food Microbiology

Definition

Food Microbiology is the science which deals with the microorganisms involved in the spoilage, contamination, and preservation of food. Microbiology is essential to food safety, production, processing, storage and preservation.

Microbial Activity in food

1. Acts as a preservative
2. Destroys many pathogenic microbes and toxins

3. Enhances nutritional value in the form of vitamins and other nutrients.

3.1.1. Importance of Microbes in Food Industry

When there is increase in food production or insufficient food production, food spoilage can adversely affect the availability of food. In order to reduce the food spoilage different kinds of microbes are used for food preservation.

There are many useful applications of microbes in the food industry. They influence the quality, availability and quantity of food. Microorganisms are used to change one substance to another which is used as food, such as milk to curd (yoghurt) and cheese, sugar to wine and bread. The food industries in which the application of microbes is used for food processing are shown in Flowchart 3.1.

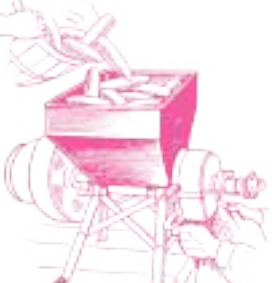
Flowchart 3.1 Importance of Microbes in Food Industry

1. Preparation of Cereal Products

a) Idli

- Idli is one of the famous foods of India especially in South India.
- It is a cereal, legume based food.

Figure 3.2 Idli



DO YOU KNOW?

World Idli Day is the concept of Eniyavan, a popular idli caterer from Chennai. It has been reported that in 2015, he made 1,328 varieties of idlis to commemorate this day. To celebrate the day, a giant 44-kilogram idli that was cut by a bureaucrat to seal the deal and declare **March 30 as World Idli Day.**

Notes

- It is made by natural fermentation of thick batter of carefully washed and soaked rice and black gram dal.
- The batter is then allowed to ferment 8 to 12 hours by means of natural microflora.
- **Leuconostoc mesenteroides** and **Streptococus thermophilus** bacteria present in grains/legumes/utensils produce lactic acid and carbon dioxide that make the batter anaerobic and leaven the product.

b) Dhokla

- Dhokla is a vegetarian culinary dish that is found mainly in the Indian state of Gujarat and part of adjacent states.
- It is prepared by soaking bengal gram dal and rice, grinding separately, and spontaneously fermenting and steaming of mixed batter.
- **Lactic acid bacteria** is responsible for fermentation.
- Dhokla can be eaten for breakfast as a main course or as a snack.

Figure 3.3 Dhokla

c) Bread

- Yeast is used to make bread.
- The flour is usually made from wheat and contains starch.
- Starch is the energy source for the yeast.
- When **saccharomyces cerevisae** (baker's yeast) is added to raising flour and water, carbon dioxide is produced which gets trapped in the dough prepared from the flour.
- The flour also contains a protein called gluten, which forms sticky stretchy threads as the yeast works on the sugar.

Notes

- The threads trap the carbon dioxide and make the dough rise well.
- The dough rises and bread is made.

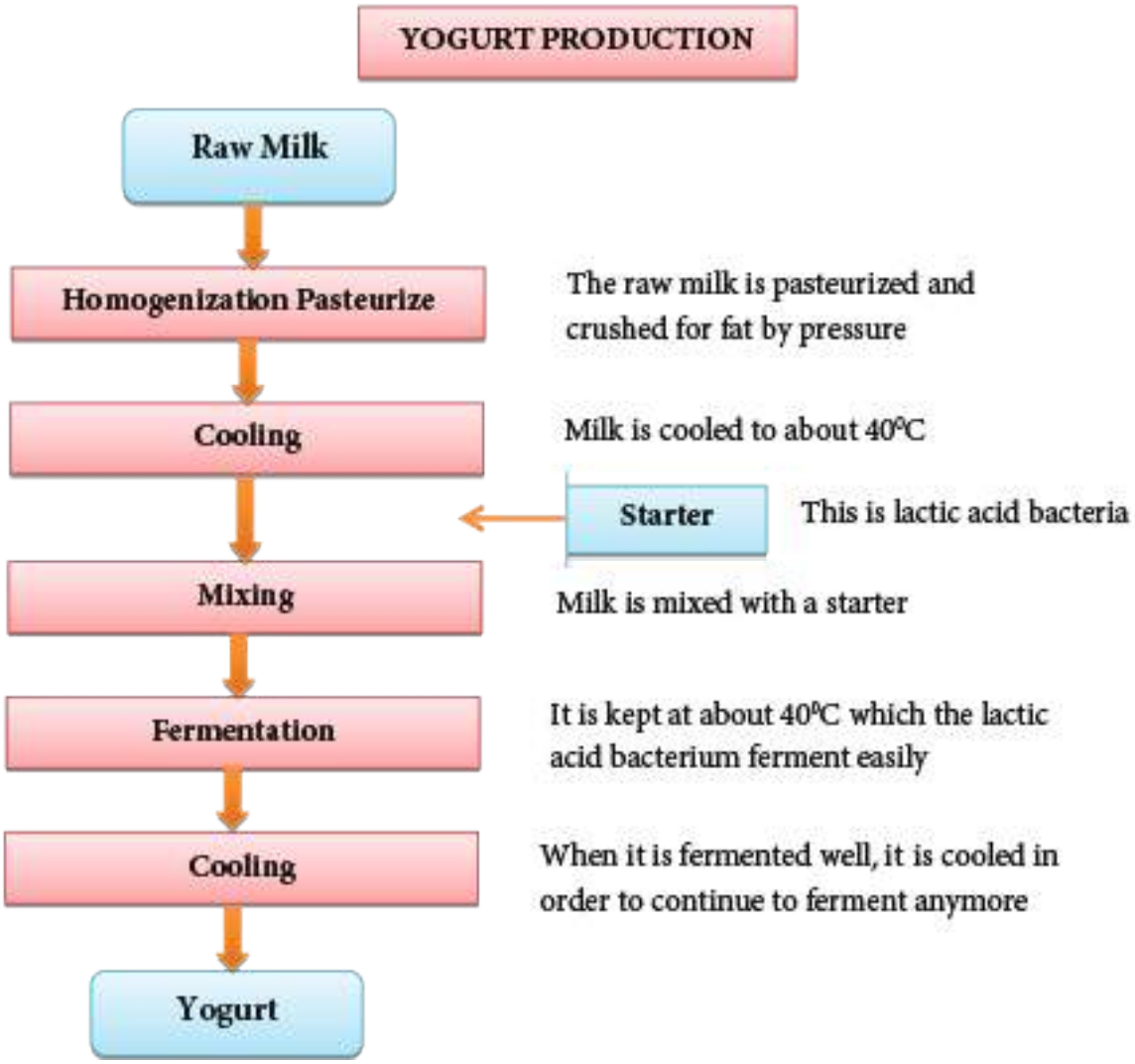
Figure 3.4 Bread

2. **Preparation of Dairy Products:** Curd (yoghurt), Butter and cheese are the dairy products where microorganisms are utilized.

a) Curd (Yoghurt)

- Curd is a fermented milk product, originating from the Indian subcontinent, usually prepared from cow milk and sometimes buffalo milk or goat milk.
- The word curd is used to refer to homemade yoghurt, while the term yoghurt refers to pasteurized commercial variety i.e., heat treated fermented milk.
- It is produced by the fermentation of milk by two species of bacteria **Lactobacillus bulgaricus** and **Lactobacillus thermophiles** (**Streptococcus thermophiles**).

Figure 3.5 Yoghurt



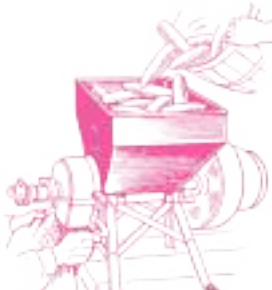
Flowchart 3.2 Yogurt Production

b) Butter

- It is composed of fat from milk with little casein and lactose.
- It is the process of shaking up cream or whole milk to make butter.

Figure 3.6 Butter

- Cream is starting substrate, butter is normally made by churning cream that has been soured by lactic acid bacteria.
- Ripened cream uses **Streptococcus cremoris** or **Streptococcus lactis** to produce lactic acid rapidly and Leuconostoc citrovorum produce the necessary flavours.

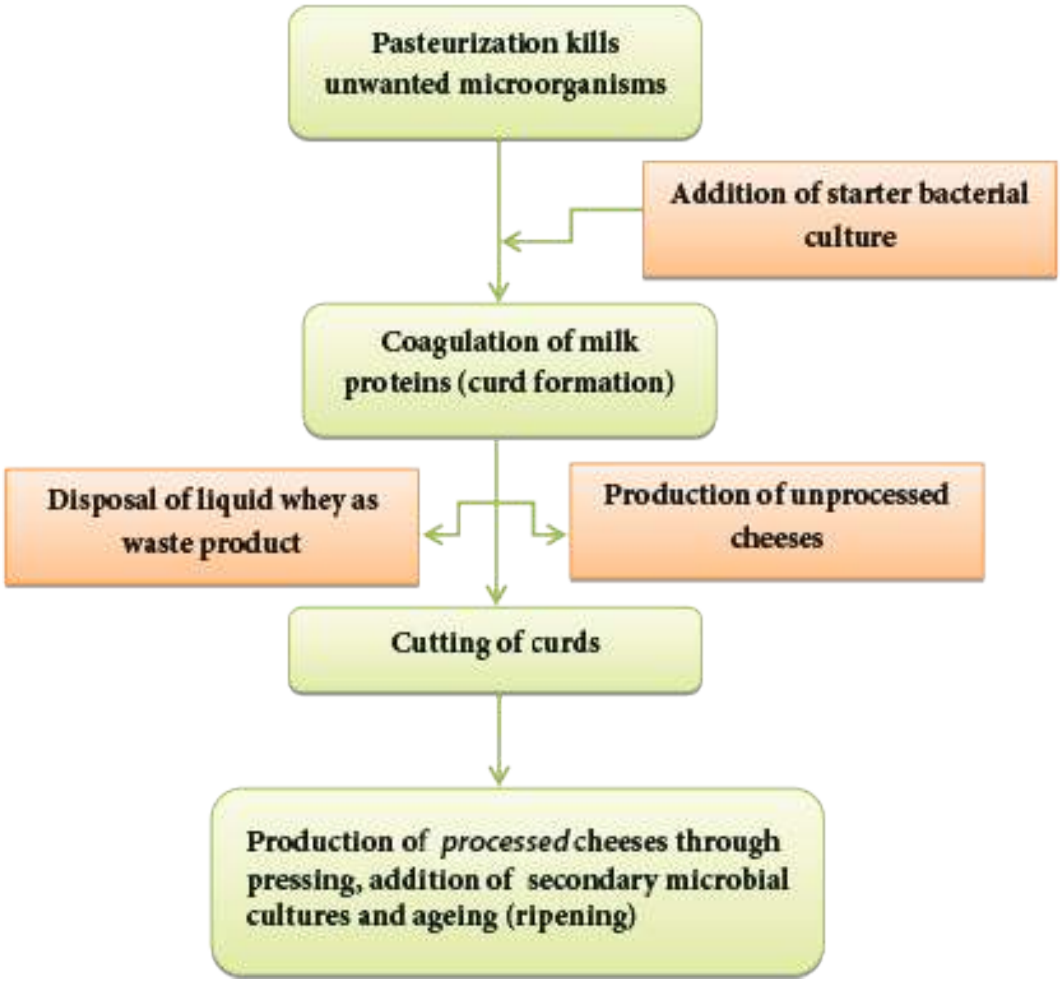


c) Cheese

- It is prepared by coagulation of casein (milk protein) present in milk.
- Hard cheese is prepared by removing much of the water

  E.g. Cheddar cheese, Swiss cheese.
- The cheese is ripened by the microorganisms such as **Streptococcus lactis** and **Streptococcus cremoris**.
- Mould such as **Penicillium camemberti** and **Penicillium Roquefort** gives Camembert and Roquefort cheese.

Figure 3.7 Cheese



Flowchart 3.3 Cheese Production

Apart from these products kumis and kefir are the fermented products obtained from the microbial action of milk.

3. Meat products

Fermented meat products such as salami, ham, and sausages are very popular foods around the world, where different cultures contribute to their texture, flavour, and safety.

Sausages

- Sausages are a meat product usually made from ground meat, often pork, beef or poultry, along with salt, spices and other flavourings.
- Other ingredients such as grains or breadcrumbs may be included as fillers or extenders.
- Lactobacillus, Staphylococcus are involved in sausage fermentation.

Figure 3.8 Sausage

4. Vegetables and Fruits Products

a) Vegetable products

Fermented vegetables should be eaten daily to aid in digestion, heal the gut and aid in the absorption of vitamins and minerals. Cucumber pickle and Sauerkraut are probably the most popular fermented vegetable products.

i) Cucumber pickle:

- Fresh cucumbers are cleaned and packed in salt resistant bacteria like **Lactobacilli** that forms lactic acid which preserves cucumber.
- This is then packed in fluids containing salt, vinegar, sugar and different spices.
- Apart from this most common and famous pickles are made by lemon and mango.

Figure 3.9 Sauerkraut

ii) Sauerkraut or cabbage pickle

- Sauerkraut is finely cut raw cabbage that has been fermented by various **lactic acid bacteria**.
- It has a long shelf life and a distinctive sour flavour, both of which result from the lactic acid formed when the bacteria ferment the sugars in the cabbage leaves.
- Cabbage and salt make up the ingredients for sauerkraut. Veggies, fruit, spices and herbs can be added to make different variations of sauerkraut.

Notes

Activity 1

List the vegetables used for the preparation of mixed vegetable pickle.

b) Fruit products

- Fermented fruits can make for an excellent gift to give family and friends. Fermented fruits can add to flavour alcoholic beverages, favorite desserts, or in recipes like chutneys, smoothies.
- Yeast breaks down the fruit sugars during the fermentation process.

Figure 3.10: Canned Fruits

Placing a chosen fruit in a jar or other container

↓

Add combination of water and sugar

↓

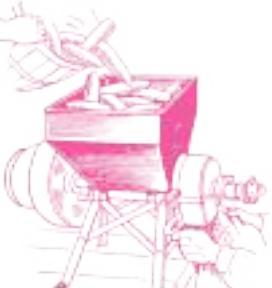
The lid is then sealed

Flowchart 3.4 Fermentation of fruits

The starter culture will convert the sugar to alcohol, and carbon dioxide gas will be produced as a by-product, forming bubbles at the top of the jar.

Example for fruit fermentation

- Fruits like peaches, plums and apricots are a popular choice for fermenting, as they are tasty and hold their color well. Wash the fruit, peel the skin and remove any pits.



Notes

- Exotic fruits like mangoes and pineapples ferment well and can be used to make chutney. Remove the skins and cut into even-sized cubes before using.
- Grapes can be fermented, but they must be pricked with a needle or cut in half to allow the cultured liquid inside.
- Peeled and sliced pears can be fermented, as can apples.
- Most berries can be fermented, except for blackberries which contain too many seeds. Strawberries ferment well in terms of flavour, but the syrup tend to bleach their color.

Storage

- Keep the fermenting fruit in the refrigerator during hot weather, but keep in mind that this will more or less halt the fermentation process.
- Once the fruit has fermented fully, should store it in the refrigerator, where it will keep for up to two months.

5. **Brewing Industry:** Yeast and bacteria are used to produce various products such as beer, wine, brandy and vinegar.

a) Beer

- Beer is made from the fermentation of malt which is derived from germinated barley grains and other grains like corn, wheat, etc.
- This fermentation process is done by the yeast **Saccharomyces cerevisae**.
- The malt beverages are prepared by the infusion of grains that have been subjected to malting (sprouting). This is also known as brewing.
- The enzyme in the grain converts starch into sugar producing an extract **'Wort'.** This extract can be treated with yeast to obtain the final product beer and its varieties.

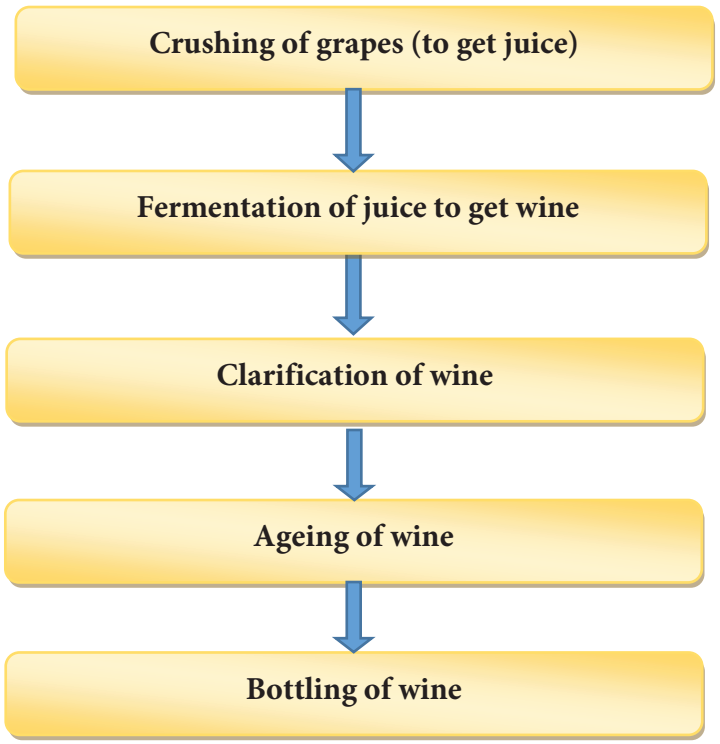
  i) **Lager:** It is a beer that is made with yeast that settles on the bottom of the container used. Due to this setting of fungi and other material in the bottom of the container, the resultant beer is a clean beer.

  ii) **Ale:** This beer is made from fungi which float on the top of brewing vats. Due to this, the beer becomes cloudier in appearance. It also has larger alcohol content than lager.

Figure 3.11 Wine

b) Wine

- Wine is made from fermented fruit juices especially from grapes are fermented by yeast.
- To make red wine, the skin is not removed while to get the white wine, skin is removed.



Flowchart 3.5: Wine Production Process using Grapes

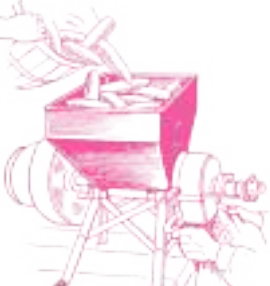
c) Vinegar

- It is a solution containing acetic acid, obtained by further fermenting alcoholic liquids with the help of the **Acetobacter bacteria**.
- Vinegar can be prepared from carbohydrate sources like cereals and fruits.

6. Preparation of Coffee and Chocolate

Figure 3.12 Coffee Beans

The pulp of coffee berries and cocoa seeds are allowed to ferment so that pulp can be removed easily with naturally occurring microbes that include yeast and bacteria such as **Lactobacilli** and **Acetobacter**.



Notes

Harvesting of coffee berries
↓
Sorting
↓
Dry / wet processing
↓
Pulping
↓
Fermentation
↓
Drying
↓
Dehulling
↓
Milling
↓
Storage

Flowchart 3.6: Coffee Processing

- Chocolate comes from the seeds of cocoa.

Fermented cocoa beans
↓
Cleaning
↓
Roasting
↓
Crushing
↓
Rolling
↓
Refining
↓
Conching
↓
Moulding
↓
Chocolate

Flowchart 3.7 Chocolate Making Process

Notes

7. Soy Sauce

- Soy sauce is another food that is made with the help of yeast and was produced in Japan for the first time.
- Soy sauce is dark brown in colour.
- It is salty in taste and is high in amino acids.
- It has a meat like flavour.
- Soy beans are soaked and then cooked to remove contaminants.
- It is then mixed with roasted wheat.
- Then the fungus **Aspergillus oryzae** is added to it and then the mix is kept at 25^0C for 20 to 40 hours and kept aerobically.

Figure 3.13 Soy Sauce

3.2.0. Food Spoilage

Definition

Food spoilage means the original nutritional value, texture, flavour of the food are damaged, the food become harmful to people and unsuitable to eat.

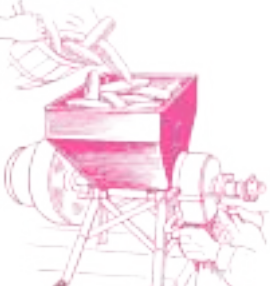
Food must be considered spoiled if it is contaminated with pathogenic microorganisms or various poisonous agents such as pesticides and heavy metals.

3.2.1. Characteristic features of food spoilage

Change in appearance: The appearance of the food changes by the microbial attack, which forms cloudiness and liquid formation in the food.

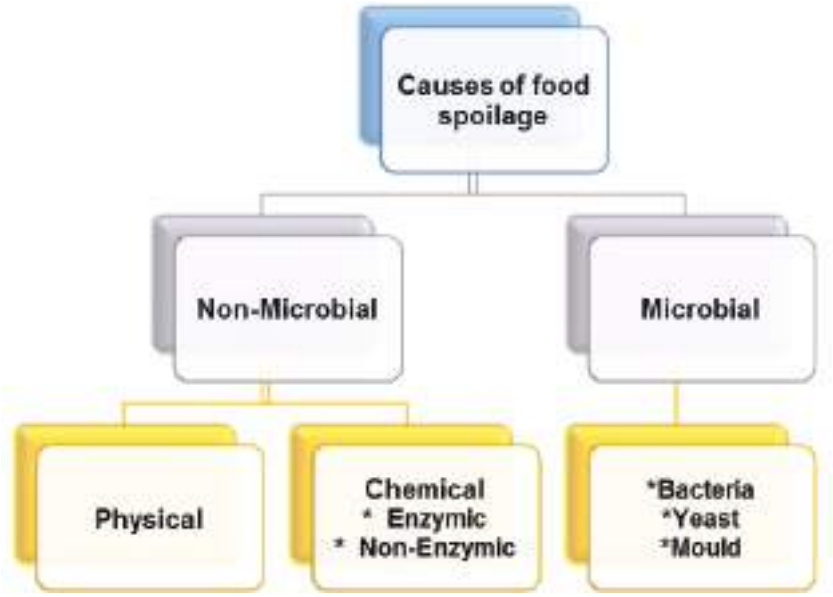
Change in texture: Texture changes occur as a result of slime formation due to an accumulation of microbial cells and tissue degradation.

Change of colour: Colour changes due to the chlorophyll breakdown and by the growth of mycelia.



Change in taste and odour: The taste and odour of the food changes due to the oxidation of nitrogenous compounds, sulphides, organic acids etc.

3.2.2. Causes of food spoilage



Flowchart 3.8 Causes of Food Spoilage

A) Non-Microbial Food Spoilage

It can be caused by foreign material in the foodstuff or by enzymes that occur in the food stuff naturally.

Figure 3.14
Spoilage by Bruises

1) Physical spoilage: It is caused by

- Moisture loss or gain.
- Damage like cuts and bruises.
- Improper temperature.
- Exposure of food to light.
- Washers, bolts and nuts in canned foods.
- Hair, flies, roaches, rodents and other pests or parts of pests.

2) Chemical spoilage:

Chemical reactions in food are responsible for changes in the colour and flavour of foods during processing and storage. It can be caused by enzymatic or non-enzymatic reaction.

a) Enzymatic reaction:

Every living organism uses specialized proteins called enzymes to drive the chemical reactions in its cells. Naturally-occurring enzymes promote major chemical changes in foods as they age.

i) **Starch degradation:** Amylolytic enzymes hydrolyses carbohydrates into the fermentative products by producing acids, alcohols and gases.

Eg: Thinning of sauces from starch degradation.

ii) **Breakdown of proteins:** Proteolytic enzymes produce decomposition of proteins like meat, fish, eggs and milk into simpler forms like amino acids, amines etc.

Eg: Leftover meat in the refrigerator will develop an off taste when reheated.

iii) **Lipid oxidation :** Rancidity of fat is caused by a chemical reaction that breaks down the fatty acids in fat to smaller molecular weight fatty acids by lipolytic enzymes and at the same time releases certain odiferous products.

iv) **Oxidizing enzymes** destroy vitamin C and produce deterioration in flavour.

v) **Browning of fruits and vegetables :**

When the cells of fruits and vegetables such as apples, avocados, bananas and potatoes are cut and exposed to the air, enzymes present in the cells bring about a chemical reaction in which colourless compounds are converted into brown-coloured compounds. This is called enzymic browning.

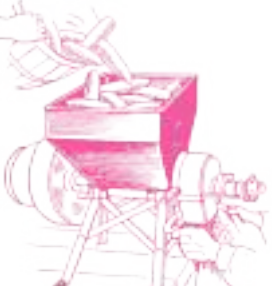
Figure 3.15 Browning of Apple

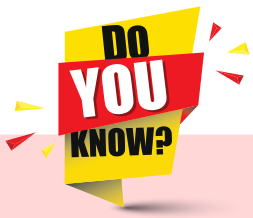
b) Non-enzymatic reaction

Non-enzymatic browning is one of the major causes of deterioration which takes place during frying, cooking, storage of dried and concentrated foods through the following reactions.

i) **Maillard reaction:** It is the reaction between reducing sugars and amino acids in the presence of heat and results in the formation of black brown insoluble pigments.

Figure 3.16 Browning of Bread





How to Prevent Cut Fruit from Turning Brown?

Keep cut fruits, such as apples, pears, bananas and peaches, from turning brown by coating them with an acidic juice such as lemon, orange or pineapple juice.

Mix them with acidic fruits like oranges, tangerines, grapefruit and other citrus fruits or pineapple. Prepare the acidic fruits first. Then, cut the other fruits, mixing them with in the acidic fruits.

ii) Caramelization: It is a type of non-enzymatic browning reaction involves the removal of water (as steam) and the breakdown of the sugar. It gives nutty flavour and brown colour.

Both of these reactions are accelerated by heat (preferably over 100°C or 212°F)

E.g: Browning of bread and brown colour of caramel.

