Fruit and vegetable processing level-II

Based on May 2019, Version 2 Occupational standards

Module Title: - Preserving Food in Cans or Sealed Containers

LG Code: IND FVP2 M18 LO (1-7) LG (66-72)

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October 2020

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LG #66	LO #1- Oversight the preparation of the packaging materials for thermal processing

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying suitable sealed containers
- Assessing container's properties function and integrity
- Identifying parts of cans and aseptic bags
- Setting up and undertaking can close machine (seamier) and aseptic filler machines
- Measuring and calculating characteristics of seamed cans

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify suitable sealed containers, parts of cans and aseptic bags
- Assessing container's properties function and integrity
- Set up and undertaking can close machine (seamier) and aseptic filler machines
- Measure and calculate characteristics of seamed cans

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information Sheet 1- Identifying suitable sealed containers

1.1Introduction

This module on handling and preservation of **fruits and vegetables** by combined methods has been prepared in response to needs, both real and perceived, that surplus crop can be used. Postharvest losses of fruits and vegetables are difficult to predict; the major agents producing deterioration are those attributed to physiological damage and combinations of several organisms. **Fruits and vegetables** provide an abundant and inexpensive source of energy, bodybuilding nutrients, vitamins and minerals. Their nutritional value is highest when they are fresh, but it is not always possible to consume them immediately. During the harvest season, fresh produce is available in abundance, but at other times, it is scarce. Moreover, most fruits and vegetables are only edible for a very short time, unless they are promptly and properly preserved.

Food preservation is an action or a method of maintaining foods at a desired level of properties or nature for their maximum benefits. In general, each step of handling, processing, storage and distribution affects the characteristics of food, which may be desirable or undesirable. Understanding the effects of each preservation method and handling procedure on foods is critical in food processing. Generally, **fruits and vegetables** can be preserved by four basic ways. These include **freezing, canning,** pickling **and drying or dehydrating**.

- **Preservation methods start with the complete analysis and understanding of the**:

✓ Whole food chain including growing,
✓ Harvesting,
✓ Processing,
✓ Packaging and
✓ Distribution;

Thus, an integrated approach needs to be applied. It lies at the heart of food science and technology, and it is the main purpose of food processing.

- **The main reasons for food preservation are to**:
  - ✓ Overcome inappropriate planning in agriculture,
  - ✓ Produce value-added products and
  - ✓ Provide variation in diet.

The principal of canning is simply to kill microorganisms present in food and to keep new microorganisms at bay. Food is sealed in the can and then heated to a temperature that destroys harmful microorganisms and any spores that could grow in the can. Canning is the technique of preserving food in airtight containers by an extensive heat treatment that inactivates enzymes and kills microorganisms that cause deterioration during storage.

1.2. Importance of canning/preserving

- ✓ Canning is a method of preserving food in which the food contents are processed and sealed in an airtight container (jars like Mason jars, and steel and tin cans).
- ✓ Canning provides a shelf life typically ranging from one to five years, although under specific circumstances it can be much longer.
- ✓ Safe method for preserving food if practiced properly.
- ✓ Involves placing foods in jars or similar containers and heating them to a temperature that destroys microorganisms that cause food to spoil.

During this heating process, air is driven out of the jar and as it cools a vacuum, seal is formed. This vacuum seal prevents air from getting back into the product bringing with it contaminating microorganisms.

There are **two main ways** to can produce **boiling hot water baths and pressure canning**. A boiling water bath involves putting food in glass canning jars and then heating the jars in a pot of boiling water. The heat forces air from the glass jars and frees the food from bacteria and microorganisms. Pressure canning food requires a pressure canner. The pressure canner you use should be based on the kind of cooking equipment you have and the amount of food you plan to can. Freezing, drying, pickling, and canning are effective ways to preserve the produce and herbs you grow during the gardening season. The method you choose depends on what you hope to do with the food when it comes time to eat it. Both cooked and raw food can be successfully canned using heat to sterilize and seal the **jar**. To can your **fruits and vegetables** at home, you will need a pressure canner, along with canning **jars**, seals, rings, lids, a funnel and a large pot for blanching. The principle involves killing bacteria inside the **jar** with heat.

Sealed containers are vacuum-sealed and may include:

- ✓ Aseptic bags and
- ✓ Bottling or any other airtight container for food products

Fig 1.1.Sealed jar

Self-Check -1	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: Short Answer Questions (4 each point)

1. Explain the reasons in detail why we need to preserve foods and write the benefits off it.---
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   ----
2. Define food preservation. ---
   ----
3. List the importance of canning:--

You can ask you teacher for the copy of the correct answers

Note: **Satisfactory rating – above 6 points** **Unsatisfactory - below 6 points**

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Information Sheet 2- Assessing container's properties function and integrity

2.1. Assessing container's properties

Container closure integrity (CCI) is the ability of a container closure system to maintain the sterility and product quality of sterile final pharmaceutical, biological, and vaccine products throughout their shelf life. Every proposed packaging system should be shown to be suitable for its intended use: it should adequately protect the dosage form; it should be compatible with the dosage form; and it should be composed of materials that are considered safe for use with the dosage form and the route of administration. If the packaging system has a performance feature in addition to containing the product, the assembled container closure system should be shown to function properly.

Information intended to establish suitability might be generated by the applicant, by the supplier of the material of construction or the component, or by a laboratory under contract to either the applicant or the firm. An adequately detailed description of the tests, methods, acceptance criteria, reference standards, and validation information for the studies should be provided.

General issues concerning with the properties of container are:

- ✓ **Protection.** A container closure system should provide the dosage form with adequate protection from factors (e.g., temperature, light) that can cause a degradation in the quality of that dosage form over its shelf life.
- ✓ **Compatibility.** Packaging components that are compatible with a dosage form will not interact sufficiently to cause unacceptable changes in the quality of either the dosage form or the packaging component.

- ✓ **Safety.** Packaging components should be constructed of materials that will not leach harmful or undesirable amounts of substances to which a patient will be exposed when being treated with the drug product.
- ✓ **Performance.** Performance of the container closure system refers to its ability to function in the manner for which it was designed. A container closure system is often called upon to do more than simply contain the dosage form. When evaluating performance, two major considerations are container closure system functionality and drug delivery.

2.2. Materials Used in Food Packaging

✓ **Glass**

Glass containers used in food packaging are often surface-coated to provide lubrication in the production line and eliminate scratching or surface abrasion and line jams. Glass coatings also increase and preserve the strength of the bottle to reduce breakage.

✓ **Metal**

Metal is the most versatile of all packaging forms. It offers a com-bination of excellent physical protection and barrier properties, formability and decorative potential, recyclability, and consumer acceptance. The two metals most predominantly used in packaging are aluminum and steel.

✓ **Aluminum.**

Commonly used to make cans, foil, and laminated paper or plastic packaging, aluminum is a lightweight, silvery white metal derived from bauxite ore, where it exists in combination with oxygen as alumina. Magnesium and manganese are often addedto aluminum to improve its streng.

✓ **Aluminum foil.**

Aluminum foil is made by rolling pure alu-minum metal into very thin sheets, followed by annealing to achieve dead-folding properties (a crease or fold made in the film will stayin place), which allows it to be folded tightly.

✓ **Laminates and metallized films.**

Lamination of packaging in-volves the binding of aluminum foil to paper or plastic film to improve barrier properties. Thin gauges facilitate application.

✓ **Tinplate.**

Produced from low-carbon steel (that is, black plate), tinplate is the result of coating both sides of black plate with thin lay-ers of tin.

- ✓ **Tin-free steel.**

Also known as, electrolytic chromium or chromeoxide-coated steel, tin-free steel requires a coating of organic ma-terial to provide complete corrosion resistance**.**

- ✓ **Plastics**

Plastics are made by condensation polymerization (polycon-densation) or addition polymerization (polyaddition) of monomerunits. In polycondensation, the polymer chain grows by condensa-tion reactions between molecules and is accompanied by formationof low molecular weight byproducts such as water and methanol

Self-Check – 2	Written test

Name…………………………………………… ID………………………… Date…

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (5 point each)

1. Write down all the properties of food container.
2. List materials of food packaging?

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Information Sheet 3- Identifying parts of cans and aseptic bags

3.1. Parts of cans and aseptic bags

Careful harvesting, handling, and transporting of **fruits** and **vegetables** to packinghouses are necessary to preserve product quality. **Asepsis**-is recognized as the state of being free from pathogenic (harmful) microorganisms. Aseptic processing can be defined as the processing and packaging of a commercially sterile product into sterilised containers followed by hermetic sealing with a sterilised closure in a manner that prevents viable microbiological recontamination of the sterile product. The benefits of aseptic processing over conventional canning include longer shelf life, wider packaging sizes, wider container materials and improved nutritional and sensory properties.

Three-piece can bodies are made from flat sheets cut from coils of tin-plated or tin-free steel, depending on the end use. The tin plating is applied to prevent rust. Tin-free steel is electrocoated with a layer of metallic chromium covered by a layer of chromium oxide. Before the bodies are formed, coatings usually applied to the interior and exterior surfaces with a roller onto the flat sheet. Three-piece interior and exterior coatings are discussed briefly below. Section 3.3 contains a detailed discussion of the coatings used in can manufacturing.

- ✓ **Cans and aseptic bags** may include:
  - ➢ Two or three piece and steel or aluminum, closures may be ring pull or require an opener.
  - ➢ Metalized polyethylene bags used for aseptic filling

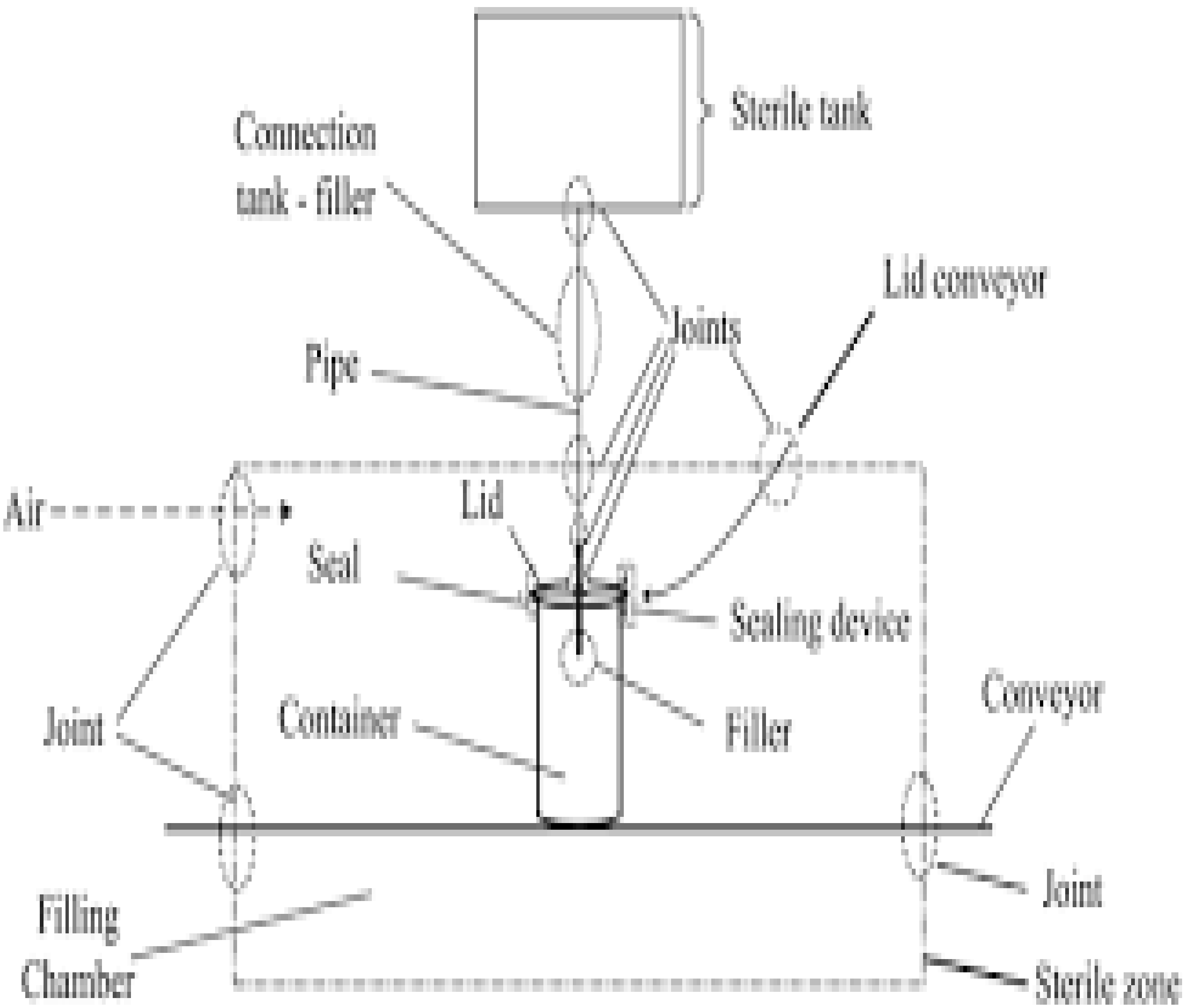


Fig 3.1parts of can

Self-Check -3	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: Short Answer Questions

1. Cans and aseptic bags may include: (4pts.)
2. List parts of a can (6pts.)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 5 points** **Unsatisfactory - below 5 points**

Information Sheet 4 - Setting up and undertaking a can closing machine (seamier) and aseptic filler machines

4.1. Container filling and closing operation

Equipment

The container and closure sterilization system and product filling and closing system shall be instrumented to demonstrate that the required sterilization is being accomplished continuously. Automatic recording devices shall be used to record, when applicable, the sterilization media flow rates, temperature, concentration, or other factors. When a batch system is used for container sterilization, the sterilization conditions shall be recorded.

Operation

Before the start of packaging operations, both the container and closure sterilizing system and the product filling and closing system shall be brought to a condition of commercial sterility.

Fig 4.1 container filling and aseptic

Aseptic Techniques and General Principles of Handling Cell Cultures

Aseptic technique is a set of *principles* and *practices* used by cell culture workers to reduce the presence of unwanted microorganisms or other cell lines in their cultures. Good aseptic technique is essential for successful long-term cell and tissue culture. Here are some useful recommendations to help improve aseptic technique:

- All supplies and reagents that come into contact with the cultures must be sterile (Phelan, 2007).
- Wash hands before and after handling any cell culture material, even if you are wearing gloves.
- Handle only one cell line at a time. There are intrinsic risks of misidentification or cross-contamination between cell cultures when more than one cell line is in use.
- Quarantine and cautiously handle all incoming cell lines until testing verifies the absence of mycoplasma. One of the most common sources of contamination is the culture given to you by a colleague in another lab. Try to obtain cell lines from repositories that certify that all material is mycoplasma-free prior to distribution.
- Avoid continuous long-term use of antibiotics within cell cultures. The overuse of antibiotics may lead to cytotoxicity and may pose an increased risk of covert mycoplasma contamination within the cell lines.
- When using multiwell plates, if contamination is restricted to one or a few wells, it can be eliminated by simply aspirating the contaminated media, filling the empty well(s) with 10% bleach, aspirating the bleach, then washing the well with 70% ethanol, and aspirating.

Self-Check - 4	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I*:* Short Answer Questions (5 point each)

1. Explain the operation of can filling and closing?
2. List aseptic technique and general principles

You can ask you teacher for the copy of the correct answers.

***Note:* Satisfactory rating – above 5 points Unsatisfactory - below 5 points**

Information Sheet 5 - Measuring and calculating characteristics of seamed cans

5.1. Introduction

Can Seaming Process In the can seaming process, a lid is mounted on the can body filled with ingredient, and then body and lid are held between chuck and lifter, and then rotated before the lid is pressed against the seaming roll to carry out seaming.

- There are two types of seaming roll (double seaming mechanism):
  - ✓ First roll and second roll. The first roll approaches the can lid, and rolls up the lid curl and body flange sections of the can before retreating. Next,
  - ✓ Second roll approaches to compress the rolled-up sections to end the seaming. In other words, the 1st roll rolls up the can lid and can body, doing mainly the bending work, while the 2nd roll compresses the rolled-up sections, and mainly does the seaming work.

When talking about measuring seams of round cans, the dimensions should be taken in 2 points, taken at 60º on both sides of the weld of a 3-piece container or at opposite points in 2-piece cans. In the case of cans of rectangular or irregular shape, measurements should be taken at each corner and in the center of each longer side. The frequency of the measurement should be at regular intervals during production. Two cans of each seam head must be taken, which must be completely inspected to determine that the integrity of the double seam is acceptable, and that the minimum levels of critical parameters are being met.

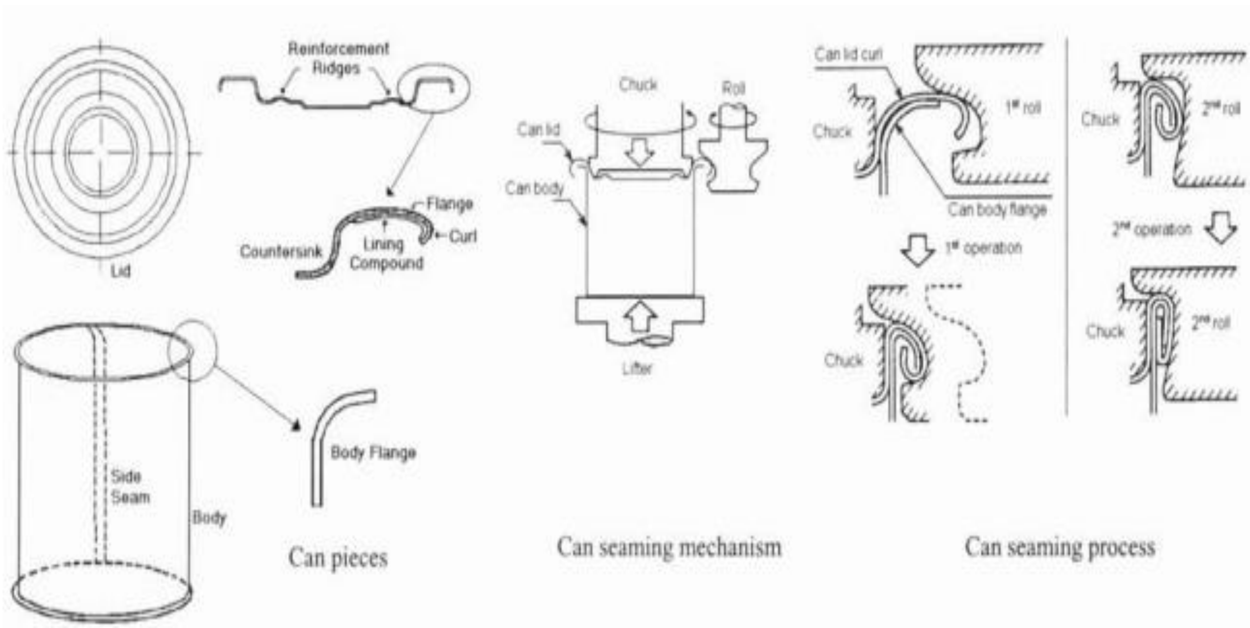


Fig. 5.1. Outline of can pieces, can seaming mechanism and process

The seams should be inspected:

- After any breakdown in the seamer.
- When the production begins.
- After making adjustments in the settings of the seamer.

- **Evaluation**

There are two procedures for the evaluation of a complete seam. This are-

- ✓ The method of opening: Complete dismantling of the seam.
- ✓ The method of sectioning the seam: Cutting the seam

If a section seam method is used, it should be noted that only the evaluation of the sectioned proportion is ensured. It is therefore necessary to “dismantle” the seam – pull down the entire seam – and examine it to ensure complete acceptability.

