የሥራና ክህሎት ሚኒስቴር
Ministry of Labor and Skills

Fruit and Vegetable Processing Level -II

Based on June 2021, Version 3 Occupational Standard





Module Title: Inspecting and Sorting Raw Materials

LG Code: IND FVP2 M05 LO (1-4) LG (14-17)

TTLM Code: IND FVP2 TTLM 1223

December, 2023

Addis Ababa, Ethiopia

Introduction to the Module

This module aims to provide trainees the knowledge, attitude and skills required to inspect and sort product and incoming materials ready for processing.

Table of Contents

Introduction to the Module **2**

LO #1- Inspect materials to confirm fitness for use **4**

Instruction sheet 4

Information Sheet 1 5

Self-check 1 25

LO #2- Sort materials **27**

Information Sheet 2 28

Self-check 2 44

LO #3- Perform washing activities **45**

Instruction sheet 45

Information Sheet 3 46

Self-check 3 54

Operation sheet – 1 56

Lap Test 58

Instruction sheet 59

Information Sheet 4- Maintaining blanching and set material 60

Self-check 4 72

Operation sheet 2 74

Reference **76**

LG #14	LO #1- Inspect materials to confirm fitness for use

Instruction sheet
This learning guide is developed to provide you the necessary information regarding the following content coverage and topics: • Confirming materials type and quality requirements • Transferring materials to required location 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: • Confirm type and quality requirement of materials • Convey or transfer materials by materials transfer equipment.
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 **4.** Accomplish the Self-checks

Information Sheet 1

1.1. Confirming materials type and quality requirements

The types and quality requirements of raw materials for fruits and vegetables vary depending on the specific product, market demands, and processing methods. However, some general considerations apply to ensure the production of high-quality processed fruit and vegetable products. In general, the quality requirements for fruits and vegetables are as follows:

- **Appearance:** fruits and vegetables should be free from defects such as bruises, cuts, and decay. They should also be the proper size, shape, and color for the variety.
- **Ripeness:** fruits and vegetables should be at the proper stage of ripeness for the intended use. For example, tomatoes for canning should be firm and slightly green, while tomatoes for salads should be ripe and red.
- **Texture:** fruits and vegetables should have the proper texture for the variety. For example, apples should be firm and crisp, while peaches should be soft and juicy.
- **Freshness:** fruits and vegetables should be fresh and free from signs of spoilage. They should also be stored at the proper temperature to maintain their freshness.

Specific Quality Requirements

In addition to the general quality requirements, there are also specific quality requirements for each type of fruit and vegetable. For example, carrots should be free from bitterness, while lettuce should be free from wilting and discoloration.

1.1.1 Quality Attributes of fresh produce

Quality attributes of fresh fruits and vegetables can be classified into three classes according to the occurrence of product characteristics when they are encountered or consumed:

Table 1.1 Quality attributes of fresh product

Class of attribute	Quality attribute	Measurement of quality attribute
External	Appearance (sight)	Visual evaluation of size, shape, gloss and colour May be accompanied by visual guides and colorimeters
	Feel (touch)	Manual evaluation of firmness and texture May be accompanied by mechanical texture analysis
	Defects	Visual evaluation of absence of defects or deterioration of colour May be accompanied by mechanical methods (e.g. ultrasound)

1.1.2Quality control and assurance

Quality control (QC) is a process through which a business seeks to ensure that product quality is maintained or improved. Quality control requires the company to create an environment where management and employees strive for perfection. This is done by training personnel, creating benchmarks for product quality, and testing products to check for statistically significant variations.

A significant aspect of quality control is the establishment of well-defined controls. These controls help standardize both production and reactions to quality issues. Limiting room for error by specifying which production activities are to be completed by which personnel reduces the chance that employees will be involved in tasks for which they do not have adequate training

Daily activities of quality control

Quality control (QC) is a process through which a business seeks to ensure that product quality is maintained or improved.

Quality control involves testing units and determining if they are within the specifications for the final product.

The quality control used in a business is highly dependent on the product or industry, and several techniques exist for measuring quality.

The food industry uses quality control methods to ensure customers do not get sick from their products.

Quality control creates safe measures that can be implemented to make sure deficient or damaged products do not end up with customers.

Understanding quality control (QC)

Quality control involves testing units and determining if they are within the specifications for the final product. The purpose of the testing is to determine any needs for corrective actions in the manufacturing process. Good quality control helps companies meet consumer demands for better products.

Why is QC needed? Creating a product is costly, time-consuming, and can be unsafe without controls in place. Additionally, if a company sends defective products out for purchase, it could be held liable for injuries or issues that arise from using its products. Quality control inspectors ensure that defective or unsafe products are identified, and the causes are corrected.