B) Microbial Food Spoilage

Definition

Microbial food spoilage can be defined as the biological process in which microorganisms can degrade and decompose the food material at optimal environmental conditions (temperature, pH, oxygen, moisture etc.) and brings some undesirable changes which make the food inedible to eat.

Microorganisms in food spoilage

Flowchart 3.9 Microbial Spoilage in Food

Bacteria

- These are the organisms which cause food spoilage at warm environment (5°-60° C), neutral acidity and in the presence of oxygen.
- Bacteria spoil foods with relatively high water content such as milk and milk products.

Figure 3.17 Bacteria Spoilage

Mould

- These are the type of fungi, which are multicellular and produce a tough visible mass on the food surface refers as "Mould growth".
- These are aerobic organisms which require oxygen to grow, slightly acidic conditions, moisture, a temperature of 20°-40° C.

Figure 3.18 Mould Spoilage

- Moulds are major causes of food spoilage relatively reduced water content such as dry cereals and cereal products and meat.

Yeasts

Figure 3.19 Yeast Spoilage

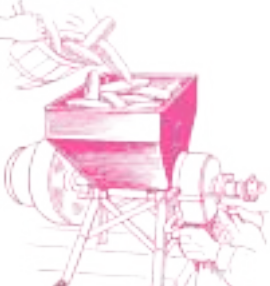
- These are also the type of fungi which are single-celled and cause "Fermentation of food".
- Yeasts are of two types namely true yeasts and false yeasts.
- True yeasts convert sugar into alcohol and carbon dioxide.
- False yeasts grow on the food surface as a dry film.
- Yeasts can be responsible for the decomposition of foods with high sugar.
- The favourable conditions for the yeasts to cause food spoilage are low pH and low moisture.

3.2.3. Based on the rate of spoilage, Foods can be categorized into three main groups

Flowchart 3.10 Classification of Foods Based on Spoilage

1. **Stable or non-perishable foods**

- Food has no water content and can be stored for long time
- These are having a long shelf life
- These foods do not spoil unless they are handled carelessly.



Eg: Sugar, jaggery, hydrogenated fat, vegetable oil, ghee, whole grains, dhals, whole nuts and processed foods like dry salted fish / meat, papads, canned foods and jams.

2. Semi Perishable Foods

- Food has less water content and can be stored for some time.
- These are having a medium shelf life.
- If these foods are properly handled and stored, they will remain unspoiled for a fairly long period.
- Shelf life of these products depends on the storage temperature and moisture in the air.

Eg: Processed pulses, cereals and their products like flour, semolina, parched rice and popcorn. Foods like potato, onion, nuts, frozen foods and certain canned foods can be stored for a week to a couple of months at room temperature without any undesirable changes of the products.

3. Perishable Foods

- Food has high water content and cannot store for a longer period.
- These are having a short shelf life.
- This group of daily used important foods that spoil readily unless special preservative methods are used.
- These foods get spoiled easily by natural enzymes.

Eg: dairy products, eggs, poultry, meat, fish, fruits and vegetables.

Activity 2

Find out time duration of spoilage of the following food items

Food items	Kept open	Under refrigeration
Idli batter		
Fruit juice		
Curd		

3.3. Primary Sources of Microorganisms in Foods

Microorganisms get into foods from both natural (including internal) sources and from external sources to which a food comes into contact from the time of production until the time of consumption.

A. Natural sources

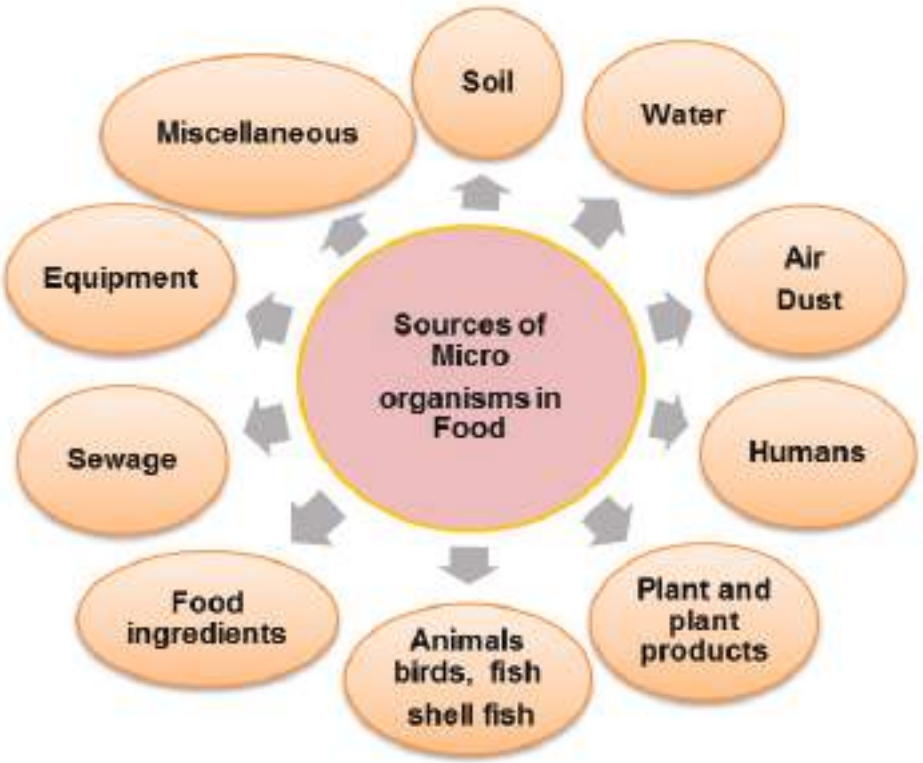
Natural sources for foods of plant origin include the surfaces of fruits, vegetables and grains, and the pores in some tubers (e.g., radish and onion). Natural sources for foods of animal origin include skin, hair, feathers, gastrointestinal tract, urinogenital tract, respiratory tract, and milk ducts in udders of milk animals.

B. External sources

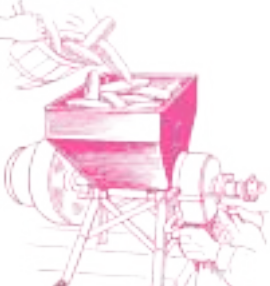
Besides natural microorganisms, a food can be contaminated with different types of microorganisms coming from outside sources such as air, soil, sewage, water, feeds, humans, food ingredients, equipment, packages, and insects. Microbial types and their levels from these sources getting into foods vary widely and depend on the degree of sanitation used during the handling of foods.

An understanding of the sources of microorganisms in food is important to develop methods to control access of some microorganisms in the food, develop processing methods to kill them in food, and determine the microbiological quality of food, as well as set up microbiological standards and specifications of foods and food ingredients.

The various sources of microorganisms in food are depicted in the following Flowchart.



Flowchart 3.11 Sources of Microorganisms in Food



1) Soil

Microorganisms can multiply in soil, their numbers can be very high (billions/g).

Figure 3.20 Soil Contamination

Sources:

- Many types of moulds, yeasts, and bacterial genera (e.g., Enterobacter, Pseudomonas, Proteus, Micrococcus, Enterococcus, Bacillus, and Clostridium) can enter foods from the soil.
- Soil contaminated with fecal materials can be the source of enteric pathogenic bacteria and viruses in food.
- Sediments where fish and marine foods are harvested can also be a source of microorganisms, including pathogens, in those foods.
- Different types of parasites can also get in to food from soil.

Remedial measures: It is reduced by

- Removal of soil (and sediments) by washing.
- Avoiding soil contamination.

2) Water

- Water is used for irrigation of crops, drinking by food animals and birds, raising fishery and marine products, washing foods, processing (pasteurization, canning, and cooling of heated foods) and storage of foods (e.g., fish on ice), washing and sanitation of equipment, and processing and transportation facilities.
- Water is also used as an ingredient in many processed foods.
- Thus, water quality can greatly influence microbial quality of foods.

Figure 3.21 Water Contamination

Sources:

- Although potable water does not contain coliforms and pathogens, it can contain other bacteria capable of causing food spoilage, such as Pseudomonas, Alcaligenes, and Flavobacterium.
- Improperly treated water can contain pathogenic and spoilage microorganisms.

Remedial measure

- To overcome the problems, many food processors use water, especially as an ingredient, that has a higher microbial quality than that of potable water.
- Wastewater can be recycled for irrigation.
- Chlorine-treated potable water (drinking water) should be used in processing, washing, sanitation, and as an ingredient.

3) Air and Dust

- Microorganisms are present in dust and moisture droplets in the air.
- They do not grow in dust, but are transient and variable, depending on the environment.
- Generally, dry air with low dust content and higher temperature has a low microbial level.

Figure 3.22
Poultry Contamination

Sources:

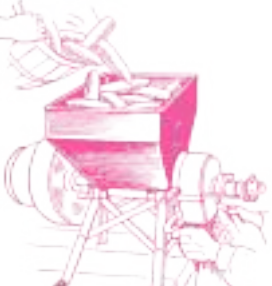
- Animal and poultry farms.
- Sewage-treatment plant.
- Spores of Bacillus spp., Clostridium spp., and moulds, and cells of some Gram-positive bacteria (e.g., Micrococcus spp. and Sarcina spp.), as well as yeasts, can be predominantly present in air.

Remedial measures: It is reduced by

- Removing the potential sources
- Controlling dust particles in the air (using filtered air)
- Using positive air pressure
- Reducing humidity level
- Installing UV light

4) Humans

- Between production and consumption, foods come in contact with different people handling the foods.
- They include not only people working in farms and food processing plants, but also those handling foods at restaurants, catering services, retail stores and at home.
- Human carriers have been the source of pathogenic microorganisms in foods that later caused food borne diseases, especially with ready to-eat foods.



Sources:

- Improperly cleaned hands.
- Lack of aesthetic sense and personal hygiene.
- Dirty clothes and hair.
- The presence of minor cuts and infection in hands and face.
- Mild generalized diseases (e.g., flu, strep throat, or hepatitis A in an early stage).
- In addition to spoilage bacteria, pathogens such as Staphylococcus aureus, Salmonella serovars, Shigella spp., pathogenic Escherisia Coli, and Hepatitis A can be introduced into foods from human sources.

Figure 3.23 Illness

Remedial measures: It is reduced by

- Proper training of personnel in personal hygiene.
- Regular checking of health.
- Maintaining efficient sanitary and aesthetic standards.

5) Plant and plant products

- Fruits and vegetables harbor microorganisms on the surface.
- Their type and level vary with soil condition, type of fertilizers and water used, and air quality.

Sources:

- Moulds, yeasts, lactic acid bacteria, and bacteria from genera Pseudomonas, Alcaligenes, Micrococcus, Erwinia, Bacillus, Clostridium, and Enterobacter Pathogens, especially of enteric types, can be present if the soil is contaminated with untreated sewage.
- Diseases of the plants.
- Damage of the surface (before, during, and after harvest).
- Long delay between harvesting and washing.
- Unfavourable storage and transport conditions after harvesting and before processing.
- Improper storage conditions following processing.

Figure 3.24
Improper Storage

Remedial measures

- Proper methods used during growing (such as use of treated sewage or other types of fertilizers).
- Damage reduction during harvesting.

Notes

- Quick washing with good quality water to remove soil and dirt.
- Storage at low temperature before and after processing.
- Some plants produce natural antimicrobial metabolites that can limit the presence of microorganisms.

6) Animals, birds, fish and shell fish

a) Food animals and birds

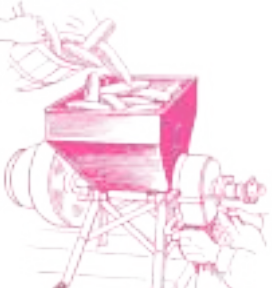
- Many spoilage and pathogenic microorganisms can get into foods of animal origin (milk, egg, meat, and fishery products) during production and processing.
- Normally carry many types of indigenous microorganisms in the digestive, respiratory, and urogenital tracts, the teat canal in the udder, as well as in the skin, hooves, hair, and feathers.

Sources

- Disease situations such as mastitis in cows and intestinal, respiratory, and uterine infections, as well as injury.
- Similarly, poor husbandry resulting in fecal contamination on the body surface (skin, hair, feathers, and udder).
- Supplying contaminated water and feed (e.g., contaminated with salmonellae).
- Milk can be contaminated with fecal materials on the udder surface, egg shells with fecal material during laying, meat with the intestinal contents during slaughtering.

Remedial measures

- The use of effective husbandry of live animals and birds, which includes good housing and supply of uncontaminated feed and water.
- Testing animals and birds for pathogens and culling the carriers.
- Thorough cleansing using good-quality water for washing carcasses (preferably with acceptable antimicrobial agents).
- Hair removal, feather removal, careful removal of digestive, urogenital, and respiratory organs without contaminating tissues.
- Removal of contaminated parts.
- Proper sanitation during the entire processing stage are necessary during slaughter.
- Proper cleaning of the udder before milking.



Notes

- Cooling milk immediately after milking, processing as soon as possible.
- Sanitization at all stages are important to keep microbial levels low in milk.
- Eggs should be collected soon after laying and washed and stored as per recommended procedures.

b) Fish and shellfish

- Carry normal microflora in the scales, skin, and digestive tracts.
- Water quality, feeding habits, and diseases can change the normal microbial types and level.

Sources

- Pathogens such as ***Vibrio parahaemolyticus, Vib. vulnificus,*** and ***Vib.cholerae*** are of major concern from these sources.
- Fish contaminated with intestinal contents during processing.
- Stored with polluted water.

Remedial measures

- Fish and marine products should be harvested from unpolluted and recommended water.
- Proper sanitation should be used during processing.
- They should be stored properly to prevent further contamination and microbial growth.
- Ice to be used for storage should be produced from potable water.

7) Food ingredients

- In prepared or fabricated foods, many ingredients or additives are included in different quantities.

Sources

- Various spices generally have very high populations of mould and bacterial spores.
- Starch, sugar, and flour might have spores of thermophilic bacteria.
- Dried coconut, egg, and chocolate.
- Many of these ingredients can be the source of both spoilage and pathogenic microorganism.

Notes

Remedial measures

- The ingredients should be produced under sanitary conditions and given antimicrobial treatments.
- Isolation of pathogens dried foods.
- Setting up acceptable microbial specifications for the ingredients.

8) Sewage

- Sewage, especially when used as fertilizer in crops, can contaminate food with microorganisms.
- This can be a major concern with organically grown food and many imported fruits and vegetables, in which untreated sewage and manure might be used as fertilizer.
- Pathogenic parasites can also get in to food from sewage.

Remedial measures

- It is better not to use sewage as fertilizer.
- If used, it should be efficiently treated to kill the pathogens.
- Effective washing of foods following harvesting is important.

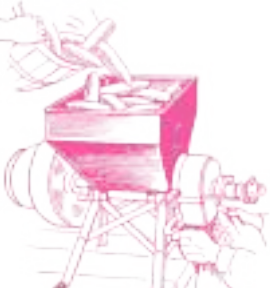
9) Equipment

- A wide variety of equipment is used in harvesting, slaughtering, transporting, processing, and storing foods.
- Many types of microorganisms from air, raw foods, water, and personnel can get into the equipment and contaminate foods.

Figure 3.25 Equipment Contamination

Sources

- Depending on the environment (moisture, nutrients, and temperature) and time, microorganisms can multiply.



- When processing equipment is used continuously for a long period of time, microorganisms initially present can multiply and act as a continuous source of contamination in the product produced subsequently.
- In some equipment, small parts, inaccessible sections, and certain materials might not be efficiently cleaned and sanitized.
- These dead spots can serve as sources of both pathogenic and spoilage microorganisms in food.
- Small equipment, such as cutting boards, knives, spoons, and similar articles, because of improper cleaning, can be sources of cross contamination.
- Salmonella, Listeria, Escherichia, Enterococcus, Micrococcus, Pseudomonas, Lactobacillus, Leuconostoc, Clostridium, Bacillus spp., and yeasts and moulds can get in to food from equipment.

Remedial measures

- Proper cleaning and sanitation of equipment.
- In addition, developing means to prevent or reduce contamination from air, water, personnel, and insects is important.
- Finally, in designing the equipment, potential microbiological problems need to be considered.

10) Miscellaneous

a) Packaging and wrapping materials and containers:

- Many types of packaging materials are used in food.
- Any failure to produce microbiologically acceptable products can reduce the quality of food.

Remedial measure:

Proper microbiological standards for packaging materials are necessary.

Figure 3.26
Damaged Packed food

b) Flies, vermins, birds, house pets, and rodents

- Flies, vermins, birds, and rodents in food processing and food preparation and storage facilities should be viewed with concern as they can carry pathogenic microorganisms.
- House pets can also harbor pathogens.

Notes

Remedial measures:

- Proper care should be taken not to contaminate food from these sources.
- Proper cleaning and sanitation need to be maintained to keep away flies, vermins, birds, and rodents in processing location.
- House pets should be away from the production and storage units.

3.4. Important properties of enzymes in fruits and vegetables

Consumption of fruits and vegetables is vital to meet the recommended daily intake of vitamins, minerals, and fibers. It is estimated that 25% to 80% of harvested fruits and vegetables are lost during transportation and storage due to its high perishability. Therefore, they need special care in both postharvest storage and processing.

3.4.1. Need and significance of enzymes

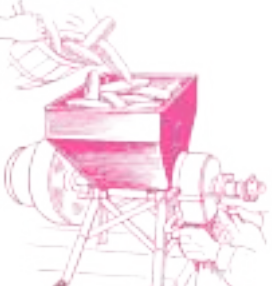
Sometimes desired characteristics of food cannot be achieved with regular chemical treatment. The results and benefits of using enzymes are:

- High quality product
- Low production cost
- Low wastage
- Minimum energy consumption
- Biodegradability

3.4.2. Sources of Food Enzymes

Table 3.1: Sources of Food Enzymes

Sources	Food Enzymes
Plants	α-amylases, β-amylases, bromelain, papain, ficin, lipooxygenase, actinidin, hemicellulase
Animals	Lipase, rennet, trypsin, catalase, chymotrypsin
Microorganisms	Protease, cellulase, lactase, α-amylases, β-amylases, lipase, invertase, pectinase



3.4.3. Applications of enzyme

The richness and availability of nutrients in fruits and vegetables encourage food processors to convert them into various food commodities.

Applications of enzymes in fruits and vegetables processing are given below:

Figure 3.27
Clarification of Juices

1. Peel removal and juice extraction

- Mixture of pectinases, hemicellulases, and cellulases are used as enzymatic treatment for peeling and juice extraction from fruits.

  Example: Citrus fruits.

2. Clear juice production from fruits and vegetables (Clarification)

- Juices from fruits and vegetables contain highly concentrated polysaccharides like pectin, cellulose, hemicellulose and starch.
- These components make juices highly opaque and viscous.
- Hence enzyme treatment is necessary in the clarification step to produce haze-free, clear juices.
- Enzymes like pectinases have been used in fruit and vegetable processing during pressing and straining of juices to reduce opaqueness and viscosity and to remove suspended pectin substances.
- The use of these enzymes also enhances the extraction process by making juices more transparent.

Figure 3.28
Purees from Fruits

3. Production of purees from fruits

- Tropical fruits like mangoes, peaches, guavas, bananas, and avocados have mostly been used to produce purees and those products have been diluted or blended with other fruit products to make even more delicious fruit cocktails.
- Protopectinase enzyme is used for this purpose

Figure 3.29
Vegetable Oil

4. Processing of vegetable oil

- Pectinolytic enzymes are used to extract the vegetable oils from coconut, canola, sunflower seed, kernel, palm, and olive by softening the structural components and degrading the cell walls.
- This improves oil quality by increasing the extraction of phenolic compounds with high antioxidant activities.

5. **Production of wine**

   Pectinases and hemicellulases have been widely used to enhance the process of grape juice fermentation and to increase overall wine production.

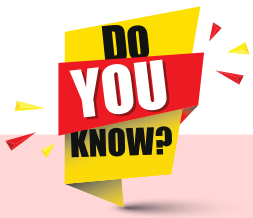
6. **In Baking industry,** lipooxygenase is used to whitening the bread whereas, β-amylase is used to improve the bread volume.

7. **In Dairy industry,** proteases, lipases, lactases are used to develop flavour compounds.

8. **In Brewing industry,** cellulase, hemicellulase, amylase, lipase are used for liquefaction, clarification and to supplement malt enzymes.

9. **Protease enzymes** such as papain**,** bromelain and ficin are used to improve meat tenderness.

10. **Cellulase** performs hydrolysis of cellulose during drying of coffee beans whereas in tea leaves production, cellulase favours fermentation process.



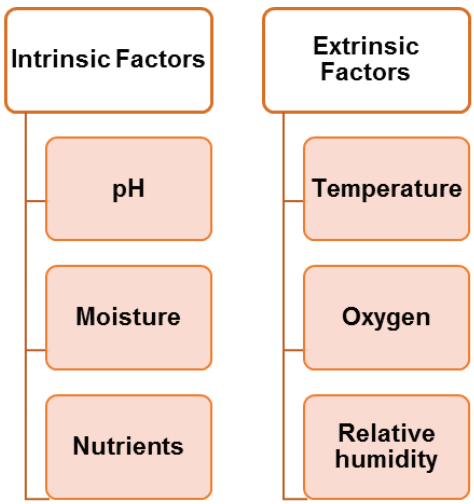
Papain enzyme is isolated from the papaya latex. The latex collected after cutting the unripen papaya is dried. The more greener the fruit, the more active the enzyme.

3.5. Factors affecting microbial growth

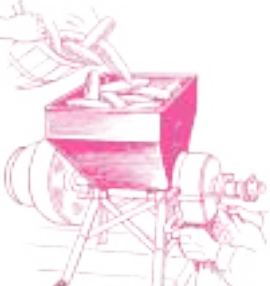
When microorganisms grow in food, they cause varying degrees of change in the food's characteristics as a result of metabolic activity. Some of these changes, like those taking place during fermentation, are desirable, while others, like those resulting in food spoilage and food poisoning are undesirable.

The factors influencing the growth of microorganisms are physical, chemical and biological in nature. The factors can be generally classified as intrinsic and extrinsic factors.

3.5.1 Factors influencing microbial growth in food



Flowchart 3.12 Factors Influencing Microbial Growth



A) Intrinsic factors

Intrinsic factors exist as part of the food product itself. The following common intrinsic factors influence the growth and multiplication of microorganisms in foods.

1) pH

The pH of a food can vary greatly. On the basis of pH, foods can be grouped as:

High-acid foods (pH below 4.6) - Most fruits, fruit juices, fermented foods (from fruits, vegetables, meat, and milk), and salad dressings.

Low-acid foods (pH 4.6 and above) - Most vegetables, meat, fish, milk, and soups.

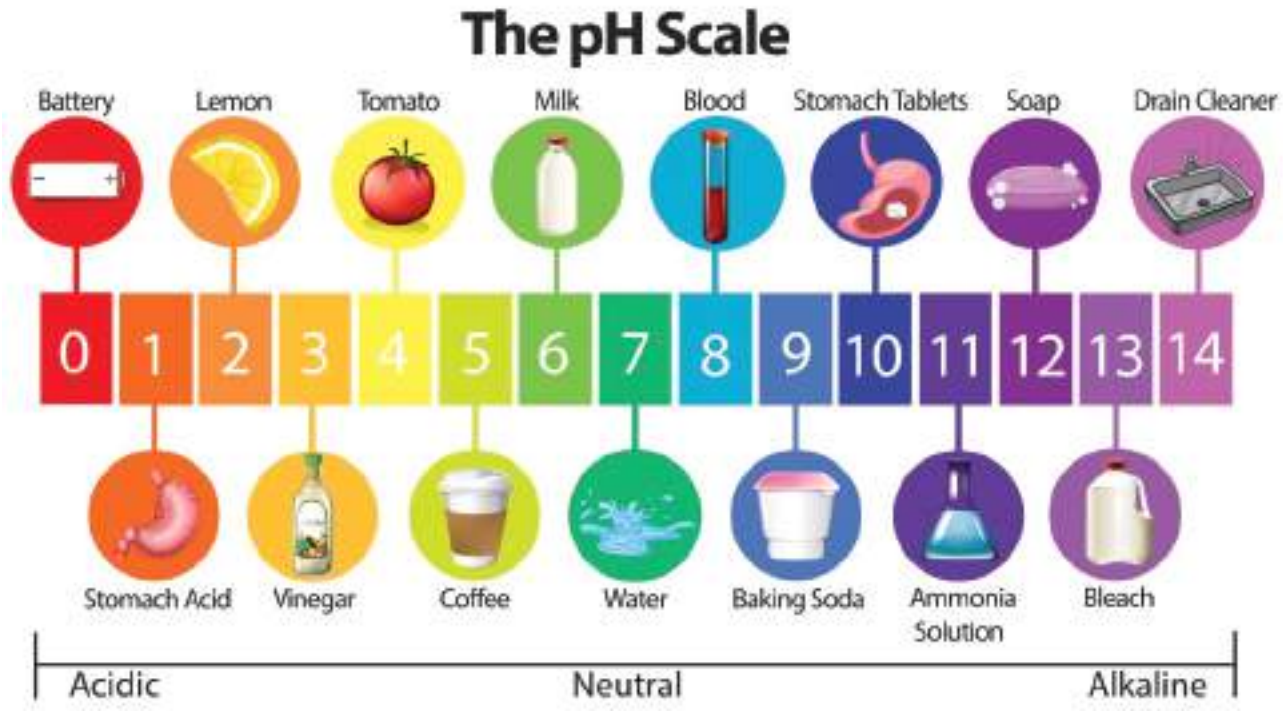


Figure 3.30 pH of Different Stuffs

- Each species has an optimum and a range of pH for growth.
- Most microorganisms grow best at close to the neutral pH value (pH 6.6 to 7.5).
- Only a few microorganisms grow in very acid conditions below a pH of 4.0.
- The pH below 4.5 does not allow the subsequent bacterial growth and are affected mostly by yeasts and moulds like in citrus fruits and vegetables.