- **The basic dimensions of the seam that must be measured are:**

  - Depth of tub Pc

- Seam height Ac
- Thickness of the seam Ec
- Length hook body Lgc
- Length hook bottom Lgf
- Tin plate thickness Ehc
- Tin plate thickness Ehf

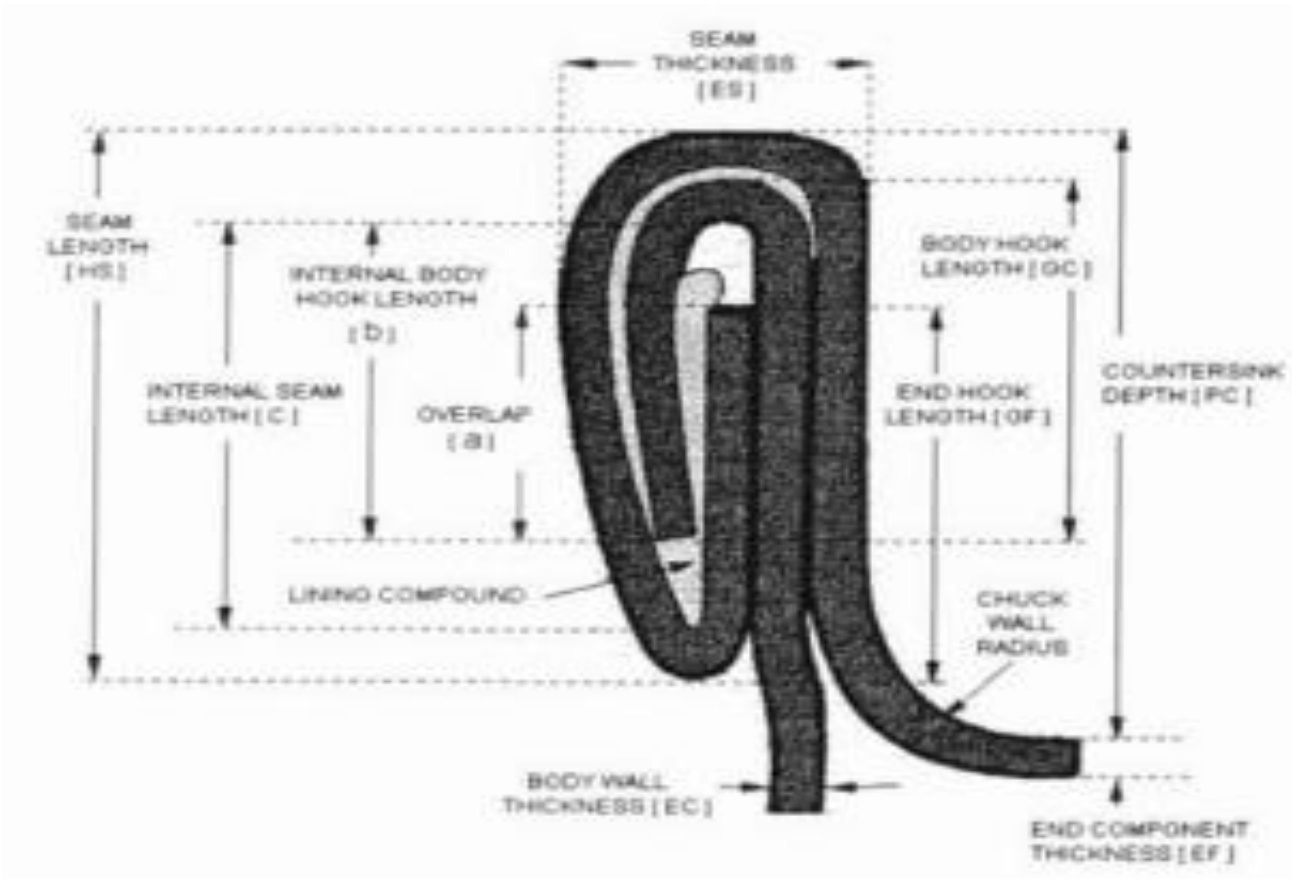
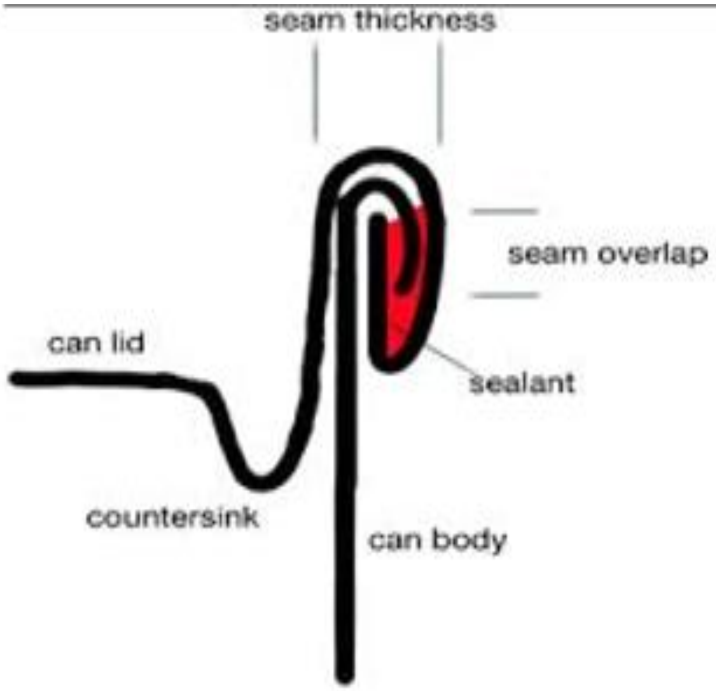


Figure5.2: - Double dimensions of the seam



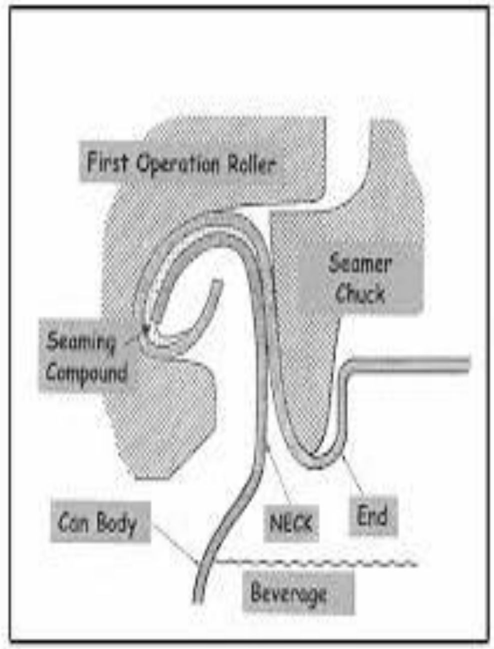


Figure5.3: Parts of seam


Figure 5.4: measuring a can seam

Self-Check – 5	Written test

Name………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (4pts)

1. **Discuss about measuring the cans seams**.
2. What are basic dimensions of the seam that must be measured
3. Draw the parts of a seam

You can ask you teacher for the copy of the correct answers.

LG #67	LO #2- Oversight food preparation and filling of cans

Note: Satisfactory rating 6 points Unsatisfactory - below 6 points

Instruction sheet
This learning guide is developed to provide you the necessary information regarding the following content coverage and topics: • Identifying raw materials quality requirement • Performing correct procedures for dicing and slicing • Implementing blanching process • Applying correct filling procedures for syrups and brines • Draining and weighing cans with headspaces • Recording net weights • Carrying out exhausting • Monitoring closing of can This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to: • Identify the quality requirements of raw materials for processing • Perform the correct procedures for dicing and slicing • Implement the blanching process • Apply the correct filling procedures for syrups and brines • Weigh cans with headspaces • Record net weights • Carry out exhausting from the can • Monitor closing of the can
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Information Sheet 1 - Identifying raw materials quality requirement

1.1. Raw materials quality requirement

Food influences the health of a population to a great degree, therefore, the control of food quality is an important government activity, and is legislatively regulated. Raw food materials quality is a complex term that includes nutritional, sensory, hygienic toxicological and technological points of view. Food has to fulfill all quality requirements, but above all, it has to be safe.

- **High quality products can be produced only from high quality raw materials**.

One can say that raw materials influence the quality of the products in the highest degree. Of course, the quality of products is further influenced by the technological procedures used. Quality depends not only on the technological procedure itself, but also on the hygienic level of machinery used, and on the total hygienic situation of the manufacturing surroundings.

The farmers, in many cases, make agreements with the food industry, not only on the quantity of raw materials produced, but above all on their quality. The quality of raw material is evaluated, and farmers are paid according to that quality (for example for wheat, milk, eggs, and so on). In all cases, the raw material must fulfill all hygienic requirements. Great attention is paid to the presence of different kinds of contamination, such as heavy and toxic metals, toxic metabolites of microorganisms, residues of pesticides, the presence of GM material, and others.

The main raw materials for the food industry are the products of agriculture. The quality of raw materials used influences the total quality of produced food. Quality control is, therefore, a cornerstone in the production of high quality food.

- **Food quality is a rather complex term. It includes:**
    - Perspectives of quality from nutritional,
    - Hygienic,
    - Sensory and

- Even technological viewpoints.

All mentioned forms of quality attributes influence the quality of the product. As will be described later, some of these attributes can influence food quality in a decisive manner. To assure for the consumer a food supply of guaranteed quality, an effective food control service and reliable control methods are needed. The raw materials for food production are heterogenic ones. According to their origins, raw materials can be divided into two basic classes, plant and animal.

The quality control of individual raw materials depends on many factors:

- ✓ The length of storage,
- ✓ Their disposition to spoilage,
- ✓ The possibility of the presence of contaminants and their ability to influence nutrition, and
- ✓ The total sensory quality of the products, and so on.

Self-Check - 1	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (4 pts each)**

1. Discuss how the raw material quality influences the quality of products.
2. What are the factors in which the quality control of raw materials depends on

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 4 points** **Unsatisfactory - below 4 points**

Information Sheet -2. Performing correct procedures for dicing and slicing

2.1 Introduction

The size of food materials is often reduced during processing for many reasons chief among which are drying, boiling or steaming and frying or roasting .Slicing of crops before drying reduces the drying time by exposing more surface area to the air. The preservation of almost all processed root and tuber crop products depends on reducing the moisture to a level, which prevents the growth of microorganism. Crops are often sliced before cooking and steaming, either for direct consumption or as one-step in a processing system. The process of cutting or slicing the crops gives rise to faster cooking.

Food of high quality can be produced from raw materials of high quality, therefore, careful attention must be paid to the cooperation between the producer of raw materials and the processors. A multi-crop slicing machine was designed, fabricated and evaluated for performance. The major components of the machine include:

- ✓ Hopper,
- ✓ Mainframe,
- ✓ Conveying disc,
- ✓ Slicing unit,
- ✓ Slicing shaft,
- ✓ Idler shaft,
- ✓ Pulley,
- ✓ Bearing,
- ✓ Electric motor base and
- ✓ Outlet.

The machine is powered by a three-phase, 1400 rpm, and 2 kW electric motor. The performance of the machine was evaluated in slicing four selected crops (carrot, potato, onion and yam), grouped into three sizes (small, medium and large) at five machine speeds of 39 rpm, 41 rpm, 43 rpm, 46 rpm and 48 rpm respectively.

Root and tuber crops occupy the same position in the tropics analogous to grains in the temperate regions as the major staple food. The storage potential of the different root and tuber crops differ, but generally, they do not store well in the fresh form and transportation is costly due to their bulkiness. Processing into staple, non-perishable and easily transportable produce offers an alternative to storage in the fresh form. They are best preserved in the dried form by processing into flour, chips and pellets for both human and livestock consumption.

A machine suitable for the cutting of agricultural produce into regular slices for the purpose of drying, roasting or frying have been designed and fabricated. Test results with the machine in slicing samples of onion, carrot, yam and potato indicated satisfactory performance. Furthermore, the optimum rotational speed of the knives obtained was 41 rpm, which gave optimum throughput capacity and slicing efficiency of 135.7 kg/h and 96% respectively. Further modification of the machine is necessary to improve the performance of the machine.

The operations involved in processing root and tuber crops include washing, peeling, size reduction (chipping, slicing and grating), drying and milling.

- There are many processes involved in food size reduction. They include:
  - ✓ Grinding or grating (cassava, yam),
  - ✓ Dicing (potato, yam, onion),
  - ✓ Slicing (carrot, onion, yam, onion and banana),
  - ✓ Milling (rice, corn and wheat), c
  - ✓ Hipping (cassava, yam and banana).

The type of crops, the end product desired and the machinery available often determines the type of size reduction method used.

Fig 2.1. Vegetable & Fruit Dicing Machine 3DD | *Cutting Cubes/Dices, Julienne Strips and Slices*

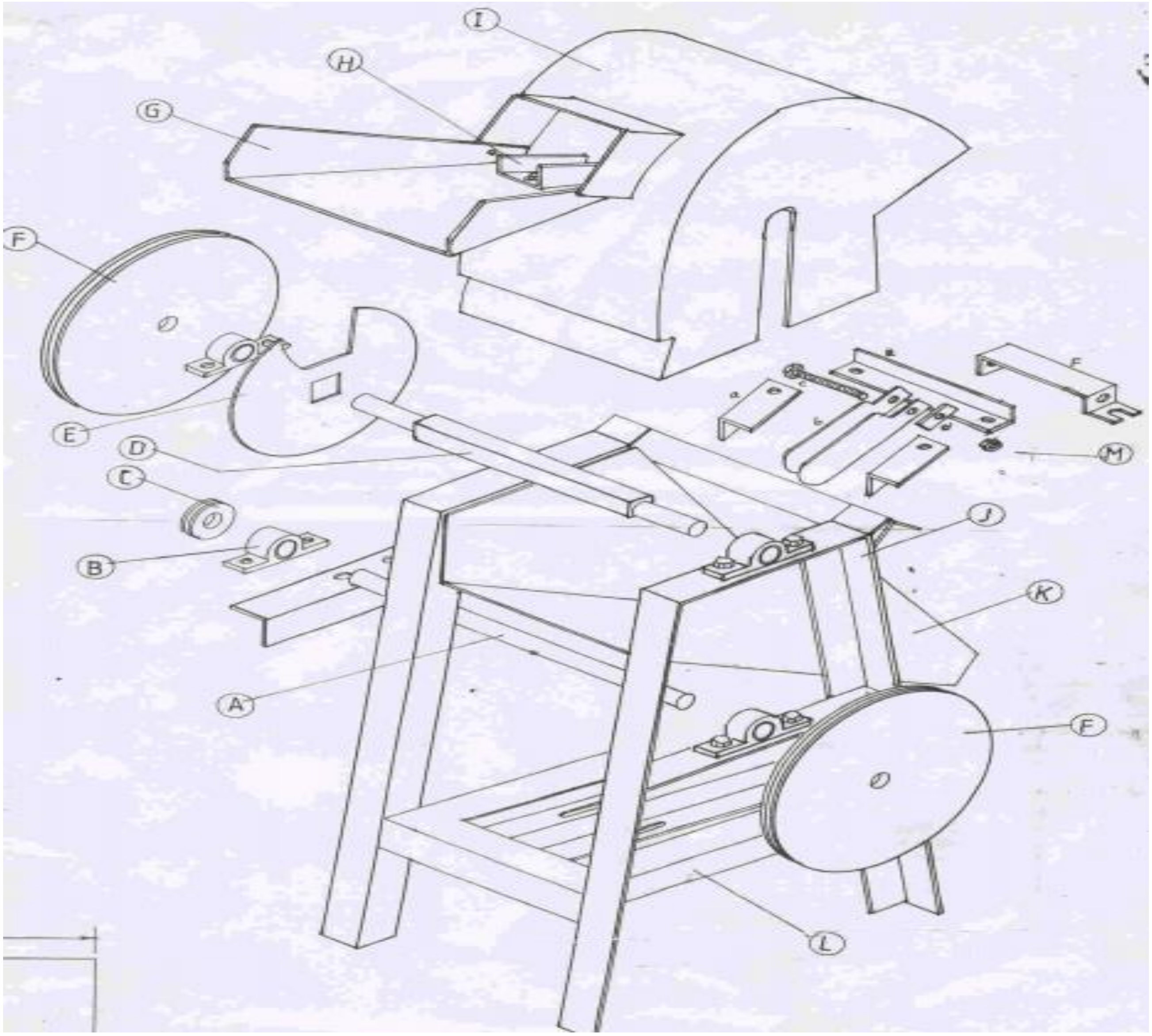


Figure 2.2: Exploded view of the slicing machine showing the component parts.

Legend: A, Idler shaft; B, bearing; C, Motor (driver) pulley; D, shaft; E, conveying disc; F, idler pulley; G, hopper; H, feed channel; I, upper housing; J, frame; K, outlet; L, motor seat; M, slicing unit.

Self-Check - 2	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (6 pts each)**

1. List the major components of the slicer/dicer machine
2. Write down the processes involved in food size reduction

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 6 points Unsatisfactory - below 6 points**

Information sheet 3 - Implementing blanching process

3.1. Introduction

Blanching is a unit operation prior to freezing, canning, or drying in which fruits or vegetables are heated for the purpose of inactivating enzymes; modifying texture; preserving color, flavor, and nutritional value; and removing trapped air. Hot water and steam are the most commonly used heating media for blanching in industry, but microwave and hot gas blanching have also been studied. Blanching serves a variety of functions, one of the main ones being to destroy enzymatic activity in vegetables and some fruits, prior to further processing. As such, it is not intended as a sole method of preservation but as a pre-treatment, which is normally carried out between the preparation of the raw material, and later operations (particularly heat sterilization, dehydration and freezing.

Blanching is also combined with peeling and/or cleaning of food, to achieve savings in energy consumption, space and equipment costs. A few processed vegetables, for example onions and green peppers, do not require blanching to prevent enzyme activity during storage, but the majority suffer considerable loss in quality if blanching is omitted or if they are under-blanched. To achieve adequate enzyme inactivation, food is heated rapidly to a pre-set temperature, held for a pre-set time and then cooled rapidly to near ambient temperatures. The factors which influence blanching time are:

- ✓ Type of fruit or vegetable
- ✓ Size of the pieces of food
- ✓ Blanching temperature
- ✓ Method of heating.

Blanching reduces the numbers of contaminating microorganisms on the surface of foods and hence assists in subsequent preservation operations. This is particularly important in heat sterilization as the time and temperature of processing are designed to achieve a specified reduction in cell numbers. If blanching is inadequate, a larger number of microorganisms are present initially and this may result in a larger number of spoiled containers after processing.

Blanching also softens vegetable tissues to facilitate filling into containers and removes air from intercellular spaces, which increases the density of food and assists in the formation of a headspace vacuum in cans.

3.2 Methods of blanching

The two most widespread commercial methods of blanching involve passing food through an atmosphere of saturated steam or a bath of hot water. Both types of equipment are relatively simple and inexpensive. Microwave blanching is not yet used commercially on a large scale.

