CHAPTER 5:

DEMONSTRATE KNOWLEDGE OF FOOD PROCESSING, SAFETY AND HYGIENE

5.1 Introduction of the Unit of Learning / Unit of Competency

This unit specifies the competencies required for food processing, safety and hygiene. It is to include principles in food processing, methods of food preservation, food quality and safety-HACCP and hygiene practices in food handling.

5.2 Performance Standard

By the end of this unit of learning/competency, the trainee should apply principles of food processing and preservation in ensuring food safety as per resource materials; process and preserve different food products in line with the available resources; apply food quality, safety and hygiene practices in food handling as per the HACCP principles and resource materials.

5.3 Learning Outcomes

5.3.1 List of the Learning Outcomes

1. Identify and describe terminologies in food processing, safety and hygiene
2. Describe principles in food processing, preservation and safety
3. Demonstrate knowledge in food quality, safety and hygiene

5.3.2 Learning Outcome 1: Identify and describe terminologies in food processing, safety and hygiene

5.3.2.1 Learning Activities

Learning activity	Special instructions
Identify and describe terminologies in food processing, preservation and food safety	Define various terminologies in food processing such as • Food • Food processing • Food preservation • Food safety
Identify and describe aims and importance of food processing, preservation and safety	

5.3.2.2 Information Sheet

Definitions

Food processing is the set of methods and techniques used to transform raw ingredients into food for consumption.

Food preservation is the process of treating and handling food in such a way as to stop or greatly slow down spoilage to prevent foodborne illness and extend its shelf-life

Food safety: is defined as handling, preparing and storing food in a way to best reduce the risk of individuals becoming sick from foodborne illnesses

Food: is any nutritious substance eaten to maintain vital life processes.

FOOD PROCESSING

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

History of food processing

The origin of food processing goes all the way back to ancient Egypt, yet the period of those developments seems to symbolize the history of the culture of mankind. Nowadays, bread, which is characterized by its use of the fermentation action of yeast and which uses wheat flour as its raw material, is baked all over the world. The origins of beer also go back to Babylon and Egypt in the period from 3,000 to 5,000 BC.

The foundation of the modern industry was built up with the introduction of machinery and technology of new methods from Germany. Nowadays, the processed foods that are thriving in grocery shops are modern processed foods and traditional foods, but their manufacturing

technology, process control and manufacturing and packaging environmental facilities have been advanced and rationalized to an incomparable extent in the last 30 years.

As a result, products with high quality and uniformity are now being manufactured. This is based on the advancement of food science, and is, moreover, due to the general introduction of hygienics, applied microbiology, mechanical engineering, chemical engineering, electronic engineering and high-polymer technology.

Importance of food processing

i) Prevent, reduce, eliminate infestation of food with microbes, insects or other vermin

ii) Prevent microbial growth or toxin production by microbes, or reduce these risks to acceptable levels

iii) Stop or slow deteriorative chemical or biochemical reactions

iv) Maintain and/or improve nutritional properties of food

v) Increase storage stability or shelf life of food as well as its supply

vi) Make food more palatable and attractive

vii) Make foods for special groups of people

viii) To save food for future use at the time of scarcity or drought etc. after suitable preservation and proper storage. Preservation of food also minimises the preparation time and energy at home.

ix) To stabilise the price of food throughout the year since seasonal food can be preserved and made available for consumption throughout the year.

Food processing methods

1) Peeling: Removal of unwanted outer layers, such as potato peeling or the skinning of peaches.

2) Chopping or slicing e.g. diced carrots.

3) Mincing and macerating: Mincing is a technique in which food ingredients are finely divided. The effect is to create a closely bonded mixture of ingredients and a soft or pasty texture

4) Liquefaction: refers to conversion of something into the liquid state, such as to produce fruit juice like mango juice

5) Fermentation: refers to the conversion of sugar to alcohol using yeast e.g. in beer breweries. Fermentation usually implies that the action of the microorganisms is desirable, and the process is used to produce alcoholic beverages such as wine, beer and cider.

6) Emulsification: an emulsion is a mixture of two immiscible liquids. One liquid (the dispersed phase) is dispersed in the other (the continuous phase). Many emulsions are

oil/water emulsions, with dietary fats being one common type of oil encountered in everyday life. Example of emulsion include butter and margarine, milk and cream.

7) Cooking, such as boiling, broiling, frying, steaming or grilling

8) Baking: the technique of prolonged cooking of food by dry heat acting by convection, and not by radiation, normally in an oven, but also in hot ashes, or on hot stones. It is primarily used for the preparation of bread, cakes, pastries, tarts, quiches and cookies.

9) Deep frying

10) Mixing

11) Addition of gas such as air entrainment for bread or gasification of soft drinks

12) Proofing

13) Spray drying

14) Pasteurization

15) Packaging: is the science, art and technology of enclosing or protecting products for distribution, storage, sale and us.

Benefits and limitations of food processing

Benefits:

1. Benefits of food processing include toxin removal, preservation, easing marketing and distribution tasks, and increasing food consistency.
2. In addition, it increases seasonal availability of many foods, enables transportation of delicate perishable foods across long distances and makes many kinds of foods safe to eat by de-activating spoilage and pathogenic microorganisms.
3. Processed foods are usually less susceptible to early spoilage than fresh foods and are better suited for long distance transportation from the source to the consumer.
4. Processing can also reduce the incidence of food borne disease.
5. Fresh materials, such as fresh produce and raw meats, are more likely to harbour pathogenic micro-organisms (e.g. Salmonella) capable of causing serious illnesses.

Limitations

1. Any processing of food can have slight effects on its nutritional density.
2. Vitamin C, for example, is destroyed by heat and therefore canned fruits have a lower content of vitamin C than fresh ones.
3. Another safety concern in food processing is the use of food additives. The health risks of any additives will vary greatly from person to person, in example sugar as an additive would be detrimental to those with diabetes.
4. Food processing is typically a mechanical process that utilizes large mixing, grinding,

chopping and emulsifying equipment in the production process. These processes inherently introduce a number of contaminate risks.

5. Food manufactures utilize industrial metal detectors to detect and reject automatically any metal fragment

Food spoilage

Spoilage is the process in which food deteriorates to the point in which it is not edible to humans or its quality of edibility becomes reduced. Various external forces are responsible for the spoilage of food. Food that is capable of spoiling is referred to as perishable food.

Reasons of food spoilage

Harvested crops decompose from the moment they are harvested due to attacks from microorganisms. These include bacteria, mould, yeast, and enzymes.

Bacteria

Various bacteria can be responsible for the spoilage of food. When bacteria breaks down the food, acids and other waste products are created in the process. While the bacteria itself may or may not be harmful, the waste products may be unpleasant to taste or may even be harmful to one's health.

Yeasts

Yeasts can be responsible for the decomposition of food with a high sugar content. The same effect is useful in the production of various types of food and beverages, such as bread, yogurt, cider, and alcoholic beverages.

Signs of food spoilage

Signs of food spoilage may include an appearance different from the food in its fresh form, such as a change in colour, a change in texture, an unpleasant odour, or an undesirable taste. The item may become softer than normal. If mould occurs, it is often visible externally on the item.

Food preservation

Food preservation is the process of treating and handling food to stop or slow down spoilage (loss of quality, edibility or nutritional value) and thus allow for longer storage. Preservation usually involves preventing the growth of bacteria, yeasts, fungi, and other micro-organisms (although some methods work by introducing benign bacteria, or fungi to the food), as well as retarding the oxidation of fats which cause rancidity. Food preservation can also include processes which inhibit visual deterioration that can occur during food preparation; such as the enzymatic browning reaction in apples after they are cut. Many processes designed to preserve food will involve a number of food preservation methods.

Preserving fruit, by turning it into jam, for example, involves boiling (to reduce the fruit's moisture content and to kill bacteria, yeasts, etc.), sugaring (to prevent their re-growth) and sealing within an airtight jar (to prevent recontamination).

There are many traditional methods of preserving food that limit the energy inputs and reduce carbon footprint. Maintaining or creating nutritional value, texture and flavour is an important aspect of food preservation, although, historically, some methods drastically altered the character of the food being preserved. In many cases these changes have now come to be seen as desirable qualities – cheese, yoghurt and pickled onions being common examples.

Preservation processes

Preservation processes include:

- Heating to kill or denature micro-organisms (e.g., boiling)
- Oxidation (e.g., use of sulfur dioxide)
- Ozonation (e.g., use of ozone [O3] or ozonated water to kill undesired microbes)
- Toxic inhibition (e.g., smoking, use of carbon dioxide, vinegar, alcohol etc.)
- Dehydration (drying)
- Osmotic inhibition (e.g., use of syrups)
- Low temperature inactivation (e.g., freezing)
- Ultra high water pressure (e.g., Fresherized®, a type of "cold" pasteurization; intense water pressure kills microbes which cause food deterioration and affect food safety)

Benefits of food processing and preservation

- Mass production of food is much cheaper overall than individual production of meals from raw ingredients.
- Reaches areas where the food item is not grown
- Easing marketing, storage and distribution tasks
- Add variety to our meals
- Increasing food consistency (season availability0
- Toxin removal
- Makes many kinds of foods safe to eat by deactivating spoilage and pathogenic microorganisms.
- Improves the quality of life for people with allergies, diabetics, and other people
- Can also add extra nutrients such as vitamins
- Processed foods are often less susceptible to early spoilage than fresh foods

Demerits of food processing and preservation

- Can lower the nutritional value of foods, and introduce hazards not encountered with naturally-occurring products
- Processed foods often have a higher ratio of calories to other essential nutrients than unprocessed foods, a phenomenon referred to as “empty calories”. So called junk food, produced to satisfy consumer demand for convenience and low cost, are most often mass produced processed food products.
- May cause adverse health effects: Preservatives such as nitrites or sulphites.
- Failures in hygiene standards in “low-level” manufacturing facilities that produce a widely-distributed basic ingredient can have serious consequences for many final products

5.3.2.3 Self-Assessment

1. Define the term food processing
2. Handling, preparing and storing food in a way to best reduce the risk of individuals becoming sick from foodborne illnesses is
    A. Food preservation
    B. Food processing
    C. Food safety
    D. Food hygiene
3. The following are preservation processes except
    A. Dehydration
    B. Osmotic inhibition
    C. Low temperature inactivation
    D. Mincing
4. Why is food preservation important?
5. Why is food processing important?
6. Discuss the merits and demerits of food processing and preservation.

5.3.2.4 Tools, Equipment, Supplies and Materials

Textbooks

Use of LCDs, video clips, charts and other teaching aids

Invitation of competent expertise

Computers with internet

Library and resource centre

Stationery

5.3.2.5 References

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5.3.3 Learning outcome 2: Describe principles in food processing, preservation and safety

5.3.3.1 Learning Activities

Learning activity	Special instructions
Identify and describe principles in food	Describe of principles of food processing and preservation
Identify and describe methods of food processing and preservation	Name and describe methods of food processing and preservation
Identify and describe effects of food processing and preservation techniques on food storage sensory and nutrition properties of food	Explain effects of food processing and preservation techniques on; • food storage • Sensory • Nutrition properties
Identify and describe traditional and modern methods in food processing and preservation for different food categories	Observe how food processing and preservation has evolved over time
Identify and describe principles in food processing and preservation as per resource materials	Observe some of the critical activities during food processing and preservation

5.3.3.2 Information Sheet

Definitions

Pasteurization: when food is heated in containers or by other method to a temperature below 100° C for a definite period of time, the process is known as pasteurization.

Gamma radiation: Use of ionizing radiation (gamma radiation) to extend shelf life or sterilize meat, seafoods, fruits, and vegetables

Sterilization: It is a process that all micro-organisms are being killed at high temperature or radiation.

Canning: a process in which over 100°C is used for killing all spoilage organisms and their spores as well as inactivating enzymes and sealing in sterile airtight containers.

Irradiation: It is the emission and propagation of energy through space or through a material medium

Food processing

As defined earlier, food processing is the conversion of agricultural product to substances which have particular textural, sensory and nutritional properties using commercially feasible methods.

There are two ain forms of processing;

i)Primary processing: conversion of raw materials to food commodities. A good example of primary processing is milling.

ii)Secondary processing: conversion of ingredients into edible products – this involves combining foods in a particular way to change properties. Baking cakes is an example of secondary processing.

Importance of food processing

- Conversion of raw food materials to edible products
- For preservation purposes
- For extension of availability and provision of accessibility
- Provision of variety and choice
- For value addition

Food processing methods that are used to preserve foods include:

- Refrigeration and freezing
- Canning
- Heating
- Irradiation
- Dehydration
- Freeze-drying
- Chilling
- Concentration
- Pickling
- Pasteurizing
- Fermentation

Principles in food processing

They pronciples of food processing include:

- Heat transfer

- Fluid flow
- Mass transfer
- Mixing
- Size adjustment
- Separation

Food preservation

All of the food preservation processes work by slowing down the activity and growth of disease causing bacteria, or by killing the bacteria all together. They also slow down or stop the action of enzymes which can degrade the quality of the food.