Notes

- The high pH allows bacterial growth which occurs mainly in non-acid foods.
- When the pH in a food is reduced below the lower limit for growth of a microbial species, the cells not only stop growing but also lose viability, the rate of which depends on the extent of pH reduction.

  Eg: Most meats naturally have a pH of about 5.6 or above. At this pH meat is susceptible to spoilage by bacteria, moulds and yeasts.

2) Moisture

- The free water in a food is necessary for microbial growth.
- It is necessary to transport nutrients and remove waste materials, carry out enzymatic reactions, synthesize cellular materials, and take part in other biochemical reactions.
- Microorganisms have varying minimum water activity requirements that supports their growth in food.
- Growth of microorganisms is greatly affected by the level of water activity in the food.

  Example: Vegetables and fruits are more susceptible to microbial spoilage than cereals.

3) Nutrient contents of food

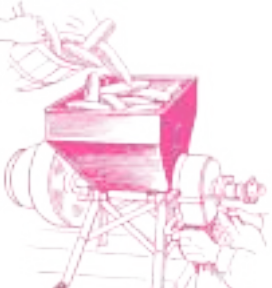
- In order to grow, multiply and function normally, microorganisms require a range of nutrients such as carbohydrate, protein, vitamins and minerals.
- Microorganisms therefore grow well on nutrient-rich foods such as milk, meat and eggs.
- These foods are hence susceptible to microbial spoilage.

B) Extrinsic Factors

Extrinsic factors important in microbial growth in a food include the environmental conditions in which it is stored. These are temperature, relative humidity, and gaseous environment.

1) Temperature

Various microorganisms are able to grow in certain temperature. According to that they are divided into following groups.



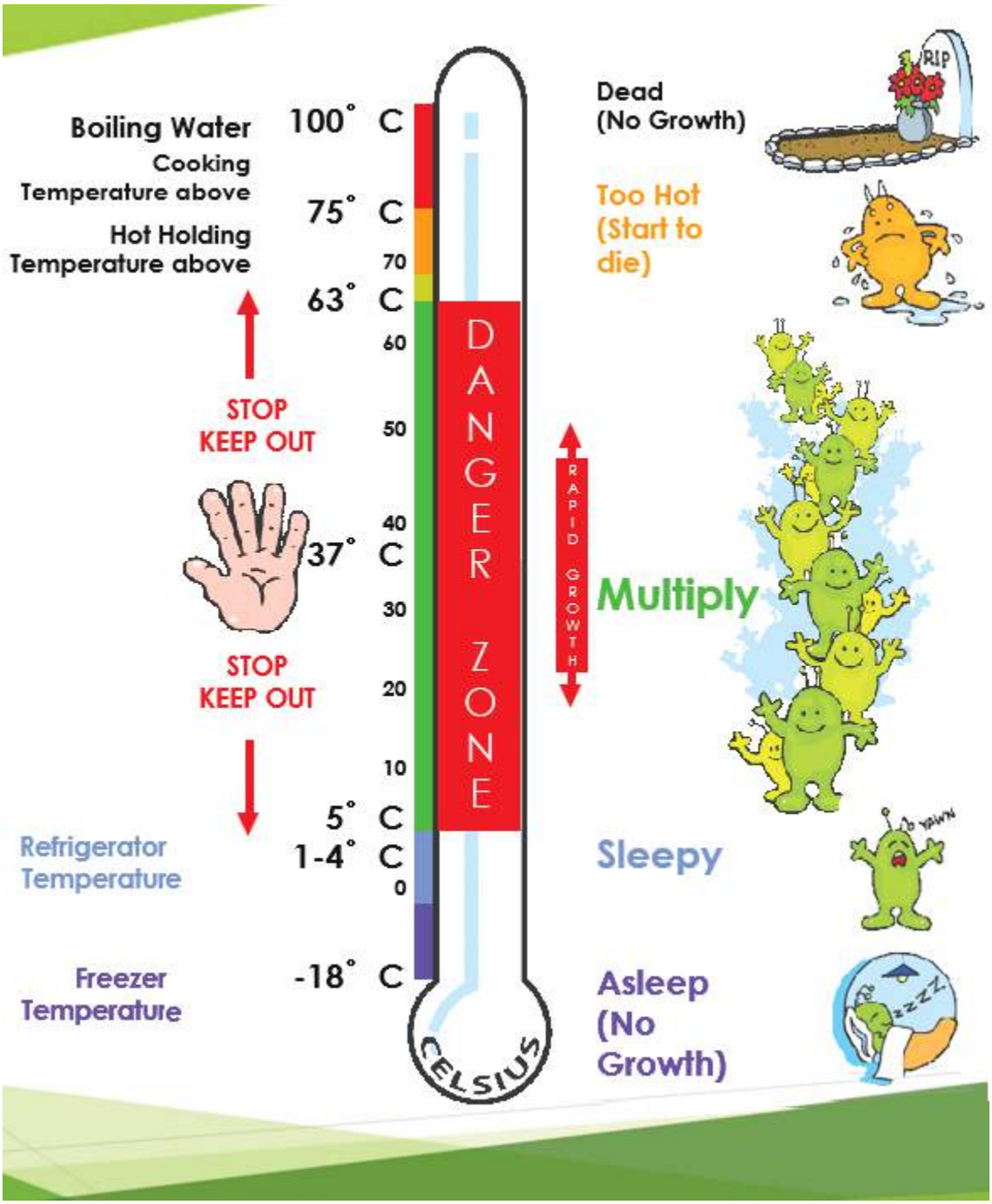


Figure 3.31 Temperature for Food, Water and Microorganisms

a) Psychrophilic microorganisms

- These can cause food spoilage at low temperature.
- These grow best at 20^0 C but also down to -10^0 C in unfrozen foods.

b) Mesophilic microorganisms

These organisms grow between 25^0C and 40^0C with an optimum temperature close to 37^0 C.

Notes

c) Thermophilic microorganisms

These grow at temperatures above 45^{0}C. Often their optimum growth temperature are between 50° and 70^0 C.

2) Oxygen

a) Aerobic microorganisms

- Many microorganisms which need oxygen to develop and reproduce are called aerobic microorganisms.
- A good example is Escherichia coli, a fecal bacterium which grows readily on many foods.

b) Anaerobic microorganisms

- There are some microorganisms that grow without oxygen, called anaerobic microorganisms.
- An example of this is Clostridium botulinum, the bacterium causing botulism, which can survive in very low oxygen environments such as tinned foods.

3) Relative humidity

- The humidity of the storage environment is an important factor for the growth of microorganisms at the food surfaces.
- If the food is stored in a dry atmosphere, microorganisms are less able to grow than if the food is stored in a humid (moist) environment.
- Therefore, dry conditions are better for food storage than moist conditions.

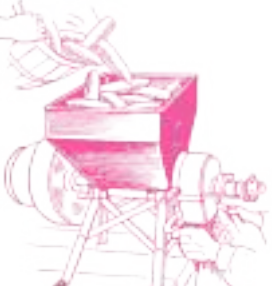
Eg: Dry grains stored in an environment with the high humidity will take up water and undergo mould spoilage.

3.5.2. Control of microorganisms in food

Although some microorganisms are desirable for the production of bioprocessed food, many are undesirable because they can cause food spoilage, food poisoning and food borne diseases.

For efficient production of bioprocessed food, the objectives are to stimulate growth and increase the viability of desirable microorganisms.

In contrast, with respect to spoilage and pathogenic microorganisms, the objective is to minimize their numbers or completely eliminate them from food.

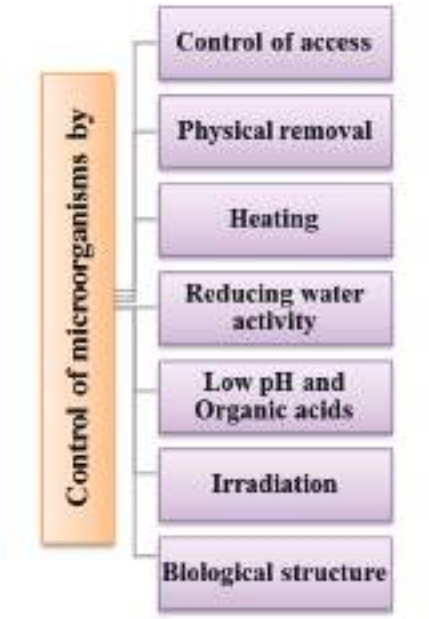


Notes

Several methods, individually or in combinations, are used to achieve these goals by

- Controlling access of the microorganisms in foods.
- Physically removing the microorganisms present in foods.
- Preventing or reducing the growth of microorganisms and germination of spores present in foods, and
- Killing microbial cells and spores present in foods.

Control /Preservation methods



Flowchart 3.13 Control of Microorganisms

a) Control of access

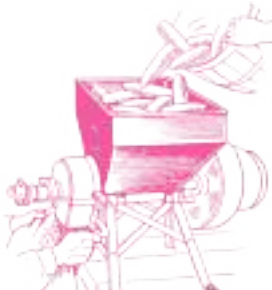
Spoilage and pathogenic microorganisms enter in food from different sources. One of the major objectives to produce a safe food with desirable shelf life is to minimize the access of microorganisms in food from various sources.

This can be achieved by

- Proper plant design
- Proper training to personnel
- Designing equipment that can be sanitized effectively, and
- Establishing an efficient cleaning and sanitation procedure.

b) Control by physical removal

- Microorganisms can be physically removed from solid and liquid foods by several methods.
- In general, these methods can partially remove microorganisms from food, and by doing so they reduce the



Notes

microbial level and help other antimicrobial steps that follow to become more effective.

- They are generally used with raw foods before further processing

This can be achieved by

Flowchart 3.14 Physical Control Methods

i) Centrifugation

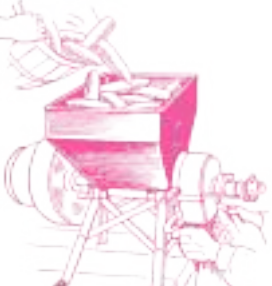
Centrifugation is used in liquid foods such as milk, fruit juices, and syrups to remove suspended undesirable particles (dust and food particles).

ii) Filtration

- Filtration is used in liquid foods such as soft drinks, fruit juices, beer, wine, and water to remove undesirable solids and microorganisms and to give a sparkling clear appearance.
- Filtration of air is also used in some food-processing operations, such as spray drying of milk.
- The process also removes some microorganisms with dust, and this reduces the microbial level in food from air.

iii) Trimming

- Fruits and vegetables showing damage (greater chance of microbial contamination) and spoilage are generally trimmed.
- Thereby areas heavily contaminated with microorganisms are removed.
- Trimming the outside leaves in cabbage used for sauerkraut production also helps to reduce microorganisms coming from soil.
- Trimming is also practiced to remove visible mould growth from hard cheeses, fermented sausages, bread, and some low-pH products.



Notes

iv) Washing

- Fruits and vegetables are washed regularly to reduce temperature and remove soil.
- Washing also helps to remove the microorganisms present especially from the soil.
- It is also used for shell eggs to remove fecal materials and dirt.
- During the processing of chicken and turkey, the carcasses are exposed to water several times.

c) Control by heating:

On the basis of temperature and time of heating the food used to destroy microorganisms, the methods can be broadly divided as low-heat processing and high-heat processing.

i) **Low-heat processing** is used to destroy mainly the microorganisms relatively sensitive to heat.

Eg: Pasteurization of milk.

ii) **High-heat processing** is used to destroy thermophilic organisms.

Eg: Methods (e.g., baking, broiling, simmering, roasting, and frying) used in cooking foods and blanching used to destroy some natural enzymes in fresh vegetables and fruits.

d) Control by reducing water activity

It is achieved either by removing or binding the free water present in food.

Example: Salting and drying reduces the water activity of a food product.

e) Control by low pH and organic acids

- It was observed that over a restricted pH range, many microorganisms present in food can grow, but at lower pH ranges many of them die.
- Many organic acids are used as food additives.
- They can be present naturally, as citric acid in citrus fruits, benzoic acid in cranberries, and sorbic acid in rowan berries.
- Acids like acetic, lactic, and propionic acids are produced in different fermented foods by desirable bacteria.
- Many acids are also added to foods and beverages to reduce the pH.

- Organic acids used in food as preservatives are acetic, propionic, lactic, citric, sorbic, and benzoic, their salts, and some derivatives of benzoic acid (e.g., paraben).

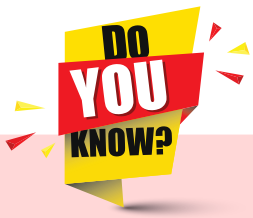
f) Control by irradiation

- Irradiation will be used to destroy many foodborne pathogens in raw and processed foods (meat, fish, and bread) as well as in air and on walls, shelves, and equipment in the food handling and processing area.
- In addition, liquids such as water and syrups have been treated with Ultra Violet rays.

g) Control by biological structure

Plant and animal foods especially in the raw state, have biological structures that may prevent the entry and growth of pathogenic microorganisms.

Eg: The skin of fruits and vegetables, shell of nuts, animal hide, egg cuticle, shell, and membranes.



How UV light is used to control microorganism? Ultraviolet germicidal irradiation (UVGI) is a disinfection method that uses short- wavelength ultraviolet (UV-C) light to kill or inactivate microorganisms by destroying nucleic acids and disrupting their DNA, leaving them unable to perform vital cellular functions.

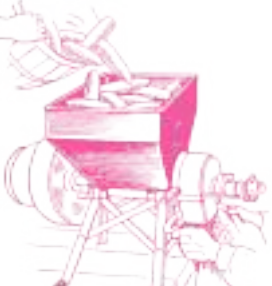
Activity 3

Tick the correct method used to reduce microbial contamination

Food items	Washing	Trimming	Heating	Radiation
Leafy vegetables				
Milk				
Meat				
Egg				

Glossary

Actinidin	:	An enzyme found especially in the kiwifruit.
Bromelain	:	It is an enzyme extract derived from the stems of pineapples.
Centrifugation	:	The action or process of using a centrifuge, typically to separate fluids of different densities or liquids from solids.
Decomposition	:	The state or process of rotting or decay.
Ficin	:	An enzyme derived from the latex of the fig tree.



Notes

Kefir	:	Fermented sheep's milk
Kumis	:	Fermented mare's milk
Mycelia	:	The vegetative part of a fungus, consisting of a network of fine white filaments.
Pathogens	:	A bacterium, virus or other microorganism that can cause disease.
Purees	:	A smooth cream of liquidized or crushed fruits or vegetables.
Rancidity	:	Unpleasant smell or taste in fat as a result of being old and stale.
Slime	:	An unpleasantly thick and slippery liquid substance formed by microbial growth.

Evaluation

I. Choose the correct answer **(1 Mark)**

1. ……. is one of the famous foods of India especially in South India.

   a) Bread b) Idli

   c) Dhokla d) Naan

2. ……. is the energy source for the yeast.

   a) Starch b) Protein

   c) Vitamins d) Minerals

3. …….. organisms grow at temperatures above 45° Celsius.

   a) Psychrophilic b) Thermophilic

   c) Mesophilic d) Zerophilic

4. Match the following

   1) Papain - i) Apple

   2) Bromelain - ii) Papaya

   3) Ficin - iii) Pine apple

   4) Pectinase - iv) Fig

   a) 1-(ii), 2-(iii), 3-(iv),4-(i) b) 1-(i), 2-(ii), 3-(iii), 4-(iv)

   c) 1-(iv), 2-(iii), 3-(ii), 4-(i) d) 1-(iii), 2-(iv), 3-(i), 4-(ii)

Notes

5. Which one of the following is considered as high acid food?

   a) Milk b) Meat

   c) Fish d) Fruit juices

6. Example for Non-Perishable food is ……

   a) Meat b) fish

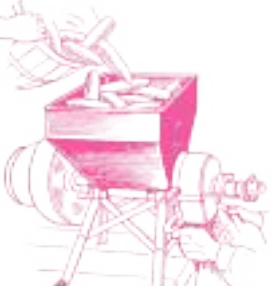
   c) Fruits d) Whole grains

II. Write in two lines (2 Mark)

1. Differentiate curd and yoghurt.
2. List out fermented cereal products.
3. Write about non-microbial food spoilage?
4. What are mesophilic microorganisms?
5. Mention the remedial measures to reduce soil contamination.
6. Enumerate the sources of microorganisms from air and dust.
7. Indicate the need to take special care in both postharvest storage and processing of fruits and vegetables?
8. Specify the enzymes used for fruit juice production.
9. Mention the two main factors influencing microbial growth in food.
10. Define aerobic microorganisms.
11. What is sausage?
12. Foods which have medium shelf life - What is it? Give example.

III. Write in three lines (3 Mark)

1. How to prepare Dhokla?
2. Explain the process of wine making.
3. How does browning occur in fruits and vegetables?
4. Relate moisture content of food with microbial spoilage.
5. Suggest some possible ways to reduce microbial contamination from water.
6. Discuss about food contamination through humans.
7. Explain the need and significance of enzymes in food processing.
8. Describe the application of enzymes in fruit and vegetable processing.



9. What are the extrinsic factors influencing microbial growth in food?
10. Explain the 4 physical methods to control growth of microorganisms.

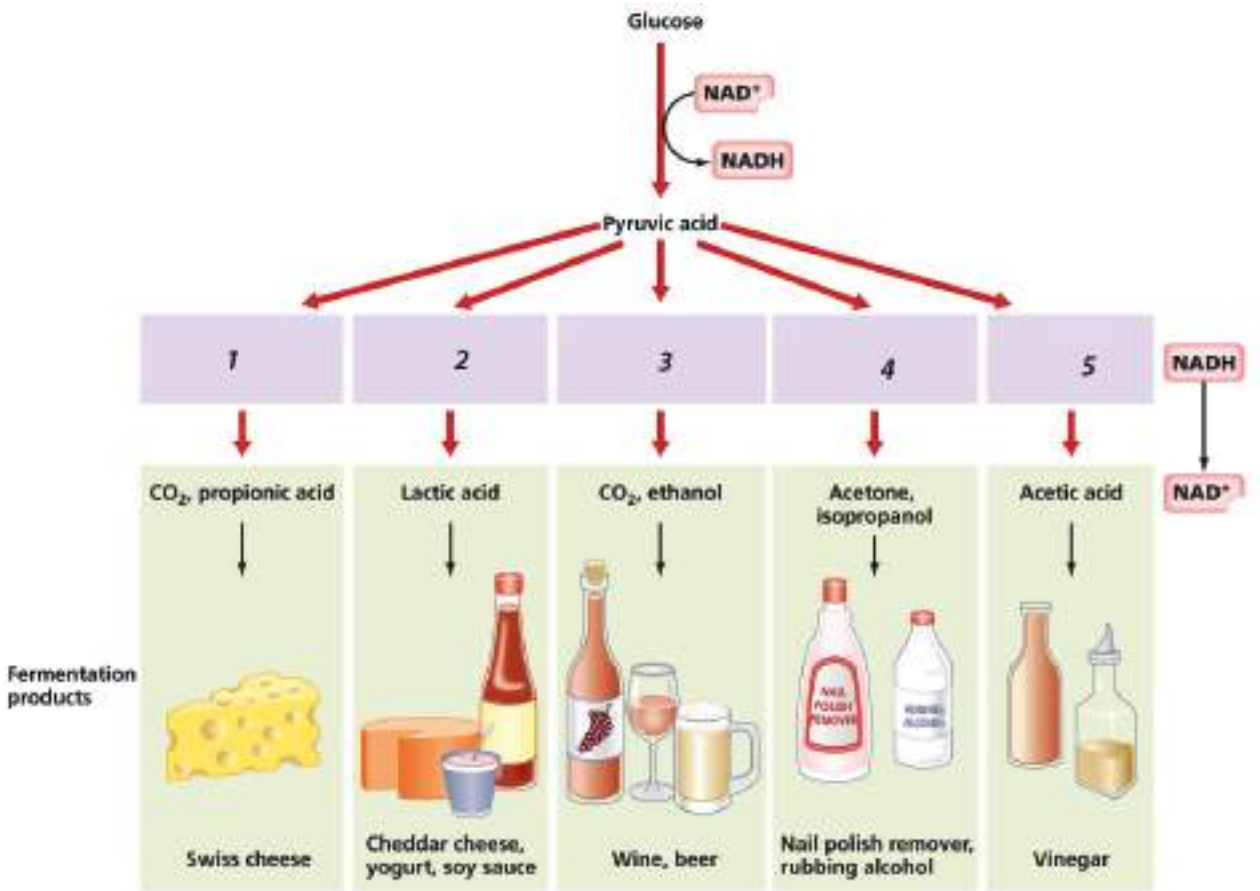
Practicals

1. Enlist and discuss beneficial microbes in food industry

Aim: To identify organisms and discuss their uses for the preparation of different food products.

Apparatus: Cheese, soya sauce, wine, vinegar, curd.

Procedure:



Tabulate the following

1. Write the name of the organism.
2. Name the food stuffs used to prepare them.
3. Name the starter culture for each.
4. What are their uses?

Notes

Result and discussion:

2. Preparation of Vinegar in the Lab

Fruit peel vinegar recipe is a great way to use fruit peels and cores which would otherwise be discarded. Apple and pear peelings are very good, but pineapple or melon skins work equally well. It may seem a little daunting, but making vinegar in the lab is very satisfying and with a little patience, very easy to do!

Aim: To prepare Vinegar from fruit peels

Figure 3.32 Vinegar

Apparatus: Glass jar, spoon, knife, muslin cloth, string.

Ingredients

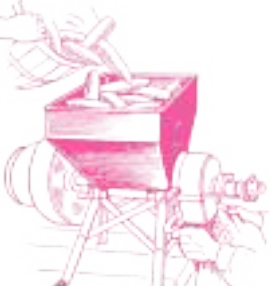
- Fruit peelings, a mix of apple, pear, pineapple and melon – 500 grams
- Sugar – 80 grams
- Starter vinegar containing a live mother, either homemade or shop-bought – 140 ml

Figure 3.33 Fruit Peel

Figure 3.34 Sugar

Procedure

1. Put the fruit peel and sugar in a clean 2-litre glass jar, then add enough water to cover the peel.
2. Add the vinegar and drape a square of muslin over the top of the jar, then secure it with string.
3. Stir the mixture with a clean spoon once a day for a week, by which point the fruit skins will start to ferment.



Notes

4. Leave the fruit to ferment for another week, stirring every now and then. Small bubbles should appear in the liquid as the fermented sugars convert to ethanol and release carbon dioxide.
5. Strain and use.

Result and discussion :

Projects

- Arrange an educational tour to Dairy Industry to visit various milk processing unit such as butter, yoghurt and ice creams and submit a report
- Prepare different flavours of milk and sell in school campus
- Prepare different flavours of butter milk and sell in school campus

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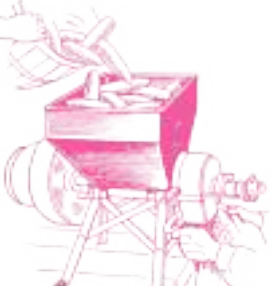


PREPARE AND MAINTAIN WORK AREA

4

Learning Outcomes

- To acquire knowledge about selection and chemical composition of various fruits and vegetables used for jam, jellies and ketchup preparation.
- To identify the machineries, tools and equipments used in food processing industries.
- To understand the various unit operations involved in food processing.
- To know the maintenance of machineries in work area.
- To gain knowledge about SOP for waste disposal.
- To identifying various chemicals and cleaning materials used for cleaning and disinfecting tools and equipments.
- To acquire knowledge of food safety standard and regulation pertaining to work place health and safety.

4.1.0. Introduction

Fruits and vegetables should be preserved as soon as possible (4-48 hours) after harvesting to stop or slow down the spoilage, loss of quality and nutritional value.

Addition of sugar to the fruits is one of the methods of preservation. When sugar is added it blends with the water present in the fruits and thus it reduces the amount of water available for the growth of microorganisms.

In Jam production, fruits are initially boiled to reduce the water content thus it reduces the bacterial growth, and then adequate amount of sugar is added so as to prevent the regrowth of bacteria.

4.1.1 Prepare Plan for Jam, Jelly and Ketchup Processing

Types and Chemical Composition of Various Fruit and Vegetable Suitable for Jam, Jelly and Ketchup

I. Jam

Jam making is a technical process. The principle ingredients are sugar, citric acid and pectin.

The term 'Jam' refers to a product made of whole fruit cut in to pieces or crushed, then heated with water and sugar to activate its pectin.

Jam is a product obtained by cooking fruit pulp with sugar and acid to acceptable consistency. It contains 0.5-0.6 percent acidity and 68 percent total solids.

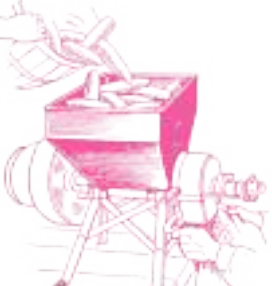
Figure 4.1 Jam

Figure 4.2 Ripening of Fruits

a. Selection of Fruits for Preservation

In order to select the fruits for preservation there is a need to know about the ripening process. Changes occurred during ripening of fruits.

- Fruit develops its full size
- Edible portion of fruit becomes soft and tender.
- The colour of the fruit changed.
- Starch present in the fruit is converted to sugar making the fruit softer and sweeter.
- Mild sweet aroma developed



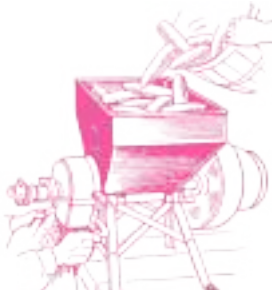
Notes

Points To Remember while Selecting Fruits

1. For jam preparations consider the size, grade and variety. Size and grade are major determinant factors.
2. For the preparation of sweet preserve select the fruit of its peak of maturity, for salty preserves go for unripe state.
3. Seasonal fruits are cheaper and have better quality.
4. Fruits should be firm and flavourful.
5. During transportation ripened fruits may deteriorate more rapidly. To avoid this follow proper storage and transportation facilities.

b. Selection Criteria for Fruits

Apple	:	It should be firm, crisp, well coloured and heavy.
Grapes	:	Shiny, plumpy, well coloured, firmly attached to the stem.
Banana	:	Slightly hard, solid yellow coloured bananas are selected. It should not have black spots / bruises on the skin.
Citrus fruits	:	(Orange, Sweet lime, Grape fruit, Lemon): It should be firm, bright, rich in colour, thin skinned and heavy according to their size.
Pears	:	Firm and ripe pears are selected. Avoid pears with dull skin and spots on the sides. Weakening of flesh near the stem shows immature.
Pineapple	:	Bright golden yellow or reddish brown coloured pineapples with fragrant aroma are good choice. It should be firm, plumpy and heavy for their size.
Plums and Prunes	:	Good colour and variety, fairly firm to soft fruits are selected.
Peaches	:	Fairly firm, having yellowish skin colour or creamy between the red areas are selected.
Apricots	:	It should be firm and heavy according to their size.