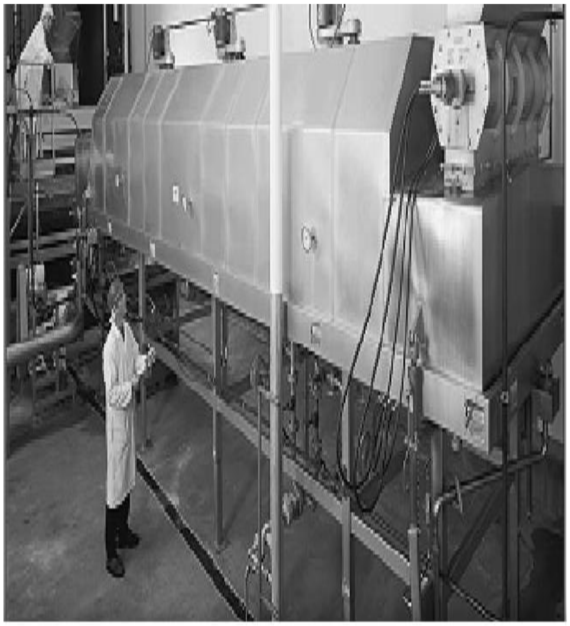
3.2.1. Steam blanchers

The preferred method for foods with a large area of cut surfaces, as leaching losses are much smaller than those found using hot-water blanchers. At its simplest, a steam blancher consists of a mesh conveyor belt that carries food through a steam atmosphere in a tunnel. The residence time of the food is controlled by the speed of the conveyor and the length of the tunnel. Typically a tunnel is 15m long and 1– 1.5m wide. The efficiency of energy consumption is 19% when water sprays are used at the inlet and outlet to condense escaping steam. Alternatively, food may enter and leave the blancher through rotary valves or hydrostatic seals to reduce steam losses and increase energy efficiency to 27%, or steam may be re-used by passing through Venture valves.

The design of the blanching chamber promotes continuous and uniform circulation of the food until it is adequately blanched. Although these blanchers have not yet been widely used at a commercial scale, they are reported to overcome many of the problems associated with both steam and hot water methods.

✓ The advantages include:

- Faster, more uniform heating
- Good mixing of the product
- A substantial reduction in the volume of effluent
- Shorter processing times and hence smaller losses of vitamins and other soluble heat sensitive components of food.



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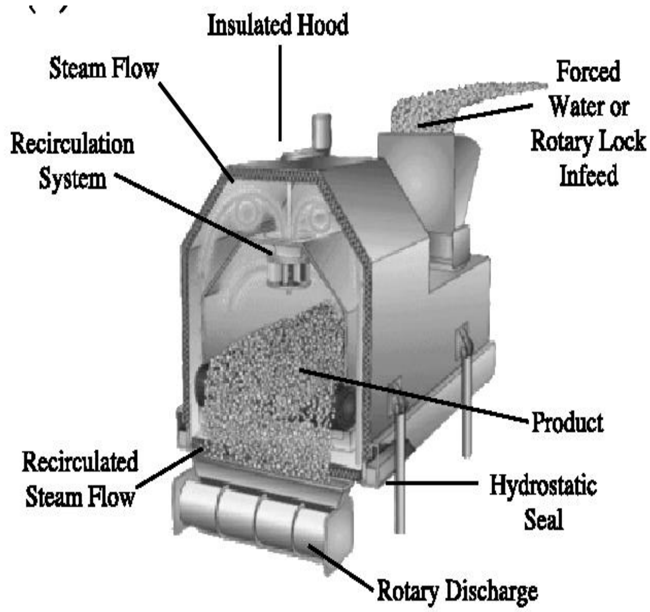

B

Fig 3.1. Turbo-Flo1 forced convection steam blancher (A); (B) schematic representation of the transversal section. (Courtesy of Key Technology, Inc.) (View this art in color at www. dekker.com.

3.2.2. Hot-water blanchers

There are a number of different designs of blancher, each of which holds the food in hot water at 70–100ºC for a specified time and then removes it to a dewatering-cooling section. The advantages and limitations of hot-water blanchers are described in Table 1.

In the widely used *reel blancher*, food enters a slowly rotating cylindrical mesh drum, which is partly submerged in hot water. The food is moved through the drum by internal flights. The speed of rotation and length control the heating time. The food remains on a single conveyor belt throughout each stage and therefore does not suffer the physical damage associated with the turbulence of conventional hot water blanchers. The food is pre-heated with water that is recirculated through a heat exchanger. After blanching, a second recirculation system cools the food.

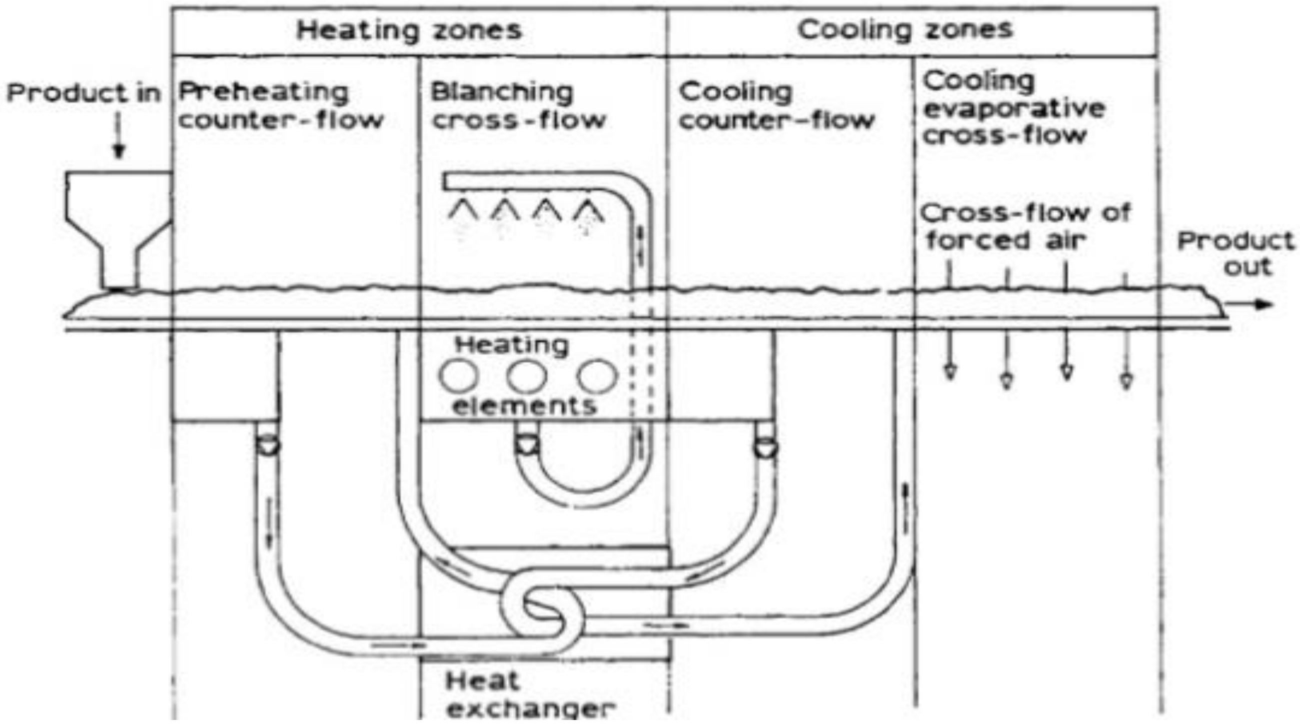

Fig 3.2. Hot water blancher

The two systems pass water through the same heat exchanger, and this heats the pre-heat water and simultaneously cools the cooling water. Up to 70% of the heat is recovered. A recirculated water-steam mixture is used to blanch the food, and final cooling is by cold air. Effluent production is negligible and water consumption is reduced to approximately 1m3 per 10 tone of product. The mass of product blanched is 16.7 – 20 kg per kilogram of steam, compared with 0.25 – 0.5 kg per kilogram in conventional hot-water blanchers. An alternative design, used for blanching broccoli, lima beans, spinach and peas, is described by Wendt *et al.* (1983) in which water and food move counter-currently.

Table 3.1 Advantages and limitations of conventional steam and hot-water blanchers

No	Equipment	Advantages	Limitations
1	. Conventional steam Blanchers	➢ Smaller loss of water-soluble components. ➢ Smaller volumes of waste and lower disposal charges than water blanchers, particularly with air-cooling instead of water. ➢ Easy to clean and sterilize.	➢ Limited cleaning of the food so washers also required. ➢ Uneven blanching if the food is piled too

			high on the conveyor. ➢ Some loss of mass in the food.
2	Conventional hot- water blancher	Lower capital cost and better energy efficiency than steam blanchers	Higher costs in purchase of water and charges for treatment of large volumes of dilute effluent. Risk of contamination by Thermophilic bacteria.

- **Effect of blanching on foods**

The heat received by a food during blanching inevitably causes some changes to sensory and nutritional qualities. However, the heat treatment is less severe than for example in heat sterilization, and the resulting changes in food quality are less pronounced. In general, the time–temperature combination used for blanching is a compromise, which ensures adequate enzyme inactivation but prevents excessive softening and loss of flavor in the food.

- **Effect on nutrients**

Some minerals, water-soluble vitamins and other water-soluble components are lost during blanching. Losses of vitamins are mostly due to leaching, thermal destruction and, to a lesser extent, oxidation. The extent of vitamin loss depends on a number of factors including:

- ✓ The maturity of the food and variety
- ✓ Methods used in preparation of the food, particularly the extent of cutting, slicing or dicing
- ✓ The surface-area-to-volume ratio of the pieces of food
- ✓ Method of blanching
- ✓ Time and temperature of blanching (lower vitamin losses at higher temperatures for shorter times)
- ✓ The method of cooling
- ✓ The ratio of water to food (in both water blanching and cooling).

- **Effect on Color and Flavor**

Blanching brightens the color of some foods by removing air and dust on the surface and thus altering the wavelength of reflected light. The time and temperature of blanching also influence the change in food pigments according to their *D* value. Sodium carbonate (0.125% w/w) or calcium oxide are often added to blancher water to protect chlorophyll and to retain the color of green vegetables, although the increase in pH may increase losses of ascorbic acid. Enzymatic browning of cut apples and potatoes is prevented by holding the food in dilute (2% w/w) brine prior to blanching. When correctly blanched, most foods have no significant changes to flavor or aroma, but under-blanching can lead to the development of off-flavors during storage of dried or frozen foods.

- **Effect on Texture**

One of the purposes of blanching is to soften the texture of vegetables to facilitate filling into containers prior to canning. However, when used for freezing or drying, the time–temperature conditions needed to achieve enzyme inactivation cause an excessive loss of texture in some types of food (for example certain varieties of potato) and in large pieces of food. Calcium chloride (1–2%) is therefore added to blancher water to form insoluble calcium pectate complexes and thus to maintain firmness in the tissues.

Self-Check -3	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (5 pts each)**

1. Define and explain blanching and factors which influence blanching time
2. Explain the two most widespread commercial methods of blanching in food canning process.
3. Discuss the advantages and limitations of conventional steam and hot-water blanchers
4. Write and explain the effects of blanching on foods.

You can ask you teacher for the copy of the correct answers

Note: **Satisfactory rating – 10 points and above** **Unsatisfactory –below 10 points**

Information Sheet-4 Applying the correct filling procedures for syrups and brines

4.1 Introduction

Can filling is a critical part of the canning operation. Before filling cans are subjected to steam jet or hot water to remove dust and foreign material. Automatic can filing machine is used by canning industry. Once the containers have been washed, they are uniformly filled with the appropriate quantity of the product in order to expel any unwanted gases, especially oxygen. Generally, for fruits filling is done by hand or machine to prevent the bruising.

- **After filling syrup or brine.**

✓ **Syrup -** is a solution of sugar in water, done only for fruits. Syrup is added to improve the flavor and serve as a heat transfer medium for facilitating processing. Strained, hot syrup of concentration 20 to 55˚ brix is used and filled at about 79 to 82℃, leaving headspace of 0.3 to 0.5cm.

✓ **Brine** - is a solution of salt of concentration 1-3%, used for vegetables. The brine should be filtered through a thick cloth before filling.

After Syruping or brining the cans are loosely covered with lids and exhausted. Lidding has certain disadvantages such as spilling of the contents and toppling of the lids. Hence lidding has now been replaced by clinching in which lids is partially seamed. Here a covering liquid is added that can be brine, a sauce, juice or syrup, according to the type of preserved food. The container is filled with the pre-set amount of product while it moves and then goes to the liquids' filler head, with the containers positioned on lifting platforms in the filling position. Here they are gravity filled and space left for a predetermined headroom gap.

Once the containers are filled and before they are sealed, they are preheated to eliminate any air trapped inside of the containers so that there is a partial vacuum that prevents alterations occurring during storage and to reduce the sterilization time, at the same time that the pressure inside the container is reduced during the period of sterilization. In the case of some acid foodstuffs, such as tinned fruit, hydrogen is produced in the can because of acid attacking the steel base of the tin plate. Once enough hydrogen is produced, the container can burst unless sufficient space has been left. Another possibility is for the filling of the product or control juice to be hot packed, which is the case especially with small sized containers. The application of jets of steam is necessary here during sealing.


Fig 4.1 Filling jars with green beans *Fig: 4.2 filling bottles with juice*

4.2. Careful control of any filling operation

- **Careful control of any filling operation is essential to ensure the following**:
  - ✓ Optimum presentation to the consumer.
  - ✓ A consistent product weight, to ensure compliance with statutory regulations and to improve the effectiveness of any subsequent screening.
  - ✓ The maintenance of a uniform headspace. Inadequate headspace may result in under processing where rotary retorts are in use, or in 'flippers'. Excessive headspace may accelerate product deterioration and/or can corrosion during storage, or result in oxidative discoloration (scorch) of exposed solids in the headspace during thermal processing.
  - ✓ The avoidance of flange contamination that may act as a potential source of seam interference which could result in product droops.

Each component of the fill must be effectively controlled to ensure uniformity of composition. Brine, oil, sauces and gravy also help displace air from between solid particulates. Unless these liquids are filled with multi head rotary vaccum fillers, sufficient distance should be left between filler and clincher seamer to allow entrapped air to escape.

Self-Check – 4	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: Short Answer Questions (4 pts each)

1. Discuss in detail, how syrups and brine are filled into a can correctly?
2. Why the careful control of any filling operation was essential?

Note: **Satisfactory rating – 4 points Unsatisfactory - below 4 points**

You can ask you teacher for the copy of the correct answers.

Information Sheet -5 Draining and weighing cans with headspaces

5.1. Weigh cans with headspaces

- **Headspace**

Headspace is the distance between the top of the jar and the top of the food. Foods that swell require more headspace when filling. If too little headspace is left, food may boil up and out of the jar, preventing a seal. If too much headspace is left, the processing time may be inadequate to drive off the oxygen within the jar, preventing the seal from forming. Recipes will specify the amount of headspace that should be left for each specific product.

Headspace, gross is the vertical distance between the level of the product (generally the liquid surface) in an upright rigid container and the top edge of the container (the top of the double seam of a can or the top edge of a glass jar).

Headspace, net of a container is the vertical distance between the level of the product (generally the liquid surface) in the upright rigid container and the inside surface of the lid. Regardless of the type of packing process that is used, all products require that a specific amount of headspace be left after filling.

Generally, the unfilled space above the food in a jar and below its lid is termed headspace. Directions for canning specify leaving 1/4-inch for jams and jellies, 1/2-inch for fruits and tomatoes to be processed in boiling water, and from 1- to 1-1/4-inches in low acid foods to be processed in a pressure canner. This space is needed for expansion of food as jars are processed, and for forming vacuums in cooled jars. The extent of expansion is determined by the air content in the food and by the processing temperature. Air expands greatly when heated to high temperatures; the higher the temperature, the greater the expansion. Foods expand less than air when heated.

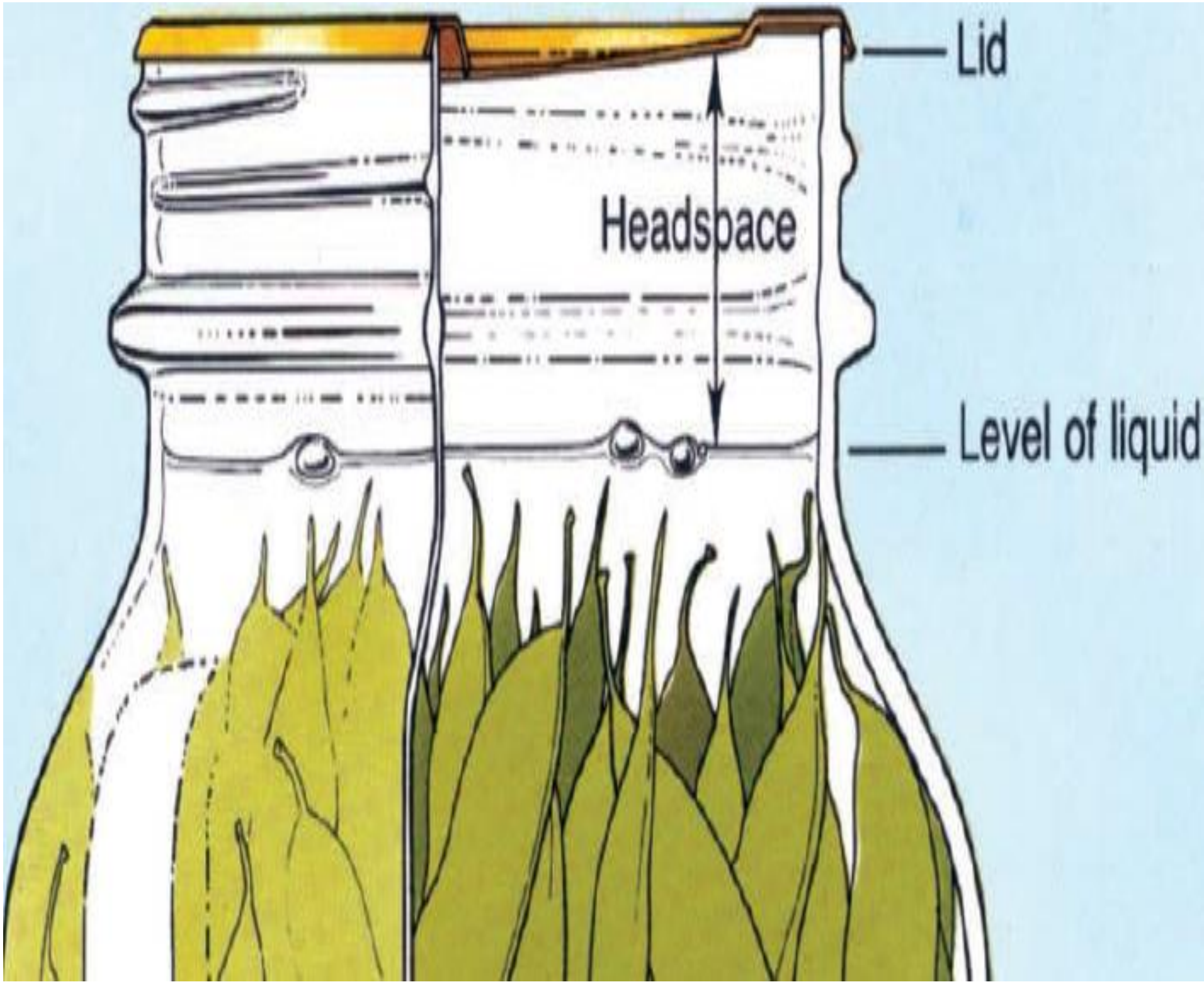

Fig 5.1.measuring headspace

Self-Check – 5	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: Short Answer Questions (4 pts each)

1. Define headspace
2. Explain the importance of measuring headspace

Note: **Satisfactory rating – 4 points** **Unsatisfactory - below 4 points**

You can ask you teacher for the copy of the correct answers.

Information Sheet -6 Recording net weights

6.1. Requirement of recording net weight

The **net weight of an item** is its total weight (known as the gross weight) minus the weight of any containers or packaging the item is in (known as the tare weight). For example, the net weight of a tin of flour is the total weight minus the weight of the tin. In other words, the net weight is the gross weight minus the tare weight.