The following principles are involved in various methods;

a.Prevention or delay of microbial decomposition (control of microorganisms)

- By keeping out microorganisms (Aseptic techniques)
- By removal of microorganisms. This is done by removing air, water (moisture), filtration, lowering or increasing temperature, increasing the concentration of salt or sugar or acid in foods
- By hindering the growth and activity of microorganisms e.g. by low temperature drying, anaerobic conditions or chemicals
- By killing the microorganisms e.g. by heat or radiations

b.Prevention or delay of self-decomposition of the food (control of enzymes)

- This will involve controlling enzymes by;
    i. Inactivating endogenous enzymes
    ii. Preventing or delaying chemical Reactions in the food

c.Controlling insects, rodents, birds and other physical causes of food deterioration. This is achieved through;

- Use of suitable chemicals to kill insects or animals to prevent them from destroying food
- Storage of dried foods in dry, airtight containers to prevent insects and rodents invasion.

Methods of food processing and preservation

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

- thermal treatment
- water removal (in form of moisture)
- dehydration

- temperature reduction during storage
- food irradiation
- reduction of pH
- protective packaging

A. Heat treatment

This method of food processing aims at killing the microrganisms that could easily cause food spoilage. Heating also destroys or inactivate enzymes thus preventing deterioration. All types of food can be preserved for a considerable period of time by cooking. The heat treatment required depends on the kind of the target micro-organisms to be killed and the composition of the food.

Classification of heat treatments used on foods:

1) Pasteurization
2) Heat at 100°C
3) Heat > 100°C (also known as commercial sterility and can easily kill spores of C. botulinum.
4) Canning

1)Pasteurization (heating to temperature below 100°C)

In this method of preservation, foods are subjected to sufficient heat to kill most of the bacterias. The food is heated in a closed system, rapidly cooked, and then placed in covered and sealed container to prevent recontamination. The temperature used ranges from 65- 75°C.

Plate heater exchanger pasteurizer

Heat treatments that kills most but not all microorganisms.

Example: milk 63ºC, 30 mins

72ºC, 15 mins

Juice 77ºC, 30 mins

88ºC, 30 secs

There are two ways of pasteurisation:

- HTST (High temperature-short time): Food product is heated at high temperature for a short time. For example, milk is heated to 72℃ and held for 15 seconds.
- LTLH (Low temperature-long time): Food product is heated at a lower temperature for longer period of time. For example, milk is heated to 62.8℃ and held for 30 minutes.

The pasteurized products are cooled promptly after the heat treatment. This method is designed to kill only vegetative cells of pathogens, not spores.

Pasteurization is important when:

1) Heat treatment will not harm the quality of product
2) Main spoilage microbes are not very heat resistant e.g. yeast in fruit juices
3) Kill pathogens
4) Any surviving organisms will be treated with other preservative methods
5) Competing organisms are to be killed, allowing a desired fermentation

Effect of pasteurization on foods

Pasteurization is a relatively mild heat treatment and even when combined with other unit operations (for example irradiation and chilling there are only minor changes to the nutritional and sensory characteristics of most foods. However, the shelf life of pasteurized foods is usually only extended by a few days or weeks compared with many months with the more severe heat sterilization. Minimizing post processing contamination is essential to ensure an adequate shelf life.

In fruit juices, losses of vitamin C and carotene are minimized by deaeration. Changes to milk are confined to a 5% loss of serum proteins and small changes to the vitamin content

2) Heating at about 100°C(boiling)

This method of processing is sufficient to kill all microbes but not spores. Many acid foods are successfully preserved at100°C.

Methods:

• Boiled • Immersion • Baking • Simmering • Roasting

• Frying • Blanching • Exposure to flowing steam

3) Heating above 100°C (sterilization)

This method of heat treatment is mainly obtained by means of steam under. The higher the steam pressure increases the higher the temperature.

Commercial sterility: Preserving foods using minimum amount of heat necessary to kill spoilage and pathogenic microorganisms. Also include heating foods at high temperature for a short time e.g. ultra heat treatment.

All commercially sterile foods should be stored in cool, dry, place to prevent any viable thermophilic spores from germinating and cause, spoilage to the foods.

Ultra Heat Treatment: Treatment of milk by heating at 150°C by steam injection followed by 'flash evaporation' of the condensed steam and rapid coding.

Differences between pasteurization and sterilisation

	Pasteurisation	Sterilisation
Function	Partial destruction of microorganisms	Complete destruction of microorganisms
Temperature	Temperature below 100°C	Temperature 100°C and above
Advantage	Minimal damage to flavor, texture, and nutritional quality	Long shelf life. No other preservation method is necessary
Disadvantage	Short shelf life. Another preservation method must be used, such as refrigeration or freezing	Food is overcooked. Major changes in texture, flavor, and nutritional quality

4)Blanching

Briefly scald food to inactivate enzymes that cause undesirable changes.

Advantages of blanching

– Improves taste

– Increases availability of out of season foods

Disadvantages

– Storage limits

  - Fruits & veggies 1 year
  - Meat 3-6 months
  - Freezing temperatures required for storage

5) Canning

Canning (also known as hermetically sealed containers) is done in tin cans, glass containers, and aluminium and plastic pouches.

Canning process

Raw food harvested

↓

Prepare, inspect, sorting, grading

↓

Washing

↓

Filled in the can

↓

Brine added

↓

Evacuated by heating the headspace (vacuuming)

↓

Sealing

↓

Heat processing

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 i.e., 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. Examples are pickles, jams, marmalades, squashes
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.
3. Food derivatives: In 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. hydrogenation.

4. Functional foods: These are foods that can have a beneficial effect on human health, e.g., probiotics, lycopene.
5. Therapeutic foods: These are used in dietary management of diseases, for example, low sodium salt, lactose–free milk for persons with lactose intolerance.

Objectives of thermal processing

a) To destroy pathogens and spoilage microorganisms

b) To destroy toxin present in foods

c) To destroy the vegetative cells and spores of yeast, bacteria and moulds

d) To destroy undesirable enzymes this can affect the quality of foods.

e) To control the growth of surviving microorganisms

f) To retain the acceptance and nutritional quality of foods

g) To reduce competition

Advantages of canning

– Increases shelf life

– Two years is considered normal shelf life

Disadvantages of canning

– Weight of product

– Requires specially treated metal cans or appropriate glass jars.

B. Temperature reduction during storage

Low temperature can lower the rate of chemical reactions and the action of enzymes. Generally, freezing can prevent the growth of most food-borne micro-organisms and the usual temperature for cold storage is 4.5-7°C.

The food industry uses a number of low temperature methods to achieve preservation of the perishable foods:

Method	Temperature range
Refrigeration	4°C to 7°C
Chilling	-2°C to 2°C
Freezing	Below 18°C

Refrigeration temperature lowers the growth rate of micro-organisms and chilling can slow down the enzymatic and microbial changes in food. For frozen food, it should be stored at or below -18℃ where the enzymatic and microbial changes may be stopped or extremely slow. To extend storage life, products such as butter, cheese, and canned goods are stored in cooled warehouses.

Psychrophiles and psychrotophs are problematic when it comes to effects of low temperature. The minimum temperature at which an organism has been found to grow is -34°C (a yeast species). Growth at freezer temperatures if it occurs is extremely slow.

Effects of freezing on microorganisms

Freezing of foods can cause initial mortality immediately on freezing and depends on the species. Surviving cells die off gradually, and the rate of death is quickest at temperatures just below freezing point, with the slowest at below -20°C. All cells rarely die off. Defrosting foods must be treated as fresh products as regards microbiological activity. Endospores and toxins are not affected by low temperatures. All frozen foods should be defrosted at 4°C to reduce or prevent microbial growth. The rate of thawing also affects microbial cells – the faster they thaw, the greater the number of survivors. Repeating freezing and thawing disrupts both the food and microbial cells. It may be a hazardous procedure if sufficient time is given for growth or survivors.

C. Dehydration

This is also known as drying. The typical methods employed include sun drying, mechanical drying and freeze-drying. Certain food preparation methods of foods may have some antimicrobial effect, e.g. blanching, addition of preservatives, cooking, fat removal and addition of sugar or other solutes. The moisture contents of dried foods vary from 2% to 50%; Intermediate moisture foods from 20% to 50% or aw =0.60- 0.85. Foods are preserved by drying for a long history, especially in Chinese foods. Mushrooms, dried shrimps and salted fish are some typical examples. Both the terms “drying” and “dehydration” mean the removal of water. “Drying” usually describes the process of drying under sunshine or open air. The other term, dehydration, usually describes the removal of moisture by applying artificial heat current under controlled conditions.

The drying process per se does not kill microorganisms. Some may be killed but most may be recovered from dried foods if present prior to drying. Most bacteria and yeasts require aw > 0.90 to grow. Dried foods are not usually susceptible to spoilage. S. aureus is the most xerotolerant of the pathogens, i.e. grows in aw of 0.86. Rehydration (i.e. the addition of water or adding to other wet ingredients) enables microorganisms present to re-commence growth.

Freeze-drying has the least destructive effect on microorganisms and depends on the age of the cells. Reduction of water activity and subsequent antimicrobial effects also occur on addition of sugar or salt, but other inhibitory factors are also involved, e.g. high chlorine levels. All microbial cells require water to grow but not to survive.

Differences between dehydration and sun-drying

Sun-drying	Dehydration
Process is slow	Process is faster
Performed under open-air conditions with little hygienic control	Carried out under controlled hygienic conditions
Difficult in cloudy weather or rainy days	Does not depend on the weather
Cost-effective as no machinery and processing cost is needed	Investment on machinery and processing cost is required

Advantages of dehydration

– Increases shelf life up to 2 years

– Lighter weight

– Lower volume

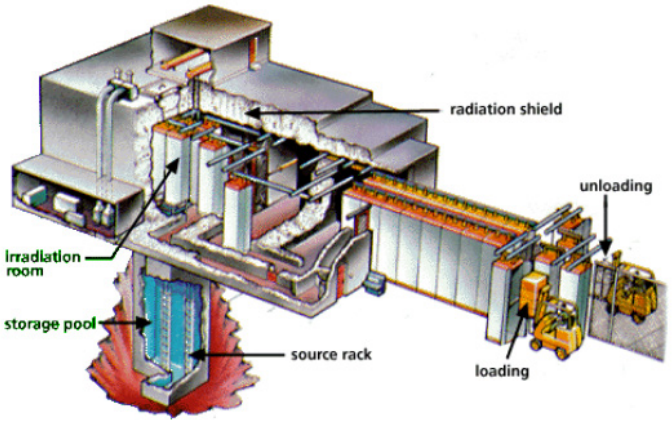
Disadvantages of dehydration

– Changes taste and texture of food

– Typically requires preparation to reconstitute food.

D. Food irradiation

Food absorbs and is heated up by radiant energies. Radiant energies can kill microorganisms without marked increase of temperature as well as marked changes in the nature of food. The type of radiation of primary interest in food preservation is electromagnetic. Shorter wavelengths are most damaging to microorganisms.



Food Irradiation Plant

The electromagnetic spectrum is divided into:

- Microwaves
- Ultraviolet rays
- X rays
- Gamma rays

Ionizing radiations have short wavelengths hence used in food preservation e.g. gamma rays, X rays, beta rays etc.

Gamma rays is the cheapest form of radiation for food preservation. X-rays essentially has the same character like gamma rays but produced differently.

Gamma rays possess the following properties;

- Electromagnetic radiations emitted from the excited nucleus of elements
- Cheapest form of radiation for food preservation
- Sources elements are either by-products of atomic fission or atomic waste products
- Have excellent penetration power

Ultraviolet (UV) radiation does not penetrate foods and is therefore used for surfaces of food-handling equipment.