Notes

Cherries : Firm, plumpy, bright uniformly red in colour and should be glossy.

c. Grouping Fruits according to their Pectin and Acid Content

Figure 4.3 Pectin Rich Foods

Pectin rich fruits : Lemons, cranberries, apple, crabapple, sour apples, sour cherries, partially ripened grapes, blackberries, partially ripened oranges, plums, guava, papaya.

Pectin poor fruits : Peaches, pomegranate, apricots, blueberries, strawberries, pears, figs, grape fruit, pineapple, raspberries.

High acid fruits : Crab apples, grapes, strawberries, apricots, currants, raspberries, gooseberries, plums, pineapple.

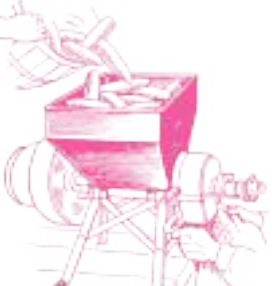
Low acid fruits : Sweet apples, sweet cherries, figs, melons, papaya, pears, peaches, blueberries.

A mixture of 1/4th slightly under ripe and 3/4th fully ripe fruits will provide best pectin content for jam preparation. Because under ripe fruit provides pectin and acid while fully ripe fruit provides colour and flavour. Lemons and bitter oranges are rich in both acid and pectin these will make good jam. Some popular combinations for preparing jam are orange and banana, apple and plum.

Activity 1:

List some other popular combinations of fruits used for preparing jam.

For preparing delicious jam, commercial pectin and lemon juice are added to balance the required pectin content and acidity.



Notes

d. Specific Requirements for Jam

1. Total Soluble Solids should be minimum of 65 percent.
2. The product should manufacture from minimum 45 percent by weight of original fruit for strawberry and raspberry fruit the weight will be 25 percent.
3. Jam should be neither too soft nor too hard to chew.
4. Jam may be prepared from any suitable single fruit or in combination with other fruits. In mixed fruit jams first named fruit should be at least 50 percent of the total fruit added.
5. Jam should have a flavour of original fruit.
6. The amount of pectin in jam should be <1 percent of its weight, the remainder is water and small amount of fibrous matter and seeds.
7. Total sugar content of jam should not be less than 68 percent.

e. Essential Components in Jam

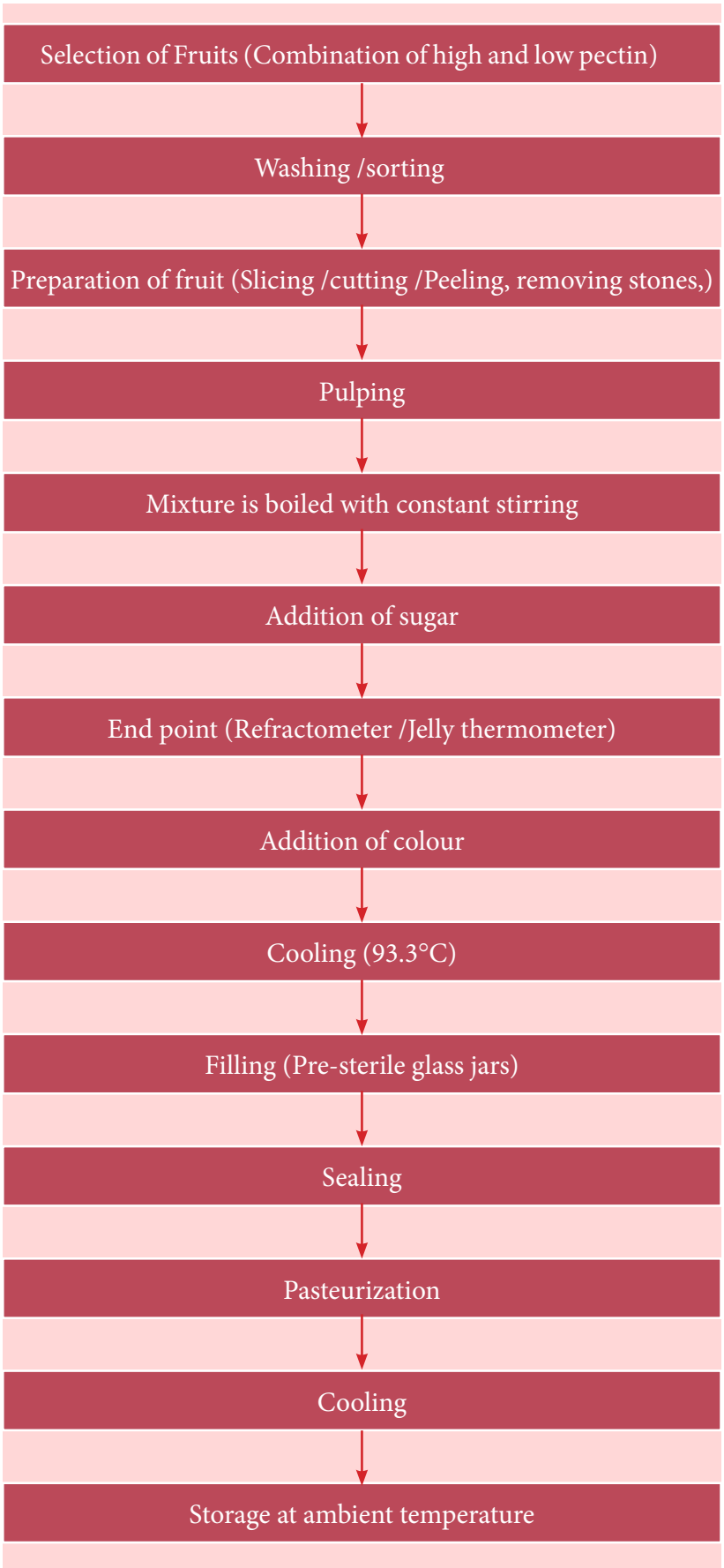
(1) Sugar : For every 45 parts of fruit 55 parts of sugar is added. If excess sugar is added jam becomes gummy and sticky. Concentration and type of sugar added are responsible for taste. The finished jam should have 20.50 percent invert sugar / glucose to avoid crystallization of sugar while storage.

(2) Pectin : It is a complex molecule formed by a polymer of D-galacturonic acid. The capacity of the pectin to form a gel depends on the degree of esterification. Gel formation occurs between pectin, water in the fruit and sugar under controlled pH.

(3) Acid : Normally low pH fruits are used for making jam and jellies. Acidity can be supplemented by ascorbic, citric, tartaric and malic acid. The pH influences the inversion of sugar and setting of jam. During inversion, sucrose is converted to glucose and fructose; it improves the brightness and flavour of the jam. For pectin jam, pH 3.3 gives a good set. The desirable range of pH for apple and plum jam is 2-3.5 and optimum pH for

Notes

f. Process of Preparing Jam



Flowchart 4.1 Jam Preparation

Good jam has a soft even consistency without distinct pieces of fruit, a bright colour, a good fruit flavour and a semi-jellied texture that is easy to spread but has no free liquid (Berolzheimer (ed) et al. 1959).

Figure 4.4 Complete Jam Production Plant

g. Judging End Point

1. Sheet or flake Test

A small portion of jam is taken out from cooking pan using spoon. It is allowed to drop. If jam drops in form of sheet in contrast to drop at once, it is considered that jam is ready. It is removed from the fire and filled in bottles while hot.

2. TSS test (Total soluble solids)

TSS of cooking jam is measured using Hand Refractometer. If the reading reaches to 68 percent, the jam is considered ready.

3. Temperature test

When the temperature of cooking jam reaches to 105°C, the jam is considered ready.

II. Jelly

Jellies are crystal clear jams. It is produced using filtered fruit juice instead of fruit pulp. It is prepared by boiling fruit with or without addition of water.

According to the Food and Drug act of Canada, jellies are of two categories:

1. Jelly
2. Jelly with pectin

Figure 4.5 Jelly

Process of Jelly Preparation

Jelly is a semisolid product made from boiling clear fruit juice with sugar and acid to a thick consistency.

a. Selection of Fruits

The fruits should be sufficiently ripe, but not over ripe and have a good flavour.

Guava, plum, sour apple, crab apple, sour cherries, cranberries, papaya and jackfruit are rich in pectin and generally used for jelly preparation.

Some fruits contain low levels of pectin such as pineapple, strawberry, and grapes. Addition of pectin powder is needed for these fruits for Jelly preparations.

Notes

Strained fruit juice with low fiber content is preferred for jelly preparation because the relationship between pectin and sugar permits the formation of continuous gel structure.

Generally 0.5 - 1per cent of pectin in the fruit extracts enough to prepare a good jelly.

For a good quality jelly the essential components of pectin, sugar, acid and water should be in following proportions:

Pectin	-	1%
Sugar	-	60-65%
Fruit acid	-	1%
Water	-	33-38%

The proportion of sugar depends on pectin grades. Pectin grades means the weight of sugar required to set one gram of pectin under suitable conditions from a satisfactory Jelly. (Eg: 100 grades pectin means 100g of sugar is required for setting 1g of pectin).

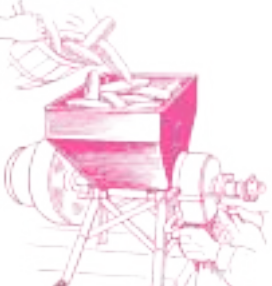
b. Jelly Formation

Jelly formation occurs due to the precipitation of pectin rather than its swelling. The rate of precipitations is influenced by the following factors.

1. Concentration of pectin in the solution
2. Constitution of pectin
3. Hydrogen ion concentration (pH) of the solution
4. Concentration of sugar in the solution
5. Temperature of the mixture

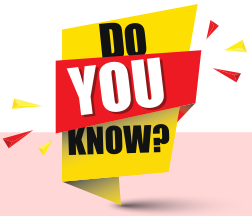
c. Specific Requirements of Jelly

1. Total soluble solids should not be less than 63 percent.
2. Acidity around as 0.7 percent.
3. It should contain 45 percent by weight of original prepared fruit exclusive of sugar and other ingredients.



d. Process of Preparing Jelly

Flowchart 4.2 Jally Preparation



Too high of a temperature or cooking for too long can destroy the pectin, resulting in a poor gel .Too much pectin will give the jelly a tough, rubbery consistency, making it difficult to spread.

DO YOU KNOW?

Determination of pectin content by Alcohol test:

Take one teaspoonful of strained extract of fruit and pour three teaspoonful of methyl alcohol gently along the side wall of the beaker. Allow to stand for few minutes.

i. If single clot is formed, it indicates that grade 'A'pectin is present.

ii. If less firm and fragmented clot is formed, it indicates that 'B' grade pectin is present.

iii. If numerous small granular clots are formed it indicates that 'C' grade pectin is present.

Figure 4.7 Ketchup

e. Determination of End Point

The end point of jelly can be judged by following methods.

1. Cold plate test
2. Sheet / flake test

f. Problems in Jellies

1. Failure of jellies to set
2. Syneresis / weeping of jelly
3. Cloudy / foggy jelly
4. Formation of crystals
5. Tough jelly

Figure 4.6 Cloud Jelly

g. Qualities of Good Jelly

1. Jelly should be sparkling, transparent and well set.
2. It should have original flavour of the fruit
3. Attractive in colour
4. It should keep its shape when removed from the mold

III. Ketchup

Ketchup is a tangy seasoned tomato sauce originated in ancient China. A brine pickled fish or a Shellfish is called **"Ke-tsiap".** During 18th centuries United Kingdom prepared ketchup with mushrooms as a primary ingredient rather than tomatoes, but it is not commonly used.

Tomato ketchup is a sweet and tangy sauce made from tomatoes, sugar, vinegar with seasonings and spices. Tomato is a most popular and widely grown fruit all over the world. Ripe tomato fruit is consumed fresh, as salads and utilized in the preparation of processed products such as puree, paste, powder, ketchup, sauce, soup and canned whole fruit.

There is no much difference between sauce and ketchup. Sauces are generally thinner. The **Total Soluble Solids (TSS)** in ketchup should be minimum 25 percent and acidity should be lesser than 1.0 percent as acetic acid. The ketchup should also meet the microbiological criteria.

Table 4.1 Microbiological Criteria for Tomato Ketchup and Tomato Sauce

Tomato ketchup and Tomato sauce	Mould count	Positive is not more than 40 percent of the field examined
	Yeast and spore count	Not more than 125 per 1/60 mm
	Total plate count	Not more than 10000 per ml

Source: Food Technology – I by A.K Singh & Co. P.No.133

According to Total Soluble Solids content ketchup is graded as follows;

For Grade A TSS level >33%

Grade B TSS level 29.33%

Grade C TSS level 25-29%

Ketchup Production

a. Selection of Fruit

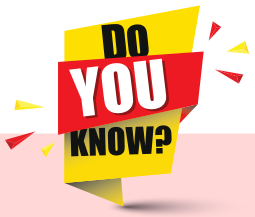
Careful selection is needed, because it affects the quality and shelf-life of the final product. The tomatoes should be deep red in colour and free from blemishes and defects.

b. Chemical Composition of Tomato

Chemical composition varies according to variety, growing environment, package practice and different stages of maturity. The composition of tomato is important because it affects the colour, nutrient content, flavour and texture of the final product.

Variable	Green	Red	Red (Ripe)
Total Solids (%)	6.4	5.8	5.2
Titrable acidity (%)	0.29	0.27	0.29
Ascorbic acid (mg/100g)	14.5	23.0	22.0
Starch (%)	0.64	0.18	0.07
Reducing Sugar (%)	2.4	3.45	3.65
Pectin (%)	2.34	1.74	1.62
Lycopene (mg/100g)	8.0	374	412.0
Beta carotene (mg/100g)	30.0	10.0	0
Protein nitrogen (mg/g of dry weight)	9.44	10.07	6.99

Table 4.2



Interesting facts about tomato

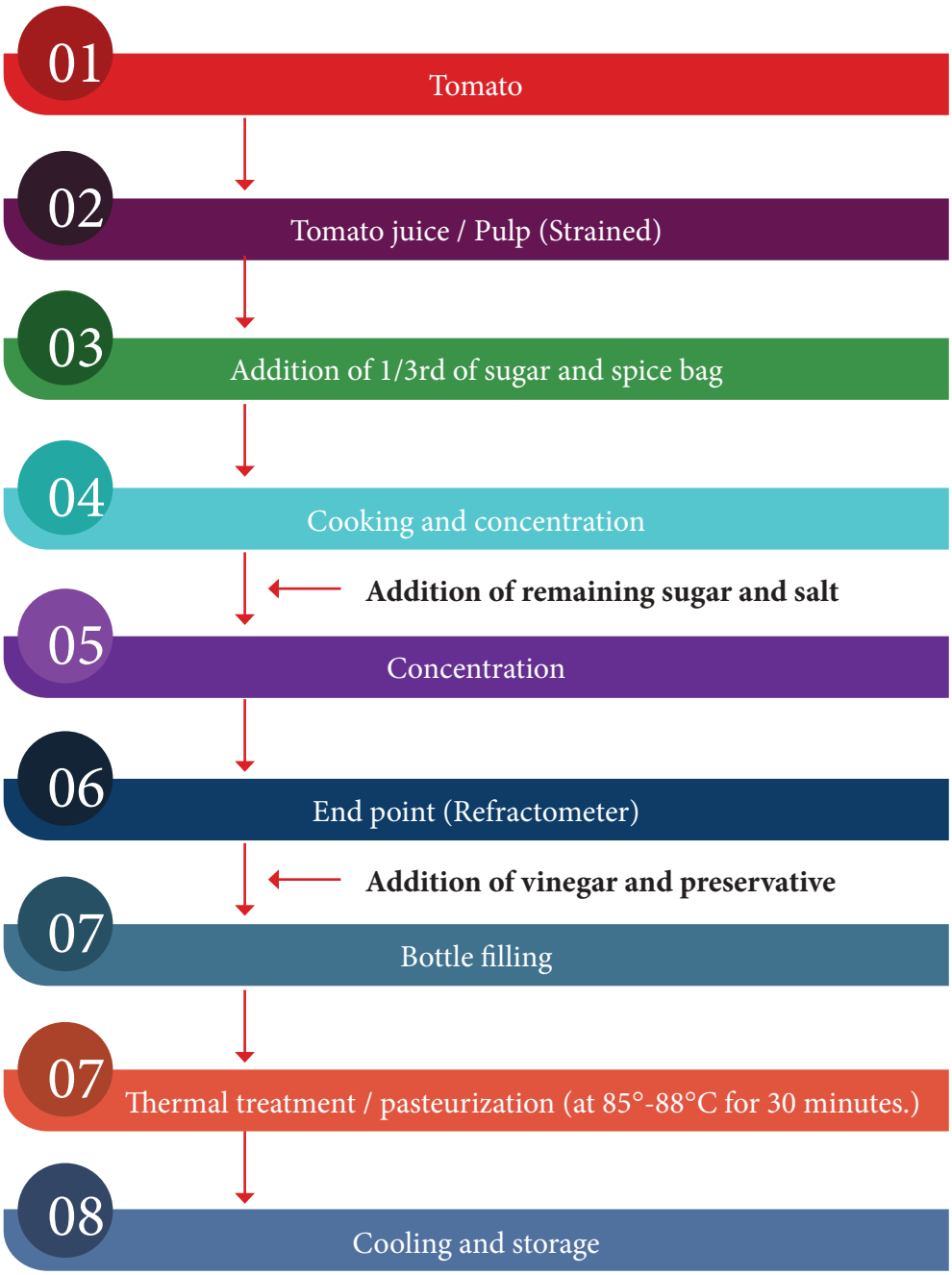
There are more than 7500 tomato varieties grown around the world.

India is the third highest producer of tomatoes after China and The United States. Tomatoes are the state vegetable of New Jersey. The first tomatoes in Europe may originally have been yellow. They were first referred to in writing as "pomo d'oro", meaning "golden apple".

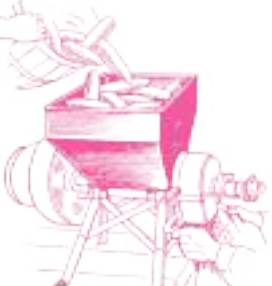
Pectin is important for the firmness of fresh tomato and influences the tomato products. Acidity of tomato is due to their citric acid and malic acid content.

Tomatoes are rich in lycopene, an antioxidant that is good for the heart and effective against certain cancers. Tomatoes are also packed with vitamin A and C, calcium and potassium. It provides very low calories i.e., 23-25 Kcal/100g. Anti-nutrient oxalates present in tomato may be responsible for kidney and gall bladder stones.

c. Tomato Ketchup Preparation



Flowchart 4.3 Tomato Ketchup Preparation



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d. Role of Ingredients in Ketchup Preparation

1. Spices

The preferred spices are red chili, black pepper, nutmeg, clove, cinnamon, cardamom, mace and cumin. Seasonings like onion, ginger and garlic also used for ketchup preparation.

2. Sugar

Sugar is used to adjust the sugar-to-acid ratio of the ketchup. It is added in the form of granulated sugar, corn syrup or other syrups. The preferred one is granulated sugar. 1/3rd of sugar is added in initial stage to retain the original colour of the fruit, Remaining will be added at the end stage. The sugar level in ketchup varies between 10-26 percent.

3. Common Salt

Salt bleaches the colour of the tomato, so it is desirable to add at end point of the process. It is added to enhance the flavour of the product and counteract the highly acidic flavour of fruit pulp. Salt of high purity is preferred and the range of salt used is varies between 1.3 and 3.5 percent.

4. Vinegar

Vinegar is used as acidulant in the product. It contains <5 percent acetic acid. Industrial scale glacial acetic acid is preferred because of low cost and it has lesser effect on heating.

Ketchup contains 1.25-1.50 percent acetic acid; vinegar provides flavour as well as microbial stability of the ketchup.

5. Thickening Agent

Insufficient pectin in Tomato ketchup results in serum separation on storage. To control this problem pectin (0.1-0.2%), corn starch (1%) and other hydrocolloids are added. Xanthan Gum is an ideal thickener for ketchup production.

e. Defects in Ketchup

The most common defects are

(1) Serum separation

(2) Blackening around the neck

(3) Microbial growth

4.2.0. Utilize the Equipments for Jam, Jelly and Ketchup Preparation

4.2.1. Types of Machineries Used in Processing in the Organization

Figure 4.8 Cherry Harvesting Machine

The process of changing raw ingredients into food, in a way, that can be consumed by humans or animals is termed as food processing. The equipment in food processing refers to processing machines, components, systems used to cook, handle, package, prepare or store food and food products. Although this equipment is primarily aimed towards consumability, preservation, palatability, few pieces of equipment also perform auxiliary or main functions such as preparation, handling and packaging

There is wide range of machineries used to perform several functions such as from harvesting raw materials to packaging the final product. According to application the machines are classified as:

Figure 4.9 Elevators

A. Harvesting Equipment

Instruments are available for the mechanical harvesting of fruits. The shaking machines that are applied for harvesting consist of vibrators operated by combustion engines. These devices shake the tree trunk and limbs. Falling fruits are caught by the collection umbrella.

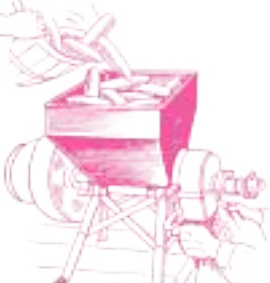
B. Transportation devices

1. Conveyor belts
2. Elevators
3. Screw conveyors
4. Pumps for materials containing solid particles
5. Pneumatic transportation devices
6. Forklift trailers

Figure 4.10
Fruit Washing Machines

C. Washing and Rinsing Machines

Washing is an extremely important step in the food industry to eliminate different contaminants (soil, pesticide residues, foreign materials). All raw materials and packaging material have to be washed. These washing equipments are categorized according to usage



1. Raw material washers
2. Packing material washers
3. Devices for washing machines and storage containers
4. Others (eg; cleaning machines)

Figure 4.11 Grading Machines

1. Raw Material Washers

i. Soaking tubs
ii. Ventilation-based washing devices
iii. Soft-product washers
iv. Brush-based washing machines

Figure 4.12 Peeling Machines

2. Packing Material Washing and Rinsing Devices

i. Bottle rinsing, double-phase can washers
ii. Bottle washing devices
iii. Case and crate washers
iv. Box washers
v. Tank washers

Figure 4.13 Destemming Machines

D. Grading, Peeling, Destemming, Seeding and Cleaning Equipment

1. Grading Equipment

i. Barrel-based grading devices
ii. Cascade-based classifiers
iii. Roll-based diameter classifiers
iv. Colour classifiers
v. Selectors

Figure 4.14 Pitter Machine

2. Peeling Devices

i. Knife-based, mechanical peeling devices
ii. Rub peelers
iii. Alkaline peelers
iv. Steam peelers
v. Combined peelers

Figure 4.15 Fruit Crushing Machine

Figure 4.16 Tube Heat Exchangers

Figure 4.17 Evaporator

Figure 4.18
Filling and Closing Machines

Figure 4.19 Pasteurization Equipment

Figure 4.20
Sterilization Equipment

3. Destemming Devices

i. Barrel-based destemmers
ii. Strawberry destemmers
iii. Cherry destemmers
iv. Red currant destemmers

4. Pitter and Halver Machines

i. Peach and apricot pitter and halver machines
ii. Cherry pitters
iii. Destoning pulping devices
iv. Universal destoners
v. Fruit-chopper Machines

E. Chopping Devices

1. Cubing, slicing and striping machines
2. Hammer crushers
3. Fruit millers
4. One or more stage pulper devices
5. Colloid mills

F. Machines of Juice Production

1. Universal horizontal basket fruit-pressing machines
2. Continuous belt press devices
3. Universal pneumatic press devices
4. Centrifuges
5. Homogenizers

G. Filtration Devices

1. Bag filters
2. Flat filters
3. Rotary vacuum drum filters
4. Ultra filters

Notes

H. Heat-Exchangers

1. Shell and tube heat exchangers
2. Multi-tube heat exchangers
3. Micro-tube heat exchangers
4. Plate heat exchangers
5. Scraped-surface heat exchangers
6. Spiral-drum heat exchangers
7. Heat pipes
8. Multi-tube spiral heat exchangers

I. Blanching and Cooking Devices

1. Double-coated, rotary, single stage vacuum evaporators.
2. Multiple effect evaporators
3. Two- or three-stage forced circulation evaporators.
4. Plate evaporators
5. Film evaporators

J. Filling and Closing Machines

1. Filling-Machine

ii. Filling machines for broken or lumpy products

iii. Fillers for materials containing pulp or coarse particles

iv. Puree and pulp fillers

v. Liquid fillers

vi. Fillers for powdered products.

2. Closing-Machine

i. Jar-closing Mechine

ii. Bottle-closing machines

iii. Can-closing machines

iv. Closing machines for plastic containers.

K. Heat-Treatment Equipment

1. Pasteurization Equipment

These are devices with open-water basin, where products are heated up to the extent required for preservation in water bath or under water curtain.

i. Batch-type pasteurizers

ii. Tunnel pasteurization devices

iii. Belt pasteurizers

2. Sterilization Equipment

i. Hydrostatic sterilizers

ii. Tower sterilizers

iii. Segmented hydrostatic sterilizers.