A. How we can measure net by weight Using a Filled Container

- **Determine the Gross Weight:** Place the object in its container or packaging on a scale. Write down the reading on the scale. This is the gross weight.
- **Determine the Tare Weight**: Transfer the object completely from its container or packaging to a separate container and set it aside. Make sure none of the object (if you are working with items like powders or crumbly substances) remains in the first container. Place all of the original packaging on the scale and record the total weight. This is the tare weight.
- **Subtract the Tare Weight from the Gross Weight**: Subtract the tare weight from the gross weight. For example, say you have a tin of soup with a gross weight of 400 grams and a tare weight of 10 grams. Work out 400 – 10 = 390. The net weight of this item is 390 grams. Check your work with a calculator if you wish.

B. How we can measure net by weight using an empty container

- **Weigh the Empty Container:**

Place the empty container on a scale. Write down the reading on the scale.

- **Work out Your Final Reading:**

Calculate your final weight, which is the weight of the object plus the weight of the container. For example, say you need 500 grams of flour for a recipe and your container weighs 15 grams. The correct reading on the scale would be 500 + 15 = 515.

- **Fill the Container**

Add your object or item to the container until the scale displays your final reading. In this example, add flour to the container until the scale reads 515 grams.

Self-Check – 6	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: Short Answer Questions (5 pts each)

1. Explain about the net weight --

   ----
2. Write down the steps of calculating net weight of filled and empty container:-------
   ----

You can ask you teacher for the copy of the correct answers

Note: **Satisfactory rating – 5 points** **Unsatisfactory - below 5 points**

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Information Sheet -7 Carrying out exhausting

7.1. Carry out exhausting from the can

Exhausting is the process of removal of air from the cans. It is very essential as it avoids the corrosion of tinplate and pin holing during the storage. Exhausting is done to:

- ✓ Minimize discoloration,
- ✓ Reduce chemical reaction between the container and the contents.

It also helps in better retention of vitamin and prevents development of excessive pressure during sterilization. For exhausting heating method is generally used but can also be done by mechanical means.

- The can are passed through a tank of hot water at 82 to 87℃ for 5-10 minutes.
- At the end of exhausting temperature at the center of can should be about 79℃.
- After exhausting can are sealed immediately with the help of can sealer and temperature should not fall below 74℃ during sealing.

Fig: 7.1. Removing air bubbles with a plastic spatula.

Self-Check – 7	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: Short Answer Questions (4 pts each)

1. Define exhausting
2. Write the importance of exhausting

Note: **Satisfactory rating – 4 points Unsatisfactory - below 4 points**

You can ask you teacher for the copy of the correct answers.

Information Sheet -8 Monitoring closing of can

8.1. Requirement of monitoring closing of the can.

Canning can be a safe and economical way to preserve quality food at home. Disregarding the value of your labor, canning homegrown food may save you half the cost of buying commercially canned food. Canning favorite and special products to be enjoyed by family and friends is a fulfilling experience and a source of pride for many people. **Many vegetables** begin losing some of their vitamins when harvested. Nearly half the vitamins may be lost within a few days unless the fresh produce is cooled or preserved. Within 1 to 2 weeks, even refrigerated produce loses half or more of some of its vitamins. The heating process during canning destroys from one-third to one-half of vitamins A and C, thiamin, and riboflavin. Once canned, additional losses of these sensitive vitamins are from 5 to 20 percent each year.

Sealing the containers is an essential part of the canning process because incorrect sealing would lead to recontamination of the foodstuff once it has been sterilized. There are various sealing alternatives according to the type of container. Glass jars are normally vacuum-sealed while tins are closed with a double seam on the seal side and they can be vacuum-sealed. Sealing can be done with either manual equipment or very modern, efficient machinery than can seal over a thousand cans a minute.

- **How canning preserves foods**

The high percentage of water in most fresh foods makes them very perishable. They spoil or lose their quality for several reasons:

- ✓ Growth of undesirable microorganisms—bacteria, molds, and yeasts,
- ✓ Activity of food enzymes,
- ✓ Reactions with oxygen,
- ✓ Moisture loss.

Microorganisms live and multiply quickly on the surfaces of fresh food and on the inside of bruised, insect-damaged, and diseased food. Oxygen and enzymes are present throughout fresh food tissues.

- **Proper canning practices include:**

- ✓ Carefully selecting and washing fresh food,
- ✓ Peeling some fresh foods,
- ✓ Hot packing many foods,
- ✓ Adding acids (lemon juice or vinegar) to some foods,
- ✓ Using acceptable jars and self-sealing lids,
- ✓ Processing jars in a boiling-water or pressure canner for the correct period.

Collectively, these practices remove oxygen; destroy enzymes; prevent the growth of undesirable bacteria, yeasts, and molds; and help form a high vacuum in jars. Good vacuums form tight seals, which keep liquid in and air and microorganisms out.

Self-Check – 8	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: Short Answer Questions (4 pts each)

1. Define canning
2. Write down the importance of canning food
3. List down the activities included in canning

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 6 points**

LG #68	LO #3- Ensure hermetic sealing of processed food product

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Accessing and applying quality requirements of raw materials
- Preparing and cooking raw materials
- Placing and sealing materials

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Access and apply quality requirements of raw materials
- Prepare and cooking raw materials
- Place and sealing materials

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information Sheet 1- Accessing and applying quality requirements of raw materials

1.1. Introduction

High quality products can be produced only from high quality raw materials. One can say that raw materials influence the quality of the products in the highest degree. Food of high quality can be produced from raw materials of high quality, therefore, careful attention must be paid to the cooperation between the producer of raw materials and the processors. As was already mentioned, the quality of products is influenced primarily by the raw materials used. For this reason, close cooperation between agriculture and processing plants is needed. The farmers, in many cases, make agreements with the food industry, not only on the quantity of raw materials produced, but above all on their quality. The quality of raw material is evaluated, and farmers are paid according to that quality (for example for wheat, milk, eggs, and so on). In all cases, the raw material must fulfill all hygienic requirements. Great attention is paid to the presence of different kinds of contamination, such as heavy and toxic metals, toxic metabolites of microorganisms, residues of pesticides, the presence of GM material, and others.

The main raw materials for the food industry are the products of agriculture. The quality of raw materials used influences the total quality of produced food. Quality control is, therefore, a cornerstone in the production of high quality food. Food quality is a rather complex term. It includes perspectives of quality from nutritional, hygienic, sensory, and even technological viewpoints. All mentioned forms of quality attributes influence the quality of the product. As will be described later, some of these attributes can influence food quality in a decisive manner. To assure for the consumer a food supply of guaranteed quality, an effective food control service and reliable control methods are needed. The raw materials for food production are heterogenic ones. According to their origins, raw materials can be divided into two basic classes, plant and animal.

- **The quality control of individual raw materials depends on many factors**:

- ✓ the length of storage,
- ✓ Their disposition to spoilage,
- ✓ The possibility of the presence of contaminants and their ability to influence nutrition, and
- ✓ The total sensory quality of the products, and so on.

Self-Check - 1	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (5 pts each).**

1. Discuss how the raw material quality influences the quality of end products
2. What are the factors in which the quality control of raw materials depends on?

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 5 points** **Unsatisfactory - below 5 points**

Information Sheet 2- Preparing and cooking raw materials

2.1. Requirement of raw materials

The term **raw material** denotes materials in unprocessed or minimally processed states; e.g., raw latex, crude oil, cotton, coal, raw biomass, iron ore, air, logs, water, or "any product of agriculture, forestry, fishing or mineral in its natural form or which has undergone the transformation required to prepare it for eating. On the other hands, **Food processing** is seasonal in nature, both in terms of demand for products and availability of raw materials. Even in the case of raw materials that are available throughout the year, such as:

- ✓ Fruit and
- ✓ Vegetable,

There are established peaks and troughs in volume of production, as well as variations in chemical composition. Availability may also be determined by less predictable factors, such as weather conditions, which may affect yields or limit harvesting.

- **Fruits and vegetables** are classified depending on which part of the plant they come from.
  - ✓ A fruit develops from the flower of a plant,
  - ✓ While the other parts of the plant are categorized as vegetables.
  - ✓ Fruits contain seeds,
  - ✓ Vegetables can consist of roots, stems and leaves.
- **Fruits, vegetables and cereals** are present in the vast majority of chilled foods and can comprise up to 100% of the raw materials purchased by some manufacturers of these products. A diverse range of chilled foods are produced and therefore, a wide variety of ingredients are used. The complexity of requirements is increased by the different formats in which ingredients might be sourced—for example, as primary raw materials (potatoes or peppers) or in a semi-processed form (diced potatoes or blanched peas)—and the different ways they are treated during processing. The provision of appropriate raw and pre-processed material is essential to the manufacturing process and without material that is "fit for purpose," chilled foods production would be impossible.

Properties of Raw Food Materials and Their Susceptibility to Deterioration and Damage the selection of raw materials is a vital consideration to the quality of processed products. The quality of raw materials can rarely be improved:

- ✓ During processing, and while sorting and
- ✓ Grading operations can aid by removing oversize,
- ✓ Undersize or poor-quality units, it is vital to procure materials whose properties most closely match the requirements of the process.

Quality is a wide-ranging concept and is determined by many factors. It is a composite of those physical and chemical properties of the material which govern its acceptability to the ''user.'' The latter may be the final consumer, or more likely in this case, the food processor.

- **Major properties used to determine raw material quality:**

- ✓ Geometric properties,
- ✓ Color,
- ✓ Flavor,
- ✓ Texture,
- ✓ Nutritive value, and
- ✓ Freedom from defects.

Geometric Properties Food units of regular geometry are much easier to handle and are better suited to high-speed mechanized operations. In addition, the more uniform the geometry of raw materials, the less rejection and waste will be produced during preparation operations such as:

- ✓ Peeling,
- ✓ Trimming, and
- ✓ Slicing

For example, potatoes of smooth shape with few and shallow eyes are much easier to peel and wash mechanically than irregular units. Smooth-skinned fruits and vegetables are much easier to clean and are less likely to harbor insects or fungi than ribbed or irregular units.

Fig 2.1 selecting fruit raw material

Fig2.2. selecting raw material vegetable

- **Purpose of raw material selection and preparation**

  ✓ Enable participants to list the raw materials and minor ingredients required to produce their product.

  ✓ Enable them to describe quality criteria and procedures used to control the quality of raw materials.

- ✓ Enable them to calculate the amounts of raw materials required.
- ✓ Produce unit weight of their product.
- ✓ Enable them to describe the need for and methods of raw material preparation for their products.

- **Procedures required for cooking prepared raw material**
  - ✓ Select the appropriate fruit/vegetable
  - ✓ Wash/clean it
  - ✓ Peel fruit
  - ✓ Cut/slice
  - ✓ Processing/cooking/ it
- **Cooking methods can be grouped into three categories:**
  - ✓ Dry-heat methods, with or without fat

Dry-heat cooking methods like stir-frying, pan-frying, deep-frying, and sautéing rely on fats and oil to act as the cooking medium. In dry-heat methods, that don't use fat—like grilling and roasting—food is cooked either by direct or indirect application of radiant heat. No liquid is used, and any fat that is added during the cooking process is intended to add flavor and not to act as a cooking medium. The result is a highly flavored exterior and moist interior.

- ✓ Moist-heat methods

Moist-heat techniques—such as steaming, shallow poaching, deep poaching, and simmering—have traditionally served as simple and economical ways to prepare foods. Many of the classic dishes of the world are prepared using moist-heat methods because water-soluble nutrients are not drawn out of the food as readily. The result is tender, delicately flavored, and healthful dishes.

- ✓ Methods using a combination of dry and moist heat

These methods, which apply both dry and moist heat, are appropriate for foods that are too tough to be successfully prepared by any other method. Tender foods such as fish and vegetables can also be braised or stewed successfully; however, they will require less cooking liquid, a lower temperature, and a shorter cooking time. The first step for most combination methods is to sear the main item. Next, braising is considered appropriate for foods that are portion-size or larger, as well as for cuts from more-exercised areas of large animals, mature whole birds, or large fish. Stewing can use the same meat cuts, but the main item is cut into bite-size pieces and the amount of liquid used in relation to the amount of ingredients varies from one style of preparation to another.

Self-Check - 2	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (5 pts each).**

1. List the Major properties used to determine raw material quality
2. Write down the procedures required for cooking prepared raw material

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 5 points** **Unsatisfactory - below 5 points**

Information Sheet 3- Placing and sealing materials

3.1. Introduction

Specific to industrial use, materials like industrial rubber, Polytetrafluoroethylene (PTFE), Fluorosilicone (FVMQ), Polyurethane (AU, EU) and others are used in the seal fabrication process. These materials are chosen because of their distinct properties that enable the seals to withstand harsh environments. A hermetic seal is any type of sealing that makes a given object airtight (preventing the passage of air, oxygen, or other gases). The term originally applied to airtight glass containers, but as technology advanced, it applied to a larger category of materials, including rubber and plastics. Hermetic seals are essential to the correct and safe functionality of many electronic and healthcare products. This seal by definition completely isolate the outside environment from what is hermetically sealed inside.

Sealants are most often placed in children and teenagers, since tooth decay can start soon after teeth come in. However, adults can sometimes benefit from sealants too, because you never outgrow the risk for developing cavities. A sealant can be placed on a tooth that does not have a cavity in its pits and grooves. These seals are meant to have zero porosity, so there is no leakage even at a molecular level.

- **A hermetic seal is considered to have three types:**
  - ✓ Glass to glass seal
  - ✓ Glass to metal
  - ✓ Metal to metal seal
- **How are sealants applied?**

- ✓ First, the teeth that are to be sealed are thoroughly cleaned.
- ✓ Each tooth is then dried, and cotton or another absorbent material is put around the tooth to keep it dry.
- ✓ An acid solution is put on the chewing surfaces of the teeth to roughen them up, which helps the sealant bond to the teeth.

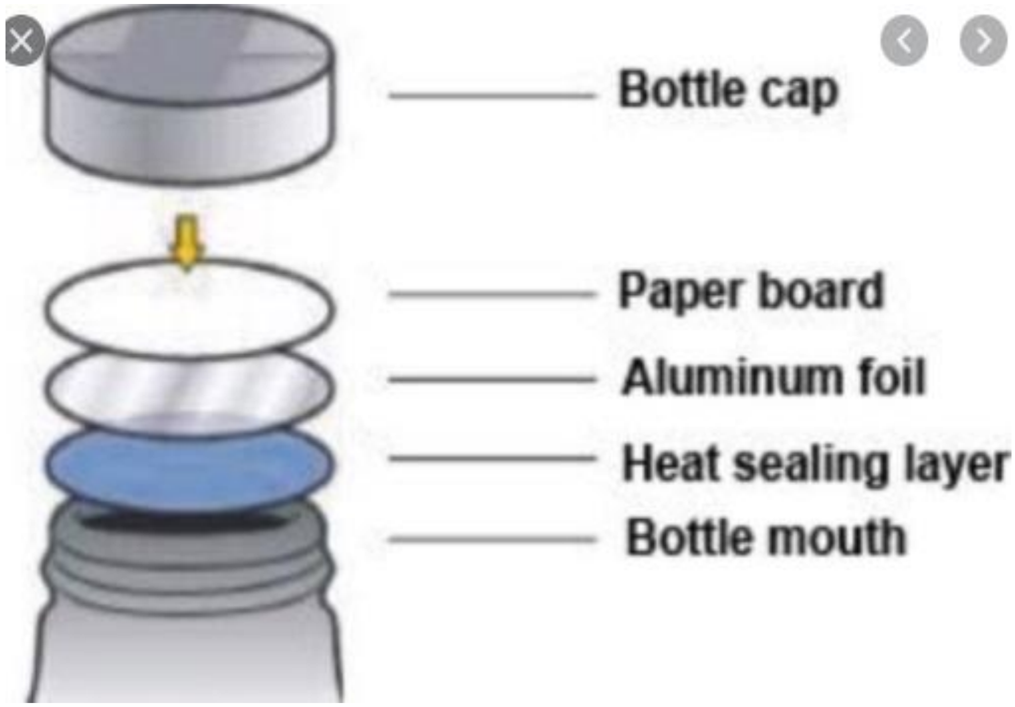

Fig 3.1. Bottle sealing

Self-Check - 3	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (6 pts each).**

1. List the types of hermetic sealant
2. Write down the ways through sealant can be applied

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 6 points** **Unsatisfactory - below 6 points**

LG #69	LO #4- Eliminate harmful micro-organisms in the hermetic sealing or canning of low acid foods

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Identifying micro-organisms of low acid food
- Interpreting D Value of micro-organisms
- Assessing types of microbial spoilage in food canning
- Documenting process

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Identify micro-organisms of low acid food
- Interpret D Value of micro-organisms
- Assess types of microbial spoilage in food canning
- Document process

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information Sheet 1- Identifying micro-organisms of low acid food

1.1. Introduction

Microorganisms require water, nutrients, appropriate temperature, and pH levels for growth. Table1 lists pH as single factor limits for growth of some important food spoilage and poisoning microorganisms. This indicates that minimum pH levels are also dependent on the types of foods. **Low-acid foods** are those that have a pH of greater than **4.6**, meaning that they contain low amounts of acid. In order to be classified as a low-acid food.

Examples of low-acid foods include:

- ✓ Meats,
- ✓ Most vegetables,
- ✓ Most starch based foods, and
- ✓ Most protein-heavy foods.

Canning low-acid food creates the dangerous environment necessary for the growth of Clostridium botulinum. Therefore, the regulations for processing and selling low-acid canned foods are more extensive than for the other food categories. In general, heterotrophic bacteria tend to be least acid tolerant among common food microorganisms. A pH value of 4.5 is especially important because this is the pH below which Clostridium botulinum is widely regarded not to grow in foods. They mentioned that growth and toxin production may occur at pH values below **4.6** if there is strict an aerobiosis, a high concentration of protein, and various acidulants used.

Below about pH 4.2, most other food poisoning microorganisms are well controlled, but those such as:

- ✓ lactic acid bacteria and many species of yeasts and
- ✓ Molds grow at pH values well below this.

Many weak lipophilic organic acids act synergistically with low pH to inhibit microbial growth. Thus, propionic, sorbic and benzoic acids are most useful food preservatives. *Ichthyophonus hoferi* is an internal parasite of various fish species. Its growth was observed at all pH values 3–7 from 0°C to 25°C and from 0% to 6% sodium chloride.

Table 1.1 Low pH Limits or Growth Range for Microbial Growth

No	Microorganism	pH Range Value	pH Inside
1	*Bacillus cereus*	4.9 – 47	-
2	Bacteria	4–9	-
3	Clostridium botulinum	4.5	–
4	Clostridium perfringens	4.5	–
5	Clostridium thermoaceticum	5.0–8.0	5.7–7.3
6	*Pseudomonas* sp.	5.0	-
7	Molds	1.5 – 11	-

- **The low acidic foods include:**
  - ✓ Meats
  - ✓ Seafood (e.g. Edible fish)
  - ✓ Poultry (e.g, chickens)
  - ✓ Dairy products
  - ✓ All vegetables
- **The high acidic foods include:**

✓ Fruits

✓ Properly pickled vegetables

High acid foods have a pH of 4.6 or less and contain enough acid so that the Clostridium botulinum spores cannot grow and produce their deadly toxin. High acidic foods can be safely canned using the boiling water bath method. Certain foods like, tomatoes and figs, that have a pH value close to 4.6 need to have acid added to them in order to use the water bath method. This is accomplished by adding lemon juice of citric acid.