UV light has the following characteristics;

- Powerful bactericidal agent
- Nonionizing
- Absorbed by proteins and nucleic acids, in which photochemical changes are produced that may lead to cell death (of bacteria as they produce mutations).
- Poor penetrative capacities
- May catalyze oxidative changes that lead to rancidity, discolorations, etc.
- May produce ozone when used for surface treatment of food

UV light can be used to decontaminate;

- Air (most efficient use)
- Liquids in films, e.g. water (long exposure time, expensive, complex)
- Surfaces (long exposure time, limited use)
- Packaging where heat is inappropriate, material must be transparent to UV or pack must be open
- Solid foods in very thin layers, e.g. sugar

Beta rays are a stream of electrons emitted from radioactive substances

- Cathode rays emitted from cathode of evacuated tube

X Rays: this is produced by the bombardment of heavy metal targets with high-velocity electrons within an evacuated tubes. It is essentially similar to gamma rays

Microwaves: When electrically neutral food is placed in an electromagnetic field, the charged asymmetric molecules are driven first one way and then another. Each asymmetric molecule tries to align itself with the rapidly changing alternating-current field. As the molecules oscillated about the axes while attempting to go to the proper positive and negative poles, intermolecular friction is created and manifested as a heating effect. This is microwave energy

Principles underlying the destruction of microorganisms by irradiation

1. Type of organisms: gram+ more resistant than gram-
2. Numbers of organisms: the larger the number of cells, the less effective is a given dose
3. Composition of suspending menstrum (food): those in protein rich food are more resistant
4. Presence or absence of oxygen: radiation resistance is greater in the absence of oxygen than in its presence
5. Physical state of food: resistance of dried cells higher than the moist ones
6. Age of organisms: resistance of bacteria high at lag phase, just prior to active cell division

Processing of foods for irradiation

The following steps are done prior to exposing food to ionizing radiations

- Selection of foods- for freshness and quality
- Cleaning of foods- remove debrils and dirt to ensure reduced number of microorganisms to be targeted.
- Packing: pack in containers to prevent against post-irradiation contamination
- Blanching/heat treatment: to destroy natural food enzymes which may cause undesirable post irradiation changes.

Factors affecting food irradiation

i) Types and species of microbes-Spores are generally radio resistant

ii) Number of microbes -The more cell present, the less effective a given dose of radiation

iii) Composition of medium- Cells in protein medium are more resistant

iv) Protein exerts protective effect against radiation

v) Presence or absence of oxygen -Resistance is reportedly increase when oxygen is absent

vi) Physical state of food -Dried cells are more resistant than moist cells

vii) Age of cells -Cells in lag phase are more resistant than in other phase

Advantages and disadvantages of irradiation

Advantages

i) there is little or no heating of the food and therefore negligible change to sensory characteristics

ii) heat sensitive nutrients are preserved/are not destroyed

iii) packaged and frozen foods may be treated

iv) fresh foods may be preserved in a single operation, and without the use of chemical preservatives

v) energy requirements are very low

vi) changes in nutritional value of foods are comparable with other methods of food preservation

vii) processing is automatically controlled and has low operating costs.

Disadvantages

i) the process could be used to eliminate high bacterial loads to make otherwise unacceptable foods saleable

ii) if spoilage micro-organisms are destroyed but pathogenic bacteria are not, consumers will have no indication of the unwholesomeness of a food

iii) there will be a health hazard if toxin-producing bacteria are destroyed after they have contaminated the food with toxins

iv) the possible development of resistance to radiation in micro-organisms

v) loss of nutritional value

vi) High cost

vii) inadequate analytical procedures for detecting whether foods have been irradiated

viii) public resistance due to fears of induced radioactivity or other reasons connected to concerns over the nuclear industry.

Application of irradiation

Irradiation can be used in a wide range of area in food preservation:

(i) Poultry products and seafood

(ii) Fruits

(iii) Prevention of sprouting in potatoes and onions

(iv) Delaying ripening in fruits

(v) Preservation of seafood

(vi) Prevention of insect infestation in dry foods and food products

E. Reduction of pH

To reduce the pH of a food, acids like vinegar or citric acid are used. Acids lower the pH and thus inhibit the growth of many micro-organisms. It is more effective against yeast and bacteria than moulds. About 20% vinegar (acetic acid) prevents the spoilage of most products. It is used in the preservation of pickles, sauces and chutney. Another acid, citric acid, is also used in the preservation of certain fruits and vegetables. Products of jams, jellies and squashes may contain citric acid. It lowers the pH of the food products and can prevent the growth of moulds.

Examples of acidulants used during food processing

Acid	Role(s)
Acetic	Provides flavour, decreases pH Sodium acetate is salt form present in vinegar
Benzoic	As sodium benzoate, effective antimicrobial agent Occurs naturally in cranberries
Citric	Provides flavour, decreases pH, acts as chelating and sequestering agent Occurs naturally in citrus fruits
Lactic	Provides tartness
Malic	Provides flavour Occurs naturally in apples
Phosphoric	Provides flavour and tartness in beverages Enhances juiciness in meats (as phosphate)
Propionic	As calcium propionate, effective antimicrobial agent Produced in some cheeses
Tartaric	Present in baking powder as potassium tartrate salt Occurs naturally in grapes

F. Protective packaging

This is also known as asepsis which is the absence of microorganisms. Packaging is valuable to food preservation operations because it aids in lengthening the life of food. Packaging helps maintain during storage the quality and properties of foods attained via processing. The packaging protects the food material from microbiological contaminants and other environmental factors. The package also helps prevents light-induced changes in stored food products and minimizes loss of moisture. Depending upon the intensity of lethal treatments (heat, pressure, radiation dose), processing not only affects the food material but also alters the (moisture and oxygen) barrier properties of packaging materials and possibly induces migration of polymer material into the food. Thus, careful choice of food packaging material is essential for successful food process operation. Preservation of foods in sealed containers followed by application of heat

treatment. How a food is packaged also influences its shelf-life. It is also important that foods are handled properly by the consumer at home. − Check "Use By" or expiration dates. − Follow storage or preparation instructions.

Effects on nutrition properties of food

All forms of processing reduce the levels of vitamin and minerals in the foods, but some have a greater effect than others.

Vitamins are the most sensitive food components and it is these that are often lost during food processing. Minerals are less sensitive and not as badly affected by processing.

Food processes that involve heating for a long time (such as boiling to concentrate sauces, jams and chutneys) lead to high losses of the vitamins.

Direct exposure to direct sunlight during the drying process may lead to destruction of vitamin A and C in fruits and vegetables.

Effect of different types of processing in vitamin content

Form of food processing	Effect on vitamin Content
Heating for a long-time (e.g. boiling)	High vitamin loss
Blanching	Medium vitamin loss
Drying	Low loss of vitamins if not exposed to sunlight
Fermentation	Minimal loss of vitamins

Traditional methods of food processing and preservation

Drying

Drying is a very widespread method of food preservation and it involves reduction of the amount of free water in the food. Dried foods have fairly long shelf life but drying should be supplemented by other methods of preservation. Appropriate drying is applied in the drying process, the nutritional quality, colour, flavour and texture of rehydrated foods are only insignificantly less than fresh food.

The stability of a dried food during storage depends on its moisture content and the ease with which the food can pick up moisture from the air. The risk of moisture pick up is greater in regions of high humidity. Dried foods must be stored in moisture-proof packaging to prevent them absorbing water from the surrounding air.

Drying has three main purposes:

- to prevent or inhibit microorganisms and spoilage enzymes
- increase shelf-life
- to reduce the weight of food for cheaper and more convenient transport and storage

Factors that affect the rate of drying

- Temperature - of the outside air and inside the dryer
- Humidity of air
- Speed of air flow throughout the dryer
- Type of fruit or vegetable (the amount of water to be lost and the level of sugars in the fruit)
- Size of the fruit or vegetable pieces
- Loading rate of the dryer (the amount of fruit/vegetable per

The basics of drying

Drying involves removing water from the food product into the surrounding air. For effective drying, air should be hot, dry and moving. These factors are interrelated and it is important that each factor is correct: - air must be dry, so it can absorb the moisture from the fruits and vegetables - heating the air around the product causes it to dry more quickly - if the air is not moving across the food, it cannot get rid of the water vapour that it has collected. A fan or air blower is needed to keep the air circulating. In summary - when food is dried, hot dry air comes into contact with the food. The hot air absorbs water from the food and is moved away from the food. New dry air takes its place and the process continues until the food has lost all its water.

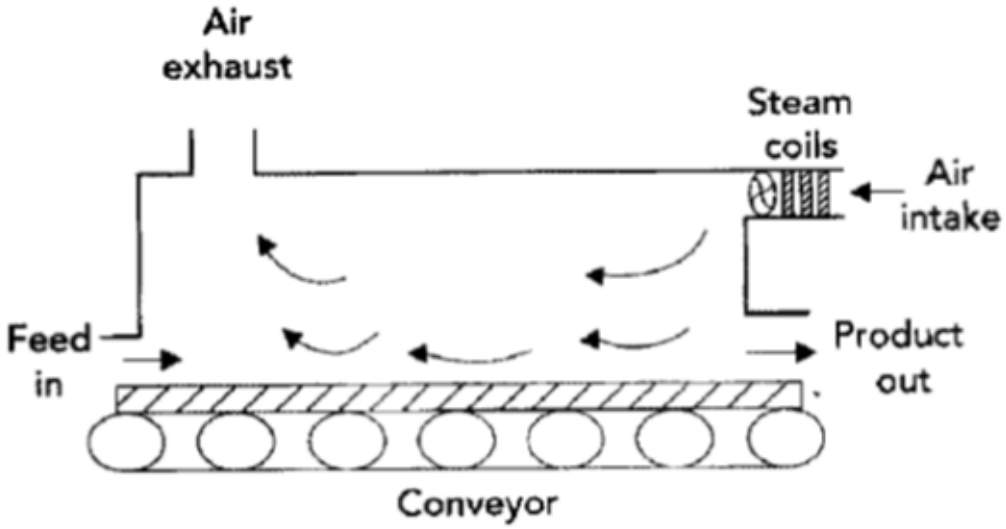
Factors affecting drying

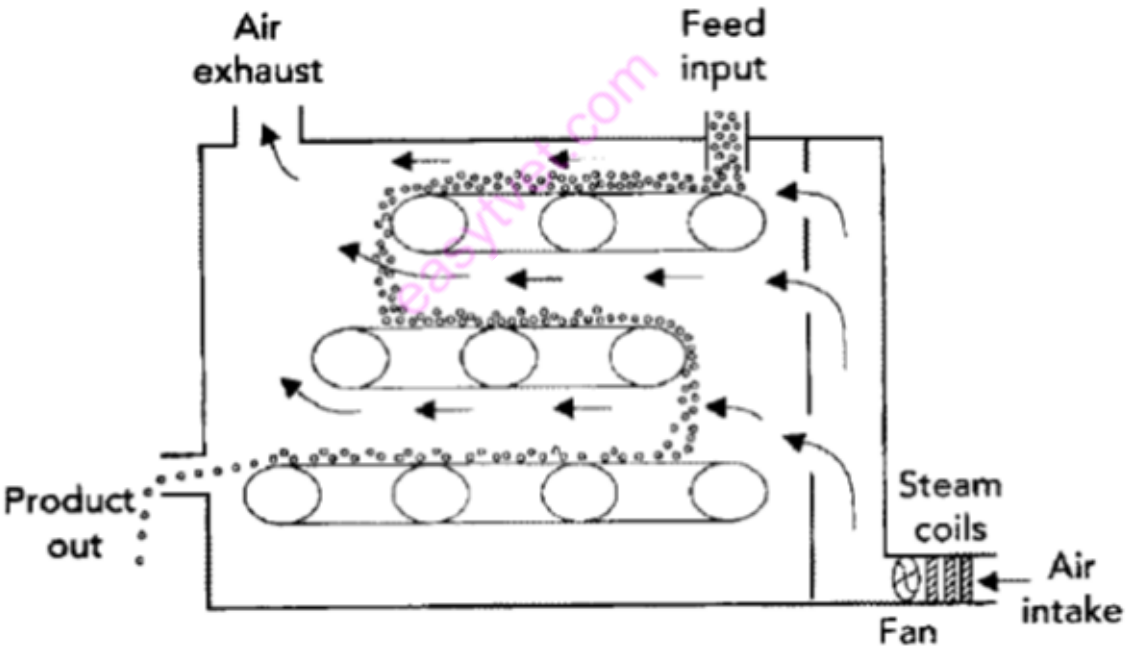
- The composition and structure of the food has an influence on the mechanism of moisture removal. For example, the orientation of fibres in vegetables (e.g. celery) and protein strands in meat allow more rapid moisture movement along their length than across the structure.
- The amount of food placed into a drier in relation to its capacity (in a given drier, faster drying is achieved with smaller quantities of food).

Types of driers

1) Hort-air driers
    a. Bin driers: Bin driers are large, cylindrical or rectangular containers fitted with a mesh base. Hot air passes up through a bed of food at relatively low velocities
    b. Cabinet driers (tray driers): These consist of an insulated cabinet fitted with shallow mesh or perforated trays, each of which contains a thin (2–6 cm deep) layer of food. Hot air is blown at 0.5–5ms1 through a system of ducts and baffles to promote uniform air distribution over and/or through each tray.
2) Tunnel driers: Layers of food are dried on trays, which are stacked on trucks programmed to move semi continuously through an insulated tunnel, having one or more types of air flow

3) Conveyor driers (belt driers): Continuous conveyor driers are up to 20m long and 3m wide. Food is dried on a mesh belt in beds 5–15 cm deep. The air flow is initially directed upwards through the bed of food and then downwards in later stages to prevent dried food from blowing out of the bed.