L. Aseptic Devices

The principle of aseptic technology is that products, it can be fruit juice, pulp or concentrate, processed with traditional technology are heat treated on flow-through heat-exchanger devices, then filling, closing and storage are done under aseptic conditions.

Aseptic Technique Requires the Following Devices

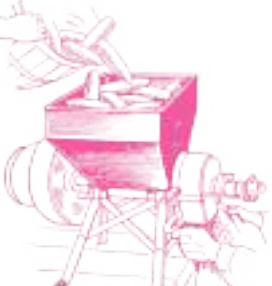
1. Pumps
2. Heat-exchangers
3. Accessories
4. Pipelines
5. Tanks
6. Filling machines

4.2.2 Maintenance of Process Equipments

Figure 4.21 Maintenance of Process Equipments

Food processing equipment is susceptible to failure and deterioration in performance over time due to wear and tear. An effective maintenance routine makes sure that operations continue, repair costs are minimized, and downtime is reduced.

Cleaning should be done regularly and often. Clean surfaces and equipment help ensure smooth and efficient operations in the plant. Constant cleaning and disinfection is necessary to maintain high hygiene standards and reduce any risks of foreign materials complaints and food borne illnesses outbreak. Cleaning also helps prevent injuries to workers particularly in the processing and packing areas where the risk of slips, trips and falls increases due to wet floors. Since each cleaning application is unique, it's important to consider many factors when setting up a cleaning process.

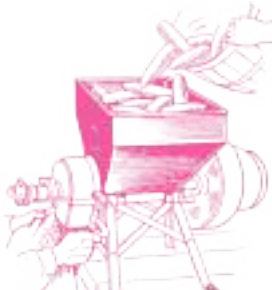


Seven variables to consider:

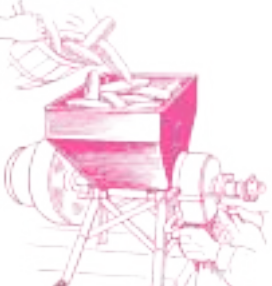
1. Choice of detergent
2. Surface Composition
3. Method of cleaning
4. Amount of detergent
5. Temperature
6. Time
7. Rinse

Table 4.3: Summary of Spare Parts and Maintenance/Cleaning Requirements for Fruit and Vegetable Processing Equipment

Type of equipment	Spare parts	Maintenance required	Cleaning
Blanchers	None	None	Daily after use with detergent and clean water
Boiling pans/ pasteurizers	None	None	Daily after use with detergent and clean water
Bottle coolers	None	None	Weekly wipe with damp cloth
Bottle washers	None	None	Weekly wipe with damp cloth
Corers	Replacement blade	None	Daily after use with detergent and clean water
Corkers	None	None	Weekly, wipe with damp cloth
Crown cappers	None	None	Weekly, wipe with damp cloth
Deep fat fryers	Electric heating element (electric versions)	Periodic check of temperature and thermostat settings	Periodic (monthly) removal of oil and cleaning
Dicers	Replacement blade	Periodic blade sharpening	Daily after use with detergent and clean water



Dryers	Plastic covers, Preferably UV resistant	Replace polythene cover each year or replace polyester cover every 3-5years	Cleaning trays after use with detergent and clean water
Fillers	None	None	After use with detergent and clean water
Filters (wine, juice)	Filter cloths or pads	None	After use with detergent and clean water, followed by sterilization using dilute bleach
Food grade drums	None	None	After use with detergent and clean water, followed by sterilization using dilute bleach
Freezer	Periodic de-icing	None	Periodic cleaning with detergent and clean water after de-icing
Fruit crushers	Motor drive belt, bolts, fuse	Monthly check belt tension, bearings, condition of wiring and bolt threads	After use with detergent and clean water
Fruit presses	None	Periodic check for wear on screw and bearing	After use with detergent and clean water
Heat sealers	Heating element	None	Weekly wipe with damp cloth. Remove any burned-on plastic immediately
Hydrometers – alcohol and brine	None	None	After use with detergent and clean water
Jam thermometer	None	None	Carefully wipe with a clean cloth



Labellers	None	Daily, check guide position	Daily - wipe down surface with damp cloth
Liquidizers	Fuse	Monthly, check bearing Tightness.	Periodic blade sharpening After use with detergent and clean water
Pasteurizing kettle	None	None	After use with detergent and clean water
Peelers	Replacement blade	None	After use with detergent and clean water
pH meters	Buffer solutions, probe	Monthly standardization	Wipe carefully with damp cloth after use
Pulper finishers	Motor drive belt, bolts, fuse	Monthly check belt tension, bearings, condition of wiring and bolt threads	After use with detergent and clean water
Reamers	None	None	After use with detergent and clean water
Refractometers	None	None	Wipe carefully with tissue paper and rinse with distilled water

Such well-maintained equipment will be cleaner, last longer, run smoothly and generally perform more efficiently.

4.2.3. Unit Operations

A wide range of food processing equipment is available to execute the various unit operations necessary during a complete production cycle, such as washing, separating, mixing, baking, freezing and sealing. Depending on the demands of the operation, this equipments can be designed and constructed to handle solid, semisolid, or liquid food products by batch or continuously.

The food processing production cycle can be broken in to several stages, characterized by a specific function during which individual unit operations are performed.

Notes

Table 4.4 Food Preparation Equipment by Unit Operation

Unit Operation	Equipment Employed
Cleaning	**Wet Processes** • Soak/floatation tanks (soaking) • Spray washers (spray washing) • Washing systems (washing) • Sterilizers (sterilizing) • Ultrasonic cleaners **Dry Processes** • Air classifiers • Magnetic separators • Screening separators
Grading	• Tungsten lights (candling) • Image processors • Laboratory equipment
Peeling/Skinning	• Pressure vessels (flash steam peeling) • Stationary/rotating blades (knife peeling) • Carborundum abrasive rollers/ bowls (abrasion peeling) • Conveyors and furnaces (flame peeling)
Sorting	Dry Processes • Air classifiers • Magnetic separators • Screening separators • Sorting machinery • Disc separators (shape sorting) • Sieves/screens (size sorting) • Machine vision sorting systems • Sorting conveyors

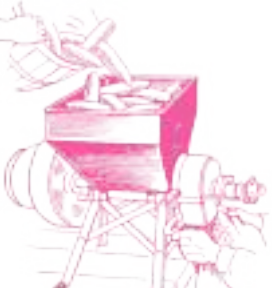


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Table 4.5 Mechanical Processing Equipment by Unit Operation

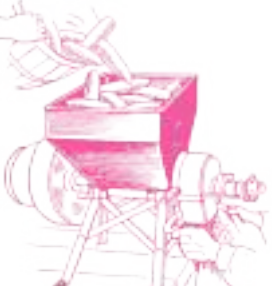
Unit Operation	Equipment Employed
Size Reduction	**Grinding/Crushing** • Impact mills • Pressure mills • Attrition mills • Jaw crushers • Roll crushers **Strainers/Pulpers** **Cutting/Chopping** • Knives/blades • Band saws • Slicing machines • Meat grinders **Extrusion** • Non-thermal extruders • Single-screw extruders • Twin-screw extruders • Refrigerated extruders
Size Enlargement	**Agglomeration** • Rotating pans • Rotating drums • High-speed agitators • Tableting equipment • Pelletizing equipment **Forming** • Bread molders • Pie and biscuit formers • Confectionary molders • Enrobing machines
Homogenization	• Homogenizers • Emulsifiers • Colloid mills • High shear mixers

Notes

Mixing	**Fluid Mixers** • Agitated tanks • Paddle mixers • Anchor mixers • Turbine mixers **Dough/Paste Mixers** • Horizontal dough mixers • Sigma-blade mixers • Cutter mixers **Solids Mixers** • Diffusive (passive) mixers • Convective (active) mixers • Drum blenders

Table 4.6 Heat Processing Equipment by Unit Operation

Unit Operation	Equipment Employed
Baking	**Baking ovens** • Direct heating ovens • Indirect heating ovens • Batch ovens • Continuous and semi-continuous ovens
Blanching	**Blanchers** • Steam blanchers • Hot water blanchers
Dehydration	**Dryers** • Convective dryers • Contact (conductive) dryers • Vacuum dryers • Freeze dryers
Evaporation	**Heat exchangers** • Evaporators • Condensers



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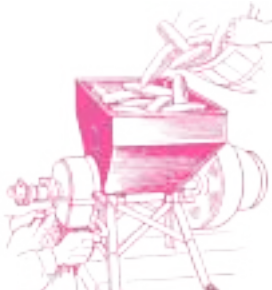
Frying	**Fryers** • Batch fryers • Continuous fryers
Pasteurization	**Pasteurizers** • In-container pasteurizers • Continuous flow pasteurizers **Heat exchangers** • Plate heat exchangers • Concentric tube heat exchangers
Roasting	**Baking ovens** • Roasting machinery • Roasting ovens • Direct heating ovens • Indirect heating ovens • Batch ovens • Continuous and semi-continuous ovens
Sterilization	**Sterilizers/sterilizing retorts** • In-container sterilizers • Continuous flow sterilizers • Heat exchangers

Table 4.7 Preservation Equipment by Unit Operation

Unit Operation	Equipment Employed
Irradiation	Irradiation equipment, such as isotopes and electron accelerators
Refrigeration (Removal of Heat)	**Chilling (-1°C–8°C)** • Chillers • Mechanical refrigerators • Cryogenic systems **Freezing (below freezing point)** • Freezers • Mechanical refrigerators • Cryogenic systems



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Water Reduction	**Drying** • Convective dryers • Contact (conductive) dryers • Vacuum/freeze dryers **Solute Addition** • Sugar • Salt **Concentration** • Evaporators • Condensers

Table 4.8 Packaging Equipment by Unit Operation

Unit Operation	Equipment Employed
Packaging Material Creation	**Printers** (e.g., flexographic, photogravure, planographic, screen, ink-jet)
Filling	Volumetric Fillers
	Net-weight/Gross-weight Fillers
Sealing	Sealers
	Form-Fill-Seal(FFS) Systems
Quality Control	Check weighers

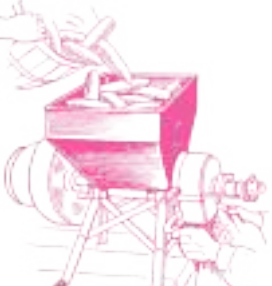
4.3.0. Maintain Work Area

4.3.1. Identify Various Section of Working Unit and their Functioning

Working unit is a unit or team of employees that have been assigned to accomplish specific tasks. In food processing industry various working units are functioning which are discussed below:

1. Raw Material Handling

Material handling include varied operations as hand or mechanical harvesting on the farm, transportation in trucks or refrigerated vehicles of perishable produce to the market or to the processing plant or to store/godowns. For conveying, wide variety of mechanical conveyors is used depending upon the type of material. Common conveyors used in the processing plant include screw conveyor, bucket conveyor, belt conveyor and vibratory conveyor.



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2. Washing / Cleaning

Fruits and vegetables are generally washed with water to remove dust, dirt and adhering surface micro flora.

a. Fruits like peach, apricot that are lye peeled are not washed before peeling.

b. Washing after peeling removes vitamins and minerals and should be discouraged.

c. Different methods of washing include soaking or agitating in water, washing with cold or hot water sprays.

d. Mechanical washers involve agitating or tumbling the commodity on moving belts or revolving screens while they are immersed in water or subjected to water sprays.

e. Washing by using high pressure sprays is most satisfactory.

3. Separating

It involves separating a solid from a solid like peeling of potatoes, separating a solid from a liquid as in filtration or a liquid from solid as in pressing of juice from a fruit. It might involve the separation of a liquid from a liquid as in centrifugation of oil from water. It might also involve removing gas from a solid or liquid as in vacuum removal or air from canned food during canning.

Common separating methods

a. Sorting: Sorting is the separation of foods into different categories on the basis of a measurable physical property.

b. Grading: After preliminary sorting, the fruit and vegetables are graded to obtain uniform quality with respect to size and colour.

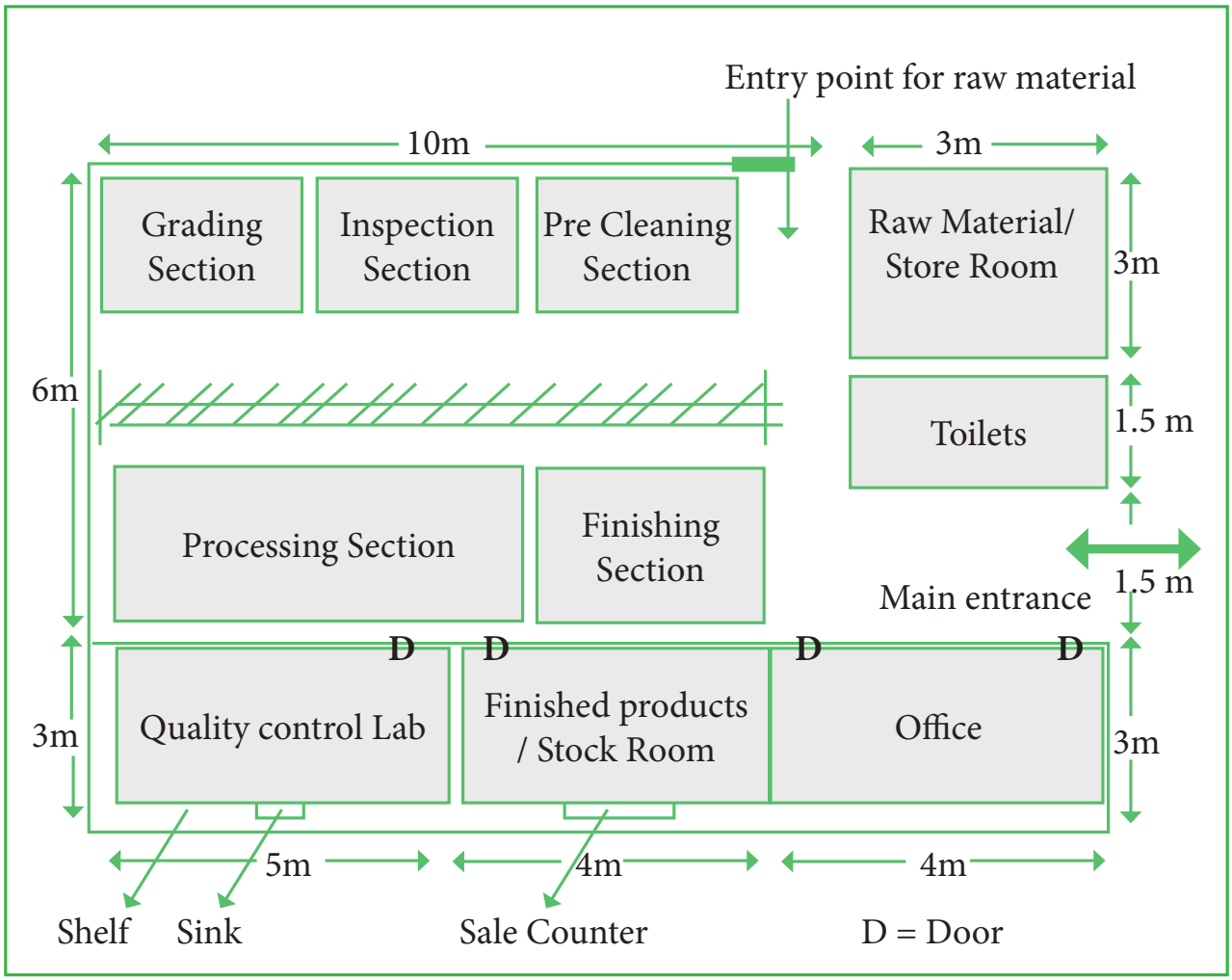
c. Peeling, coring and pitting: Peeling of fruits and vegetables is carried out to remove unwanted or inedible material and to improve the appearance of the final product.

4. Disintegrating

It covers wide range of operations that are used to sub-divide large masses of foods into smaller units or particles. It may involve cutting, slicing, chopping, grating, pressing to extract juice, pulping and homogenizing.

5. Pumping

Pumping is used for moving liquids from one processing step to another. Single screw type and gear type pump are used for this purpose.



6. Mixing

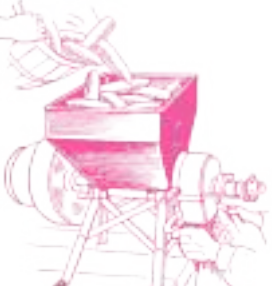
There are different types of mixers depending upon the type of material to be mixed. They may be used for mixing solids with solids, liquid with liquids, liquids with solids, and gases with liquids.

7. Heating

Heating of foods is carried out to destroy the micro-organisms, to preserve the food as in case of pasteurized milk and canned peas and to make them more tender and palatable as in cooking operations. Foods are heated by conduction, convection, radiation or their combination.

a. **Blanching:** Treatment of fruits and vegetables by dipping in boiling water or steam for short periods followed by immediate cooling is called blanching.

b. **Pasteurization:** Pasteurization is a relatively mild heat treatment in which the food is heated below 100°C to destroy selected vegetative microbial pathogens or to inactivate enzymes.



Notes

c. **Processing:** Heat processing consists of heating cans to a predetermined time and temperature combination of heating to eliminate all possibilities of microbial spoilage.

d. **Sterilization:** Sterilization is a more severe heat treatment given to a food to destroy both spoilage and pathogenic micro-organisms, after packaging the food in a hermetically sealed container. The thermal processing criterion for acid and medium acid foods (pH<4.5) is the destruction of heat resistant vegetative micro-organisms or enzymes.

8. Cooling

Cooling is the subtraction of heat energy which is added during processing. The cooling may be done to the degree where food is chilled to refrigerated temperature.

9. Evaporation

Evaporation in the food industry is used principally to concentrate foods by removal of water. All liquids boil at lower temperature under reduced pressure and are the key to modern evaporation. Vacuum evaporators and multi stage evaporators can easily remove water.

10. Drying

Drying involves the removal of water with minimum damage to the food. Evaporators will concentrate the food 2-3 folds or more while driers take the foods very close to total dryness that is to 97-98% solids.

11. Forming

Forming is done in the breakfast cereals and snack food industries. The characteristic shapes of the popular breakfast cereals are the result of pressure extrusion through dies, together with adherence operating conditions like pressure, temperature, dough consistency and other variables.

12. Packaging

The packaging of food is necessarily required to protect the food from microbial contamination, dirt, dust, light, moisture and the losses. The foods are packaged in metal cans, glass, plastic bottles, paper and metallic films, and pouches.

4.3.2. Outline Hygiene and Sanitation Standards in Processing Unit

Figure 4.22
Personal Hygiene

Personal Hygiene

The word hygiene is used to describe an application of sanitary principles for the preservation of health. Personal hygiene refers to the cleanliness of a person's body. The health of workers plays an important part in food sanitation. People are potential sources of microorganisms that cause illness in others through the transmission of viruses or through food poisoning.

Sanitation

The word sanitation is derived from the Latin word sanitas, meaning "health". So when it is applied to the food industry, sanitation is "the creation and maintenance of hygienic and healthful conditions."

Basic Rules of Hygiene, Sanitation and Safety in Food Processing

A three-word definition of Food Sanitation is protection from contamination. With this in mind, all functions and operations must be included in a sanitation programme. All food products must be protected from contamination from receiving (and before) through distribution. Therefore, another definition could be: "sanitation is a way of life".

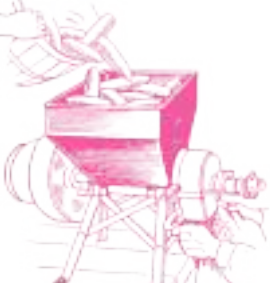
Facilities required in the Processing room

- A changing room where clothing and shoes that are not worn for work can be stored. Separate hand-washing facilities for staff, with soap, clean water, nail brushes and clean towels or hot-air hand dryers. Hand-washing facilities should not be used for washing equipment.
- Toilets, which should be separated from the processing room by two doors or located in a nearby building.
- First aid materials.
- Protective aprons or coats washed regularly, hats/hairnets, and if necessary, gloves and shoes/boots.
- Cleaning chemicals, stored away from the processing room.

Personal Cleanliness and Conduct

Personal cleanliness must be maintained while involved in food handling operations:

- Sanitary protective clothing, hair covering, and footwear must be worn and maintained in a clean, sanitary manner.



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- Gloves, if worn, must be clean and sanitary.
- All food-handling personnel must remove objects (i.e. watches, jewelry) from their person which may fall into or contaminate the food product.
- Chewing Tobacco, gum, and eating food are not permitted while handling food and in food-handling areas.

Hygiene and Sanitation

Personal Hygiene

- Wear a hat/hairnet that completely covers the hair. Do not comb hair in a processing room or storeroom.
- Cover all cuts, burns, sores and abrasions with a clean, waterproof dressing.
- Do not smoke or eat in any room where there is open food because bacteria can be transferred from the mouth to the food.
- Do not spit in a processing room or storeroom.
- Wash hands and wrists thoroughly with soap after using the toilet, eating, smoking, coughing, blowing nose, combing hair, handling waste food, rubbish or cleaning chemicals. Dry them on a clean towel before handling food again.
- Keep finger nails cut short.
- Do not wear perfume or nail varnish as these can contaminate products.
- Do not handle any food if you have sores, boils, septic spots, a bad cold, chest infection, sore throat or a stomach upset. Report any of these to the manager and do alternative work.
- Do not cough or sneeze over food.

Cleaning

- Clean the processing room, toilets and washing facilities, and storerooms every day.
- Use the correct chemicals to clean equipment, make sure there are no food residues and rinse the equipment with clean water of drinking quality.
- Make sure all cleaning cloths are washed and boiled each day. Do not hang them on equipment, products or window ledges to dry.
- Clean thoroughly and do not leave dirty equipment until the end of the day before cleaning it.

Notes

- Keep the outside area around the processing room clean and tidy, keep grass cut short.

Sanitation

- Put all wastes into bins that are not used for anything else. Empty the bins periodically during the day away from the processing site.
- Prevent all animals from entering the processing area or storerooms.
- Visitors should only enter the processing room wearing protective clothing and under supervision.
- Keep food covered wherever possible.
- Keep all food, tools and equipment off the floor.
- Store ingredients in sealed containers.
- Do not use broken or dirty equipment.
- Report any signs of insects, rodents or birds to the manager.

4.3.3. Standard Operating Procedures (SOP)

Standard operating procedures are written, step-by-step instructions that describe how to perform a routine activity. Employees should complete them in the exact same way every time so that the business can remain consistent. Standard operating procedures help maintain safety and efficiency. It can be in the form of Flow chart, Tabulation or Document.

Need for standard operating procedures

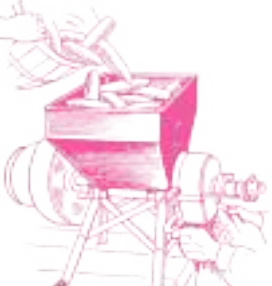
Save time and money: When the same task is completed in many different ways, it will always take longer to complete. Having a standard operating procedure in place streamlines the process so employees can accomplish more in less time.

Provide consistency: Having a standard operating procedure in place ensures that regardless of who is working, the work is being completed the correct way.

Improve communication:

Standard operating procedures make the work easier because no longer do they have to guess as to how they should be performing the work.

Allow the owner to hold their employees accountable: Without standard operating procedures; employee evaluations become a matter of personal opinion, which is hardly fair to their employees. But SOP helps to evaluate the employees without the written standards in place.



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Create a safer work environment: Standard operating procedures ensure that employees perform their job functions in a safe and consistent manner.

Steps to follow when Creating Standard Operating Procedure

1. **Develop a list of the processes**

   Create a detailed list of processes that need standard operating procedures. This list will serve as a starting point for creating standard operating procedure.

2. **Plan the process**

   In this step, there is a need to decide on a format for the process. It can be a step-by-step guide or a workflow diagram .

3. **Talk with employees**

   Talk with employees with the list of processes helps to understand the process that actually performs it on a daily basis.

4. **Write, review, and edit the process**

   Reviewing SOP will helps to determine who will be responsible for oversight and maintenance of the standard operating procedure. Ensure that the language is clear, can be easily followed, and can be completed successfully. Incorporate relevant edits and suggestions to improve the document.

5. **Maintain the process**

   Maintain and update SOP at least once per year will make it to remain relevant and useful.

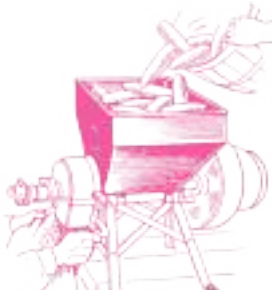
Elements of writing SOP

- The title of the procedure
- An SOP identification number
- A publication date or revision date
- The name of the organization, division, or agency that the SOP applies to
- Names and signatures of those who prepared and approved the procedures outlined in the SOP

Standard operating procedures are time-consuming to create at first but the benefits are worth it.