- ## Canning low-acid foods

A low-acid food is defined as a food having a pH of more than 4.6, while a high-acid food is defined as a food with a pH value of 4.6 or lower. This value is critical because of one particular bacterium, *Clostridium botulinum*, which produces a dormant form called a spore. These spores are extremely hard to kill and may survive for many years, waiting for a chance to grow. An improperly processed can of food provides an ideal environment for *Clostridium botulinum* spores, since the bacteria cannot survive in the presence of oxygen. *Clostridium botulinum* produces an extremely potent neurotoxin among the deadliest poisons known. Trace amounts of this toxin, which causes the food-borne illness known as botulism, are enough to kill. Fortunately, the spores of *Clostridium botulinum* will not grow if the pH of a food is 4.6 or less. For low-acid foods with a pH value greater than 4.6, these spores must be killed by heating during the canning process. Because these spores are very heat resistant, canned low-acid foods must be pressure-cooked at high temperatures for long periods. Temperatures of 240°F (115.6°C) or greater are commonly used and process times may range from 20 minutes to several hours.

Most vegetables, meat and poultry foods fall into the low-acid food category. Because of the necessity of insuring the proper processing of low-acid foods, there are a number of detailed regulations governing their production. Anyone wishing to can low-acid foods must be registered with the FDA, use certified equipment, have received proper training at a "Better Process Control School" and keep extensive records as specified by federal regulations (21CFR Part 113 for FDA-regulated foods and 9 CFR Part 318 for USDA regulated foods).

- **Canning high-acid foods**

Examples of high-acid foods include jams and jellies, pickles and most fruits. Because there is no fear of *Clostridium botulinum* growth, these foods require much less heating than low-acid foods. To be safe, such foods need only to reach pasteurization temperatures. For foods with a pH value of 3.5 or less, 175°F (79.5°C) is a sufficient pasteurization temperature. Those foods with a pH range between 3.5 and 4 have a recommended pasteurization temperature of 185°F (85°C). For foods with a pH range of 4 to 4.3, the recommended pasteurization temperature rises to 195°F (90.5°C). Foods with a pH value of 4.3 to 4.5 have a recommended pasteurization temperature of 210°F (99°C).

These pasteurization temperatures are sufficient to kill all microorganisms except for bacterial spores. Since the spores will not grow because of the low pH, the food is considered commercially sterile. A high-acid food will therefore not need the high-temperature process a low-acid food requires. A high-acid food may typically be processed in a hot water or steam bath at atmospheric pressures – no pressure-cooking is required. For this type of processing, the sealed container is heated in the bath until the internal temperature of the slowest heating point reaches the recommended pasteurization temperature for two to10 minutes, depending on the pH value and other properties of the food. The time required to reach this temperature will vary, and is usually set by a Recognized Process Authority after reviewing the food, evaluating the process and perhaps conducting heat penetration tests.

It is important not to over-fill the containers when a water or stream bath process is used in order to allow room for product expansion during processing. A headspace of at least one-fourth of an inch (7 mm) is recommended between the lip of the container and the surface of the food or brine. It is also important to make sure the containers are completely covered with water during the process to insure even heat penetration and avoid under-processing. An alternative processing method is to heat the high-acid food product to pasteurization temperatures and fill it hot into jars for sealing. This popular processing technique is known as “hot filling” or “hot-fill/hold.” Hot filling works well if done properly. It is important to keep in mind the container must be sealed before the food drops below the recommended pasteurization temperature.

For this reason, it is a good practice to heat the food to five to 10 degrees above the recommended pasteurization temperature before filling. This allows time for filling and sealing. For example, if the recommended pasteurization temperature for the product is 185°F (85°C), then the product should be heated to approximately 195°F (90.1°C) prior to filling. Keep in mind with a hot-fill process the inner surfaces of the jar, jar neck and cap must also reach pasteurization temperatures in order to kill any microorganisms present on these surfaces. One good way to insure this is to turn each container upside down and hold it for least two minutes after filling and sealing. This allows the hot product to sterilize the inner jar surfaces. After this hold period, the jars may be cooled if desired.

Self-Check -1	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (5 pts each)**

1) What are the difference between high acidic and low acidic foods?
2) Give examples for each type of foods and write which bacteria can influence them.
3) Define Canning of low and high-acid foods
4) Explain Canning of low and high-acid foods in detail.

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 10 points** **Unsatisfactory - below 10 points**

Information Sheet 2- Interpreting D Value of micro-organisms

2.1. D Value of micro-organisms

Decimal reduction time (D value)-is a measure of the heat resistance of a microorganism. D-value gives time in minutes needed at a certain temperature to kill 90% of the target microorganism. The decimal reduction time *D* is defined as the time necessary for a 90% reduction in the microbial population. Alternatively, the *D* value is the time required for a one log-cycle reduction in the population of microorganisms.

- **General model for description of the microbial curve would be:**

- **DN/dt = $-kN^n$**… Equation (1)

  Whereas:
  - ✓ ***k*** is the rate constant and
  - ✓ ***n*** is the order of the model.

This general model describes the reduction in the microbial population **(*N*)** as a function of time.

A special case of Equation 1 is:

- **D *N*/d*t* = - *kN*** , ……… eq (2)

n is 1.0: a first-order kinetic model.

This basic model has been used to describe survivor curves obtained when microbial populations are exposed to elevated temperatures. Alternatively, the *D* value is the time required for a one log-cycle reduction in the population of microorganisms. Based on the definition of decimal reduction time, the following equation would describe the survivor curve:

$\log N_0 - \log N = t/D$ ………… *eq (3)*

- $D = t / \log N_0 - \log N$ … *eq (4)*

$N/N_o = 10^{-t/D}$ ---------------------------- eq (5)

A solution to Equation (2), when the initial population is *N* 0 and the final population is *N* at time *t*, would be:

- $N/N_o = e^{-kt}$ -------------------------------- **(eq 6)**

By comparison of Equations (5) and, (6), it is evident that:

$$K = D / 2.303$$

The kinetics of a chemical reaction are more often described by Equation (1), and the rates of change in chemical components are expressed by first-order rate constants (*k*). In many situations, the changes in quality attributes of food products during a preservation process are described in terms of first-order rate constants (k).

Example 2. 1: The following data were obtained from a thermal resistance experiment conducted on a spore suspension at 112°C:

Time (min)	**Number of survivors**
0	10^6
4	$1.1 * 10^5$
8	$1.2 *10^4$
12	$1.2 *10^3$

Determine the *D* value of the microorganism.

Approach

The microbial population will be plotted on a semi-log plot to obtain the slope.

Solution

1. On a semilog graph paper, plot the number of survivors as a function of time (Eq1). From the straight line obtained, determine the time for a one-log cycle reduction in the population of spores, which gives the D value as 4.1 minutes.

2. Alternatively, this problem can be solved using a spreadsheet by first taking the natural logarithm of the number of survivors and entering the data in a linear regression model.

The D value of 4.1 minutes is obtained.

Z-value relates the resistance of an organism to differing temperatures.

(***z -value***)- is defined as the increase in temperature necessary to cause a 90% reduction in the decimal reduction time *D*.

Self-Check - 2	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (4 point each)**

1. Define and explain the D value of the microorganism.
2. Drive the formula for D value.
3. Write what No, N, t and k represents.

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 6 points** **Unsatisfactory - below 6 points**

Information Sheet 3- Assessing types of microbial spoilage in food canning

3.1 Microbial spoilage in food canning

Thermophilic and **mesophilic** organism are responsible for canned food spoilage. Thermophilic bacteria can survive at a high temperature of 100℃. Facultative thermophiles can grow at 43℃ and obligate thermophiles grow at 43-77℃. Spoilage by mesophilic organism is the indication of under processing. Generally, Clostridium, Bacillus, yeast and fungi cause spoilage of can due to formation of carbon dioxide and hydrogen.

- ✓ **Thermophiles can cans three types of spoilage**:

a) **Flat sour**: Flat sour spoilage occurs mostly in non-acidic foods by Bacillussuch as B. coagulansand B. sterothermophilus, which produce acid without gas formation. Flat sour spoiled product is unfit for consumption as it has sour odour and highly acidic.

b) **Themophilic acid spoilage**: Clostridium thermosaccharolyticum, an obligate thermophile, is responsible for TA spoilage in which cans swell due to production of carbon dioxide and hydrogen.

c) **Sulphide spoilage**: also known as, sulphur stinker is caused by Clostridium nigrificansin low acid foods and occurs in case of under processing of canned foods. No foods are created equal. Some are naturally high in acid, some are only slightly acidic. Some foods contain an abundance of free moisture, while others are very dry. These characteristics contribute not only to the way a food looks, feels, and tastes, but also to the ability of microorganisms to survive and grow. As a food entrepreneur, you should be aware of how ingredients in your product make the food look, feel, and taste; as well as how the ingredients create environments for microorganisms like bacteria, yeast, and molds to survive and grow.

In canned foods, the most important safety concern is the ability of a bacterium known as *Clostridium botulinum* to grow within the food product. Under certain conditions, *Clostridium botulinum* can survive and grow inside of a sealed container of food and produce a deadly toxin. If the toxin is ingested, the consumer may suffer from botulism which can be fatal. The food processor can avoid this devastating scenario by understanding the properties of t m he food products they are canning and following a process developed specifically for their food product by an expert in the field. One of the first steps in ensuring safe food understands how a food pmroduct should be classified.

Fig 3.1. Canned food samples are tested for the toxin produced by Clostridium botulinum.

The **two types of bacteria** of concern in food preservation are organisms of public health significance and spoilage-causing bacteria. In low-acid foods with a pH greater than 4.6, the organism of public health significance is Clostridium botulinum. Clostridium botulinum spores are capable of growing in low-acid (pH _ 4.6) products during storage and hence must be heat treated to the equivalent of at least 121.1°C for 3 min. Canned foods are processed based on the survival probability for C. botulinum of 10 - 12 or one survivor in 1012 cans. The organism most frequently used to characterize low-acid food spoilage by mesophilic spore formers is PA 3679, a strain of C. sporogenes.

Most food companies accept thermal inactivation of 10^{-5} for mesophilic spore formers and 10^{-2} for thermophilic spore formers. The processing time depends on the bioburden of the most resistant bacteria in a particular food, the spoilage risk involved, and whether food can support the growth of potential contaminating bacteria.

- **The numbers and types of MO in a food are largely determined by:**
  - ✓ Environment from which the food was obtained.

- ✓ Microbiological quality of the food in its raw or unprocessed state (intrinsic factors).
- ✓ Handling and processing sanitation.
- ✓ Effectiveness of packaging, handling and storage conditions in restricting microbial growth (extrinsic factors).

Self-Check - 3	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (4 pts each)**

1. Write and discuss the types of organism that are responsible for canned food spoilage
2. The numbers and types of microorganisms in a food are largely determined by what?

3. Discuss the properties/characteristics of Clostridium botulinum in canned foods.

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 6 points** **Unsatisfactory - below 6 points**

Information Sheet 4- Documenting process

4.1. Documenting the process for eliminating the risk of microbial spoilage

There are different methods to minimize or eliminate microbial spoilage in food processing. Some of them are:

- ✓ Develop unfavorable condition e.g. temperature, moisture
- ✓ Processing foods in different processing ways e.g. thermal processing
- ✓ Addition of additives
- ✓ By preserving

There are six factors that affect/influence bacterial growth, which can be referred to by the mnemonic FATTOM:

- ✓ Food
- ✓ Acid
- ✓ Temperature
- ✓ Time
- ✓ Oxygen
- ✓ Moisture

- **Each of these factors contributes to bacterial growth in the following ways:**

- ✓ **Food:** Bacteria require food to survive. For this reason, moist, protein-rich foods are good potential sources of bacterial growth.
- ✓ **Acid:** Bacteria do not grow in acidic environments. This is why acidic foods like lemon juice and vinegar do not support the growth of bacteria and can be used as preservatives
- ✓ **Temperature:** Most bacteria will grow rapidly between 5°C and 60°C (40°F and 140°F). This is referred to as the danger zone.
- ✓ **Time**: Bacteria require time to multiply. When small numbers of bacteria are present, the risk is usually low, but extended time with the right conditions will allow the bacteria to multiply and increase the risk of contamination
- ✓ **Oxygen**: There are two types of bacteria. Aerobic bacteria require oxygen to grow, so will not multiply in an oxygen-free environment such as a vacuum-packaged container. Anaerobic bacteria will only grow in oxygen-free environments. Food that has been improperly processed and then stored at room temperature can be at risk from anaerobic bacteria.

- ✓ **Moisture**: Bacteria need moisture to survive and will grow rapidly in moist foods. This is why dry and salted foods are at lower risk of being hazardous.

Self-Check – 4	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (5 pts each)**

1. Discuss factors that affect/influence bacterial growth.
2. List the factors that affect/influence bacterial growth.

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 5 points** **Unsatisfactory - below 5points**

LG #70	LO #5- Assess the impact of acidification in relation to hermetic sealing or canning of low acid foods

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Measuring food acidity
- Identifying relationship between acidity and growth of micro-organisms
- Establishing Critical Control Points (CCPs)

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Measure food acidity
- Identify relationship between acidity and growth of micro-organisms
- Establish Critical Control Points (CCPs)

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information Sheet 1- Measuring food acidity

1.1. Measure food acidity

The pH value of a food is a direct function of the free hydrogen ions present in that food. Acids present in foods release these hydrogen ions, which give acid foods their distinct sour flavor. Thus, pH may be defined as a measure of free acidity. More precisely, pH is defined as the negative log of the hydrogen ion concentration.

- **If a food has a pH value of 3.0**, then the concentration of hydrogen ions present in that food is equal to 10^{-3} (0.001) moles/liter. In addition, if the pH value is 6.0, then the concentration of hydrogen ions equals 10^{-6} (0.000001) moles/liter.
  - ✓ These examples show that the concentration of hydrogen ions decreases as the pH value of the food increases. This explains the sometimes confusing fact that a low-pH food is a high-acid food and vice versa.
- **The range of pH is commonly considered to extend from 0 to 14**;
  - ✓ A pH value of 7.0 is neutral, because pure water has a pH value of exactly 7.0;
  - ✓ Values less than 7.0 are considered acidic,
  - ✓ While those greater than 7.0 are considered basic or alkaline.

Figure 1.1 below shows the approximate pH values of several types of foods. A few foods, such as egg whites, sweet corn, and some baked goods may be basic. However, most foods are naturally acidic, with a pH value that is less than 7.0. Even so, the pH value of a particular food may have a dramatic effect on the type of processing needed to safely preserve it. **Acidity of food items** is commonly measured with pH meters and titrators. PH meters (and electrodes) measure the pH value. Titration delivers accurately the acid content. Acidity often also indicates whether a food item is fresh and/ or has been stored properly.

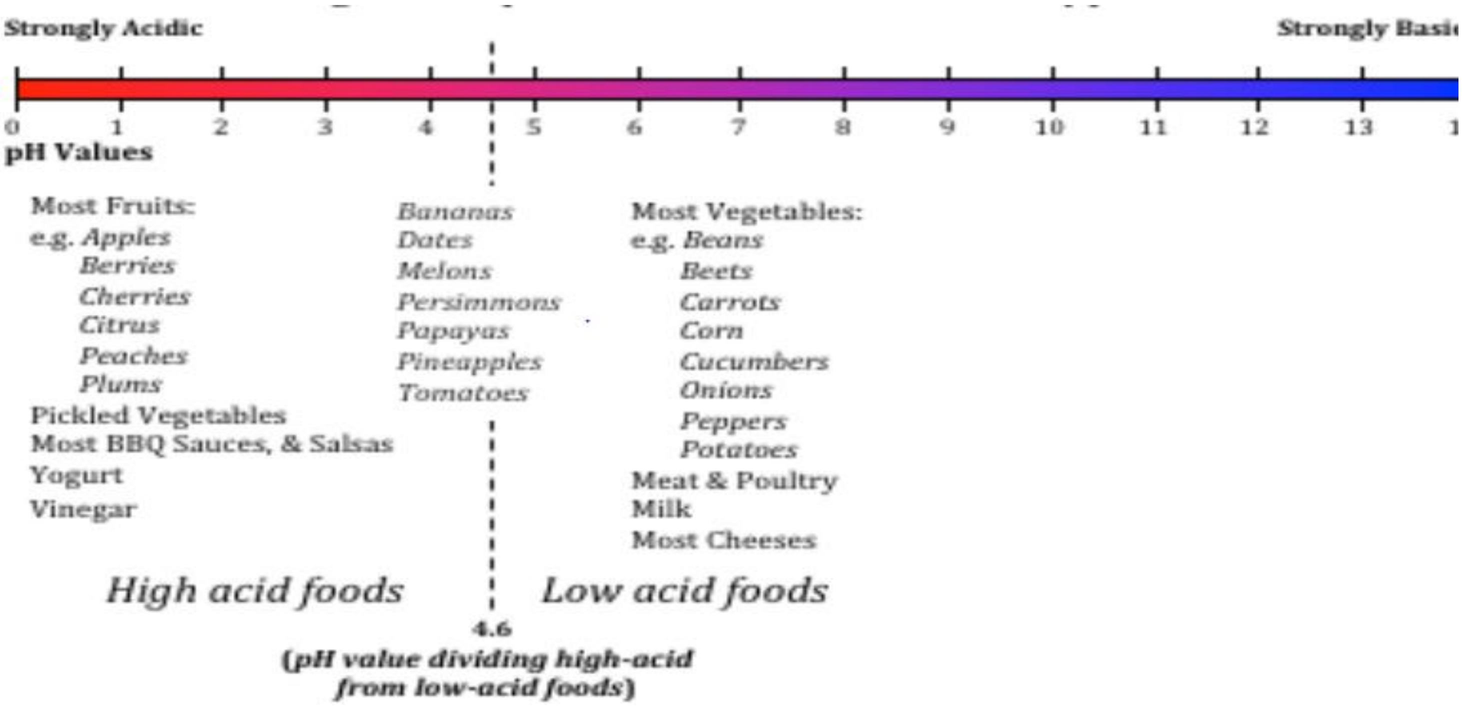

Fig 1.1. pH scale and common food types

1.2. Types of Food acidity

- **Organic acids:**
  - ✓ Citric,
  - ✓ Malic,
  - ✓ Lactic,
  - ✓ Tartaric, and
  - ✓ Acetic acids being the most common
- **Inorganic acids**;
  - ✓ Phosphoric and Carbonic acids (arising from carbon dioxide in solution) often play an important and even predominant role in food acidulation.
- **The organic acids present in foods influence:** -
  - ✓ Flavor (i.e. Tartness)
  - ✓ Color (through their impact on anthocyanin and other pH-influenced pigments)
  - ✓ prevent/retard the growth of microorganisms or inhibit the germination of spores
  - ✓ Providing the proper environment for metal ion chelation, an important phenomenon in the minimization of lipid oxidation.
- **Organic acids may present** : -
  - ✓ Naturally, - By Fermentation –
  - ✓ Added as part of a specific food formulation

1.3. The importance of determining food acidity

Determine the degree of maturity of fruits and vegetables The titratable acidity of fruits is used, along with sugar content, as an indicator of maturity, generally the higher the maturity, the lower the acid content. E.g. in the ripening process, such as tomatoes from green to mature stage, there is an increase in sugar content. To determine the freshness of foods for example in milk, the more the lactic acid levels, means that milk is rotten. Acidity indicators reflect the quality of food. The amount of organic acids in food directly affects the food **flavor, color, stability, and the level of quality**. Determination of acid on the microbial fermentation process Such as **fermentation products in soy sauce, vinegar and other acids is an important indicator of quality**.