4) Fluidized-bed driers

Drying effect on foods

- All products undergo changes during drying and storage that reduce their quality compared to the fresh material and the aim of improved drying technologies is to minimize these changes while maximizing process efficiency.

•The main changes to dried foods are to the texture and loss of flavor or aroma, but changes in color and nutritional value are also significant in some foods.

Effect of drying food on its nutritional value

Large differences in reported data on the nutritional value of dried foods are due to wide variations in the preparation procedures, the drying temperature and time, and the storage conditions. In fruits and vegetables, losses during preparation usually exceed those caused by the drying operation

Vitamins have different solubilities in water and as drying proceeds, some (for example riboflavin) become supersaturated and precipitate from solution, so losses are small.

Others, for example ascorbic acid, are soluble until the moisture content of the food falls to very low levels and these react with solutes at higher rates as drying proceeds. Vitamin C is also sensitive to heat and oxidation and short drying times, low temperatures, low moisture and oxygen levels during storage are therefore necessary to avoid large losses.

Fermentation

Fermentation is the process in which chemical changes are brought about in an organic substrate through the action of enzymes elaborated by microorganisms. Any partial breakdown of carbohydrates taking place in the absence of oxygen.

It is a metabolic process that converts sugar to acids, gases or alcohol. Biochemically, fermentation is the metabolic process in which carbohydrates and related compounds are partially oxidized with the release of energy in the absence of any external electron acceptors.

Fermentation usually implies that the action of microorganisms is desirable, and the process is used to produce alcoholic beverages such as wine, beer and cider. Fermentation is also employed in the leavening of bread, and for preservation techniques to create lactic acid in sour foods such as sauerkraut, dry sausages, kimchi and yogurt, or vinegar (acetic acid) for use in pickling foods

Importance of fermentation

a) Cholesterol synthesis inhaling

b) Anticancer effects

c) Decreases cooking time hence saves energy

d) Prevention of infections

e) Increased shelf life

f) Adds microbes to the gut

g) Improves flavor of food

h) Eliminates antinutrients

i) Increases micronutrients in food e.g. vit B

j) Make food more digestible e. g in Lactose intolerance

k) Produces carbon dioxide e.g. in bread, beer, champagne

l) Reduced toxicity from some foods e.g. fermentation of cassava to make gari

Products for fermentation

- Dairy products: cheese, kefir, kumis and cultured milk products such as yoghurt
- Meat-based products: Chorizo, Salami, pepperoni
- Fish-based products: Fish sauce, shrimp paste, garum, rakfi
- Non beverage plant products
- Beverages and related products
- Grain-based products: beer, bread, rice wine, malt whisky, grain whisky
- Tea-based: Kombucha
- Fruit-based: wine, vinegar, cider, perry
- Bean-based products: soy sauce, stinky tofu, soybean paste
- Vegetable-based: kimchi and pickles

Examples of processed foods

Processed cheese

Processed cheese, process cheese, cheese slice, prepared cheese, or cheese food is a food product made from normal cheese and sometimes other unfermented dairy ingredients, plus emulsifiers, extra salt, food colourings or whey Many flavours, colours, and textures of processed cheese exist. Although processed cheese was first invented in 1911 by Walter Gerber of Thun, Switzerland, it was James L. Kraft who first applied for an American patent for his method in 1916.

Advantages:

Processed cheese has several technical advantages over unprocessed cheese, including;

- Extended shelf-life
- Resistance to separation when cooked
- Uniformity of product.

The use of emulsifiers in processed cheese results in cheese that melts smoothly when cooked. Disadvantages:

Processed cheese is often criticized for its possible health effects (associated with chemical preservatives, artificial colours/flavours, and trans-fats), inferior taste, and small range of flavors, which is far narrower than the range for unprocessed cheeses and normally very mild.

Yoghurt

Yogurt is a dairy product produced by bacterial fermentation of milk. The bacteria used to make yoghurt are known as “yoghurt cultures”. Fermentation of lactose by these bacteria produces lactic acid, which acts on milk protein to give yoghurt its texture and its characteristic tang. Dairy yoghurt is produced using a culture of Lactobacillus delbrueckii subsp. bulgaricus and

Streptococcus salivarius subsp. thermophilus bacteria. In addition, Lactobacillus acidophilus, bifidobacteria and Lactobacillus casei are also sometimes added during or after culturing yoghurt. The milk is first heated to about 80 °C (176 °F) to kill any undesirable bacteria and to denature the milk proteins so that they set together rather than form curds. The milk is then cooled to about 45 °C (112 °F). The bacteria culture is added, and the temperature is maintained for 4 to 7 hours to allow fermentation.

Health benefits of fermented milks

a) Benefits to lactose-intolerant individuals

b) They lower serum cholesterol, and

c) Possess an anticancer activity.

- Probiotics
- Probiotics refers to the consumption of products that contain live organisms that are or are believed to be beneficial to the consumer. The objective here is the ingestion of the organisms, and they consist generally of various lactic acid bacteria and/or bifidobacteria.

Advantages of fermentation

– Improves taste

– Adds value to crops, such as cucumber

Disadvantages of fermentation

- It is a lengthy process in comparison to other food processing techniques.

Smoking

The addition of smoke and heat to preserve food by the action of the chemicals from the smoked wood and the partial drying of the food.

Salting

Salting or curing draws moisture from the meat through a process of osmosis. Meat is cured with salt or sugar, or a combination of the two. Nitrates and nitrites are also often used to cure meat and contribute the characteristic pink colour, as well as inhibition of Clostridium botulinum.

Sugar

Sugar is used to preserve fruits, either in syrup with fruit such as apples, pears, peaches, apricots, plums or in crystallized form where the preserved material is cooked in sugar to the point of crystallisation and the resultant product is then stored dry. This method is used for the skins of citrus fruit (candied peel), angelica and ginger.

A modification of this process produces glacé fruit such as glacé cherries where the fruit is preserved in sugar but is then extracted from the syrup and sold, the preservation being maintained by the sugar content of the fruit and the superficial coating of syrup

5.3.3.3 Self-Assessment

1. Define the following terms;
   A. Pasteurization
   B. Canning
   C. Irradiation
2. The conversion of raw materials to food commodities is known as _____
   A. Food processing
   B. Food preservation
   C. Secondary processing
   D. Primary processing
3. _____ is the conversion of agricultural product to substances which have particular textural, sensory and nutritional properties using commercially feasible methods.
   A. Food processing
   B. Food preservation
   C. Secondary processing
   D. Primary processing
4. _____ is mainly used on surfaces of food handling equipment as does not penetrate foods
   A. Ultraviolet radiation
   B. Gamma rays
   C. Beta rays
   D. X-rays
5. The following factors affect food irradiation (indicate true/false for each point)
   A. Types and species of microbes
   B. Number of microbes
   C. Composition of medium
   D. None of the above

6. Aseptic techniques involve;
   A. Removal of microorganisms
   B. Hindering the growth and activity of microorganisms
   C. Keeping out microorganisms
   D. Killing the microorganisms
7. Vinegar can be used to preserve the following except
   A. Squashes
   B. Pickles
   C. Chutney
   D. Sauces
8. Direct exposure to direct sunlight during the drying process may lead to
   A. Destruction of vitamin a and c in fruits and vegetables.
   B. Improvement of vitamin d content of the food
   C. Burning effect
   D. Loss of the original color and taste
9. Explain the two forms of food processing
10. Discuss the principles of food preservation
11. Explain the canning process
12. Discuss the principles underlying the destruction of microorganisms by irradiation
13. Discuss the importance of fermentation

5.3.3.4 Tools, Equipment, Supplies and Materials

HACCP manual

Textbooks

LCDs, video clips, charts and other teaching aids

Invitation of competent expertise

Computers with internet

Library and resource centre

Stationery

Food processing plant

Equipped laboratory

Food samples

Reagents

5.3.3.5 References

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5.3.4 Learning outcome 3: Demonstrate knowledge in food quality, safety and hygiene

5.3.4.1 Learning Activities

Learning activity	Special instructions
Demonstrate understanding of quality control of food and food safety during processing	Define common terms in food quality, safety and hygiene Identify the safety risk present for each food Identify foods that are at greatest risk of contamination Determine the most important qualities to control
Apply HACCP principles in food processing and preservation	Demonstrate competency in design and development of a HACCP workbook Competently fill in the HACCP workbook of a food processing plant
Identify foodborne illnesses	Identify and describe common food infections Demonstrate knowledge on the microorganisms responsible for foodborne illnesses and their prevention Classify the foodborne illnesses based on the causative agents (viral, bacterial, fungal etc) Demonstrate competency in preventing and managing foodborne illnesses
iIdentify and describe food hygiene	• Demonstrate ability to maintain sanitation • Demonstrate competency to work in a hygienic manner • Observe food, personal and kitchen hygiene during food processing
Identify and describe principles in food processing and preservation as per resource materials	Observe some of the critical activities during food processing and preservation

5.3.4.2 Information Sheet

Definitions

- Control point: Any point in a specific food system where loss of control does not lead to an unacceptable health risk
- Critical control point (CCP): Any point or procedure in a food system where control can be exercised and a hazard can be minimized or prevented
- HACCP plan: The written document that delineates the formal procedures to be followed in accordance with these general principles
- Hazard: Any biological, chemical, or physical property that may cause an unacceptable consumer health risk (unacceptable contamination, toxin levels, growth, and/or survival of undesirable organisms)
- HACCP (Hazard Analysis Critical Control Point) – A food safety system designed to keep food safe throughout its flow in an establishment.
- Hazard Analysis – The process of identifying and evaluating potential hazards associated with food in order to determine what must be done.
- Critical Limit – A set range (minimum and maximum) limit a CCP must meet in order to prevent, eliminate, or reduce the hazard to an acceptable limit.
- Monitoring – The process of analyzing whether your critical limit are
- Foodborne illness: an infection or irritation of the grastrointestinal tract caused by foods or beverages that contain harmful bacteria, parasites, viruses or chemicals.

Quality control of food and food safety during processing; from farm to fork

It is imperative for a food processor to determine what safety risk is present for each food which can be classified as follows;

a) Pathogenic microorganisms: bacteria and viruses

b) Spoilage microorganisms: fungi and bacteria

The most important qualities to control include;

i) pH

- Bacteria thrive in a pH neutral environment
- Items with pH above 8 tend to be very bitter and toxic
- Foods with pH below 6 tend to be tart or sour

ii) Temperature

- The temperature danger zone is 40-140°F; there is rapid multiplication of microorganisms
- At temperature <40°F there is very slow growth
- At temperature <28°F there is neither growth nor death

- At temperature >140°F, death of microorganisms is observed

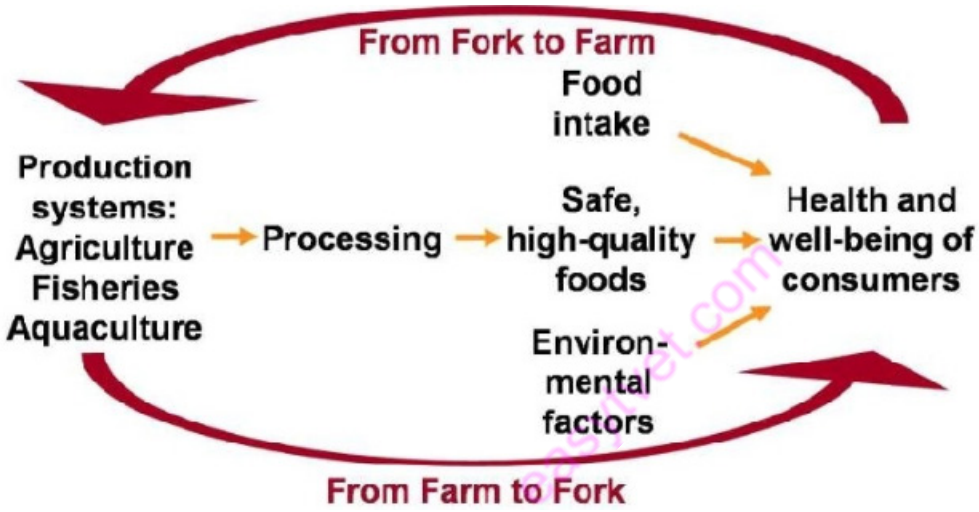
iii) Moisture content

- Bacteria need a high moisture content hence disease causing bacteria will be absent in dry foods.
- Fungi can grow in lower moisture hence causing spoilage

iv) Protein content

- Bacteria need protein but fungi rarely requires it hence most carbohydrates do not have disease causing bacteria although they may undergo spoilage

Food safety and quality are the primary aspects of food production, processing, and consumption. Decent quality and safety protocol are necessary to prevent the entire food chain from the farmers who grow it to the consumers from compromise.