How Is It done? Quality testing is generally completed in each step of a manufacturing or business process. Employees often begin by testing raw materials, pulling samples from the manufacturing line, and testing the finished product. Testing at the various stages of manufacturing helps identify where a production problem is occurring and the remedial steps it requires to prevent it in the future. In a non-manufacturing business, quality testing can involve customer service evaluations, questionnaires, surveys, inspections, or audits. A business can use any process or method to verify that its end product or service meets the customer's needs and is safe and legal.

- **Quality Control vs. Quality Assurance**

Quality Control (QC) and Quality Assurance (QA) are two distinct aspects of the broader quality management system within an organization. While both are essential for ensuring product or service quality, they involve different approaches and focus on different stages of the production or service delivery process.

Definition:

Quality control (QC): QC is a reactive process that involves the inspection and testing of products or services to identify and correct defects. It is concerned with the identification and elimination of defects in the final output.

Quality assurance (QA): QA is a proactive process that focuses on the prevention of defects by establishing processes and standards. It involves systematic activities, such as process design, training, and documentation, to ensure that the production or service delivery processes consistently meet specified requirements.

Timing:

Quality control (QC): QC activities take place during or after the production of goods or the delivery of services. It is a post-production process that aims to identify and correct defects before the products reach customers.

Quality assurance (QA): QA activities are implemented before or during the production process. It is a pre-production or concurrent process that aims to establish and maintain processes to prevent defects from occurring.

Focus:

Quality control (QC): the primary focus of QC is on the end product or service. It involves checking the final output to ensure that it meets the specified quality standards.

Quality assurance (QA): the primary focus of QA is on the processes used to create the product or deliver the service. It aims to ensure that these processes are well-designed, consistently followed, and capable of meeting quality standards.

Responsibility:

Quality control (QC): QC is typically the responsibility of the inspection team or individuals who check the final product for defects. It is often performed by a separate quality control department.

Quality assurance (QA): QA is the responsibility of everyone involved in the production process. It requires a company-wide commitment to quality and often involves the implementation of quality management systems.

Goal:

Quality control (QC): the goal of QC is to identify and correct defects in the final product or service to ensure that it meets the specified quality standards.

Quality assurance (QA): the goal of QA is to prevent defects by establishing and maintaining effective processes. It aims to improve and optimize processes to consistently produce high-quality products or deliver high-quality services.

In summary, while quality control is concerned with identifying and correcting defects in the final output, quality assurance focuses on preventing defects by establishing and maintaining effective processes. Both QC and QA are essential components of a comprehensive quality management system, working together to ensure that products or services meet or exceed customer expectations.

1.1.3Types of quality control method

When one chart analyses a specific product attribute, it is called a univariate chart. A chart that measures variances in several product attributes is called a multivariate chart. Tracking variances allows businesses to see how many defects per production unit they produce and what types of defects are occurring. Here are a few examples of some methods used.

- **X-Bar Chart**

Randomly selected products are tested for the given attributes the chart is tracking. A common form of a quality control chart is the X-Bar Chart, where the y-axis on the graph tracks the degree to which the variance of the tested attribute is acceptable. The x-axis tracks the samples tested. Analysing the variance pattern on this chart helps you determine if defects are occurring randomly or systematically

- **Taguchi Method**

The Taguchi Method of quality control is another approach that emphasizes the roles of research and development, product design, and product development in reducing the occurrence of defects and failures in products. The Taguchi Method considers design more important than the manufacturing process in quality control and tries to eliminate variances in production before they can occur.

- **100% Inspection Method**

This 100% inspection method is a quality control process involving looking at and assessing all product parts. This type of quality control is done to rule out flaws in products. This method is often used to evaluate valuable metals and produce. The 100% inspection method calls for data about the manufacturing process and software to analyze inventory.

The challenge of using this method is that looking at every single item used to build a product is expensive and could destabilize or render the product unusable. For example, if you use this method to examine organic strawberries, you risk damaging the berries, rendering them unsellable.

Quality controls methods help standardize production and reactions to quality issues in various industries, from food production to automobile manufacturing.

1.1.4 Quality Control Careers

Quality control can be a rewarding career if you enjoy working with people, communicating, presenting results, and working to make products better and safer. To become a quality control inspector, you'll need (depending on the industry)

- A high school diploma for entry-level positions
- A bachelor's degree, depending on the industry
- Experience in an industry
- Licenses and certifications for some industries and businesses
- Other qualities that are necessary for quality control professionals are
- Attention to detail
- Mechanical and math skills
- Physical abilities and strength
- Technical skills
- Performance under pressure
- Career Path

The route to a career in quality control and assurance varies by industry, so there may be differences. However, you'll generally need several years of experience in your industry. Typically, you begin by being hired as a quality assurance or control associate after meeting educational and work experience requirements. Once you gain work experience as a quality specialist or associate, you may move into a senior specialist position and begin managing teams of quality control specialists.