There are two ways to express food acidity:

- **Titratable acidity;** Simple estimate of the total acid content of food and Better predictor of acid impact on flavor. Titratable acidity is determined by neutralizing the acid present in a known quantity (weight or volume) of food sample using a standard base. The endpoint for titration is usually either a target pH or the color change of a pH-sensitive dye, typically phenolphthalein.

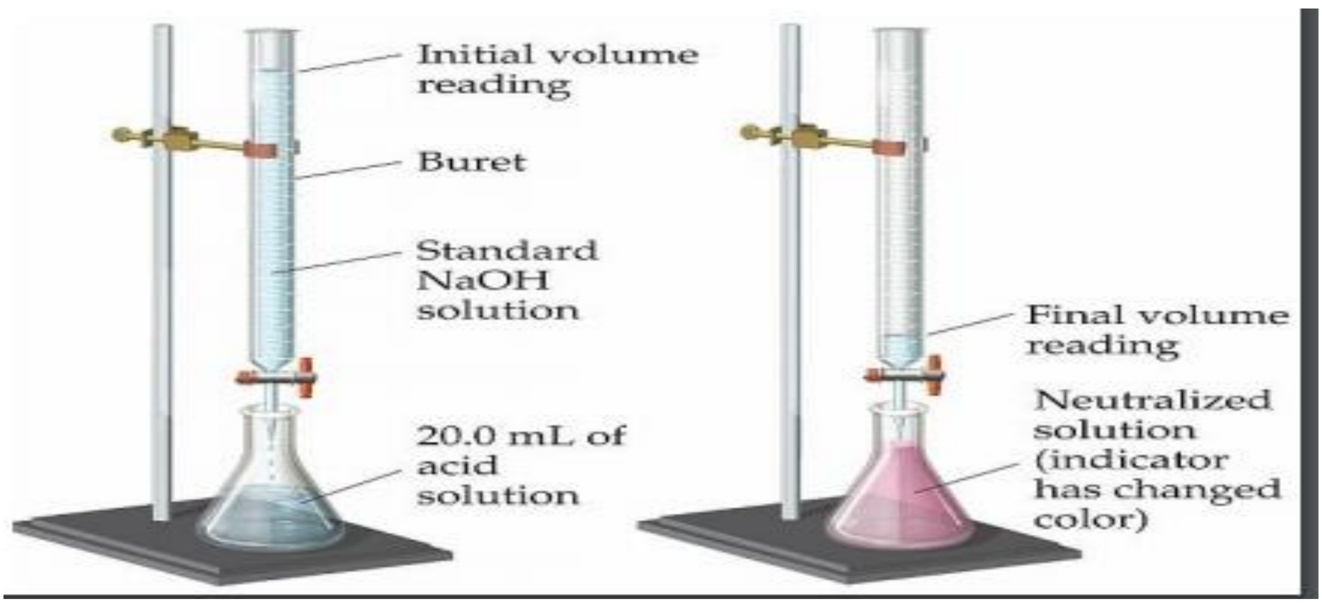

Fig 1.2. The amount of base needed for neutralization reflect the acid content

<u>Not book:</u>

- ✓ Titratable acidity provide a simple estimate of acid in food,
- ✓ Routine titration cannot differentiate between individual acids.
- ✓ Therefore, titratable acidity is usually stated in terms of predominant acid fig

1.3. Color at end

- **Hydrogen concentration pH**; Depend on the strength of acid condition.

Determination of total acidity in juice:

The acidity of natural fruit juices is the result mainly of their content of organic acids. For example, most fruits contain the tricarboxylic acid (citric acid) whereas grapes are rich in tartaric acid & peaches, apricots and plums in malic acids. Both tartaric & malic acids are dicaroxylic acids.

Method:

The acidity of fruit juice may be determined by simple direct titration with 0.1M sodium hydroxide, using phenolphthalein as an indicator.

- ✓ Weight 10 gm juice in beaker.
- ✓ Add 25 ml of distilled water.
- ✓ Titrate with 0.1M NaOH, using 2 drops of phenolphthalein as an indicator.

Calculations:

Calculate percent acidity of fruit juice (citric acid):

- ✓ **Wt. of citric acid** = $\frac{0.1M\ NaOH \times \text{vol. of } NaOH \text{ (in liter)} \times 192.43}{3}$

  192.43 g/mol is the molecular weight of citric acid

- ✓ % **of total acidity** = (wt. of acid / wt. of sample) X 100

  Normal range for citric acid = 0.39 - 1.1 %

Self-Check – 1	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions**

1. Write down the importance of measuring food acidity (10 pts)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 5 points Unsatisfactory - below 5points**

Information Sheet 2- Identifying relationship between acidity and growth of micro-organisms

2.1. pH and microbial growth

- Microorganisms, including**:**
  - ✓ Yeasts,
  - ✓ Molds, and
  - ✓ Bacteria are sensitive to a food's pH.
- Very low or very high pH values will prevent microbial growth.
- No unprocessed food has a pH value high enough to offer much preservative value.
- Many foods do have pH values low enough to offer some protection against microbial growth.
- Very few foods have pH values low enough to completely inhibit the growth of microorganisms, especially:
  - ✓ yeasts and
  - ✓ Molds, which can tolerate lower pH conditions than most bacteria.
- For almost all foods, some combination of microbial controls, such as:
  - ✓ Heat processing,
  - ✓ Refrigerated or
  - ✓ Frozen storage, or
  - ✓ Drying must be used to help preserve the food.
- Of these, the most common is **heat processing or canning**.

Canned foods may be defined as any food sold in a hermetically sealed (water and airtight) container at non-refrigerated temperatures.

- Some of the most important pieces of information used in a canning operation are:
  - ✓ **processing times** and
  - ✓ **Temperatures**.
- To be clear, processing times do not in this case refer to the time needed to cook the food.

Rather, by processing times we mean the heating times needed for canned food products to reach what is known as "**commercial sterility**."

- We may define commercial sterility as the point when any harmful microorganisms capable of growing in the food have been killed.
- The exact processing time for a canned food product will depend on several factors. These include:
  - ✓ The pH. of the food,
  - ✓ The thickness or viscosity of the product,
  - ✓ The size of the food particles,
  - ✓ The dimensions of the container, and
  - ✓ The temperature of the cooking medium.

For canning in particular, the pH of the food plays a key role in determining the extent of heat processing needed to insure a safe final product.

2.2. Releashinship between acid and micro organisms

Most vegetables, meat, and poultry foods fall into the low-acid food category. Because of the necessity of insuring the proper processing of low-acid foods, there are a number of detailed regulations governing their production. **a low-acid food** is defined as a food having a pH of more than **4.6** while a high-acid food is defined as a food with a pH value **of 4.6** or lower. This value is critical because of one particular bacterium, *Clostridium botulinum*, which produces a dormant form called a spore. These spores are extremely hard to kill and may survive for many years, waiting for a chance to grow. An improperly processed can of food provides an ideal environment for *Clostridium botulinum* spores, since the bacteria cannot survive in the presence of oxygen. Temperatures of 240°F (115.6°C) or greater are commonly used and process times may range from 20 minutes to several hours for low acid food.

Examples of high-acid foods include jams and jellies, pickles, and most fruits. Because there is no fear of *Clostridium botulinum* growth, these foods require much less heating than low-acid foods. To be safe, such foods need only to reach pasteurization temperatures. For foods with a pH value of 3.5 or less, 175°F (79.5°C) is a sufficient pasteurization temperature. Those foods with a pH range between 3.5 and 4.0 have a recommended pasteurization temperature of 185°F (85°C). For foods with a pH range of 4.0 to 4.3, the recommended pasteurization temperature rises to 195°F (90.5°C). Foods with a pH value between 4.3 and 4.5 have a recommended pasteurization temperature of 210°F (99°C).

Examples of low acid foods include beans, beets, carrots, corn, cucumber, onion, peppers and potatoes.

Generally, if the acidy of food increase the availability of microorganisms is low, while it increase if the acidity of food became low.

Self-Check – 2	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **choose the correct answer (6 pts each)**

1. The exact processing time for a canned food product will depend on several factors:
   A. The pH. of the food,
   B. The thickness or viscosity of the product,
   C. The size of the food particles,
   D. The dimensions of the container, and
   E. The temperature of the cooking medium.
   F. All
2. Which is not microorganisms, A. Yeasts, B. Molds, C. Bacteria D. None

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 5 points** **Unsatisfactory - below 5points**

Information Sheet 3- Establishing Critical Control Points (CCPs)

3.1. Establishing Critical Control Points (CCPs) for acidified foods.

Hazard analysis critical control point (HACCP) is a systematic approach to the **identification, evaluation, and control** of food safety hazards based on the following seven principles:

- ✓ Conduct a hazard analysis.
- ✓ Determine the critical control points (CCPs).
- ✓ Establish critical limits.
- ✓ Establish monitoring procedures.
- ✓ Establish corrective actions.
- ✓ Establish verification procedures.
- ✓ Establish record-keeping and documentation procedures

- **A critical control point (ccps):**
  - ✓ The 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.
  - ✓ Complete and accurate identification of CCPs is fundamental to controlling food safety hazards.
  - ✓ The information developed during the hazard analysis is essential for the HACCP team in identifying which steps in the process are CCPs.
- **Critical Limit**:

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.

A hazard analysis of a typical acidified foods operation reveals several potential hazards:

- ✓ Raw materials must be inspected for wholesomeness and be free from decay and unsound tissues which might harbor harmful microorganisms.

- ✓ Raw materials must be purchased from reputable suppliers and be grown on fields using safe agronomic practices. Any fertilizers from human or animal waste should be properly composted and applied. Pesticides should be approved and applied in accordance with label procedures.
- ✓ Raw produce shall be washed in potable water to remove surface residues and foreign materials.
- ✓ Other ingredients shall be purchased from reputable suppliers, be produced in inspected processing establishments and be of food grade.
- ✓ All ingredients must be protected from contamination or spoilage using refrigeration or other appropriate means.
- ✓ Formulated ingredients which are not shelf stable shall be held under refrigerated conditions to prevent the growth of harmful microorganisms.
- ✓ Workers with communicable diseases and those with skin infections shall be excluded from handling foods or utensils because of the danger of spreading harmful microorganisms.

3.2. Control Point

- ✓ A critical control point is a step in the process, which must be controlled to assure food safety.
- ✓ The identification of a critical control point is based on the CCP decision tree.
- ✓ The first step in the CCP decision tree is to determine whether any preventive measures exist for this particular hazard.
- ✓ For example, one possible hazard at a restaurant is food-borne illness from undercooked pork.
- ✓ A finished equilibrium pH of **4.6 or below** to prevent botulism is always a critical control point for acidified foods.
- ✓ Other points such as those considered below may also be critical, depending on the **product** and **process.**
- ✓ A terminal heat treatment of **180^{o}F** will reduce the population of harmful and spoilage microorganisms in the product.

Materials such as:

- ✓ Peppers,
- ✓ Tomatoes and

- ✓ Cucumbers may need to be sliced, chopped or pierced to provide intimate contact with the brine.

Container closures shall be intact and free from food product on sealing surfaces in order to provide proper hermetic seal.

The critical control point for acidified foods is a finished equilibrium pH of 4.6 reached within 24 hours.

- **Critical Limits/Monitoring**

Critical control points are located at any step where hazards can be either:

- ✓ Prevented,
- ✓ Eliminated ,or
- ✓ Reduced to acceptable levels.

Examples of CCPs may include:

- ✓ Thermal processing,
- ✓ Chilling,
- ✓ Testing ingredients for chemical residues,
- ✓ Product formulation control, and
- ✓ Testing product for metal contaminants.

The specified heat process, at a given **time** and **temperature** designed to destroy a specific microbiological pathogen, could be a CCP. Likewise, refrigeration of a precooked food to prevent hazardous microorganisms from multiplying, or the adjustment of a food to a **pH** necessary to prevent toxin formation could also be CCPs.

- **Critical control points are measurable and must have established critical limits**.

These critical limits should be monitored as in the example below. One critical control point for all acidified foods is a finished equilibrium pH of 4.6 or below. This determination must be made within 24hours by the following procedure:

- Drain and rinse the solid material. Chop peppers and such materials as necessary to allow brine to drain
- Place solids in a blender and blend thoroughly.
- Check the pH with a properly calibrated pH meter calibrated with pH 4 and pH 7 buffers.

- If the pH is below 4.0, record the pH for the lot.
- If the pH is between 4.0 and 4.5, repeat the procedure.
- If the pH is above 4.5, follow the corrective actions and record as a process deviation.
- Record all observations.

- **Corrective Actions**

When the monitored critical control point indicates loss of control, (e.g. critical limits not met) predetermined corrective actions must be taken. A corrective action for pH readings outside of the critical limits is indicated below. If the pH exceeds 4.5 and the product has been held at room temperature more than four hours, discard the contents of the jar and the lids. Jars may be thoroughly washed and recovered. Reprocess the product with new brine, heat and seal. Record the reprocessing in the process deviation log. Retest for pH within 24hours as noted above.

- **Records**

Critical control point measurements such as process conditions and pH determinations shall be documented for each lot. Coded lots of finished products shall be traceable to all ingredient, quality, process and container records. All process deviations must be recorded in a separate log together with information on the disposition of affected lots.

- **Verification**

Logs of pH determinations shall be reviewed and signed by the certified supervisor on a daily basis, within 24 hours of production. A control chart of pH determinations for each product shall be maintained to visually spot trends in pH readings.

Self-Check – 3	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: Short Answer Questions (5 pts each)

1. How critical limits should be monitored in establishing Critical control points (CCPs) for acidified foods
2. Explain Critical control points (CCPs)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 5 points** **Unsatisfactory - below 5 points**

LG #71	LO #6- Monitor retort operation

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Loading containers onto baskets
- Sealing retort
- Removing air trapped inside retort
- Maintaining sterilization temperature
- Building up pressure
- Cooling can use chlorinated water.

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Load containers onto baskets
- Seal retort
- Remove air trapped inside retort
- Maintain sterilization temperature
- Build up pressure
- Cool can use chlorinated water.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information Sheet 1- Loading containers onto baskets

1.1. Introduction

When perishable goods must be transported by sea, refrigerated ships with air circulation systems are used, along with refrigerated containers. Air, however, is widely considered the best way to transport perishable goods. Perishable cargo may be defined as goods that can deteriorate if not stored or transported under ideal circumstances or if exposed to adverse temperature, humidity and other environmental conditions. Pack produce into sturdy, opaque, breathable containers. Waxed cardboard boxes work well; plastic storage containers with holes drilled in them are also suitable. **Fragile fruits and vegetables**, such as peaches and tomatoes, should be packed in a single layer. Wrap each fruit individually in tissue or brown packaging paper and place it in a single layer on top of the prepared insulated bubble wrap. Add packing peanuts to fill in any gaps. Then place a box liner sheet on top of the fruit. Continue layering fruit and InsulTote box liners until the box is completely full.

Packaging fresh fruits and vegetables is one of the more important steps in the long and complicated journey from grower to consumer;

- ✓ Bags,
- ✓ Crates,
- ✓ Hampers,
- ✓ Baskets,
- ✓ Cartons,
- ✓ Bulk bins, and
- ✓ Palletized

Containers are convenient containers for handling, transporting, and marketing fresh produce. More than 1,500 different types of packages are used for produce in the United States and the number continues to increase as the industry introduces new packaging materials and concepts. Although the industry generally agrees that container standardization is one way to reduce cost, the trend in recent years has moved toward a wider range of package sizes to accommodate the diverse needs of wholesalers, consumers, food service buyers, and processing operations.

Loading and unloading/handling equipment and dedicated ports dominate the systems may then be re-packed into surface containers for subsequent woven into bags or baskets and used for carrying meat, fruit and vegetables countries laws designed to protect manual workers are rarely enforced. Container loading is a pivotal function for operating supply chains efficiently. Underperformance results in unnecessary costs (e.g. cost of additional containers to be shipped) and in an unsatisfactory customer service, (e.g. violation of deadlines agreed to or set by clients). Thus, it is not surprising that container-loading problems have been dealt with frequently in the operations research literature. It has been claimed though that the proposed approaches are of limited practical value since they do not pay enough attention to constraints encountered in practice. Shipping grapefruits in the middle of summer or apricots in the dead of winter can be successful.

- **Guidelines for Transport with Metal Wire Baskets**

✓ Make sure you always put the heaviest items on the bottom. If you put heavier items on top, they could damage the container underneath.

✓ Try to distribute the weight evenly in your baskets so they don't suddenly shift to one side.

✓ You should also secure your wire baskets when transporting them overseas. Turbulence on the ocean could lead to your baskets sliding around, which could damage the contents of the basket or injure someone nearby.

✓ If you have loose cargo in one of your baskets, consider tying your items down to the floor of the basket, so they don't shift during transit.

✓ If you are shipping folded collapsible containers, secure them together so they are easier to move. Otherwise, they could easily slip out and move around during transit.

✓ Avoid stacking your baskets too high during transit or they may fall down and injure someone, especially if there is a lot of turbulence during the trip.

✓ When shipping with stackable wire baskets, secure your containers together to avoid containers falling over.

✓ Avoid leaving empty space around your collapsible containers. Insert bricks, air bags, nets and other shipping supplies to prevent the containers from moving around.

✓ Avoid overloading your containers and always adhere to the weight guidelines.

- **How to Ship Fruits & Vegetables:**

✓ Select fruits that are sturdy enough to endure shipping. Those with hard skins (apples, pears, citrus, apricots, and cherries) are good travelers. Softer fruits (plums and peaches) will only arrive safely with extra packaging and careful handling. Avoid berries and other fragile fruits.

✓ Choose perfect fruit (no bruises, brown spots or damage) that is slightly under-ripe.

✓ Determine the best shipping box. Wooden crates are preferred for fragile fruit but corrugated boxes are fine if enough padding is used. Choose a box large enough to include the padding needed to protect the food from mishandling and temperature changes.

✓ Prepare the box by lining it with an InsulTote insulated bubble wrap box liner; this product acts as a heat deflector and insulator (InsulTote offers many sizes of box liners with no minimum order required).

✓ Wrap each fruit individually in tissue or brown packaging paper and place it in a single layer on top of the prepared insulated bubble wrap. Add packing peanuts to fill in any gaps. Then place a box liner sheet on top of the fruit.

✓ Continue layering fruit and InsulTote box liners until the box is completely full. More padding decreases the chance that your product will be damaged in transit.

✓ Ship the box overnight if possible. Depending on the weather, sturdy fruits will stand up to 2 – 3 day shipping. Plan to ship early in the week to avoid your package waiting in transit over the weekend.

Note: Know the laws regarding interstate shipments and prohibited fruits. Contact the Department of Agriculture in the state(s) where you plan to ship. Look online for the specific state; most websites will also list a help line. Your local post office is a source of information as well. Ignore this step and risk paying large fines for shipping prohibited produce, plants and other items!

- **How to ship food so it stays fresh**

✓ Wrap baked goods to create an airtight seal. ...

✓ Select appropriate insulation for food that must remain cold or frozen. ...

✓ Package items that can melt thaw or contain liquid in watertight plastic. ...

✓ Choose the best refrigerant for cold or frozen items. ...

✓ Pad and pack to minimize movement.

Self-Check – 1	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: Short Answer Questions

1. List the ways of transporting fruit and vegetable(8 pts)--
----

You can ask you teacher for the copy of the correct answers.