If food safety lapses, this can lead to the contamination of food and people would be exposed to severe health risks.

Food quality has to do more with the taste colour, texture and nutritional value of the food we eat, and it takes professionals to come up with a standard for the food quality. Some manufacturers use panels or people such as tea tasters to monitor food quality. Over the recent years, new technological advancements allow for better enhancement of food quality.

The following are some of the approaches to safety and quality in food processing;

Facility Location And Design

To ensure food safety and quality, design and location of a food processing facility need to be taken into account. The facilities should have a firm plan, and the materials used for the internal structure should be durable, easy to clean and maintain and prevent a buildup of dirt. Also, the facility should be worker-friendly, this means that it should be safe for the staff work. Location is crucial since you want to be located near clean water to clean the firm, windy areas might not be suitable for a food manufacturer since wind brings a lot of dust in the facility.

Pest Control

Pest control plays a crucial role in food safety. Cockroaches and flies are among the troublesome insects which can help spread disease and eventually lead to the development of food-borne illnesses. Stored product insects are also destructive as they can damage and contaminate food during transport and storage. Other pests that cause damage are rodents such as rats, and these can destroy the building fixtures and machinery as well as spreading deadly diseases.

The best way to take care of the pest problem is to Investing in a pest control monitoring and detection system. This system will help prevent pests from entering a food processing facility, and assist in the compliance of food safety guidelines.

Waste Management

An appropriate waste removal and storage procedure should be provided, and this is purposefully to ensure that proper food safety practices are followed. Waste management is a crucial factor in food processing since any contact to of waste to the food could lead to contamination or significant callbacks. The waste disposal should be managed following set regulations to prevent accumulation, the risk of contamination and the attraction of pests.

Machinery and Production Line Design

A facility's production line should have a layout that allows easy maintenance and cleaning of machinery and surrounds. The plan should also be able to prevent contamination of the food products and ingredients during the production process.

The food processing machines should have a design that complies with food safety regulations. The regulations are aimed to avoid poor designs. Sometimes poor designs can lead to food materials building up in hidden places which are difficult to clean making rot and contamination inevitable. There are set standards for machinery design so that each machine performs at a high standard of hygiene.

There are principles which assist when coming up with a design for processing machinery. These principles are used to address the issue of poor design and come up with one that meets all standards, and they are as follows:

1. Cleanable to a microbiological level.
2. Made of compatible materials.
3. Accessible for inspection, maintenance, cleaning, and sanitation.
4. No product or liquid collection.
5. Hollow areas hermetically sealed.
6. No niches.
7. Sanitary operational performance.
8. Hygienic design of maintenance enclosures.
9. Hygienic compatibility with other plant systems.
10. Validate cleaning and sanitizing protocols.

Cleaning

Institute proper cleaning and disinfecting programs. A cleaning schedule will help ensure food safety complies. Also to prevent foodborne illnesses from breaking out, the correct hygiene standards should be met.

Microorganisms can cause food poisoning in the processing facility and the best way to avoid this is through the use of disinfectants. The food preparation areas should be properly disinfected, also utensils and machinery used within food processing cycle should be adequately cleaned as well. Microbes will not contaminate food products created if surfaces are always clean.

Keeping track with the correct cleaning schedule will also reduce the risk as well as preventing pests from coming into the facility and getting into contact with food.

Maintenance

To ensure the production of safe foods and that everything runs smoothly and correctly, a proactive maintenance measure for premises and food processing machinery should be established. Some researchers claim that failure to ensure equipment is properly maintained under the correct sanitary conditions has caused some foodborne illnesses outbreaks. Machines performances can be affected by pests such as rats and mice which gnaw at the power cables. They also contaminate components which have direct contact with the food products. This is why maintenance is crucial for the normal functioning of a food processing facility.

Personal Hygiene

Food safety requirements can be met by installing the correct facilities for staff to ensure proper personal hygiene is met. This will help reduce the spread of bacteria since they can quickly be spread through biological and physical contamination.

To reduce the risk of contamination staff should ensure they follow effective hand washing techniques, try to minimize direct hand contact with raw food. They should also ensure that they use gloves safely and dispose of them properly.

Staff Training

Staff should be educated on how to follow food safety practices, and this will help reduce the risk of food contamination in the processing zone. Regulations dictate that food handlers are supervised and trained in food handling practices suitable in their fields.

Food safety and quality is a global concern that affects the world's population. Ensuring safety and quality will lead to reduced food wastage, hunger and starvation in the world as well as providing quality foods to everyone's tables.

Principles of HACCP

Principle 1: conduct hazard analysis:

Assess the hazards and risks associated with the growing, harvesting, raw materials, ingredients, processing, manufacturing, distribution, marketing, preparation, and consumption of the food in question.

The process of conducting a hazard analysis involves two stages:

i) Hazard identification — During this "brainstorming session" stage, the HACCP team reviews the ingredients used in the product, the activities conducted at each step and the equipment used, the final product and its method of storage and distribution, and the intended use and consumers. Based on this review, the team develops a list of potential biological, chemical or physical hazards which may be introduced, increased or controlled at each step in the production process.

ii) Hazard evaluation — during this stage, the HACCP team evaluates the severity and likelihood of each potential hazard occurring and decides which ones must be addressed in the HACCP plan. (Such considerations do not include common dietary choices which lie outside of HACCP.)

After completing the hazard analysis, the hazards associated with each step in the production of the food should be listed along with any measures that are used to control the hazards. The term "control measure" is used because not all hazards can be prevented, but virtually all can be controlled.

Principle 2: Determine CCP(s):

A critical control point is defined as a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level. The potential hazards that are reasonably likely to cause illness or injury in the absence of their control must be addressed in determining CCPs. The principle seeks to minimize and/or to control the hazard. It focuses on;

- Heat process steps where time-temperature relations must be maintained to destroy given pathogens
- Freezing and time to freezing before pathogens can multiply
- The maintenance of pH of a food product at a level that prevents growth of pathogens
- Employee hygiene

One strategy to facilitate the identification of each CCP is the use of a CCP decision tree. (Keep in mind that a decision tree is merely a tool; it is not a mandatory element of HACCP, nor is it a substitute for expert knowledge).

Examples of CCPs may include:

- Chilling
- Thermal processing
- Product formulation control
- Testing ingredients for chemical residues
- Testing product for metal contaminants

CCPs must be carefully developed and documented. In addition, they must be used only for purposes of product safety. Different facilities preparing similar food items can differ in the hazards identified and the steps which are CCPs. This can be due to differences in each facility's layout, equipment, selection of ingredients, processes employed, etc.

Principle 3: Establish Critical Limits for each CCP identified

A critical limit is a maximum and/or minimum value to which a biological, chemical or physical parameter must be controlled at a CCP to prevent, eliminate or reduce to an acceptable level the occurrence of a food safety hazard. This could mean keeping refrigeration temperatures within a certain specific and narrow range or making sure that a certain minimum destructive temperature is achieved and maintained long enough to effect pathogen destruction. A critical limit is used to distinguish between safe and unsafe operating conditions at a CCP.

Each CCP will have one or more control measures to assure that the identified hazards are prevented, eliminated or reduced to acceptable levels. Each control measure has one or more associated critical limits.

Critical limits may be based upon factors such as:

- Temperature
- Time
- Physical dimensions
- Humidity
- Moisture level
- Water activity
- pH
- Titratable acidity
- Salt concentration
- Available chlorine
- Viscosity
- Preservatives
- Sensory information such as aroma and visual appearance

Critical limits must be scientifically based. For each CCP, there is at least one criterion for food safety that is to be met. The critical limits and criteria for food safety may be derived from sources such as regulatory standards and guidelines, literature surveys, experimental results and experts.

Principle 4: Establish Procedures to Monitor each CCP

The monitoring of a CCP involves the scheduled testing or observation of a CCP and its limits; monitoring results must be documented. If, for example, the temperature for a certain process step should not exceed 400C, a chart recorder may be installed.

Microbial analyses are not used to monitor since too much time is required to obtain results. Physical and chemical parameters such as time, pH, temperature, and water activity (^) can be quickly determined and results obtained immediately.

Monitoring serves three main purposes:

a. It facilitates tracking of the operation. If monitoring indicates that there is a trend towards loss of control, then action can be taken to bring the process back into control before a deviation from a critical limit occurs.

b. It is used to determine when there is loss of control and a deviation occurs at a CCP (i.e., exceeding or not meeting a critical limit). When a deviation occurs, an appropriate corrective action must be taken.

c. It provides written documentation for use in verification.

When it is not possible to monitor a CCP on a continuous basis, it is necessary to establish a monitoring frequency and procedure that will be reliable enough to indicate that the CCP is under control, such as statistically designed data collection or sampling systems.

Principle 5: Establish Corrective Actions

Corrective actions to be taken when deviations occur in CCP monitoring should be established. This because there is no system which is perfect and when preventative measures fail, corrective actions must come into play so as to prevent potential hazards from reaching the consumers.

- The actions taken must eliminate the hazard that was created by deviation from the plan. If a product is involved that may be unsafe as a result of the deviation, it must be removed.
- Although the actions taken may vary widely, in general they must be shown to bring the CCP under control.

Corrective actions should:

- Determine and correct the cause of non-compliance
- Determine the disposition of non-compliant product
- Record the corrective actions that have been taken

Principle 6: Establish Procedures for Verification

Verification refers to the activities, other than monitoring, that influence the validity of the HACCP plan and also confirms that the processes are being implemented as per the plan.

Establish procedures for verification that the HACCP system is working correctly.

Verification consists of methods, procedures, and tests used to determine that the system is in compliance with the plan. An effective HACCP system requires little end-product testing, since sufficient validated safeguards are built in early in the process. Therefore, rather than relying on end-product testing, firms should rely on frequent reviews of their HACCP plan, verification that the HACCP plan is being correctly followed, and review of CCP monitoring and corrective action records.

Verification confirms that all hazards were identified in the HACCP plan when it was developed, and verification measures may include compliance with a set of established microbiological criteria when established.

The following information is needed to validate a HACCP plan:

i) Scientific studies

ii) Expert advice

iii) In-plant observations, measurements and evaluations

Principle 7: Establish Effective Recordkeeping Systems

An effective recordkeeping systems should be established to document the HACCP plan. The HACCP plan must be on file at the food establishment and must be made available to official inspectors upon request. Forms for recording and documenting the system may be developed, or standard forms may be used with necessary modifications.

Typically, these may be forms that are completed on a regular basis and filed away. The forms should provide documentation for all ingredients, processing steps, packaging, storage, and distribution.

Generally, the records maintained for the HACCP System should include the following:

1. A summary of the hazard analysis, including the rationale for determining hazards and control measures

2. The HACCP Plan

- Listing of the HACCP team and assigned responsibilities
- Description of the food, its distribution, intended use and consumer
- Verified flow diagram
- HACCP Plan Summary Table that includes information for:
    - Steps in the process that are CCPs
    - The hazard(s) of concern
    - Critical limits
    - Monitoring
    - Correction actions

- o Verification procedures and schedule
- o Record-keeping procedures

Developing HACCP plan

Step 1: Assembling the HACCP team

The team should be made up of individuals, from engineering, production, quality assurance, food microbiology & sanitation departments, who have specific knowledge and expertise about the product and process. External experts can also be added into the team so as to help weigh in on potential chemical, biological and/or physical hazards.

Step 2: Description of the product

It is the responsibility of the HACCP team to provide the general description of the food, ingredients used and processing methods followed. They should also determine the method of distributing the product and the state of food during circulation e.g. refrigerated, frozen or at ambient temperature

Step 3: Identification of the product's customer and intended use

The targeted users of the product may be the general public or specific population group e.g the infants, geriatrics, pregnant and lactating mothers etc

Step 4: construction of flow diagram describing the production process

All the steps involved should be stated in clarity and simplicity. The diagram can be a block-type design — it should does not need to be as complex as engineering drawings. Also, including a simple schematic of the facility can be useful for understanding product and process flow.

Step 5: On-site confirmation of flow diagram

The HACCP team should perform an on-site review of the operation to verify the accuracy and completeness of the flow diagram, and modifications should be made to the diagram as needed. After these first five preliminary tasks have been completed, the following seven principles of HACCP are applied.

The next steps will then be the seven principles of HACCP in their correct order.