Waste disposal

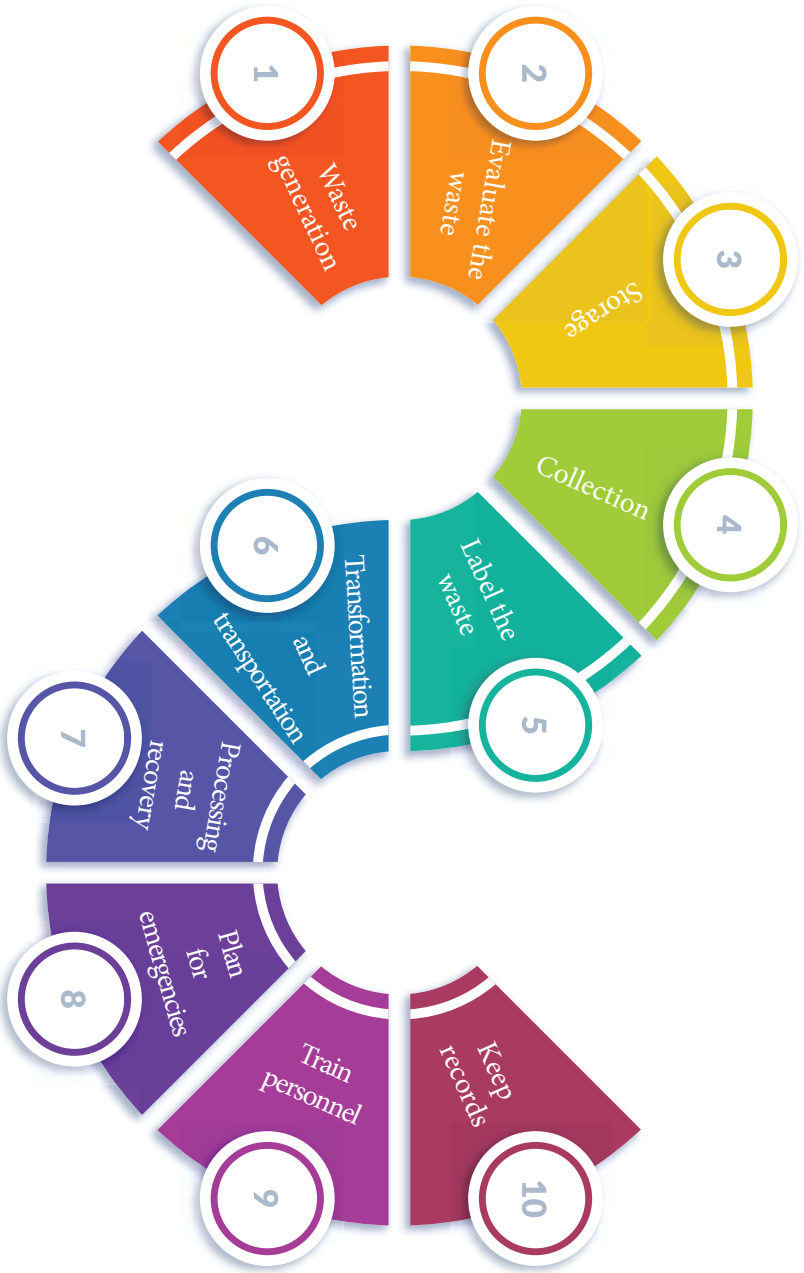
Food processing wastes are those end products of various food processing industries that have not been recycled or used for



Notes

other purposes. They are the non-product flows of raw materials whose economic values are less than the cost of collection and recovery for reuse; and therefore discarded as wastes. Food waste is an untapped energy source that mostly ends up rotting in landfills, thereby releasing greenhouse gases into the atmosphere. It is difficult to treat or recycle food waste since it contains high levels of sodium salt and moisture, and is mixed with other waste during collection.

Types of wastes- Solid, Liquid, Organic Recyclable, Hazardous waste



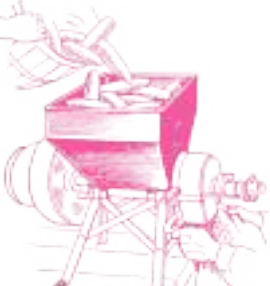


Figure 4.23 Waste Management

Methods of Waste Disposal

1. Solid Waste

b. Open Burning

c. Sea dumping process

d. Solid wastes sanitary landfill

e. Incineration method

f. Composting process

g. Disposal by Ploughing into the fields

h. Disposal by hog feeding

i. Salvaging procedure

j. Fermentation/biological digestion

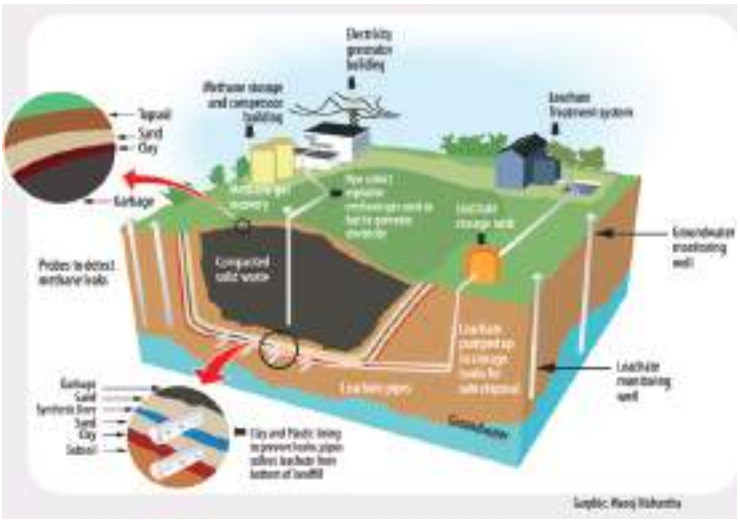


Figure 4.24 Sanitary Landfill

2. Proper waste disposal

c. Place food scraps in proper containers.

d. Do not allow containers to overflow. Empty them before they are completely full.

e. Do not stack full refuse containers.

f. Report broken or defective containers.

g. If wearing gloves while disposing of refuse, you should remove the soiled gloves once the job is done and, when returning to work, wash and sanitize hands properly

h. Push garbage down using a tamper or other tool. Do not push it down with your hand or foot.

Notes

3. Methods of liquid waste disposal

d. Sedimentation and dewatering

e. Incineration

f. Composting

g. Solidification

SOP for waste disposal

1. Wearing protective gloves, coat, boots (safety tools) before handling wastes
2. Segregation of wastes according to standards
3. Collecting waste in bins wrapped with plastic
4. Collection of waste
5. Cover the bin and tie
6. Transportation for further processing
7. Cleaning the garbage room and bins
8. Cover the bins with fresh garbage covers
9. Place the bins in proper position
10. Cleaning hands

Activity 2:

Visit nearby food industry and write the common waste disposal procedure followed by them.

4.4.0. Maintain Processing Machineries and Tools

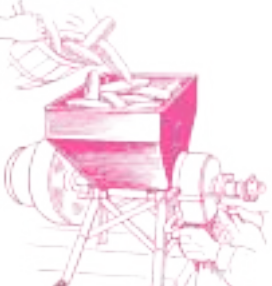
4.4.1. Types of Tools and Equipment and their Functioning in Processing Unit

There are various tools and equipments used in food processing industries starting from preparation till packaging of products. Different equipments are used to perform different function.

1. Pre Preparation Equipments

a. Scales

Small scales (0-2kg) used to weigh out small amounts of ingredients or laboratory chemicals and larger scales (0-50kg) for weighing fruit and vegetables. The small scales can be operated using batteries or electric power. The large scales should be hung from a door lintel. Calibrated scoops, cups or other measures, which contain the correct quantity of an ingredient when filled level with the top, can also be used instead of scales.



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b. Cutting boards

These are made from food grade nylon and are designed to withstand cutting by knives.

c. Fermentation tanks/food grade drums

Fermentation tanks should be made from food grade plastic or stainless steel and not from black or yellow plastic water containers. Tanks and drums should have a wide neck that allows easy access for cleaning.

d. Fillers / Insulated filling tanks

At a small scale, solid and viscous products (such as pickles, jams or chutneys) are filled by hand using jugs, funnels, scoops or ladles. Liquid products can be filled using small gravity fillers, made by fitting a tap to a stainless steel or food grade plastic tank. Three or four valves can be fitted to a tank to enable several workers to fill containers at the same time.

e. Filters

Filters for juices, wines are bags made from muslin or fine cotton cloth.

f. Blanchers

Hot water blanchers are boiling pans that are used mainly for vegetables. These are less acidic than fruits and therefore the pan can be made from aluminum. A mesh scoop is used to remove the hot vegetables. Steam blanchers use the same pans and have a removable mesh base to hold the vegetables above the boiling water.

g. Dicers

Manual dicing machines first cut the material into strips and these are then cut into cubes. The machines produce uniform sized cubes, which are difficult to achieve using a knife.

h. Fruit crushers

Powered machines that are used to crush pineapples or other hard fruits consist of a rotating screw inside a casing. The casing has a screen in the base. Juice/pulp drains from an outlet in the base of the casing and skin is ejected from the end of the casing down a chute. The casing should be fitted with wing nuts to remove it easily. In operation, pineapples are cut into large pieces and fed into the hopper water.

Figure 4.25 Reamer

Figure 4.26 Hydrometers

Figure 4.27 Jam Thermometers

Figure 4.28 pH meter

Figure 4.29
Refractometer

i. Fruit presses

Manual fruit presses have a stainless steel cage in which a press plate is raised and lowered by a screw. In operation a muslin or cotton bag is placed in the cage and pulp is poured in. The bag is closed and the press plate is lowered. After a few minutes, additional turns of the screw increase the pressure further. Juice is collected via a pipe. The screw is then raised and the bag is removed

j. Reamers

There are two types of reamer that are used in fruit processing: one is designed to extract coconut meat from the shell and the other is used to extract juice from halved citrus fruits. A citrus juice reamer attachment can also be obtained to fit an electric mixer.

2. Preparation Equipments

a. Boiling pans/pasteurizers

There are two types of boiling pans: One is a simple stainless steel (or less desirably aluminum) pan can be placed directly over the heat source used in smaller scale. The other one is a 'double jacketed' stainless steel boiling pan used in larger scales of operation.

b. Deep fat fryers

The simplest fryer is a pan of oil over a fire, but there is little temperature control and a risk of burning both the oil and the product. Thermostatically controlled electric deep fat fryers overcome these problems. Employs heated (160–180°C) fat or oil to transfer heat directly to food material. Reduces moisture content, forms a surface crust (changes texture and structure), and inactivates microorganisms which improves shelf life and overall quality.

3. Equipments used to Detect End point of Cooking (or) Processing

a. Hydrometers – alcohol and brine

This is a graduated glass tube that floats in a sample of liquid (e.g. wine or brine) in a measuring cylinder. Different types are used to measure sugar, alcohol and salt concentration, by measuring the specific gravity of the liquid. Specific gravity reading is used to calculate the percent of alcohol in wine or the salt concentration in brine.

b. Jam thermometers

This is a special thermometer that has readings up to 120°C and is strengthened to withstand sudden changes in temperature. It is inserted into boiling jam and the reading is used to determine when to stop boiling

c. pH meter

Small hand-held pH meters are suitable for process control, but they are relatively expensive. They should be calibrated against buffer solutions that are supplied with the instrument and also calibrated for the ambient temperature. pH can also be measured using pH papers, which are cheaper but less accurate than meters.

Figure 4.30 Capsule Sealer

d. Refractometers

A refractometer measures sugar concentration as o Brix, which corresponds to per cent of sugar. There are two ranges: 0-50o Brix for juices, sauces, syrups and 40-80o Brix for jams and other concentrated preserves.

Figure 4.31 Corkers

e. Laboratory glassware/equipment

The laboratory equipment used for testing fruit and vegetable products Includes glass beakers, pipettes, flasks and a burette.

4. Equipments Used for Packaging

a. Capsule sealer

The machine heats plastic capsules that are used as a tamper-evident seal on bottles. In operation the thermostatically controlled machine is switched on and allowed to heat up. A bottle is placed on the tray with the capsule inside the heating element until the capsule has shrunk and sealed (a few seconds).

Figure 4.32 Crown Cappers

b. Corkers

A corking machine compresses the cork and inserts it into the bottle. In operation a cork is inserted into hole in the top of the machine and a bottle is held in place by the sprung stand. The lever is then lowered to force the cork into the bottle.

c. Crown cappers

A hand operated Crown capper is a simple equipment that is placed over the cap on a bottle and is then struck with a hammer to seal it. Another design has two handles that are lowered to force the cap onto the bottle.

Figure 4.33 Heat Sealers

d. Heat sealers

These machines simultaneously melt and press plastic to weld two layers together, thus sealing a bag. A small bulb lights

Figure 4.34 Label Applicators

when the bar is pressed down and the bar should be released about one second after the light goes out (to allow the film to cool).

f. Label applicators

A platform holds a stack of labels below an opening in the table, with the top label level with the surface. Glue is applied to the label and a round container is rolled over the opening and the label is picked up and pressed onto the container. The guide rails ensure that the label is applied in the same position on every container.

g. Pot and bottle sealers/cappers

Twist-on-twist-off (TOTO) caps and plastic caps are usually fitted by hand. Small machines are available to seal Roll-On-Pilfer-Proof (ROPP) caps onto jars or bottles. A heat sealer for sealing foil or plastic lids onto plastic pots can be made using a domestic iron, held on a drill stand.

5. Preservation Equipment

a. Freezers and Chillers

Reduces the temperature of food material to depress the biochemical and microbiological activities of microorganisms and enzymes which cause spoilage and helps to maintain quality and characteristics of food material.

b. Dryers

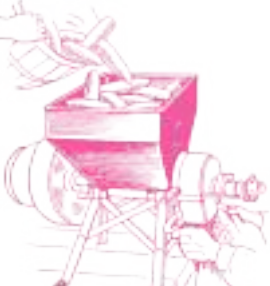
Reduce the amount of water in food (solid, semi-solid, or liquid) to inhibit microbiological and enzymatic activities which cause spoilage and thus it Increase the shelf life of food products

Employs heat to remove (i.e., evaporate) water from solid, semi-solid, or liquid food material with the intention of producing a solid food product with sufficiently low water content.

6. Other equipment

a. Gas burners/cylinders/regulators

The burner is connected to the cylinder using special orange rubber gas pipe and a regulator. The screw fittings that connect the pipe should be tightened as much as possible and the joints should be tested by applying detergent and switching on the gas supply. Any sign of bubbles in the detergent should be investigated and the leak corrected. Care should also be taken not to damage the gas pipe by placing heavy objects on it or allowing it to get too close to the burner.



b. General tools, work tables

Basic equipments such as buckets, tables, stainless steel knives are used to prepare raw materials. Aluminium or stainless steel sheet is the preferred material for the surface of work tables. Any parts of equipment that are in contact with acidic fruits (e.g. boiling pans) should be made from stainless steel or less desirably aluminium. Other metals should not be used because they react with the fruit and cause off-flavours or colour changes in the product. Food grade plastic should be used for all containers.

c. Hosepipes and spray guns

The hose is used to wash down equipment, floors etc. The spray gun is adjustable and can spray a single jet or a wide spray.

d. Motors/isolators/starters

A qualified electrician should wire electric motors. Motors should not be wired directly to 13 amp sockets and a starter and isolator should be fitted.

e. Protective gloves, hats, hairnets, coats, boots

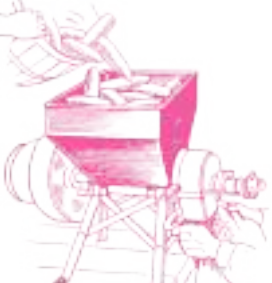
These tools are used to safeguard the persons handling with machineries and also to maintain hygiene and sanitation in food products.

4.4.2 Description of the Working Performance of Machines and Tools

Table 4.9 Working Performance of Machines and Tools

S.No.	Types of Machineries	Functions
1	Washing and Rinsing Machines	Removes foreign matter and contaminants such as soil, oil, insects, skins, chemicals etc. from the surface of raw food material via wet and dry cleaning processes.
2	Grading Devices	Assesses several characteristics of food matter (e.g., flavour, damage, skin colour, aroma, etc.) to determine the overall quality
3	Peeling Devices	Removes inedible or undesirable material to increase the overall quality and/or appearance of the final food product
4	Sorting	Classifies and separates foreign matter and contaminants from raw food material based on a measurable physical characteristic (typically size, shape, weight, or colour)
5	Fruit-chopper Machines	Reduces the average particle size of solid food matter through mechanical processes involving compression, shear, or impact force

6	Machines of Juice Production	Reduces the average particle size and increases the consistency of semi-solid and liquid food matter
7	Mixing Devices	• Combines and disperses two or more components into one another to achieve and maintain a uniform mixture and/or an alteration to the functional or aesthetic qualities of the food product (e.g., texture) • Type of equipment depends on the form of the food components—gas/liquid, liquid/liquid, liquid/solid, solid/solid
8	Blanching and Cooking Devices	• Employs heated water or steam to reduce the number of microorganisms and inactivate undesirable enzymes which can cause spoilage. • Also cleans, removes entrapped air, softens, and improves the overall quality • Typically follows preparation operations and precedes preservation operations, such as packaging, dehydrating, or freezing. Suitable for fruits and vegetables
9	Evaporator Categories	• Removes volatile solvents (typically water) from food material by boiling to increase the concentration of solid contents • Increases the shelf life of food products due to the reduced water content, but also increases the rate of chemical deterioration • Reduces the weight and volume of the final food product • Typically precedes operations, such as crystallization, precipitation, and coagulation Suitable for liquid-based food products
10	Pasteurization Equipment	• Processes food material under medium temperatures (70–100°C) to inactivate most enzymes and microorganisms (but not spores) which cause spoilage • Produces food products with limited shelf lives (short-term preservation method) • Little to no impact to quality and characteristics beyond the shelf life • Suitable for dairy, fruit/vegetable-based, wine, beer, and egg products



11	Sterilization Equipment	• Processes food material under high temperatures (100 °C) to inactivate all microorganisms and enzymes (including microbial spores) • Can be heated by steam, hot water, or direct flames • Produces food products with long shelf lives (long-term preservation method) May result in a significant impact on quality and characteristics
12	Filling and Closing Machines	Used to fill a set volume of the packaging containers with liquid, paste, or small pieces of solid food material Capable of forming, filling, and sealing flexible film packaging containers

4.4.3. Types of Chemicals, Material for Cleaning

In the food industry, chemicals are routinely used to sanitize and disinfect product contact surfaces. These chemicals provide a necessary and required step to ensure that the foods produced and consumed are as free as possible from microorganisms that can cause food borne illness.

To disinfect means to destroy or irreversibly inactivate specified infectious fungi and bacteria, but not necessarily the spores, on hard surfaces.

Figure 4.35
Equipment Cleaning

To sanitize means to reduce microorganisms of public health importance to levels considered safe based on established parameters, without adversely affecting either the quality of the product or its safety.

While disinfection measures may be employed in food processing and preparation, it is much more common to utilize sanitization methods to reduce microbial presence.

I. Sanitizing agents

Sanitizing agents or sanitizers are chemical compounds that destroy harmful microorganisms. A number of formulations are now marketed, of which 5 types are generally used. These are:

1. Chlorine based
2. Iodine based
3. Ammonium compounds
4. Acid-anionic surfactants
5. Phenolic compounds

1. Chlorine based:

These comprise of chlorine compounds such as hypochlorites and chloramines. These are inexpensive and therefore most extensively used as bactericides in food plants.

Notes

Just before equipment and utensils are used, they are rinsed with a bactericide in large food. These formulations are active against all microorganisms and spores at a concentration of 25 mg per litre at pH 10 or less, and at a temperature of about 50°C. Bacteria are destroyed in less than 15 seconds by a sodium hypochlorite solution containing 50 parts per million (ppm) of available chlorine. The concentrations increase as the temperatures fall although higher concentrations do not increase effectiveness.

2. Iodine based:

Iodine based products are stable and do not deteriorate easily, have long shelf life, destroy most bacterial cells but not spores. They are effective in hard water and non-corrosive. They leave no residues and are not irritating to the skin. They are brown in colour and their concentration is measured visually. The formulations work slowly at pH 5.0 or above and may stain some surfaces. The ideal concentration for use is 12.5 - 25 mg per litre at 24 - 49°C.

Iodophores:

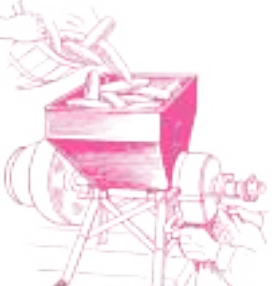
These are complexes of iodine and surface active agents in which the surfactants act as carriers and solubilizers for the iodine. An iodophore solution has all the properties of iodine as a germicidal agent is practically odourless, low irritant and does not stain. It can be used wherever a general purpose sanitizer is required.

3. Ammonium compounds:

Also known as quaternary ammonium compounds (QUATS), these were developed to destroy organisms in food industries and they possess high germicidal activity, low odour when used in normal or specified concentrations. They are also highly stable, non-corrosive and have low toxicity. They are water soluble and lower surface tension of solutions, and therefore can contact and kill organisms that are not accessible to non-wetting germicides. These compounds are however, sensitive to pH or level of acidity or alkalinity, working best at pH 9.0-10.0.

4. Acid anionic surfactants:

These are stable compounds, active against microorganisms, odourless, do not stain and are effective in hard water. Even when they leave a residual antibacterial film, it is low in toxicity. These compounds are most effective at pH 1.9 - 3.0, although they corrode metal surfaces, except stainless steel and aluminium. Spores survive their action even in concentrations of 100 - 200 mg per litre at temperatures of 24 - 43°C.

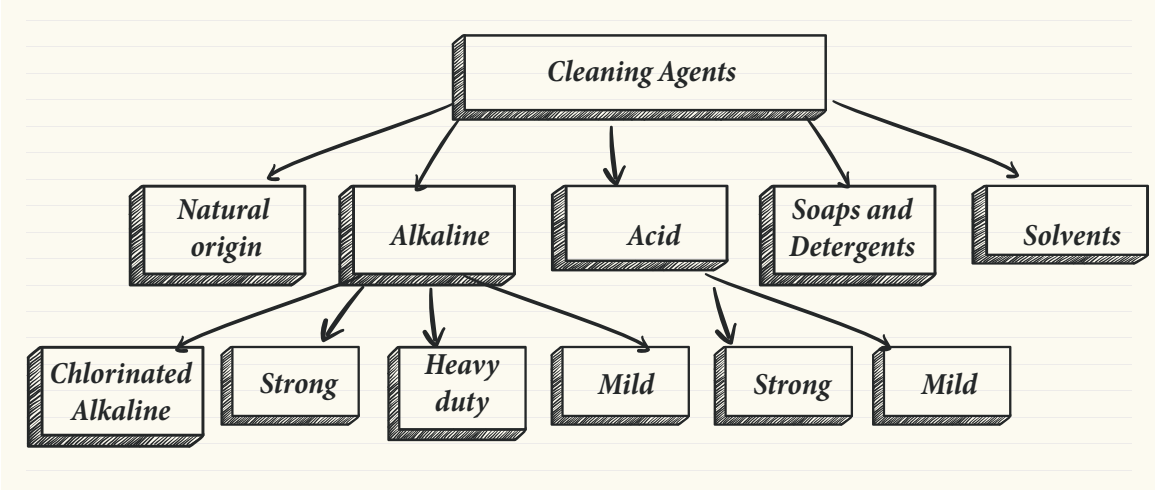


5. Phenolic sanitizers:

These are more stable in combination with synthetic anionics. They act as deodorizers but have limited application in sanitizing food handling equipment.

II. Cleaning agents

Cleaning agents are soaps, which are still used today in solid, liquid and powdered forms. Some cleaning agents are called detergents, a term usually used for synthetic products which are more alkaline than soaps. Cleaning agents dissolve or disperse soil and hold odours although they may leave a residue on surfaces if not used properly.



Flowchart 4.5 Classification of Cleaning Agents

1. Soaps:

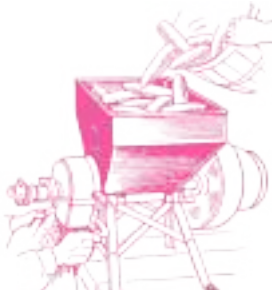
Soaps are alkaline salts of organic acids used commonly for cleaning but they form insoluble deposits if used with hard water. A number of improved formulations are now marketed for different uses.

2. Synthetic Detergents

The major components of synthetic detergents serve essentially the same function as soap-emulsification of fats, oils, and greases except that there is no reaction to cause curd formation. Synthetic detergents are effective because their addition lowers the surface tension of the solution, promotes wetting of particles, and deflocculates and suspends soil particles.

3. Alkaline Cleaning compounds:

Alkalines are cleaning compounds which have a pH between 7 and 14. These include phosphates, silicates, carbonates and borates. Trisodium phosphate (TSP) is the most used compound although it is less reliable and harsher than some



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of the newer materials. Alkalines are generally used because of their ability to prevent or remove hard water deposits. Silicates are especially useful for cleaning tin and aluminium, where other alkaline materials may cause surface discolouration or itching. Soda ash and sodium carbonate are commonly available, as well as, they are cheap and good.

a. Strong Alkaline Cleaners

These cleaners have strong dissolving powers and are very corrosive. Examples of strongly alkaline compounds are sodium hydroxide (caustic soda) and silicates. The addition of silicates tends to reduce the corrosiveness and improves the penetrating and rinsing properties of sodium hydroxide. These cleaners are used to remove heavy soils, such as those from commercial ovens and smokehouses, and have little effect on mineral deposits. Caustic soda, which has highly germicidal activity, protein dissolution, and deflocculating /emulsifying properties, is used for removing heavy soils.

b. Heavy-Duty Alkaline Cleaners

These compounds have moderate dissolving powers and are generally slightly corrosive or non corrosive. The active ingredients of these cleaners may be sodium meta silicate (a good buffering agent), sodium hexa meta phosphate, sodium pyrophosphate, sodium carbonate, and tri sodium phosphate, which are known for its good soil-emulsification activity. The addition of sulfites tends to reduce the corrosion attack on tin and tinned metals. These cleaners are frequently used with high-pressure or other mechanized systems. They are excellent for removing fats but have no value for mineral deposit control.

c. Mild Alkaline Cleaners

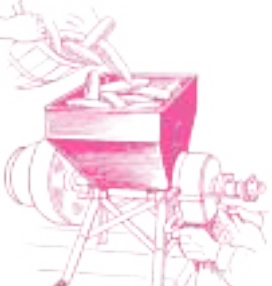
Mild cleaners frequently exist in solution and are used for hand cleaning of lightly soiled areas. Examples of mild alkaline compounds are sodium bicarbonate, tetra sodium pyrophosphate, phosphate water conditioners (sequesters) and alkyl aryl sulfonates (surfactants). These compounds have good water-softening capabilities but exhibit no value for mineral deposit control.

d. Chlorinated Alkaline Cleaners

Hypochlorite is added to these cleaners to peptize the proteins for easier removal. These cleaners are well adapted to cleaning-in-place (CIP) of pipes, tanks, and vats and remove effectively fats, oils, grease, and proteins

4. **Acid Cleaning Compounds**

These compounds, especially blends of acids such as phosphoric, nitric, sulfuric, and sulfamic, remove encrusted



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surface. Organic acids, such as citric, tartaric, sulfamic, and gluconic acid, are also excellent water softeners, rinse easily, and are not corrosive or irritating to the skin. Although inorganic acids are excellent for removing and controlling mineral deposits, they can be extremely corrosive and irritating to the skin.

a. Strong Acid Cleaners

These compounds are corrosive to concrete, most metals, and fabrics. Some of these cleaners, when heated, produce corrosive, toxic gases, which can ulcerate lungs. Strongly acid cleaners are used in cleaning operations to remove the encrusted surface matter and mineral scale frequently found on steam-producing equipment, boilers, and some processing equipment. Strongly acid agents used for cleaning operations in food plants are hydrochloric, hydrofluoric, sulfamic (amino sulfonic acid), sulfuric and phosphoric acids.

b. Mild Acid Cleaners

These compounds are mildly corrosive and may cause allergenic reactions. Some acid cleaners attack skin and eyes. Examples of mildly acid cleaning compounds are levulinic, hydroxyacetic, acetic, and gluconic acids. The organic acids, which are used as manual cleaning products, are higher in cost than are the other acid cleaning compounds. These mild compounds can also function as water softeners.