You may attend professional development courses sponsored by your employer or be required to gain certifications such as Six Sigma. You might also need to earn a professional designation such as Certified Quality Inspector. Moving up the career path, you have more options. You may be able to choose from or be selected to be

1.1.5 Types of Quality Control

Quality control (QC) can be categorized into four main types, each serving a specific purpose in ensuring the quality of products or services. These four types are:

- **Preventive Control:**

Objective: Preventive control aims to avoid defects or errors before they occur in the production process.

Methods: This type of control involves implementing measures such as employee training, process standardization, and the use of best practices to prevent deviations from quality standards.

Example: Providing training to workers on the proper use of equipment and procedures to minimize the likelihood of errors.

- **Detective Control:**

Objective: Detective control is focused on identifying defects or errors after they have occurred but before the product is delivered to the customer.

Methods: This involves activities such as inspections, testing, and audits to identify and correct defects before the products reach the customer.

Example: Performing regular inspections of manufacturing processes to catch any deviations from quality standards and correct them before the final product is completed.

- **Corrective Control:**

Objective: Corrective control is implemented to address defects or errors found in the final product or during the production process.

Methods: This type of control involves taking corrective actions to fix identified issues and prevent their recurrence. It may include rework, process adjustments, or changes to procedures.

Example: If a defect is identified during the final inspection, implementing corrective measures to address the issue and ensure that subsequent products meet quality standards.

- **Statistical Control:**

Objective: Statistical control uses statistical methods to monitor and control the variability in a process and ensure that it remains within acceptable limits.

Methods: Statistical control involves the use of statistical tools such as control charts and data analysis to understand the variation in a process and identify any trends or patterns that may indicate a deviation from the norm.

Example: Using statistical process control charts to monitor the dimensions of manufactured parts and take corrective action if there is a statistically significant deviation from the expected values.

These four types of quality control are often interrelated and are implemented as part of a comprehensive quality management system. The goal is to ensure that products or services consistently meet or exceed customer expectations by addressing quality issues at various stages of the production process.

There are several methods of quality control. These include an x-bar chart, Six Sigma, 100% inspection mode, and the Taguchi Method.

1.1.6 Important of quality control

Quality control is crucial in various industries for several reasons, and its importance extends across the entire lifecycle of a product or service. Here are some key reasons why quality control is essential:

- **Customer satisfaction:** high-quality products or services lead to increased customer satisfaction. Meeting or exceeding customer expectations builds trust and loyalty, contributing to positive customer experiences.
- **Brand reputation:** consistently delivering high-quality products or services enhances a company's reputation. A positive reputation can lead to customer recommendations, increased market share, and a competitive advantage.
- **Cost savings:** quality control helps identify and correct defects early in the production process, reducing the need for rework, scrap, or warranty claims. This leads to cost savings and improved overall efficiency.
- **Compliance and standards:** adhering to quality control processes ensures that products or services comply with industry standards, regulations, and legal requirements. This is essential for avoiding legal issues and maintaining a license to operate.

- **Risk management:** quality control helps identify and mitigate risks associated with defects or deviations from standards. By addressing issues proactively, companies can prevent potential liabilities and financial losses.
- **Competitive advantage:** high-quality products or services can set a company apart from its competitors. It can be a differentiator in the market and attract customers who prioritize quality over lower-cost alternatives.
- **Operational efficiency:** implementing quality control measures improves the efficiency of production processes. By identifying and addressing issues promptly, companies can maintain smooth operations and meet production deadlines.
- **Continuous improvement:** quality control is part of a broader commitment to continuous improvement. By regularly assessing and refining processes, organizations can optimize their operations and stay ahead of changing market demands.
- **Customer retention:** satisfied customers are more likely to remain loyal and continue purchasing products or services from a company. Quality control contributes to long-term customer relationships and repeat business.
- **Employee morale and engagement:** employees are more likely to take pride in their work when they know that the products they produce meet high-quality standards. This can boost morale, job satisfaction and overall engagement.
- **Market access:** many industries and markets have strict quality standards that companies must meet to enter or stay in the market. Quality control is essential for obtaining regulatory approvals and certifications.
- **Data-driven decision making:** quality control processes often involve data collection and analysis. This data-driven approach allows companies to make informed decisions based on objective information, rather than relying on assumptions or guesswork.

In summary, quality control is a critical component of effective business management. It not only ensures that products or services meet specified standards but also contributes to customer satisfaction, cost savings, and overall business success. It is a proactive and strategic approach to delivering value to customers while maintaining operational efficiency.