Implementation and management of HACCP plan

The commitment of the management is very critical to the successful implementation of a HACCP plan. A plan describing the individuals' roles and responsibilities for developing, implementing and maintaining HACCP system should also play a key role in the implementation of a HACCP system. Once this is in place, the individuals involved should

be well trained on the implementation so they understand what is expected of each one of them.

Maintaining an effective HACCP system depends largely on regularly scheduled verification activities. The HACCP plan should be updated and revised as needed.

Download a sample HACCP manual here

https://myhaccp.food.gov.uk/help/guidance/resources

Food borne illnesses

Food borne illnesses are also known as food poisoning

There are 3 main Causes of Food Borne Illnesses:

1. Cross-Contamination
2. Time-Temperature Abuse
3. Poor Personal Hygiene

1. Cross contamination

Cross contamination occurs when microorganisms are transferred from one surface or food to another. The microorganism can transfer from:

Hand to food: When food is contaminated during handling; preparation, storage, service. It occurs mostly because of poor food handling practices such as not washing hands.

When to wash hands

When to wash hands

Before:

- Beginning food preparation
- Putting on disposable gloves
- Serving customers
- Handling a baby

After:

- Arriving at work and after break
- Using the restroom, washing sinks
- Eating, drinking, smoking, chewing tobacco and gums
- Using the telephone
- Using handkerchief or tissue
- Using handkerchief or tissue
- Handling inventory
- Handling raw foods
- Touching or scratching a part of the body
- Coughing, sneezing

- Handling garbage
- Touching dirty surfaces

Food to food: When harmful organisms from one food contaminate other foods

Preventing food to food contamination

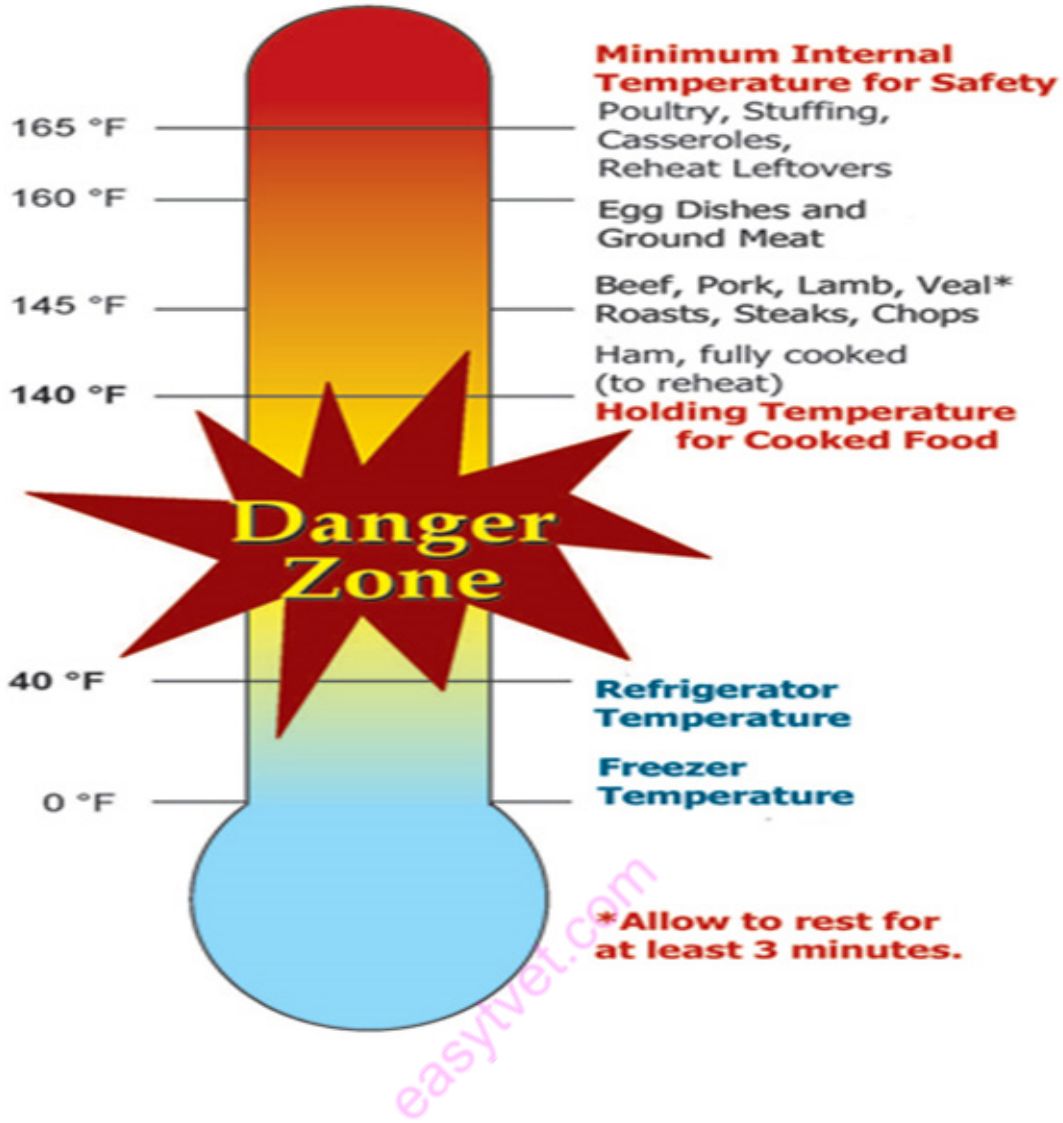
- Always keep raw foods separate from ready-to-eat foods
- In the refrigerator, ready to eat foods must be stored above raw food
- Don't mix left over foods with fresh foods
- Wash fruits & veg. in running water
- Do not let raw meat and raw vegetables be prepared on the same surface at the same time
- Prepare ready to eat foods first- then raw foods
- Prepare raw and ready to eat foods in separate areas of the kitchen

Equipment to food: when equipment harbors contaminants and they get into food

- Use separate cutting boards for different foods (meat-veg)
- Prepare raw foods in separate area from fresh and ready to eat foods
- Clean & sanitize equipment, work surfaces & utensils after preparing each foods
- Use specific containers for various food products.
- Make sure cloth and paper towel used for wiping spills are not used for any other purposes

2. Time-Temperature abuse

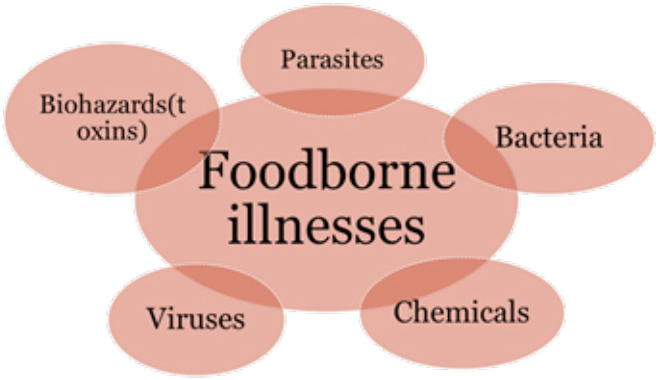
Happens when food is exposed to Temperature Danger Zone (40ºF -140ºF) for more than 4 hrs. It's the temperature range in which food-borne bacteria(e.g E.coli, salmonella) can grow to dangerous levels and can cause illness



3. Poor personal hygiene

Factors contributing to outbreaks of food poisoning:

- Storage at ambient temperature
- Inappropriate cooling
- Contaminated processed food
- Undercooking
- Contaminated canned food
- Inappropriate thawing
- Cross contamination
- Infected food handlers



Common causes of foodborne illnesses

Classification of food borne illnesses

- Food-borne infections – Where the disease is produced by living organisms such as certain bacteria, parasites, viruses,etc entering the body through consumption of food that contains living disease-causing microorganisms.
- Food Intoxication – caused by eating food that contains a harmful chemical or toxin produced by bacteria or other source. It is also where the disease is produced by substances called toxins or poisonous agents in the food before consumption.
- Toxin-mediated infection - caused by eating a food that contains harmful microorganisms that will produce a toxin once inside a human body.

Types of food-borne illnesses caused by bacteria

Bacteria are classified as "spore forming" and "non spore forming". Spores enable cells to survive environmental stress such as cooking, Freezing, high salt condition, drying and high acid condition.

1. Botulism

It is caused by a bacteria known as clostridium botulinum, an anaerobic and spore forming bacteria. This organism produce a neurotoxin, deadly biological toxin to man. Spore forming bacteria are found in foods that are grown in soil and animal products.

Type of illness: Bacterial intoxication

Symptoms: Dizziness, double vision, difficulty in breathing and swallowing

Onset time: 12-36 hrs.

Food Sources: Improperly canned foods, vacuum packed, Refrigerated foods

Prevention: Discard bulging cans ,

Do not use home canned foods

Do not mix and store oil and garlic

Saute onion as needed

Don’t store left over potatoes in a foil

2. Campylobacteriosis

It is caused by campylobacter Jejuni bacteria. This bacteria requires a very strict amount of air for growth (microaephilic).

Type of Illness: bacterial infection

Symptoms: watery, bloody diarrhoea, fever, nausea, vomiting, abdominal pain, headache, muscle pain

Onset time: 7-10 days

Food Sources: Unpasteurized milk, raw poultry, beef faecal contaminated water

Preventive measures:

- Personal hygiene,
- Follow hand washing guidelines
- Avoid cross contamination
- Cook all meat
- Maintain good pest control
- Use pasteurized dairy products
- Use safe water

3. E. Coli Infection

This food infection is caused by Escherichia coli, a facultative anaerobic bacteria which produces shiga toxin, a poisonous substance.

Type of Illness: Bacterial Infection

Onset time: 3-8 days

Symptoms: Bloody diarrhoea followed by kidney failure

Haemolytic Uremic Syndrome

Food Sources: undercooked ground beef, unpasteurized apple juice, undercooked fruits & vegetables, raw milk, dairy products

Prevention

- Good personal hygiene
- Avoid cross contamination
- Cook all poultry, meat carefully

- Use pasteurized milk and dairy products
- Wash all fresh fruits & vegetables in a clean running water

4. Listeriosis

This foodborne illness is caused by a facultative anaerobic bacteria known as Listeria Monocytogenes. This bacteria has the ability to survive in high salt foods, and can grow in refrigerated temperature.

Type of Illness: Bacterial Infection

Onset time: 3- 7 days

Symptoms: headache, stiff neck, confusion, loss of balance, convulsion, dangerous for pregnant women (may result to premature delivery, fetal death)

Food Sources

- raw milk, meat
- refrigerated ready to eat foods
- processed foods (hotdogs, deli meats, luncheon meats)
- soft cheeses

Prevention

- Good personal hygiene
- Avoid cross contamination
- cook all meat, poultry carefully
- Use pasteurized milk, milk products
- Wash all fruits & vegetables in a clean running water
- Clean & sanitized utensils & equipment

5. Perfringens foodborne illness

This infection is caused by a microaerophilic bacteria known as Clostridium perfringens.

Type of Illness: Bacterial toxin mediated infection

Onset time: (8- 22 hrs.)

Symptoms: Severe abdominal cramps; severe diarrhoea

Food Sources

- cafeteria germs
- spices, gravy
- improperly cooled foods
- foods not cooked to the right temperature

Prevention

- Good personal hygiene
- Avoid cross contamination
- Cook all meat carefully

6. Salmonellosis

This food infection is caused by a facultative anaerobic bacteria called salmonella bacteria. It is mostly brought about by faecal contamination.

Type of Illness: Bacterial infection

Symptoms: stomach cramps, diarrhoea, head ache, nausea, fever, vomiting

Type of Illness: Bacterial infection

Symptoms: stomach cramps, diarrhea, head ache, nausea, fever, vomiting

Food Sources

- contaminated by soil, insects, intestinal waste of animals
- raw meat, fish, eggs,
- raw salad dressing, cake mixes, sliced fruits & vegetables
- dried gelatin, peanut butter

Prevention

- Good personal hygiene
- Avoid cross contamination
- Cook all meat carefully

7. Shigellosis

It is a food infection caused by shigella bacteria, a facultative anaerobic bacetria. It mainly comes from human intestines, polluted water, spread by flies and food handlers.

Type of Illness: Bacterial infection

Symptoms

Diarrhea,fever,Abdominalcramps,dehydration

Food Sources: foods that are prepared by human contacts e.g. salads, ready to eat meats

pasta salads, lettuce, moist foods

Prevention

- Good personal hygiene
- Avoid cross contamination

- Use clean water
- control flies
- cook foods properly

8. Staphylococcal illness

This foodborne illness is caused by facultative anaerobic bacteria called staphylococcus aureus. It can grow in cooked or safe foods that are recontaminated. It is commonly found in human skin, hands, hair, nose and throat.