5. Solvent Cleaners

Solvent cleaners are normally used on petroleum-based soils and greases in the maintenance area. Their use should be strictly controlled. Solvent cleaners are ether or alcohol type materials capable of dissolving soil deposits. These compounds are most frequently used to clean soils caused by petroleum products, such as lubricating oils and greases.

Activity 3

Select the type of cleaning agents.

S.No	Cleaners	Strong alkaline	Heavy duty alkaline	Strong acid	Mild acid
1	Gluconic acid				
2.	Phosphoric acid.				
3	Sodium carbonate				
4	Sulfamic acid				
5	Levulinic acid				
6	Sodium hydroxide				

Figure 4.36 Foam Cleaning

Figure 4.37 Spray Cleaning

Figure 4.38 Fogging Cleaning

Figure 4.39 Cleaning and Disinfection of Equipment

III. Methods of Cleaning

There are a number of methods which can be used to apply detergents and disinfectants.

1. Manual Cleaning

using cloths, mops, brushes, pads, etc. It is normally used in small areas, equipment that is non-water proof or requires dismantling or areas which are difficult to clean by other methods. It is a labor intensive method and may limit the use of certain chemicals for safety reasons. To ensure cleaning is effective the method must be clearly defined and staff trained to an appropriate level.

2. Foam Cleaning

This is the common method for cleaning most food operations. Large areas such as floors, walls, conveyors, tables and well-designed production equipment are ideal for foam cleaning. Foam is a carrier for the detergent. The foam should be applied in an even layer. Coverage rates are quick and chemical usage is economical. The equipment itself may be mobile and centralized.

3. Spray Cleaning

Spray cleaning works on a pressure washer with chemical induction. It should be used where foaming properties are not essential for the cleaning action.

4. Fogging Cleaning

Aerial fogging uses compressed air or other equipment to generate a fine mist of disinfectant solution which hangs in the air long enough to disinfect airborne organisms.

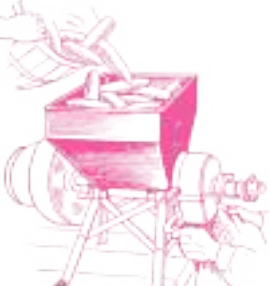
5. Washing Machine

This is normally an automatic or semi-automatic washing process conducted within a purpose built machine. There are many machine designs depending on the application, e.g. Utensil washing. Chemicals used in these machines should be low foaming. An effective system for controlling the dose of chemical should be employed and temperature control systems should be used where critical.

4.4.4. Procedure to Disinfect Tool and Equipment

Cleaning and disinfection may in some cases be combined into one operation using a sanitizer which has the action of both a detergent and a disinfectant.

There is a need to clean and sanitize food processing plant and equipment sufficient to produce food free of physical, allergenic, chemical and microbiological hazards. In addition, it is important that employees understand the reasons why a food plant must be cleaned.



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Reasons to Sanitize Food Processing Plant and Equipment

- To reduce the risks from food hazards –food poisoning and foreign body contamination
- To comply with local and international legislation
- To meet specific customer requirements,
- To meet the requirements of global food safety standards (GFSI)
- To maintain positive audit and inspection outcomes
- To allow maximum plant productivity
- To present a hygienic visual image
- To promote safe working conditions for staff, contractors and visitors
- To maintain product shelf-life
- To avoid pest infestation

The correct sequence of a general cleaning procedure for surfaces in a food plant is

1. Gross Clean/Preparation
2. Pre-rinse
3. Detergent application
4. Post-rinsing
5. Disinfection
6. Terminal rinsing

1. Gross Clean/Preparation:

A well designed cleaning procedure will provide for the removal of all food pieces greater than a fingernail before applying detergent. Ideally this should be done dry by hand, scrapping or other physical method. The collected material should be placed in waste receptacles and removed from the area. All ingredients, food and packaging materials should also be removed from the area prior to gross cleaning.

2. Pre-rinsing:

The purpose of this step is to remove deposits which cannot be easily removed by picking, scrapping or other manual form of gross cleaning. Excess water should be removed following pre-rinsing to avoid dilution of the detergent in the following step.

Notes

3. Detergent Application:

The purpose of the detergent is to remove the layers of proteins, greases and other food deposits that remain on surfaces. Detergents are not designed to remove large pieces of food deposits or thick layers of fat. Foam should be conducted carefully and methodically and there should be a check to ensure that all surfaces have been covered. Detergents should be made up and used according to the suppliers instructions and appropriate time should be allowed for the detergent to work.

4. Post Rinsing:

The purpose of post rinsing is to remove the remaining food deposits. Care should be taken to minimise the amount of splash and aerosol formed which may re-contaminate surfaces. After post rinsing the surface should be free of all visible deposits, layers of soiling and residues of detergent. Any residues of detergent may neutralise the action of any subsequent disinfectant. Any pools or accumulations of water should be removed following post rinse.

5. Disinfection:

Disinfection should only be carried out on a visually clean, well rinsed surface, with minimal amounts of water. Direct food contact surfaces should be disinfected at least daily with other surfaces disinfected on a regular basis. Disinfectants should be used safely according to the supplier's instructions.

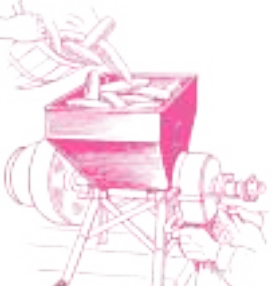
6. Terminal Rinsing:

Most disinfectants are safe to leave on non-food contact surfaces without final rinsing. In some sections of the food industry there is a requirement to rinse food contact surfaces with water after disinfection. The standard of the water is important to ensure that the disinfected surface is not re-contaminated.

Sanitation Check list for Food Processing Equipment

STEP 1: Dry clean

- Empty scrap bins
- Wipe down and sanitize sensitive electronic elements such as photo eyes and electrical panels, then cover them
- Sweep floors and wipe walls around equipment
- Scrap away caked –on residue with plastic implements
- Blow away loose material with compressed air, working from top to bottom



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- Sweep floors again
- Using dry cloth, wipe away excess soils
- Remove parts to be cleaned and send to washing room

STEP 2: First rinse

- Wear protective gloves when handling hot water
- Assign one person to fill buckets and bring them to operators
- Let hot water sit for 10 minutes before using
- Rinse equipment to break down remaining food residues

STEP 3: Foam and scrub

- Foam, allowing detergent to penetrate remaining food soils
- Scrub manually rather than using pressurized water

STEP 4: Second rinse and inspection

- Rinse equipment with hot water and a clean rag
- Allow equipment to air-dry
- Inspect equipment with flash light to check for missed spots

STEP 5: Drying and reassembly

- Follow the Sanitation Standard Operating Procedure for each piece of equipment
- Use lint free towels or air to dry the equipment
- Coordinate efforts with maintenance department for prompt reassembly

STEP 6: Inspection

- Ensure entire area around equipment is cleaned before inspection
- Designated inspectors should use flashlights to inspect all areas of equipment
- Critical inspection points should be identified and labeled based on micro- hit analysis
- Operator who cleaned the equipment should accompany inspector to resolve any issues found.

Notes

4.4.5. Knowledge of Food Safety Standard and Regulation

Consumers have a right to expect that the foods they purchase and consume will be safe and of high quality. They have a right to voice their opinions about the food control procedures, standards and activities that governments and industry use to ascertain that the food supply has quality characteristics. The FAO, WHO and WTO issued a joint statement at the International Forum on Food Safety and Trade to emphasize the need to constantly evolve food standards and regulations to keep up with rapid scientific developments and changes in production, trade, consumption and consumer demand. It is essential to know the food safety standards and follow them for a safety and healthy living.

Food Safety Standards and Regulations cover the various regulatory and compliance aspects of the food industry like licensing, labelling, use of additives, food standards and so on.

A food safety plan is a document which describes how an organization which produces food ensures that it maintains the safety of that food. Areas covered include food handling, approved suppliers, staff health, hygiene and training, waste management, cleaning and pest control. Food industry needs standards that permit flexibility and efficiency in producing and marketing foods that will serve customers both at national and global level.

Food Safety Standards and regulations are laid down for articles of food and to regulate their manufacture, storage, distribution, sale and import, to ensure availability of safe and wholesome food for human consumption.

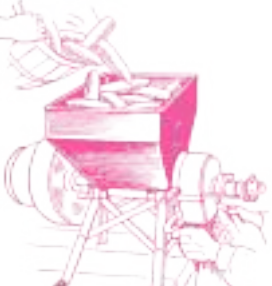
1. Food Safety and Standards Authority of India (FSSAI)

a. What is FSSAI?

- Food Safety and Standards Authority of India (FSSAI) is an autonomous statutory body established under the Food Safety and Standards Act, 2006 (FSS Act).
- Ministry of Health & Family Welfare, Government of India is the administrative Ministry of FSSAI.
- Headquarters is in Delhi.

b. FSSAI Structure

- The FSSAI comprises of a Chairperson and 22 members out of which one – third are to be women.



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- The Chairperson of FSSAI is appointed by the Central Government.
- The Food Authority is assisted by Scientific Committees and Panels in setting standards and the Central Advisory Committee in coordinating with enforcement agencies.
- The primary responsibility for enforcement is largely with the State Food Safety Commissioners.

c. FSSAI Legislative Framework:

Highlights of Food Safety and Standards Regulations 2011

- It covers Licensing and Registration, Packaging and Labeling of Food Businesses, Food Product Standards and Food Additives Regulation.
- It prohibits and restricts on sales or approval for Non-Specified Food and Food Ingredients, such ingredients may cause harm to human health.
- It provides for Food Safety and Standards on Organic Food and regulates Food Advertising.

d. Seven Key Processes

1. Set standards of food products
2. Develop safe food practices
3. License food businesses
4. Ensure compliance through inspections
5. Test food for standards
6. Train and build capacity
7. Citizens Outreach

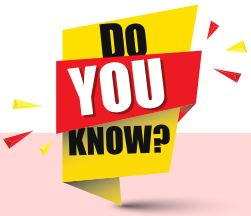
e. Functions

- Framing of regulations to lay down the standards and guidelines of food safety.
- Granting FSSAI food safety license and certification for food businesses.
- Laying down procedure and guidelines for laboratories in food businesses.
- To provide suggestions to the government in framing the policies.

- To collect data regarding contaminants in foods products, identification of emerging risks and introduction of rapid alert system.
- Creating an information network across the country about food safety.
- Promote general awareness about food safety and food standards.

f. The FSSAI has prescribed standards for the following:

- Dairy products and analogues
- Fats, oils and fat emulsions
- Fruits and vegetable products
- Cereal and cereal products
- Meat and meat products
- Fish and fish products
- Sweets and confectionery
- Sweetening agents including honey
- Salt, spices, condiments and related products
- Beverages, (other than dairy and fruits & vegetables based)
- Other food product and ingredients
- Proprietary food
- Irradiation of food
- Fortification of staple foods i.e. vegetable oil, milk, salt, rice and wheat flour/maida.



The FSS Act is a bucket for all the older laws, rules and regulations for food safety. The FSS Act took 7 older acts into one umbrella.

- Prevention of Food Adulteration Act, 1954
- Fruit Products Order, 1955
- Meat Food Products Order, 1973
- Vegetable Oil Products (Control) Order, 1947
- Edible Oils Packaging (Regulation) Order 1988
- Solvent Extracted Oil, De-Oiled Meal and Edible Flour (Control) Order, 1967
- Milk and Milk Products Order, 1992.

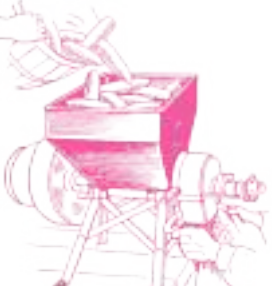
2. Bureau of Indian Standards (BIS)

Standards for achievement in all areas are provided by the nodal institution for standards in India, called the Bureau of Indian Standards (BIS). These include standards for equipment, food, environmental hygiene and sanitation and so on.

The ECO mark was a standard launched by the BIS in an attempt to preserve the environment from pollutants. The mark ensures the consumer those products such as detergents, sanitizers and others do not produce hazardous waste materials, are biodegradable and can be recycled. The ISI certification mark on packaging and equipment also serves the same purpose.

3. Codex Alimentarius

The most important global body for food standards is the Codex Alimentarius Commission (CAC). CAC task force on foods



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and is in the process of developing standards, guidelines and other principles for such product traits, introduced into foods with respect to safety. CAC is run jointly by the FAO and WHO CAC produces the Codex Alimentarius, a collection of harmonised international food standards, guidelines and codes of practice. The food safety measures are based on scientific principles to adapt to the evolving global food trade, the evolution of knowledge and changing consumer needs and preferences. The process involves specialists in multiple scientific areas, expert technical bodies, consumer organizations, production and processing industries, food control officials and traders.

4. Hazard Analysis and Critical Control Point (HACCP)

HACCP is a systematic approach to food safety that focuses on preventing contamination from biological, chemical, physical and radiological hazards. HACCP was first developed for the design and manufacture of food for the US space programme. The hazards include bacteria, viruses, natural toxins, pesticides, drug residues, decomposition, parasites, allergens, unapproved food and colour additives, and radioactive compounds.

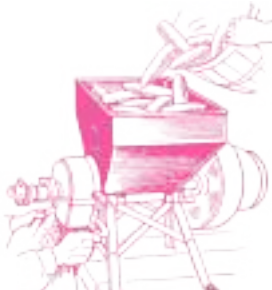
HACCP is used at all stages of food production, from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product. Each food processing or handling business must develop an HACCP system and tailor it to its individual product, processing and distribution conditions.

The seven principles of HACCP

The seven principles of HACCP are accepted by government agencies, trade associations and the food industry around the world. These principles are:

1. Conduct a hazard analysis.
2. Identify critical control points (CCPs).
3. Establish critical limits for critical control points.
4. Establish monitoring procedures.
5. Establish corrective actions.
6. Establish verification procedures.
7. Establish record-keeping and documentation procedures.

Keeping in mind consumer health, the government of India has taken the initiative to formulate a code and has laid down the internal norms for minimum residue levels (MRLs)



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for pesticides in water and foods. The government has set up departments to monitor implementation of the standards in registered organizations and proper machinery for regular inspection of plant and premises exists.

5. Food Safety Audits (FSA)

According to the FSA, good food hygiene is all about controlling harmful bacteria, which can cause serious illness. The four main 'C's to remember for good hygiene are:

a. Cross-contamination

b. Cleaning

c. Chilling

d. Cooking

a. Cross-contamination:

Cross-contamination is when bacteria is spread between food, surfaces or equipment used in the kitchen. This is most likely to happen whenever raw food touches or drips onto other food, surfaces or equipment. So avoid cross-contamination and ensure to deliver a high level of food safety.

b. Cleaning:

Proper maintenance of cleaning of workers, equipment, surfaces and where required, food can stop harmful bacteria from spreading.

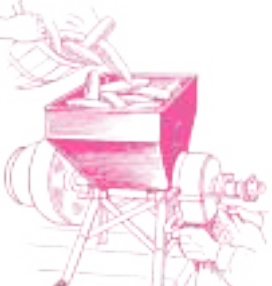
c. Chilling:

Correctly storing food within a chilled environment, such as a refrigerator, can help to stop harmful bacteria from growing. It is extremely important that these types of food are not left to stand at room temperature as this can cause them to spoil. Ensure any chilled food is cold enough upon delivery and has not been held at a higher temperature during transit.

d. Cooking:

Cooking food kills bacteria. Whether cooking or reheating, food must be cooked correctly and should be steaming hot throughout.

In considering market to consumer practices, the usual thought is that food ought to be safe in the market and the concern is safe delivery and preparation of the food for the consumer.



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4.4.6. Regulation Pertaining to Work Place in terms of Health and Safety

General Safety

By doing things right, will give safety on the job for everyone. Accidents occur in many ways but most often can be traced back to one of two basic factors: ignorance or carelessness. Always be concerned with one's own safety and with the safety of others around the industry.

General list of safety precautions in any work area

- "Horseplay" is one of the biggest causes of injuries on the job and it may be grounds for dismissal.
- Never work while under the influence of drugs or alcohol, as it is a hazard to individual and to co-workers.
- Pay particular attention to moving objects, such as equipment, dollies, mixers, and slicers.
- Walk; do not run, in the work areas.
- Stay completely alert on the job.
- Avoid back strain by lifting properly.

a. Keep floors safe

1. Wet floors are dangerous. Keep them dry.
2. Pick up or wipe up any spilled item immediately, particularly water or other similar liquids.
3. When liquid or fat is spilled, have one person watch the area and warn others of the danger while another goes for a mop. Small areas may be sprinkled with salt to provide traction until the spill is cleaned up.
4. Walk. Do not run or slide across the floor.
5. Keep all traffic areas clear of boxes, garbage cans, portable equipment, mops and brooms, etc.
6. When mopping floors, do only a small area at a time.

b. Housekeeping

Good housekeeping is an important part of safety and accident prevention. Good housekeeping is a necessity for a safe and sanitary processing unit. A clean work environment leads to pride in workmanship and a safe operation.

Notes

Good housekeeping procedures include the following:

- Do not block exits.
- Keep floors and work areas clean, dry, and grease-free.
- Keep steps and ladders in serviceable condition.
- Keep emergency equipment clean and unobstructed.
- Ensure that all signs and caution labels are in good condition and visible.

c. Personal Protective Equipment

Personal protective equipment (PPE) list should include the following items.

1. Clothing

This includes well-fitted pants and jackets with all buttons fastened. Sleeves should be close fitting because sleeves that are loose and flowing are potential fire hazards when working over open gas burners. Health regulations require that all food handlers wear hair nets or use other approved methods for keeping hair under control. Aprons should be made of non-combustible and flame-resistant materials that do not melt under heat.

2. Footwear

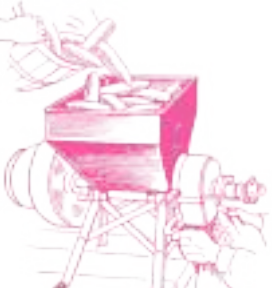
Approved footwear must be worn by employees in all industrial occupations. Footwear should provide enough back support to not cause future back problems. Footwear suitable for commercial foodservice establishments must have a non-slip sole and a closed toe and closed back. Footwear should be sturdy and comfortable, and if the environment of work requires steeled toes, such footwear should be worn. High leather tops on shoes are a good idea as they will protect feet from hot grease or liquids.

3. Hand protection

The most common type of gloves used in food service establishments are natural rubber latex gloves, synthetic rubber gloves, and vinyl gloves. Mesh gloves should be used when cleaning the meat slicer. Thick plastic gloves should be used when handling cleaning products.

4. Eye protection

Eye protection in the form of safety goggles or masks should be worn whenever there is a chance of eye injury. Particles flying through the air can easily land in eye and possibly do permanent damage. Eye protection is important, for example, when working



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with the band saw cutting through bone or when working with corrosive cleansers that could splash into your face.

5. Hearing protection

Approved hearing protection must be worn when high-level noise conditions exist. These conditions are common in food manufacturing operations.

6. Respirators

Respirators should be used to protect from inhaling harmful fumes or vapors such as those that often come from concentrated cleaning liquids. The respirator unit should be properly fitted to provide the best protection.

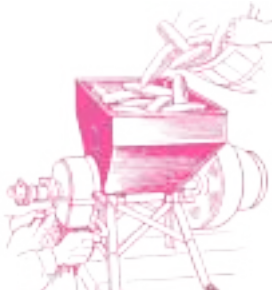
d. Safe working

Safe clothing and work practices

- Wear shoes that protect the feet from falling objects.
- Do not wear any loose clothing or jewels that could get caught in running machines. Wear overalls.
- Prevent staff from running inside a building.
- Do not allow customers, children or animals into the processing room.
- Immediately clean up any water, oil or grease on the floor using sawdust, sand, and husks.
- Cover burning electrical equipment with a damp cloth or sand. Never use water to put out flames.
- Shield gas burners from direct sunlight because the flames can become invisible.
- Do not put cleaning chemicals into old food containers.
- Have a first aid box containing sterilized dressings, cotton wool, adhesive plasters and bandages.

e. Equipment Safety

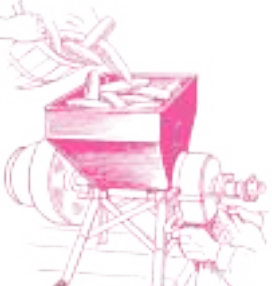
Extreme care should be taken when operating equipment. Before attempt to operate any tool or piece of equipment, one must be fully trained by an experienced operator. Make sure that all guards are in place and function properly and that all electrical connections are properly made.



Notes

Precautions to be followed while operating machinery

- Ensure that only trained staff enters the premises or operate machines.
- Do not allow staff to start a machine unless they know how to stop it. Only one person should operate a machine at any one time.
- Make the layout of machinery logical, and leave sufficient space around it so that there are few chances for operators to get in each other's way.
- Do not try to attract operators' attention by touching or calling them from behind if they are using a machine. Always speak to them from the front, or wait until they have finished what they are doing.
- Train staff to be familiar with potential hazards (e.g. potentially dangerous machines), and what they should do in case of an accident. Use charts hung on the wall near to each machine to show safety precautions.
- Ensure that guards are fitted and in place over any moving parts of a machine and alert staff to machines that appear to be standing still when running at high speed.
- Never allow staff to clean, adjust or lean over moving machinery and do not allow them to leave a running machine un-attended.
- Encourage operators to report any loose parts on a machine.
- Do not allow staff to work with equipment that is defective. Put a note on any machine that is under repair saying 'DO NOT TOUCH'.
- Do not allow anyone to touch inside electric equipment while it is connected. Regularly check the cords of electrical appliances to ensure that outside covers are not broken and wires are not exposed.
- Never start a machine until you are sure all parts are in their proper places. If it is a machine that operates with gears, check the gear position.
- Must be aware of the lock-out procedures that are to be followed before repairing or cleaning any machine
- When using electrical power equipment, always follow the manufacturer's instructions and recommendations.



Notes

- Do not wear rings, a wristwatch, or a tie when operating electrical power equipment.

f. Emergency shutdown systems

Emergency shutdown systems or "panic buttons" are that only one switch has to be thrown to kill the power to a large amount of equipment. These systems are to be used when a person is being electrocuted or is caught in a piece of machinery. Under these circumstances, panic button is helpful because we don't have time to find correct switch of particular equipment.

g. Guards and barriers

Guards and barriers are used as safety devices on many pieces of equipment used. One should operate a piece of equipment if all guards and barriers are in position.

h. Electrical

One should aware of the location of the main panel or sub-panels being used, and to shut them off in case of an emergency .If Electrical extension cords used, should be orderly and not allowed to become tangled. Such cords should be taped to the floor whenever possible as this will reduce the chance of someone tripping over them.

i. Water supply

All staff must know the water shutoff location. If a pipe breaks or bursts, the water may damage material, tools, and equipment. In addition, water may create an electrical hazard if it comes in contact with electrical panels or outlets.

j. Gas supply

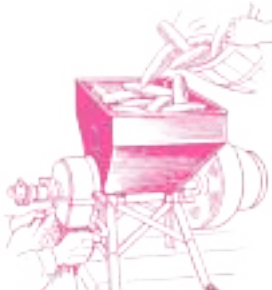
Locate the gas shutoff because, escaping gas can cause an explosion that could injure someone or do great damage.

The Occupational Health and Safety Regulation (OHS Regulation),

OHS Regulation contains all the rules, regulations, and responsibilities relating to Work Safe BC, employers, and workers.

1. Work Safe BC (British Columbia)

dictates that every employer must make a copy of the Regulation readily available at each place of employment so workers can refer to it. The Regulation begins with a general explanation of terms, the procedure for notification of injury, and first aid requirements.



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Worker's Compensation Act 1923

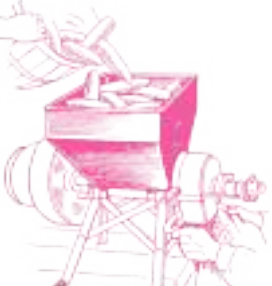
Employees or Worker's Compensation Act, 1923 is one of the most important social security law. The act's main aim is to provide financial protection and assistance to employees and their dependents through compensation in case of any accidental injury occurs during the course employment. It is generally applicable to the cases where such incidents lead to either death or disablement of the worker.