***Note:* Satisfactory rating – above 4 points** **Unsatisfactory - below 4 points**

Information Sheet 2- Sealing retort

2.1. Introduction

The retort pouch is a flexible laminated food package that can withstand thermal processing. It has the advantage of offering the shelf stability of metal cans, coupled with the texture and nutrient value associated with frozen foods. The retort pouch has been considered the most significant advance in food packaging since the metal can, and has the potential to become a feasible alternative to the metal can and glass jar. **Retorting** is heating of low acid foods prone to microbial spoilage in hermetically sealed containers to extend their shelf life. The goal of retort processing is to obtain commercial sterilization by application of heat. Retort processing technology helps obviate the requirement of refrigeration during storage of food products and thereby enables production of food products that can be stored at ambient temperature. Sometimes also called an Autoclave or Sterilizer, a Retort is a pressure vessel used in the food manufacturing industry to “commercially sterilize” food after it has been placed into its container and the container has been hermetically sealed. More on commercial sterilization later.

The **retorting or sterilization** process (technology that destroy all harmful microorganisms hence increases the shelf life of food) ensures the stability of the Ready-to-Eat foods in retort pouches, on the shelf and at room temperature. Much of the food consumed each year is preserved by packaging it in hermetically sealed containers in a process known as canning. One of the most important steps in the canning of foods is ‘**thermal processing;** more commonly referred to as the **retorting operation**. In this operation, strict specifications concerning both time and temperature must be adhered to and repeated, batch after batch, to obtain sterile product of uniform quality. Thermal processing is performed in batches using a cylindrical pressurized vessel called a retort. Retorts are classified as vertical or horizontal, depending on the position of their long axis; a vertical retort is loaded from the top, a horizontal retort is loaded from a side end.

- ✓ In either retort type, the canned product is cooked by 1 of 2 processes.

- ✓ Steam cooking, for product stored in metal containers
- ✓ Water cooking, for product stored in glass jars Steam cooking is performed in a steam atmosphere devoid of air. Water cooking is performed in steam-heated water

The Control Master controller (or a PLC) is used to control the temperature and pressure inside the retort. The profile control feature in Control Master is widely used in retort process for set point profiling. Special new features such as guaranteed ramp/soak, self-seeking set point and 8 segment events, together with the Control Master's existing maths, alarm, interlocking logic and control capabilities makes Control Master well-suited for complex retort processes.

Figure 2.1 Examples of Retort Pouches

Retort pouches are made of a multilayer laminate film material that can withstand the retort process and produce a shelf stable food product. The packaging material is currently used to package numerous components of United States military rations as well as commercially-available food products for general consumers.

Advantages of using retortable flexible containers

Retort pouches combine the advantages of the metal can with the frozen boil-in-the-bag. The attributes of flexible containers offer benefits for the consumer, retailer, and manufacturer alike:

- ✓ The thin profile of the pouch or container provides rapid heat transfer for both preparation and for sterilization during processing. A 30–40% reduction in processing time is possible, with energy savings.
- ✓ Reduced heat exposure results in improvements in taste, colour, and flavor; there are also fewer nutrient losses.
- ✓ Preparation of products that need to be heated to serving temperature can be accomplished in 3–5 min by immersing the pouch in boiling water or placing the plastic container in a microwave oven.
- ✓ Storage space of the retort pouch or container in a paperboard carton is no larger than that for cans; disposal space is less.
- ✓ Shelf life of retort pouch products is equivalent to that of foods in metal cans.
- ✓ Refrigeration or freezing is not required by packers, retailers, or consumers.
- ✓ Pouches and containers do not corrode externally and there is a minimum of product–container interaction.
- ✓ Opening the pouch requires only tearing the pouch across the top at the notch in the side seam, or by using scissors. The container lid may be peeled open or cut with a knife.
- ✓ The flexible container is safer in that a consumer would not be cut as on a metal can or be faced with broken glass as with glass jars.
- ✓ Empty retort pouches and nesting containers offer processors a reduction in storage space and lighter weight. Compared with empty cans, an equal number of retort pouches use 85% less space and are significantly lighter.
- ✓ Advantages for the retailer include savings in shelf space and the shape makes it easier for the retailer to handle and display the product.
- ✓ The use of a flat carton as an overwrap to hold one or two pouches provides for better product identification on the shelf than cans. The pouch also offers the opportunity to market multipacks, e.g., entree in one pouch and accompaniment such as rice in another.
- ✓ Energy requirements for container construction are less than that for cans.

Self-Check – 2	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (5 pts each)**

1. What are the two (2) retort operation process in which canned product is cooked
2. Define retorting operation means

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 5 points Unsatisfactory - below 5 points**

Information Sheet 3- Removing air trapped inside retort

3.1 Remove air trapped inside retort

The **removal of air from the retort** occurs by injecting steam at one end and removing the air at the other end. The elimination of air from the retort is fundamental to assure uniformity and efficiency of the sterilization, since the presence of regions with stagnant air act as a thermal insulator, decreasing the efficiency of the heat transference process, resulting in sub processing. Even though the outflow of steam demanded at this stage is of short duration, it makes up 25–50% of the total steam consumed during the whole thermal processing. Furthermore, the condition becomes worse in installations using many retorts, where two or more units may be in the venting cycle at the same time, resulting in a great demand on steam production.

The **retort pouch** is a very demanding package that consists of a three-layer laminate that will be processed like a can, will be shelf-stable, and allows the convenience of frozen boil-in-the-bag products. It may be composed of an outer layer of polyester film, a middle layer of aluminum foil, and an inner layer of modified polypropylene. Material for retort pouches must provide superior barrier properties over a long shelf life, seal integrity and toughness/puncture resistance, and must withstand the thermal rigors of a canning process, which might have temperatures up to **135 °C (275 °F).** The advantage of the retort pouch over a can is its flatter shape compared to the round shape of a can; thus, a more uniform heat and less heat is required to bring the temperature in the product center to the safe level. Since air is considered an insulating medium, saturating the retort vessel with steam is a requirement of the process. It is inherent in the process that all air be evacuated from the retort by flooding the vessel with steam and allowing the air to escape through vent valves.

It is well known that the heat transfer properties of air or air-steam mixtures are inferior to those of steam and that, because of this; entrapped pockets of air in a cannery retort may lead to under-processing and spoilage. Consequently there is a need for adequate purging or venting of air from any retort during the processing ‘come-up’period.

Steps required to remove air from retort include:

- ✓ **Come Up Vent Open (A Sterilization Step);**

The purpose of this step is to saturate the vessel with steam, and to eliminate all air that may have been trapped in the retort. This step is accomplished by opening the vent valve and opening the steam control valve (and, if configured, opening the steam bypass valve.)

- ✓ **Come Up Vent Closed (A Sterilization Step);**

During this step, the vent valve is closed and the temperature is controlled and ramped to Cook Temperature (unless multiple Come up Vent Closed steps are utilized.) In order to successfully complete this phase, both time and temperature conditions, established in the recipe must be met **simultaneously**. At the end of the scheduled come-up time, the retort must be at, or above, scheduled cook temperature. If it does not meet these conditions, the step time may be extended so that the recipe temperature can be reached, without creating a deviation.

- ✓ **Cook (A Sterilization Step)**

The purpose of the Cook Step is to maintain the recipe temperature for the time required by the recipe. In order to successfully complete this step, the temperature condition established in the recipe (the filed process) must be met for the length of time defined for the step. Should a temperature drop occur at any time during the step, then a temperature deviation condition is created

- ✓ **Pressure Cool Fill;**

This step begins the cooling process. The cooling water enters the retort as overriding pressure control is initiated. In the initial phase of this step, steam is collapsed by the cooling water, which is displaced by large quantities of air. As the vessel fills, pressure will build as the air is compressed by the rising water level. The BPR valve is used to relieve excess pressure while the air valve is used to make up pressure.

- ✓ **Pressure Cool**

This step continues the retort cooling process. Cooling water continues to flow into the Process Vessel and flows out through the drain valve, which controls the level.

- ✓ **Atmospheric Cool**

This step continues the retort cooling process. Cooling water continues to flow into the Process Vessel and flows out through the drain valve, which controls the level.

- ✓ **Drain (Not Recipe-Configurable)**

This step drains the water from the retort. The drain is opened the water gravity-drains from the retort. When the level condition is met, the step ends. Note: To accelerate the drain step, limited overriding air pressure (2-5psi) may be used during the step.

- **Generally, in order to remove air from retort:**

- ✓ Container are loaded into the chamber.
- ✓ The retort lid is sealed

Venting stage

- ✓ Air trapped inside the retort is removed prior processing
- ✓ If air is present at agiven, pressure the temperature inside the retort will be lower than that attained by steam alone.
- ✓ A mixture of air and steam may stratify leading to cool spots where there is air.

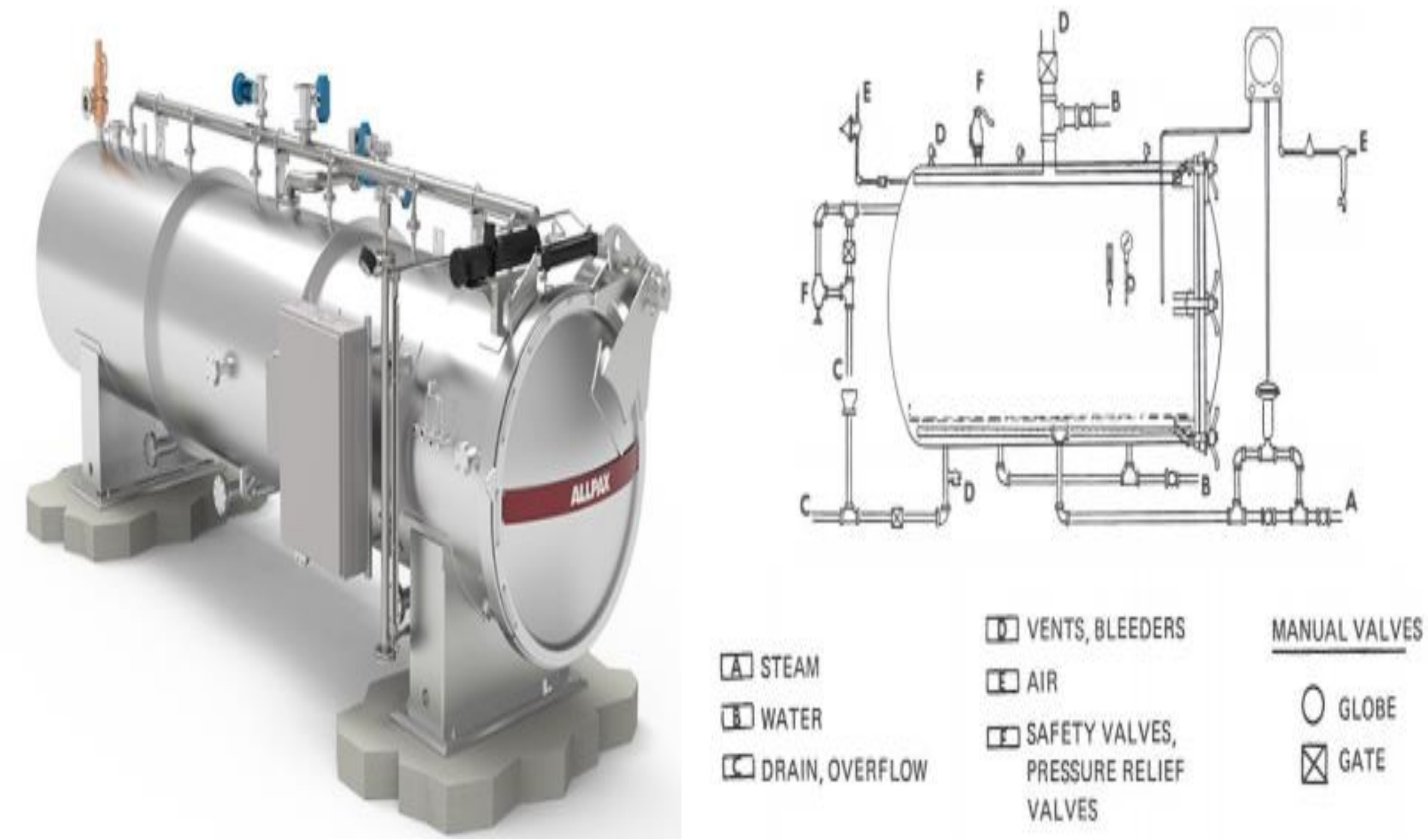

Fig 3.1 Schematic drawing of a horizontal report

Self-Check – 3	**Written Test**

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (5 pts each)**

1. Explain the ways through air trapped can be removed from retort;--------------------------------------
----

You can ask you teacher for the copy of the correct answers.

***Note:* Satisfactory rating – above 2.5 points Unsatisfactory – below 2. 5 points**

Information Sheet 4- Maintaining sterilization temperature

4.1 Sterilization temperature

Fruit and vegetable juices and beverages are generally preserved by thermal processing, currently being the most cost-effective means ensuring microbial safety and enzyme deactivation. However, thermal treatments may induce several chemical and physical changes that impair the organoleptic properties and may reduce the content or bioavailability of some nutrients; in most cases, these effects are strongly dependent on the food matrix. Moreover, the efficacy of treatments can also be affected by the complexity of the product and microorganisms. The **thermal processing** of canned food is the most important step in the canning procedure. Retort operating procedures must ensure that uniform processing temperature is achieved and **maintained** throughout the locations of the canned containers during the process.

Sterilization is necessary for the complete destruction or removal of all microorganisms (including spore forming and non-spore forming bacteria, viruses, fungi, and protozoa) that could contaminate pharmaceuticals or other materials and thereby constitute a health hazard. Since the achievement of the absolute state of sterility cannot be demonstrated, the sterility of a pharmaceutical preparation can be defined only in terms of probability. The efficacy of any sterilization process will depend on the nature of the product, the extent and type of any contamination, and the conditions under which the final product has been prepared. The requirements for Good Manufacturing Practice should be observed throughout all stages of manufacture and sterilization.

Classical sterilization techniques using;

- ✓ Saturated steam under pressure or
- ✓ Hot air are the most reliable and should be used whenever possible.

The method of choice for sterilization in most labs is **autoclaving**; using pressurized steam to heat the material to be sterilised. This very effective method kills all microbes, spores and viruses, although, for some specific bugs, especially high temperatures or incubation times are required. The recommendations for sterilization in an autoclave are 15 minutes at 121-124 °C (200 kPa).1 the temperature should be used to control and monitor the process; the pressure is mainly used to obtain the required steam temperature. Alternative conditions, with different combinations of time and temperature, are given below.

Specific temperatures must be obtained to ensure the microbicidal activity. The two common steam-sterilizing temperatures are **121°C (250°F) and 132°C (270°F).** Sterilization is the process of killing all micro organ- isms (bacterial, viral, and fungal) with the use of ei- ther physical or chemical agents. A disinfectant is a chemical substance that kills microorganisms on in- animate objects, such as exam tables and surgical in- struments. ... Skin can never be completely sterile.

- ✓ **Common methods** of sterilization include:
- ✓ physical methods and
- ✓ Chemical methods.

Physical methods include:

- ✓ Dry heat,
- ✓ Steam,
- ✓ Radiation, and
- ✓ Plasmas.

Radiation encompasses a variety of types, including:

- ✓ Gamma radiation,
- ✓ electron beam,
- ✓ X-ray,
- ✓ Ultraviolet,

- ✓ Microwave, and
- ✓ White (broad spectrum) light.

The texture of the canned vegetables, pasta, fish and meats is often softer than desired; canned milk products may be too brown; the surface of canned meats and other solid-packed products may be darkened by contact with the inner surface of the hot can, etc. Excess heat also has economic implications; energy consumption is a significant component of food processing costs.

Factors affecting sterilization by heat are:

- ✓ Nature of heat: Moist heat is more effective than dry heat
- ✓ Temperature and time: temperature and time are inversely proportional. As temperature increases the time taken decreases.
- ✓ Number of microorganisms: More the number of microorganisms, higher the temperature or longer the duration required.
- ✓ Nature of microorganism: Depends on species and strain of microorganism, sensitivity to heat may vary. Spores are highly resistant to heat.
- ✓ Type of material: Articles that are heavily contaminated require higher temperature or prolonged exposure. Certain heat sensitive articles must be sterilized at lower temperature.
- ✓ Presence of organic material: Organic materials such as protein, sugars, oils and fats increase the time required.

Self-Check – 4	**Written Test**

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (6 pts each)**

1. List the importance of sterilization:---

   ----
2. Write down the factors affect the sterilization:---

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 6 points** **Unsatisfactory - below 6 points**

Information Sheet 5- Building up pressure

5.1 Introduction

The simplest and most effective means of storing a large part of our food supply is by canning, in which preservation by heat or thermal processing is used to provide a safe and palatable product. The thermal processing of canned foods, commonly known as "**cooking, retorting, or processing**" is the application of heat at a specified temperature for a specified time.

- **This operation has two fundamental purposes:**

✓ The first is to produce a commercially sterile product.

The product is contained in a hermetically sealed container and is subjected to heat treatment at a temperature and for a time sufficient to destroy all organisms that might adversely affect the consumer's health. Heat treatment also destroys more resistant organisms that could produce spoilage under normal storage conditions.

- ✓ The second purpose is to cook the food to a point where a minimum of further preparation is necessary for its consumption.

Obviously, the processing equipment for this most important operation must be properly installed, equipped, and operated in accordance with proven practices. Retorts are closed pressure type vessels that use steam from an outside source such as steam boilers or steam generators.

Pressure Buildup is a practice of building up pressure in oil or gas wells so that liquids can come out to the surface through the wellbore. Retort processing conditions of temperature, overpressure, and sterilization time were used to determine the impression depth on the pouch surface from contact with the retort rack during retort processing, also referred to as a waffling defect. When the well pressure starts decreasing from a producing well after a certain period of time, Pressure Buildup is performed by **shutting down the wells and allowing the pressure to buildup;**

- ✓ Well pressure can be buildup by performing Pressure Buildup tests.
- ✓ In order to perform such tests, the production rate needs to be stabilized for several days in the oil and gas wells that need to be tested for Pressure Buildup.
- ✓ Once the stabilization is reached, a pressure-measuring device is placed near the perforations for several hours before shut-in of the well is done.

This method helps in building up the pressure in the reservoir and formation properties can be estimated by understanding the rate of Pressure Buildup in the time for which well was shut-in.The **retort pressure**, attained as a result of cooking **at high temperature** in a closed vessel, must be relieved before the product can be safely removed. If the retort has been filled with small cans, the pressure can be reduced to atmospheric immediately in a process known as blowdown.

However, if the retort contains large cans, it is necessary to lower their internal pressure before blowdown takes place to prevent them from exploding or distorting. The reduction of internal can pressure is obtained by circulating cooling water through the retort whilst maintaining retort pressure at the value attained during cooking by introducing pressurizing air. When can internal pressure has dropped to a safe value, indicated by the temperature of the cooling water leaving the retort dropping to a desired value, blowdown can take place without the threat of can damage.

Self-Check – 5	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (5 pts each)**

1. The thermal processing of canned foods includes:---

----
2. Explain Pressure Buildup--

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 5 points** **Unsatisfactory - below 5 points**

Information Sheet 6- Cooling can use chlorinated water

6.1. Cool chlorinated water

Cooling water systems remove heat from components and industrial equipment. **Water-cooling** is typically used for cooling large industrial facilities, such as power plants, chemical factories and petroleum refineries. Cooling systems operate by transferring heat from a heat source, such as a power plant or industrial equipment, to a heat sink, typically water. Partly fill a plastic bucket with water and get a flat paddle to use as a stirrer. Slowly add the chlorine powder to the water and stir until it has all dissolved. Do this out in the open air. Take the bucket of chlorine solution to the water tank and slowly pour it into the tank. Chlorination was effective against biological fouling: up to a 10–1000-fold decrease in bacterial and archaeal numbers was detected. Chlorination also changed the diversity of the biofilm-forming community.