The interesting thing about this illness is that the carriers are both healthy and unhealthy people. It can grow in high salt or high sugar, and lower water capacity.

Type of Illness: Bacterial intoxication

Symptoms: nausea, vomiting,

- Abdominal cramps, headaches
- Food sources
- Foods that are prepared by human contacts
- Left overs, meat,
- Eggs, egg products,
- Potato salad, salad dressings

Prevention

- Good hygiene
- Avoid cross contamination
- Cover a burn or cut wounds
- Wear a disposable gloves when preparing foods
- Cook foods thoroughly

Food hygiene

The food safety and hygiene rules and regulations cover three main areas;

- Personal hygiene
- Kitchen hygiene
- Food handling

Personal hygiene

- Clean and cover cuts and wounds

- Never use bare hands when handling ready to eat foods
- Disposable gloves should be used once
- Take a bath everyday
- Wear appropriate attire
- Observe proper hand washing procedures at all times
- Use a handkerchief to blow the nose, while sneezing e.t.c
- Hair should be kept short and clean

Kitchen hygiene

- There should be nothing in the kitchen to attract pests. Spilt food should be cleaned immediately.
- All equipment and utensils should be cleaned and stored in a clean area
- Work surfaces should be cleaned every day. The floor should be cleaned as soon as spills occur.
- Cloths such as dishcloths and tea towels should be washed daily because dirty clothes are prone to harbouring infectious microorganisms
- Use kitchen bins to dispose of kitchen waste.
- Kitchen bins should be kept outside the kitchen and stored away from the window leading to the kitchen.
- Bins should have tightly closing lids. They should also be easy to clean and maintain

Processing room

- Keep the building clean and tidy at all times.
- Do not let animals into the room.
- Keep out insects and pests.
- Toilets must be in a separate room.
- Store the raw materials in a separate room or cupboard.
- Keep the cleaning materials in a separate room or cupboard.
- Store the finished products in a separate room.
- The store room must be in a cool dry place away from the direct sunlight.
- Only use clean water to wash equipment.

Food hygiene

- Personal hygiene guidelines should be followed
- Always avoid handling food directly if possible, especially cooked food.
- Keep food covered to prevent contamination
- Utensils and equipment should always be kept clean
- Ensure to cook food thoroughly
- Refrain from wearing jewellery, make up, and nail polish
- Hot foods should be eaten while hot
- If a food is eaten cold, it should be cooled as fast as possible and refrigerated within 90 minutes.
- Cold foods should be kept below 5◦C in a refrigerator.
- Cooked food should not be stored too long; up to 3 days in a refrigerator. For longer storage, food should be frozen.
- Avoid reheating food by preparing food that is just enough for a meal.

Plant design and surface layout

Plant design is defined as the overall design of a processing plant. Several stages are involved in designing which may include identification and selection of the product to be processed feasibility analysis and appraisal, design, economic evaluation, design report preparation, procurement of materials, installation and commissioning.

Plant design specifies;

- Equipment to be used
- Performance requirements for the equipment
- The placement of equipment, storage space, shop facilities, office spaces, and site plans etc.
- Required instrumentation and controls, and process monitoring and control interconnections
- Utility and waste treatment requirements, connections and facilities
- The rationale for site selection
- The basis for selecting and sizing critical pieces of equipment

Factors to consider when planning a food plant design and layout.

1. Product flow: – consider if the plant processing with the available equipment will need a linear flow or otherwise

2. Equipment spacing: – ensure that the equipment is properly laid out in the facility to leave adequate room for personnel movement
3. Space for maintenance operations: – ensure that all the equipment has at least 75 cm clearance from the nearest wall to facilitate movement and manipulation during maintenance operations. The doors should open freely
4. Orient the equipment in the plant to facilitate suitable product flow
5. Process parameters (or indicators) should be visible and accessible to facilitate quick implementation of corrective mechanisms
6. Properly place all the operating control panels within reach and properly labelled
7. Consider all other safety concerns within the plant.

Plant layout

Plant layout refers to an optimum arrangement of different facilities including human resource, plant and machinery, material. It is very difficult to change a layout once implemented and the cost of doing so would be very high.

The problem of plant layout should be seen in relation to overall plant design which includes many other functions such as product design, sales planning, selection of the production process, plant size, plant location, building, diversification etc. The layout problem occurs because of many developments including:

- Change in product design
- Introduction of new product
- Obsolescence of facilities
- Changes in demand
- Market changes
- Competitive cost reduction
- Frequent accidents
- Adoption of new safety standards
- Decision to build a new plant

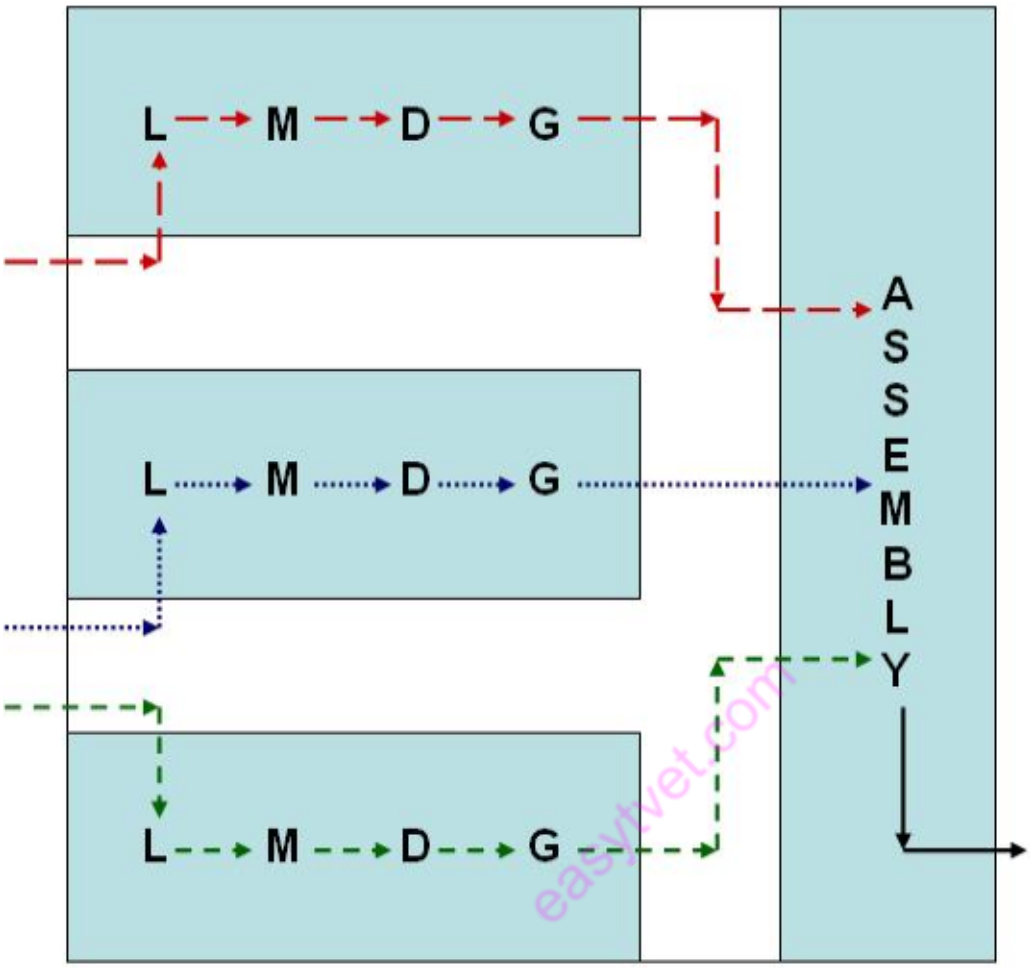
Types of layouts

Depending upon the focus of layout design, the basic types of the layouts are:

1. Product or line layout
2. Process or functional layout
3. Cellular or group layout
4. 'Fixed Position' Layout

Product or line layout

Product focused systems, whereby only one product is produced in a given area, would best fit this type of layout. Work stations are organised in the sequence of appearance in the production process.



Product or line layout

The decision to organize the facilities on a product or line basis is dependent upon a number of factors and has many consequences which should be carefully weighed. Following conditions favor decision to go for a product- focused layout.

- High volume of production for adequate equipment utilization
- Standardization of product
- Reasonably stable product
- demand Uninterrupted supply of material

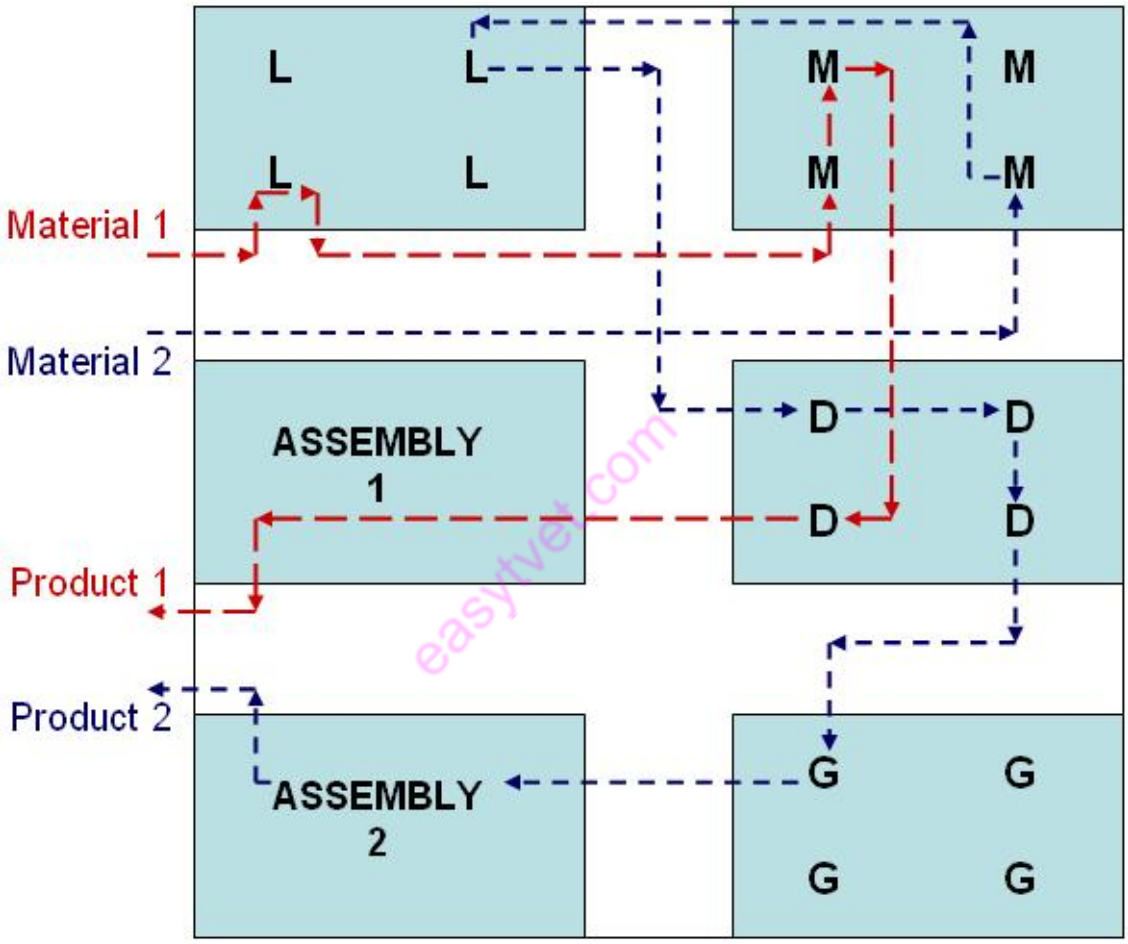
Some of the major advantages of this type of layout are:

- Reduction in material handing
- Less work-in-process

- Better utilization and specialization of labor
- Reduced congestion and smooth flow
- Effective supervision and control

Process or functional layout

It is a layout that is designed for process focused system whereby the processingunits are organized by functions. It is more applicable in a plant where there are low volumes of production of unstandardized products. It is cost effective when flexibility is the basic system requirement.