2. Employer's Responsibilities

The Act lists many, but not all, of the responsibilities of all employers. A few of these responsibilities are noted below. Additional conditions are noted in the OHS Regulation.

The employer must ensure that

- All work is carried out without undue risk of injury or industrial disease
- Machinery and equipment are capable of safely performing the functions for which they are used
- All permanent and temporary buildings and structures are capable of withstanding any stresses likely to be imposed on them
- All buildings, excavation structures, machinery, equipment, tools, and places of employment are maintained in good condition so workers will not be endangered
- Regular inspections are made to prevent structures, grounds, excavations, tools, equipment, machinery and work from becoming unsafe
- Any unsafe conditions are corrected without delay
- Each worker is supplied, at no cost, with all protective safety equipment required by Work Safety BC regulations
- All workers are instructed in the safe performance of their duties
- An accident prevention program is set up
- There is a safe means of entry to and exit from the work area
- Firefighting equipment is provided and maintained
- Workers with physical or mental impairment are not assigned to work where their impairment endangers themselves or others



Notes

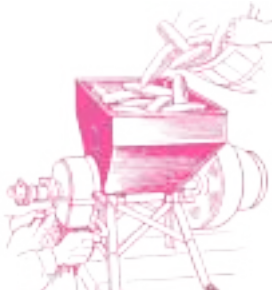
- If the person's ability to work is so affected by alcohol, drugs, or other substances as it affects their health or safety or any other person, that person is not allowed to enter, permitted to remain on the premises of any place of employment.

3. Employee's Responsibilities

Workers are responsible for their own safety on the job. It is responsibility of the employee's to wear proper clothing for the job site and to use the PPE provided by the employer or required for a specific job.

Worker should keep the following personal responsibilities in mind:

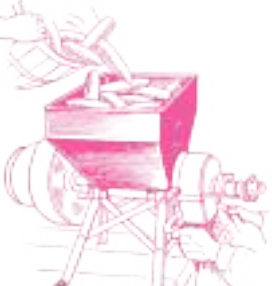
- He must not remove any safety equipment from machines or equipment. This includes shields from grinders, mixers, etc.
- He must had adequate instruction about a piece of machinery or equipment before he uses it.
- He must make sure that no machine, equipment, or tool is used in a way that would cause injury to someone else.
- He must make sure that there are safe entrances to and exits from the workplace.
- He must make sure that the work area is safe for the movement of workers, equipment, and materials.
- He must wear protective eyewear when using grinders and other equipment that may be hazardous to the eyes.



Notes

Glossary

Acidulants	:	These are chemical compounds that gives tart, sour, acidic flavour to fruits
Agglomeration	:	A mass or collection of things
Esterification	:	Chemical reaction between two reactants form an ester as an end product
Extrusion	:	The process of forming something by forcing through a small opening
Flexographic	:	Form of printing process which utilizes a flexible relief plate
Forklift trailers	:	These are designed specifically for the transport of small machines, access equipment and materials handling equipment.
Hydrocolloids	:	A substance which forms a gel in the presence of water
Hydrostatic sterilizer	:	It is a continuous sterilizer in which the process is carried out under sufficient depth of water to maintain the required pressure.
Lycopene	:	Plant pigment gives red and pink colour to fruits
° Brix (Degree brix)	:	Sugar content of an aqueous solution. 1° Brix is 1 gram of sucrose in 100 grams of solution
Photogravure	:	An image produced from a photographic negative to a metal plate and etched in.
Pneumatic press		A pneumatic press is machine derives its mechanical action from a pressure source by means of compressed air.
Planographic	:	The art or technique of printing from a flat surface directly
Polymer	:	Substance or material consisting of very large molecules, composed of many repeating subunits
Syneresis	:	Contraction of a gel accompanied by the separating out of liquid



Notes

Thickening agent	:	Substance which increase the viscosity of liquid without changing other properties
Xanthan gum	:	Polysaccharide composed of glucose, mannose and glucoronic acid

Evaluation

I. Choose the correct answer (1 mark)

1. During ripening, the changes takes place in fruits are ……

   1. Development of sweet aroma

   2. Conversion of starch to sugar

   3. Edible portion become harder

   4. Develop its full size

   a. 1, 2 and 4 are correct b. 3 and 4 are correct

   c. 3 and 4 are wrong d. 2 and 3 are wrong

2. Match the following:

   1. Pectin rich fruit (i) goose berries

   2. Pectin poor fruit (ii) melons

   3. High acid fruit (iii) Pomegranate

   4. Low acid fruit (iv) black berries

   a. 1-(iv), 2-(iii), 3-(i), 4-(ii) b. 1-(iii), 2-(iv), 3-(ii), 4-(i)

   c. 1-(iii), 2-(iv), 3-(i), 4-(ii) d. 1-(ii), 2-(iv), 3-(i), 4-(ii)

3. Ketchup contains …… percent acetic acid.

   a.1.75 – 2 b. 1.25 – 2 c. 1.25 – 1.50 d. 1.75 – 2

4. Select the correct maintenance procedure for Jam thermometer.

   a. Rinse with detergent and clean water

   b. clean using acids

   c. Wipe using a clean cloth

   d. Dip in a brine solution

Notes

5. The process of subtracting heat energy during processing is called …….

   a. Cooling b. Sterilization

   c. Pasteurization d. Evaporation

6. The word sanitation is derived from..... Word 'sanitas'

   a. French b. German

   c. Latin d. Greek

7. For measuring sugar concentration in jam the equipment used is ……..

   a. Refractometer b. pH meter

   c. Thermometer d. Hydrometer

8. Give one example for the following sanitizing agents

   a. Chloric based……

   b. Iodine based ……..

9. Expand - BIS - ……

10. Expand -CAC - ……..

II. Define the following terms

a. Sorting

b. Grading

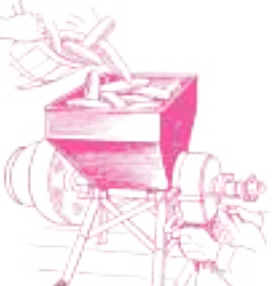
c. Blanching

d. SOP

e. Hygiene and Sanitation

III. Write in two lines (2 Mark)

1. Write selection criteria for any 5 fruits in jam preparation.
2. How will you classify the fruits according to their pectin and acid content?
3. Enlist the methods for judging the end point for jam and jellies.
4. What are the characteristics of a good jelly?
5. List the defects in ketchup preparation.
6. How will you eliminate the contamination of raw materials, Name the equipments used for this purpose?



Notes

7. Name the machines used for juice production.
8. Write the importance of maintenance in processing equipments.
9. List the equipments used for grading fruits.
10. Give the classification of cleaning agents.
11. What is the procedure followed for cleaning processing plants?
12. Expand FSSAI and list their functions.

III. Write in three lines (3 Mark)

1. What are the specific requirements for jam?
2. What is aseptic devices? List the devices required for aseptic technique.
3. Name the unit operations involved in packaging and list the equipments employed.
4. Discuss about the personal cleanliness to be maintained in food handling operations.
5. Differentiate pasteurization and sterilization.
6. What are the methods used for cleaning and disinfecting equipments?
7. Write the need for sanitation in food processing equipments. Give any four reasons.
8. Write a note on Personal Protective Equipment (PPE).
9. Write any five precautions to be followed while operating machinery.
10. Explain SOP for waste disposal.

Practical

Aim : To gain knowledge about the machinery needed in processing Tomato ketchup, Jams and Jellies.

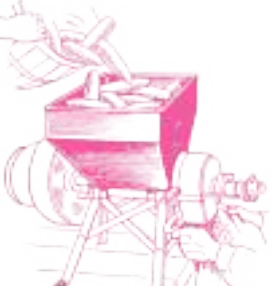
Apparatus : paper, pen, pencil

Procedure:

Tabulate the following machinery and find the uses and maintenance of each.

Machineries	Uses	Maintenance
• Pulper Machine • Slicing Machine • Juice Extractor • Steam Jacketed Kettle • Mixer/Grinder • Bottle Washing and Filling Machine • Filter • Cap Sealing Machine • Stirrers • SS Utensils • Burner • Weighing Scales • Hand Gloves • Miscellaneous Tools and Equipment • Testing Equipment		

Machineries	Uses	Maintenance
• Tomato Washer • Sorting Conveyor • Elevator • Tomato Crushing Machine • Tomato juice Extractor • Destoning / Pulping Machine • Tank • Transfer Pump • Tubular Preheater /Pasteurization • Vacuum Evaporator/continuous/forced circulation evaporator • Filling & Packaging		



Notes

Project

1. Visit a processing unit and note the following

a. Fruits used for preparing jams and jellies

b. Preparing the fruits before starting the process

c. Extraction of pectin

d. Preparation of jams and jellies

e. Preservatives used

f. Machinery used

g. Care and maintenance of machinery

h. Safety procedure

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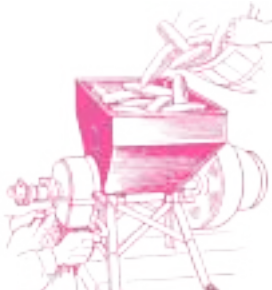

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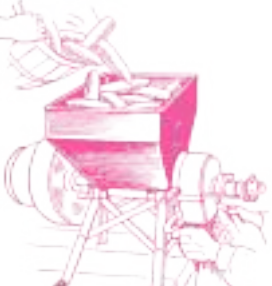

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Notes

Model Question Paper

Marks: 60

I. Choose the correct answer: (10x1 = 10)

1. …….. is a process of converting food stuffs to prolong their duration, storage and reduce time in culinary procedure.

   a. Food preservation b. Food processing

   c. Food contamination d. Food adulteration

2. The processed food surmi and derivations comes under ……. subsector.

   a. Fisheries b. Milk and dairy

   c. Cereals and grains d. Meat and poultry

3. ……. helps in inactivation of food enzymes.

   a. Cutting b. Chopping

   c. Blanching d. Frying

4. The temperature zone at which bacteria grow is called ……

   a. Easy zone b. Secure zone

   c. Good zoned. d. Danger zone

5. ……..is an example of functional foods.

   a. Probiotics b. Boiled foods

   c. Aerated foods d. Fried foods

6. ……..stops moisture from entering food.

   a. Spice b. Oil c. Sugar d. Salt

7. …… helps in preparation of jams and jellies.

   a. Citric acid b. Vinegar c. Pectin d. MSG

8. ……. is one of the famous foods of India especially in South India.

   a) Bread b) Idli c) Dhokla d) Naan

9. ……. is the energy source for the yeast.

   a) Starch b) Protein c) Vitamins d) Minerals

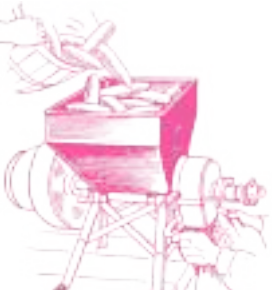
10. Select the correct maintenance procedure for Jam thermometer.

    a. Rinse with detergent and clean water

    b. clean using acids

    c. Wipe using a clean cloth

    d. Dip in a brine solution



Notes

II. Write in two lines (2 Mark) (10x2 =20)

1. Define food processing.
2. Expand PMKSY.
3. List the major segments of food industry..
4. What do you mean by minimal food processing?
5. Name the natural preservatives.
6. Write on chelating agents.
7. Give a short note on osmotic dehydration.
8. List the fruits and vegetables that can be canned.
9. Define 'Starter Culture" with an example.
10. Differentiate curd and yoghurt.
11. What are mesophilic microorganisms?
12. Specify the enzymes used for fruit juice production
13. How will you classify the fruits according to their pectin and acid content?
14. What are the characteristics of a good jelly?
15. Name the machines used for juice production.

III. Write in three lines (3 Mark) (10x3 = 30)

1. Classify food processing and explain.
2. Draw the need of food processing.
3. Write any five reasons to add fruits and vegetables in our daily diet.
4. Mention the techniques used to prepare fruits and vegetables for minimal food processing.
5. Enumerate the benefits of drying and dehydration.
6. What are the two methods of canning?
7. Explain the steps for starting fermentation.
8. List the advantages of fermentation.
9. Do you think processed food is good for health? Explain.
10. How to prepare Dhokla?
11. How does browning occur in fruits and vegetables?
12. Discuss about food contamination through humans.
13. Discuss about the personal cleanliness to be maintained in food handling operations.
14. Write a note on Personal Protective Equipment (PPE).
15. What are the methods used for cleaning and disinfecting equipments?

AVENUES AVAILABLE FOR VOCATIONAL ASPIRANTS...

Institutional Support for MSMEs

Ministry of Micro, Small and Medium Enterprises- A branch of the Government of India and the apex executive body for the formation and administration of rules, regulations and laws relating to micro, small and medium enterprises in India.

Micro enterprise:

A business operation on a very small scale, especially one in the developing world that is supported by microcredit. (Ex. i. Trading, merchandising and retail, ii.Food business, iii. Agriculture and aquatics, Rice farming, iv. Graphic and Design, v. Arts and Craft, Furniture making, vi, Licensed Professional services, etc).

Small enterprise:

A small enterprise is an enterprise where the investment in plant and machinery is more than Rs. 25 lakh but does not exceed Rs. 5 crore.

Medium enterprise:

A Medium enterprise is an enterprise where the investment in plant and machinery is more than Rs. 5.

1. Commissionerate of Industries & Commerce

Formulate policies for MSME sector in Tamil Nadu

2. MSME Trade & Investment Promotion Bureau

To promote export and Investment in MSME sector

3. District Industries Centre

Implement the state policies at district level

4. Indcoserve and Sagoserve

Industrial Cooperative Societies to improve the socioeconomic conditions by providing gainful employment to the economically weaker sections and in ensuring remunerative prices to the growers like small tea growers and tapioca cultivators

5. Entrepreneurship Development & Innovation Institute

Training and Support for startup ecosystem

6. TN Small Industries Development Corporation

Provide Infrastructure for MSMEs - developed plots/shed

7. Tamil Nadu Industrial Investment and Corporation(TIIC) and Tamil Nadu Industrial Co-operative Bank (TAICO)

Provides -Strong financial support to MSMEs for securing loans and working capital needs

8. Tamil Nadu Small Industries Corporation Limited

Manages small scale units set up by the Government. They manufacture wooden, steel and engineering products

Schemes for MSMEs

1. MSME Subsidy Schemes

The micro, small and medium enterprises (MSMEs) have been accepted as the engine of economic growth and for promoting equitable development. The labour intensity of this sector is much higher than that of the large enterprises. The MSMEs play a pivotal role in the overall industrial economy of the country. With

its agility and dynamism, the sector has shown admirable innovativeness and adaptability.

Taking cognizance of the contribution made by the micro, small and medium enterprises to the economy of the state, the Government of Tamil Nadu has introduced various incentives and concessions to catalyse the growth of this sector.

The following incentives and concessions are being extended to the MSMEs in the state:

A. Capital Subsidy

25% capital subsidy on the value of eligible plant and machinery, subject to a maximum of Rs. 50.00 lakhs.

Eligibility:

- All new micro manufacturing enterprises established anywhere in the state.
- All new small and medium enterprises under the following 15 thrust sectors established anywhere in the state excluding additional capital subsidy and employment generation subsidy:

Electrical and electronic industry	Pollution control equipments
Leather and leather goods	Sports goods and accessories
Auto Parts and Components	Cost effective building materials
Drugs and pharmaceuticals	Readymade garments
Solar energy equipment	Food processing
Gold and diamond jewellery for exports	Plastic (Except "One time use and throw away plastics")
Alternate products to one time use and throw away plastics	Rubber, Electric Vehicle Components, Charging infrastructure and its Components

- All new small and medium manufacturing enterprises established in the 251 industrially backward blocks.
- All new agro based small and medium manufacturing enterprises established in the 385 blocks of the state.
- Existing manufacturing enterprises of the above categories which have taken up substantial expansion/diversification of the existing activities.

Additional Capital Subsidy:

- Additional capital subsidy for enterprises set up by women/scheduled caste/scheduled tribe/differently abled and transgender entrepreneurs at the rate of 5% on the value of eligible plant and machinery, subject to a maximum of Rs. 2 lakhs.
- Additional capital subsidy for promotion of cleaner and environment friendly technologies at the rate of 25% on the value of eligible plant and machinery / equipment meant for environment improvement or sustenance subject to a maximum of Rs. 3lakhs.
- Employment Intensive Subsidy at the rate of 5% on the value of eligible plant and machinery, subject to a maximum of Rs. 5 lakhs.

B. Low Tension Power Tariff Subsidy

Eligible MSME units are provided 20% low tension power tariff subsidy for 36 months from the date of commencement of production or from the date of power connection obtained, whichever is later.

Eligibility:

- All new micro manufacturing enterprises established anywhere in the state.
- All new agro based micro, small and medium manufacturing uring enterprises established in the 385 blocks of the state.

- All new small and medium manufacturing enterprises established in the 251 industrially backward blocks.
- Existing manufacturing enterprises of the above categories which have taken up substantial expansion/diversification of the existing activities.

C. Generator Subsidy

Micro, small and medium manufacturing enterprises established anywhere in the state are eligible for a subsidy of 25% on the cost of generator set purchased (upto 320 KVA capacity), subject to a maximum of Rs. 5 lakhs.

D. Back-Ended Interest Subsidy

Back-ended interest subsidy at the rate of 5 % subject to a maximum of Rs.10 Iakhs for a period of 5 years is being provided to micro, small and medium manufacturing enterprises for term loans upto Rs.100.00 Iakhs obtained for technology upgradation/ modernization and Credit Guarantee Fund Trust Scheme(CGFTS).

2. Scheme for promotion of Energy Audit and Conservation of Energy

The Government have introduced Promotion of Energy Audit and Conservation of Energy (PEACE) scheme for promoting energy efficiency in MSME units. Under this scheme, the Government would reimburse 50% of the cost of conducting energy audit and 25% of the cost of machinery &equipments replaced, retrofitted and technology acquired for the purpose of improving energy efficiency, based on the recommendations of the energy audit.

Objectives of the Scheme:

i. Creating awareness & educating MSMEs about benefits / advantages of the new techniques/ technologies for saving energy.

ii. Undertaking in-depth studies of high energy consuming MSME clusters and identify gaps and potential barriers for energy conservation and promoting adoption of suitable techniques/ technologies to achieve energy efficiency.

iii. Encouraging MSMEs for adopting energy audits to improve energy efficiency and fuel substitution, and monitoring the impIementation of recommendations.

Incentive for Conducting Detailed Energy Audit:

a. Main objective is to identify the major sources of energy in use, identify the lapses in energy usage and areas to improve energy usage, determine the level of consumption of the energy sources and recommend measures that will enhance energy savings in the industry.

b. 50% of the energy audit cost subject to a maximum of Rs.0.75 lakh per energy audit per unit.

c. Eligible MSMEs shall file their claims within one year from the date of completion of energy audit.

d. Incentive for Implementing Energy Audit Recommendations:

   a. The objective is to incentivise MSMEs to implement the recommendations of the Energy Audit Report and to optimize the energy consumption leading to energy saving and moneysaving in electricity bills.

   b. Eligibility - all manufacturing MSMEs in the state which have undertaken energy audit and have achieved at least 15% energy savings in terms of number of units of energy consumed per unit of product manufactured.

   c. 25% of the cost of the eligible components, subject to a maximum Iimit of Rs.2,00,000.

3. Scheme for acquiring quality certification

To encourage MSMEs to acquire quality standard certifications for process and product

such as ISO 9000/ ISO 14001 / ISO 22000 / Hazard Analysis and critical point (HACCP) / Good Hygienic Practices (GHP) / Good Manufacturing Practice (GMP) certifications, BIS certification, Zero defect and Zero Effect (ZED), Rating etc., the Government is providing reimbursement subsidy at the rate of 100% on the charge incurred by the MSMEs for acquiring such quality certifications subject to a maximum of Rs. 1.00 lakh

4. Business Facilitation Act

Tamil Nadu Business Facilitation Act, 2018 was enacted to ensure single point receipt of applications for securing clearances that are required to establish or expand an enterprise and for clearances required during normal course of business including renewals in a time-bound manner. The Act also provides for an effective grievance redressal mechanism in case of failure of Competent Authorities to act within the time limit and for matters connected therewith or incidental thereto.

The Act covers 54 clearances covering pre-establishment, pre-operation, renewals, incentives, etc. District Industries Centres and Guidance Bureau are designated as Nodal Agencies for MSMEs and large industries respectively for operating the single window mechanism.

The Act provides for a 3 tier institutional structure:

1. MSME District Single Window Committee
2. MSME State Single Window Committee, and
3. MSME Investment Promotion and Monitoring Board to monitor and review the progress of the single window mechanism.

5. Single Window Facilitation for MSMEs

The MSME Department supports the entrepreneurs who come forward to set up an enterprise. The entrepreneurs can get all licenses/approvals from various departments under the single window mechanism.

The Government of Tamil Nadu takes cognizance of the need for continuously improving the ease of doing business in the state. In order to demonstrate the state's interest in creating an investor friendly climate, conducive to the domestic and global business community, the MSME Department has implemented the online Single Window Portal to deliver requisite services to the investors in a time-bound and transparent manner through online mechanism from 11 departments such as the Directorate of Town and Country Planning (DTCP), Tamil Nadu Pollution Control Board (TNPCB), Fire, Directorate of Industrial Safety and Health (DISH), etc. during the pre-establishment, pre-operation and renewal stages.

The Single Window Portal for MSMEs is available at https://www.easybusiness.tn.gov.in/msme.

6. Micro and Small Enterprises Facilitation council

In the MSMED Act 2000, one of the objectives is to facilitate settlement of delayed payments to micro and small enterprises for the goods supplied by them to major industrial undertakings. Accordingly, the Government has constituted four regional Micro and Small Enterprises Facilitation Councils at Chennai, Tiruchirappalli, Madurai and Coimbatore. Applicants, who intend to file applications under this, can file applications online at https://samadhaan.msme.gov.in.

7. New Entrepreneur cum Enterprise Development Scheme

"New Entrepreneur—cum-Enterprise Development Scheme (NEEDS)" has been introduced by the Government to assist educated youth to become first generation entrepreneurs.

Objective:

To assist first generation entrepreneurs to set up their manufacturing / service enterprises with financial assistance for a maximum project cost of Rs 5 crores from banks or state financial agency.

Eligibility:

Age should be between 21 years to 35 years for General Category and not exceeding 45 years for Special Category (SC / ST / BC / MBC / Minority / Women / Ex-Servicemen / Differently Abled / Transgender).

Should possess educational qualification of any degree / diploma / ITI / vocational training from a recognized institution.

Highlights of the Scheme:

Promoter's contribution is 10% of the project cost for General Category and 5% for Special Category of entrepreneurs.

Individual based subsidy @25% of project cost (not exceeding Rs 30 lakhs).

3% interest subvention for the entire term loan period.

50%earmarked for women beneficiaries.

15 days training on entrepreneurship by EDll-Chennai.

No income ceiling.

Selection of beneficiaries by district level Task Force chaired by the District Collector.

Subject to availability, reservation upto 25% for allotment of plots/sheds in SIDCO Industrial Estates.

8. AMMA Skill Training and Employment Scheme

The Amma Skill Training and Employment Scheme aims at promotion of the MSME sector by providing them with necessary skilled human resources. The scheme aims to train unemployed youth in enhancing their skill for employment with 30% reservation for women. The MSME units providing training to the candidates selected by them will have to pay a stipend of 5000/- per month/candidate upto six months. Out of this, 2,000/- per month will be reimbursed by the Government of Tamil Nadu to the MSMEs after completion of the training programme. The trained candidates will be issued with a certificate by the Tamil Nadu Skill Development Corporation(TNSDC).

The objective of the scheme is to fuIfiII the requirement of skilled human resources in the manufacturing sector through on the job training of candidates fulfilling the norms of NSDC / NSDA / Sector Skill Council / MES / other agencies and possessing required educational qualification and age limit (18 years to 45 years) prescribed for each trade. Disbursement of stipend is done by the TNSDC.

9. UYGEP

The Unemployed Youth Employment Generation Programme (UYEGP) has been introduced to create employment opportunities for the marginalized sections of the society.

Objective:

To create employment opportunities to for the marginalized sections of the society with financial assistance for a maximum project cost of Rs. 10 lakhs for manufacturing activities, Rs. 5 lakhs for service and business activities.

Eligibility:

Age should be between 18 years to 35 years for General Category and upto 45 years for Special Category comprising SC/ ST/ BC/ MBC/ Minority/ Women / Ex-Servicemen / Differently Abled / Transgender.

Pass in VIII Standard.

Family income not exceeding Rs. 5 lakhs per annum.

Highlights of the Scheme:

Promoter's contribution is 10% of the project cost for General Category and 5% for Special Category of entrepreneurs.

Subsidy @ 25 % of project cost (not exceeding Rs 1.25 lakhs).

7 days EDP training.

Selection of beneficiaries by district level Task Force chaired by the General Manager, District Industries Centre.

10. PMEGP

The **Prime Minister's Employment Generation** have been accepted as the engine of economic Programme (PMEGP) is being implemented with effectfrom2008-09.

Objective:

Creation of self employment opportunities in both rural and urban areas with financial assistance for a maximum project cost of Rs. 25 lakhs for manufacturing sector and Rs. 10 Iakhs under service sector.

Eligibility:

Age should be minimum of 18 years.

Beneficiaries should have passed minimum 8th Std. to avail loan above Rs. 10 lakhs in manufacturing sector and above Rs. 5 lakhs in service sector.

No income ceiling.

Highlights of the Scheme:

Promoter's contribution is 10% for General Category and 5% for Special Category (SC/ST/OBC/ Minorities/Women/ Ex-Servicemen/DA).

Subsidiaries from 15% to 35% as detailed below:

Category of Beneficiary	Rate of Subsidy	
	Urban	Rural
General Category	15% of the Project Cost	25% of the Project Cost
Special Category	25% of the Project Cost	35% of the Project Cost

Higher Secondary – First Year – Food Processing (Vocational Skills)

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