The most common cooling water systems are:

- ✓ Once-through systems and
- ✓ Open recirculating cooling towers.

Natural water sources contain diverse species of microorganisms:

- ✓ Bacteria,
- ✓ Algae and
- ✓ Fungi.

The interaction between the microorganisms and the cooling system material surfaces challenges the operational performance of the system by such phenomena as microbial-influenced corrosion (MIC) and micro fouling. When chlorine gas (Cl2) is added to the water (H2O), it hydrolyzes rapidly to produce hypochlorous acid (HOCl) and the hypochlorous acid will then dissociate into hypochlorite ions (OCl-) and hydrogen ions (H+). Because hydrogen ions are produced, the water will become more acidic (the pH of the water will decrease). Chlorine gas is the least expensive form of chlorine to use. The typical amount of chlorine gas required for water treatment is 1-16 mg/L of water. Different amounts of chlorine gas are used depending on the quality of water that needs to be treated.

The benefits of chlorination are:

- ✓ Proven reduction of most bacteria and viruses in water.
- ✓ Residual protection against recontamination.
- ✓ Ease-of-use and acceptability.
- ✓ Proven reduction of diarrheal disease incidence.
- ✓ Scalability and low cost.

The aim of water treatment is to convert raw water from its contaminant-laden stage to an aesthetically acceptable and hygienically safe product. Water acquires many impurities during its passage through the hydrologic cycle. In addition, its uts for domestic, industrial, commercial, agricultural and recreational purposes adds greatly to these impurities. Various combinations of unit operations and processes are used in practice for the removal of impurities. **Temperature** is another important factor for water disinfection with chlorine. Warm temperatures are desired to increase the capabilities of chlorine, but temperatures that are too high may damage the produce. In general, every 18 ^{0}F drop in water temperature will double the required contact time.

The nature and impurities in raw water and the end use of treated water determine the degree of required treatment. Chlorine levels up to **4 milligrams per liter (mg/L or 4 parts per million**

(ppm) are considered safe in drinking water. At this level External, no harmful health effects are likely to occur. Clean water provision is a critical component of emergency response, and chlorination is widely used in emergencies to treat water. To provide responders with practical, evidence-based recommendations for implementing chlorination programmes and recommend areas for future research, we conducted a literature review of chlorination in emergencies, supplemented with a literature review on chlorination in general.

Operation Sheet 1	Operating Procedures/Techniques for Pressure canner

Operating Procedures of Pressure Canner

Step 1: Put 2 to 3 inches of hot water in the canner.

Step 2: Leave the weight off the vent port or open the petcock. Heat on high heat until steam flows from the petcock or vent port.

Step 3: Maintaining high heat, exhaust steam for 10 minutes and then place the weight on the vent port or close the petcock. The canner will pressurize in the next 3 to 5 minutes.

Step 4: Start timing the canning process when the dial gauge indicates the recommended pressure or when the weighted gauge begins to jiggle or rock.

Step 5: Regulate the heat under the canner to maintain a steady pressure at or slightly above the correct gauge pressure. The correct gauge pressure must be maintained for the entire processing time.

If the pressure drops below the target pressure, reset your timer and process for the entire recommended processing time.

Step 6: When the timed process is over, turn off the heat, remove the canner from the heat if possible, and let the canner cool enough to lose pressure.

Do not try to hurry the cooling process. Forced cooling may result in spoilage. Cooling the canner with cold running water or opening the vent port before the canner is fully depressurized may cause jars to lose liquid and to fail to seal. Forced cooling may also warp the lids of older-model canners, causing steam leaks.

Step 7: After the canner has lost pressure, remove the weight from the vent port or open the petcock.

- Wait 10 minutes, unfasten the lid, and remove it carefully.
- Lift the lid away from you so that the steam does not burn your face.

Step 8: Remove jars with a lifter, and place them on a towel or cooling rack. Allow the jars to cool undisturbed at room temperature for 12 to 24 hours.

LAP Test	Practical Demonstration

Name: ______________________________ Date: ________________

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2- hours.

Task 1: Apply general Operating Procedures for pressure canner

Task 2: Operate pressure canner

Self-Check – 6	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (4 pts each)**

1. What is cooling water
2. Explain the purpose of cooling water
3. List the benefits of water chlorination

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 6 points** **Unsatisfactory - below 56points**

LG #72	LO #7- Review a canning operation

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Reviewing Critical Control Points (CCPs)
- Reviewing data to ensure adherence within critical limits
- Reviewing operating procedures

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information Sheet 1- Reviewing Critical Control Points (CCPs)

1.1. Reviewing Critical Control Points (CCPs) for a canning operation

Hazard analysis critical control point **(HACCP)** is important because it prioritizes and controls potential hazards in food production. By controlling major food risks, such as microbiological, chemical and physical contaminants, the industry can better assure consumers that its products are as safe as good science and technology allows. Additionally, HACCP- is a technique for reviewing and analyzing a specific manufacturing operation's compliance with the GMP, with the objectives of identifying control procedures and implementing preventive measures required to ensure consumer safety and to prevent economic fraud. It is a system of self-regulatory quality control, which, if properly implemented, can be used by both manufacturers and regulatory agencies to provide assurance about the safety of the product. A number of quality control points exist in the processing of the product. However, critical control points (CCP) are those points in a food production process where failure to carry out control measures will introduce unacceptable risks to the consumers. These CCP's need to be identified and a system of monitoring and recording data at these points set up.

1.2. Canning Methods

There are two safe ways of processing food in canning methods:

- The boiling water bath method and
- The pressure canner method

A. The boiling water bath

- ✓ Jars of food are heated completely covered with boiling water (212°F at sea level) and cooked for a specified amount of time.
- ✓ Safe for tomatoes, fruits, jams, jellies, and pickles and other preserve.

B. Pressure canning

Why Choose Pressure Canning to Preserve Food?

In this method, Jars of food are placed in 2 to 3 inches of water in a special pressure canner which is heated to a temperature of at least 240° F. This temperature can only be reached using the pressure method. A microorganism called Clostridium botulinum is the main reason why pressure processing is necessary. Though the bacterial cells are killed at boiling temperatures, they can form spores that can withstand these temperatures. The spores grow well in low acid foods, in the absence of air, such as in canned low acidic foods like meats and vegetables. When the spores begin to grow, they produce the deadly botulinum toxins (poisons).The only way to destroy these spores is by pressure cooking the food at a temperature of 240°F, or above, for a specified amount of time depending on the type of food and altitude. Foods that are low acid have a pH of more than 4.6 and because of the danger of botulism, they must be prepared in a pressure canner.

These is the only safe method of preserving vegetables, meats, poultry and seafood

1.3. Canning equipment

- **Water bath canners**
  - ✓ Water bath canner is a large cooking pot, with a tight fitting lid and a wire or wooden rack that keeps jars from touching each other.

✓ The rack allows the boiling water to flow around and underneath jars for a more even processing of the contents. The rack also keeps jars from bumping each other and cracking or breaking.

✓ The diameter of the canner should be no more than 4 inches wider than the diameter of your stove's burner to ensure proper heating of all jars.

Fig 1.1.water bath canning

- **Pressure Canner**
  - ✓ Pressure canner is a heavy pot with a lid that can be closed steam-tight. The lid is fitted with a vent (or pet-cock), a dial or weighted pressure gauge and a safety fuse.
  - ✓ It may or may not have a gasket.
  - ✓ The pressure pot also has a rack.

Fig 1.2. Pressure canner

- **Parts of pressure Canner**

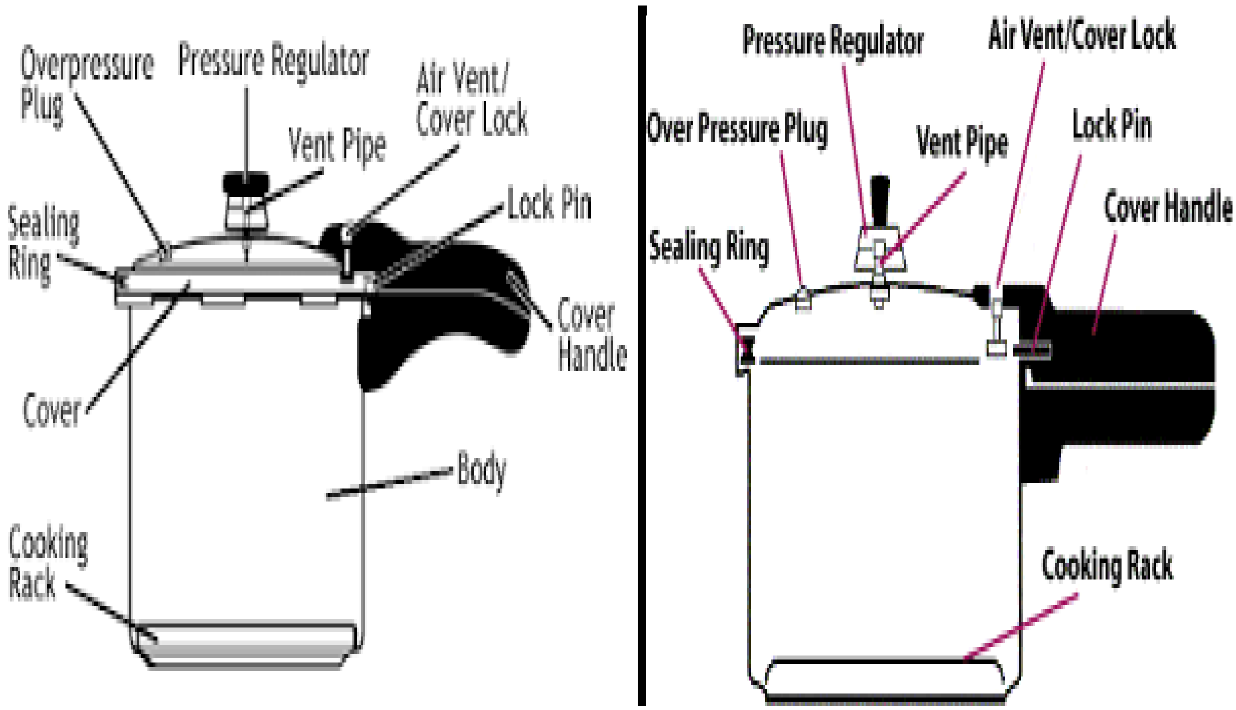

Fig 1.3 Parts of pressure canner.

- ✓ **Pressure Regulator**

This pressure regulator acts as a safety device to prevent pressure in excess of 15 pounds from building in the pressure canner.

This pressure regulator adjusts to maintain 5, 10, or 15 pounds of pressure in the canner. The correct pressure is obtained when the pressure regulator begins a gentle rocking motion. See instruction manual for directions on how to adjust the regulator to maintain the desired pressure.

- ✓ **Vent Pipe**

The pressure regulator fits on the vent pipe and allows excess pressure to be released.

- ✓ **Air Vent/Cover Lock**

The air vent/cover lock automatically "vents" or exhausts air from the pressure canner and acts as a visual indicator of pressure in the canner. Not all brands feature an automatic air vent/cover lock. For canning, this device is primarily useful in locking the cover and indicating the presence of pressure in the canner. It is also necessary to "vent" air from the canner by allowing steam to flow from the vent pipe for a specified length of time before the pressure regulator is put in place.

- ✓ **Locking Bracket/pin**

The locking bracket on the inside of the pressure canner body engages with the air vent/cover lock to prevent the cover from being opened when there is pressure in the unit. Pressure canners manufactured before 1978 do not have cover locking devices. On units manufactured after that date, the design of the device will vary by brand and, therefore, may be different than illustrated here.

- ✓ **Sealing Ring**

The sealing ring fits into a groove in the pressure canner cover and forms a pressure-tight seal between the cover and the body.

- ✓ **Overpressure Plug**

The overpressure plug will automatically release pressure if the vent pipe becomes clogged and pressure cannot be released as normal. All pressure canners have some type of overpressure release. The design of this device, however, varies widely by brand and model.

- ✓ **Canning/Cooking Rack**

This rack must be placed in the bottom of the pressure canner to hold jars off the bottom of the unit while canning

- ✓ **Pressure Dial Gauge**

The dial gauge has a pointer which moves over a readable dial and indicates the pressure within the canner. The gauge does not regulate pressure.

Fig 1.4 Pressure Dial Gauge

- **Jars**

Mason jars and Ball jars specifically designed for home canning are best. Jars come in a variety of sizes from half-pint jars to half-gallon jars. Pint and quart Ball jars are the most commonly used sizes and are available in regular and wide-mouth tops. If properly used, jars may be reused indefinitely as long as they are kept in good condition.

Jar Lids

Most canning jars sold today use a two-piece self-sealing lid which consists of a flat metal disc with a rubber-type sealing compound around one side near the outer edge, and a separate screw-type metal band. The flat lid may only be used once but the screw band can be used over as long as it is cleaned well and does not begin to rust.

In general:

- ✓ Control measure is an action or procedure that will reduce, prevent or eliminate a potential hazard. A critical control point is a step at which a control measure is applied.
- ✓ HACCP is a management system in which food safety is addressed through the analysis and control of biological, chemical, and physical hazards from fruit and vegetable production, procurement and handling, to manufacturing, distribution and consumption of the finished product.

Self-Check -1	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (5 pts each)**

1. Write and explain in detail about the two safe ways of processing food in canning methods**.**
2. Explain each Parts of pressure Canner.
3. Write and explain each **Canning equipment** used in food canning process.
4. Define Critical control points (CCP).

Note: **Satisfactory rating – above 10 points   Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Information Sheet 2- Reviewing data to ensure adherence within critical limits

1.1. Reviewing data to ensure adherence within critical limits

The second step in the development of a HACCP plan is to establish critical limits for each critical control point. Critical limits (CL) are the parameters that indicate whether the control measure at the CCP is in or out of control. The National Advisory Committee on Microbiological Criteria for Foods (NACMCF) states that a CL is a **maximum or minimum value** to which the;

- ✓ 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.

The establishment must consider the food safety standard that must be met at each CCP. Critical limits are designed to ensure applicable targets or performance standards pertaining to the specific process or product.

- **Critical limits** are most often based on process parameters such as:
- ✓ Temperature,
- ✓ Time,
- ✓ Physical dimensions, or
- ✓ Presence of target pathogens, whereas critical limits must be actual values that can be measured or quantified.

A critical limit is used to distinguish between safe and unsafe operating conditions at a CCP. Critical limits should not be confused with operational limits which are established for reasons other than food safety. 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.

Additionally, Critical limits may be based upon factors such as:

- ✓ Temperature,
- ✓ Time,
- ✓ Physical dimensions,
- ✓ Humidity,
- ✓ Moisture level,
- ✓ Water activity (a_w),
- ✓ pH,
- ✓ Titratable acidity,
- ✓ Salt concentration,
- ✓ Available chlorine,

- ✓ Viscosity,
- ✓ Preservatives, or
- ✓ Sensory information such as aroma and visual appearance.

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. The CLs must also be designed to work effectively given the capabilities and limitations of the establishment's processes.

Self-Check – 2	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (6 pts each)**

1. Define critical limit;--
   ----
2. List the factors of critical limit---

   ----
3. Write down the importance of critical limits;---

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 9 points** **Unsatisfactory - below 9 points**

Information Sheet 3- Reviewing operating procedures

3.1. Reviewing operating procedures to ensure a quality and safe canned product.

- **Operating Procedures for pressure canning**

- ✓ **Put 2 to 3 inches of hot water in the canner**: When canning fish or other foods with a long processing time, add additional water (a total of 4 to 5 inches) to be certain the canner does not boil dry. Place filled jars on the rack, using a jar lifter. Fasten canner lid securely.
- ✓ **Leave the weight off the vent port or open the petcock**: Heat on high heat until steam flows from the petcock or vent port.
- ✓ **Maintaining high heat:** exhaust steam for 10 minutes and then place the weight on the vent port or close the petcock. The canner will pressurize in the next 3 to 5 minutes.
- ✓ **Start timing the canning process:** when the dial gauge indicates the recommended pressure or when the weighted gauge begins to jiggle or rock.
- ✓ **Regulate the heat under the canner:** to maintain a steady pressure at or slightly above the correct gauge pressure. The correct gauge pressure must be maintained for the entire processing time. If the pressure drops below the target pressure, reset your timer and process for the entire recommended processing time. Quick and large pressure variations during processing may cause jars to lose liquid. Generally, weighted gauges on **Mirro canners** should jiggle about two or three times per minute. On **Presto canners**, the weighted gauge should rock slowly throughout the process. Always read the manufacturer's instruction sheet for how to check for proper pressure.
- ✓ **When the timed process is over, turn off the heat**: remove the canner from the heat if possible, and let the canner cool enough to lose pressure. Do not try to hurry the cooling process. Forced cooling may result in spoilage. Cooling the canner with cold running water or opening the vent port before the canner is fully depressurized may cause jars to lose liquid and to fail to seal. Forced cooling may also warp the lids of older-model canners, causing steam leaks. Pressure loss in older canners should be timed. Standard-size heavy-walled canners require about 30 minutes when loaded with pints and 45 minutes when loaded with quarts. Newer thin-walled canners cool more rapidly and have vent locks. These canners are depressurized when their vent lock pistons drop to a normal position.

- ✓ **After the canner has lost pressure**, remove the weight from the vent port or open the petcock. Wait 10 minutes, unfasten the lid, and remove it carefully. Lift the lid away from you so that the steam does not burn your face.
- ✓ **Remove jars with a lifter**, and place them on a towel or cooling rack. Allow the jars to cool undisturbed at room temperature for 12 to 24 hours.

NB: Low-acid vegetables must be processed in a pressure canner to minimize the risk of food spoilage.

3.2. Canning Utensils

Helpful items in canning and preserving foods:

- ✓ **Jar lifter:** essential for easy removal of hot jars.
- ✓ **Jar funnel:** helps in pouring and packing of liquid and small food items into canning jars.
- ✓ **Lid wand:** magnetized wand for removing treated jar lids from hot water.
- ✓ **Clean cloths:** handy to have for wiping jar rims, spills and general cleanup.
- ✓ **Knives:** for preparing food.
- ✓ **Narrow, flat rubber spatula:** for removing trapped air bubbles before sealing jars.
- ✓ **Timer or clock:** for accurate food processing time.
- ✓ **Hot pads**
- ✓ **Cutting board**

Self-Check -3	Written Test

Directions: Answer all the questions listed below briefly. Use the Answer sheet provided in the next page:

Instruction I: **Short Answer Questions (6 pts each)**

1. List and write the uses of the helpful items/utensils which are used in canning and preserving foods.
2. Write each o*perating* Procedures *for pressure canning.*

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – above 6 points** **Unsatisfactory - below 6 points**

Operation Sheet 1- Operating the preservation of fruit and vegetable

Sequence of preservation of fruit/vegetable

The following steps are used for preserving of fruits/vegetables.

1. Wearing personal protective equipment properly
2. Prepare material, tools and equipment required for preserving
3. Select ripe fruit/ vegetables
4. Washing and sorting
5. Peeling, coring and cutting
6. Blanching (90^oc for2-5minuts)
7. Cooling
8. Filling($79-82^o$c) which include: brining (1-3%) and syrup ($20-55^o$brix)
9. Exhausting($79-82^o$c)
10. Sealing
11. Processing (Acidic-100^oc and non-acidic $115-121^o$c)
12. Cooling (39 ^{o}c)
13. Labeling
14. Storing; (Storage at high temperature should be avoided as it shortens the shelf-life of the Product).

LAP TEST	Performance Test

Name………………………………. ID……………………………..
Date…………………………………….

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task-1 show the procedure of preserving fruit /vegetable

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