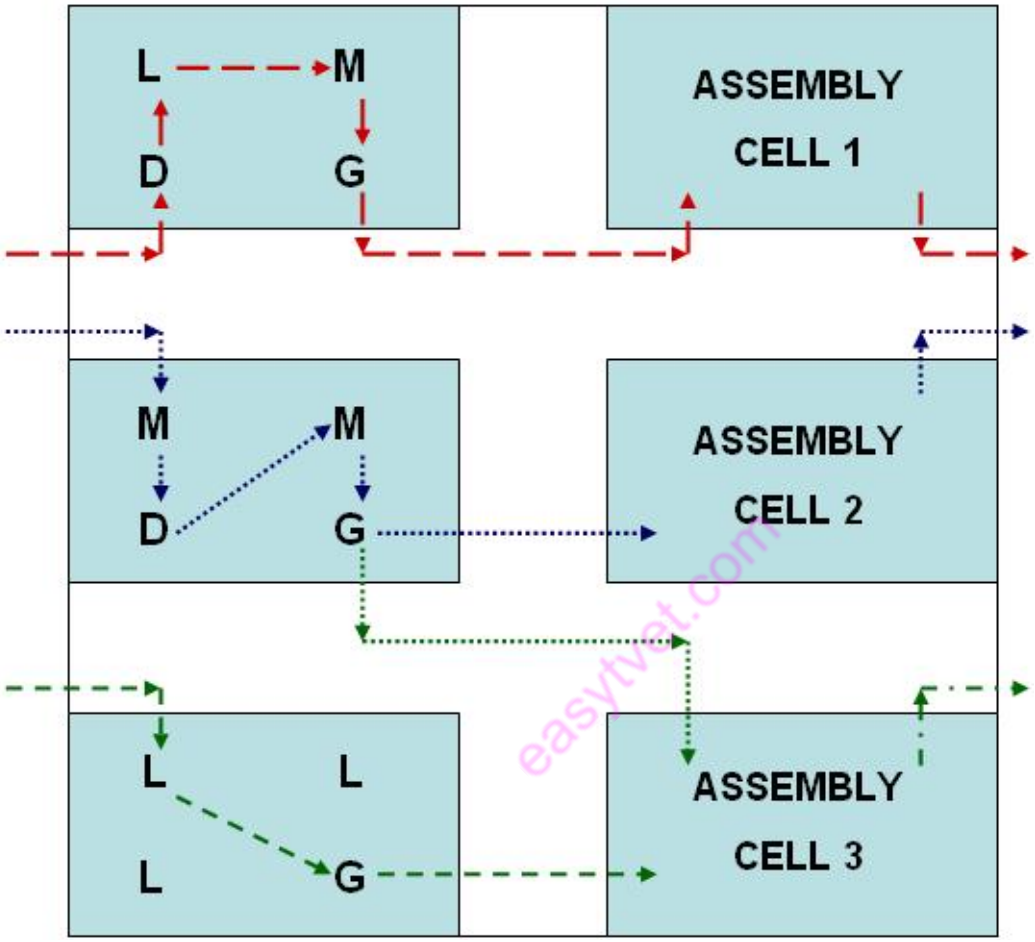


Advantages of a process layout

- Better equipment utilization
- Higher flexibility
- Greater incentive to individual worker
- More continuity of production in unforeseen conditions like breakdown, shortages, absenteeism etc.

Cellular or group layout

t is a special type of functional layout in which the facilities are clubbed together into cells. This is suitable for systems designed to use the concepts, principles and approach of group technology. Such a layout offers the advantages of mass production with high degree of flexibility. We can employ high degree of automation even if the number of products is more with flexible requirements. In such a system the facilities are grouped into cells which are able to perform similar type of function for a group of products.



Cellular or group layout

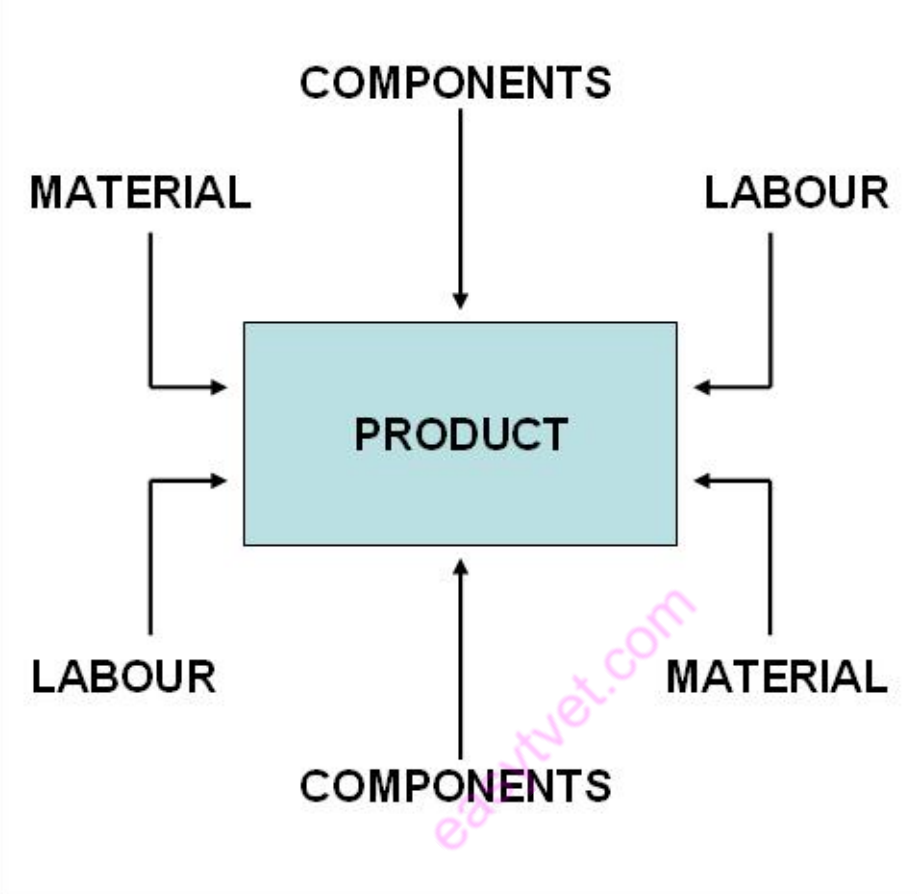
Advantages

- Each cell manufactures products belonging to a single family.
- Cells are autonomous manufacturing units which can produce finished parts.
- Commonly applied to machined parts.
- Often single operators supervising CNC machines in a cell, with robots for materials handling.
- Productivity and quality maximised. Throughput times and work in progress kept to a minimum.
- Flexible.

- Suited to products in batches and where design changes often occur.

Fixed position layout

This is a suitable layout for plant that produces single, large, high cost components or products. The product is usually static hence labour, tools and equipment come to the work site.



Fixed position layout

Food premises and equipment hygiene

Food premises are classified depending on:

Whether commercial or welfare:

– Commercial - purpose generating profit.

– Welfare – put up of taking care of the well-being of customer.

Market served (whether general or restricted):

– General market - market which is open to everyone

– Restricted market- it serves specific group of people.

Ownership: who owns the establishment?

– privately owned

– Public or government owned.

Whether catering is the major or minor activity:

– Commercial : catering is the main activity

– Welfare: catering is not always available to public and catering is secondary to main business.

Operational Requirements

Inspection of food facilities is carried out by public health officials who certify that a facility has met food safety and hygiene requirements.

Key elements assessed include:

- Design and layout of premises,
- Handwashing facilities and toilets,
- Transport,
- Equipment,
- ventilation,
- personal hygiene,
- water supply,
- waste management e.T.C

Sanitation and waste management

Sanitation refers to the provision of facilities (latrines and toilets) and services for the safe disposal of human urine and faeces, the maintenance of hygienic conditions, through services such as garbage collection and wastewater disposal. It is primarily concerned with liquid waste.

Globally, insufficient sanitation is a key cause of disease and improving sanitation is known to have a significant beneficial impact on health both in households and across communities.

Waste management: the collection, transport, recovery and disposal of waste, including the supervision of such operations and the after-care of disposal sites, and including actions taken as a dealer or broker.

Although sanitation and waste management address different issues using different techniques, they have a number of features in common. For example, they both:

- Deal with wastes
- Are concerned with safeguarding human health and preventing disease
- Cause major problems if not done correctly
- Help to reduce environmental pollution (introduction into the environment of substances liable to cause harm)
- Need to be paid for by the users, the city authorities or the government

Types of liquid and solid waste

Waste: a substance/object which is disposed of or is intended to be disposed of by the provisions of national law.

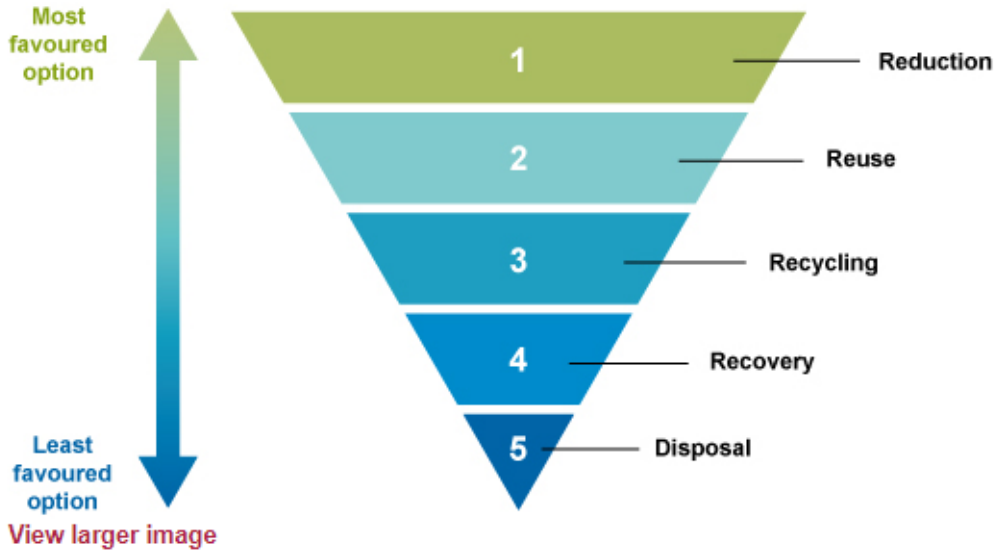
Liquid wastes include;

- blackwater- waste water that contains human waste and urine
- greywater- waste water from human washing and bathing, kitchen sinks, clothes washing etc
- stormwater - wastewater that flows on the surface of the land to join streams. Note that this is considered as wastewater because it contains many different contaminants.
- Sewage is a combination of wastewater coming from any of the above sources and flows in underground sewers or open ditches.
- Excreta is a combination of urine and faeces.

Solid wastes include:

- Residential waste: from households and residential areas. This is sometimes called household waste. Garbage, rubbish, trash and refuse are other terms for residential waste.
- Commercial waste: from businesses such as food and drink establishments, shops, etc.
- Industrial waste: from various types of industrial processes, e.g. food processing, paper manufacture, manufacture of chemicals and metal processing.
- Institutional waste: from public and government institutions, e.g. offices, religious institutions, schools, universities, etc. This is similar to residential and commercial waste in composition.
- Municipal waste (or municipal solid waste) covers all the above wastes produced in an urban area. It is similar in composition to residential waste but excludes some industrial wastes.
- Healthcare waste: any solid waste produced in hospitals, clinics, health posts and other health facilities.
- Agricultural waste: waste that comes from farming.
- Waste from open areas: street sweepings, contents of roadside dustbins, ditches and other public places.
- Construction and demolitionwaste: from various types of building and demolition activities in urban areas.
- Electronic and electrical waste (e-waste): wastes generated from used electronic devices and household appliances.

The waste hierarchy



The waste hierarchy

5.3.4.3 Self-Assessment

1. Define the following terms
   A. Food borne illness
   B. Critical control point
   C. Hazard
2. The following are types of potential food hazards except
   A. Biological Hazards
   B. Radioactive Hazards
   C. Chemical Hazards
   D. Physical Hazards
3. Indicate if the following statements about determination of critical control point are true or false
   A. It focuses on heat process steps where time-temperature relations must be maintained to destroy given pathogens
   B. It overlooks freezing and time to freezing before pathogens can multiply
   C. It focuses on the maintenance of ph of a food product at a level that prevents growth of pathogens
   D. It does not focus on employee hygiene

4. Clostridium botulinum produces _____ a deadly biological toxin to man
    A. Aflatoxin
    B. Mycotoxin
    C. Neurotoxin
    D. Nutratoxin
5. Differentiate between sanitation and waste management
6. Discuss the various types of plant layout for a food processing plant
7. Why is design important for a food processing plant
8. Illustrate the different designs of processing plant layout
9. Discuss the principles of HACCP
10. Describe the steps followed when developing HACCP plan
11. Discuss the causes, symptoms and preventive measures for the following foodborne diseases
    A. Listeriosis
    B. Campylobacteriosis
    C. Salmonellosis
    D. Botulism

5.3.4.4 Materials

HACCP manual/workbook

Textbooks

LCDs, video clips, charts and other teaching aids

Invitation of competent expertise

Computers with internet

Library and resource centre

Stationery

Food processing plant

Equipped laboratory

Food samples

Reagents

5.3.4.5 References

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