Quality control (QC) is the process of maintaining an acceptable quality level to the consumer. Quality assurance (QA) is the system to assure that the overall QC job is being done effectively. Quality control starts in the field with the selection of the proper time to harvest until marketing.

1.1.7 Standardization and inspection of fresh produce

Food standards are used to maintain uniformity of product quality and safety, to gain market access and establish market presence, to provide different consumers with equal information about the product and to prevent economic fraud or market exclusion. Standardization allows for correct food labelling – the basis for consumer confidence

1.1.8 Inspection and sorting

The main purpose of inspection is to provide the client with objective, independent, and impartial information regarding the condition and safeness of the raw materials suitable for further processing. There are several reasons for inspection but the main focus is to achieve quality products which always an expectation both in business and in the world of work. Inspection is done either on a continuous basis (where inspectors frequent checks the quality of the commodity along the packing lines), or on a sample basis (where representative samples of a lot are randomly selected and inspected to determine whether the product meets the grade specification for which it is packed). When inspection is completed, confirming or certificating are applied by the inspector on the basis of applicable official standards.

To ensure uniformity of inspection:

- inspectors are trained to apply the standards,
- visual aids,
- determining quality and maturity and
- Good working environments with proper lighting are provided.

In fruit and vegetable handling , if the fruit producer has followed GAPs and the harvest and handling have been accomplished effectively, fruit arriving at the processing plant should be

reasonably sanitary and of optimum quality, thus simplifying succeeding operations. Nevertheless, quality cannot be taken for granted. In many cases the basis for payment is the condition of the fruit or vegetables as received. Hence sampling and analysis for composition and quality are mandatory.

Government norms, an industry association, or agreement between producer and processor in advance of the crop purchase can dictate applicable quality standards. Some agreements are seasonal or even ready before planting or harvest. A representative sample of the shipment may be drawn according to statistical procedures, thus, an inspection is conducted to see visible defects and foreign matter and then analyzed for microbial load, pathogens, pesticide residues, aflatoxin level, color, sugar, acid, flavor, or other important safety and quality attributes.

Rejection at this stage is a serious matter, since considerable time, effort and expense has already been invested in the suspect lot. If the defect is correctable (cleanup, resorting and inspection) a price penalty may be imposed or alternate processing required. However, if the lot cannot be corrected, contamination (microbial or chemical) or far off-standard composition/quality disposal costs and reputation damages, result. In either circumstance process flow is disrupted and plant operations suffer. Thus for reasons of quality and safety it is important that all the produce must undergo careful inspection to prevent wastage of any sort. Inspection can be manual, depending upon workers observing and removing defects or automatic, affected by computer controlled sensors to detect off color, shape or size. Sophisticated instrumentation operating at high speed is being increasingly employed in modern processing facilities, although the human eye, hand and mind still commonly make the final decision.

1.2. Transferring materials to required location

1.2.1. Using material in transferring fruit and vegetable

In fruit and vegetable processing, materials transfer equipment is crucial for efficiently moving raw materials, intermediate products, and finished goods throughout the production process. The specific equipment used depends on the nature of the materials, the processing requirements, and the layout of the processing facility. Here are some common materials transfer equipment used in fruit and vegetable processing

After the raw materials have been thoroughly inspected they will then be brought to the processing location using **conveyors or flumes pumped** system.

- **Conveyor**

Conveyor is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials.

Conveyor systems allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries. Some of basic characteristics of conveying equipment's are:-

- ✓ Transporting material from one place to another over stationary structure.
- ✓ Caries material in continuous stream with its distinct feature such as endless chain or belt.
- ✓ Can be done horizontally, vertically or inclined.
- ✓ When the equipment does horizontal conveying, it is known as conveyor and when it does vertical, it is known as elevator.
- ✓ Conveying is mainly used in mining, construction and in some of the industries.

- **The advantage of using conveyors**:-
  - ✓ It increases the output.
  - ✓ It facilitates continuity in operation.
  - ✓ It results in time saving.
  - ✓ There are no waiting periods..



Figure1.2. Conveyor

- **Types of conveyors**
  - ✓ **Vibratory Conveyors:** Vibratory conveyors use vibrations to move materials, making them suit
  - Application: gentle transfer of sensitive fruits and vegetables during sorting and processing able for delicate fruits and vegetables



Figure . 1.3 Vibratory conveyors

- ✓ **Roller Conveyors:** Roller conveyors use rollers to move materials and are often used for crates or bins of fruits and vegetables.
- Applications: Moving containers of fruits and vegetables within the processing facility.



Figure 1.4 roller conveyors

- ✓ **Pneumatic Conveyors:** Pneumatic conveyors use air pressure to transport powdered or small-sized fruits and vegetables through pipelines.

- Applications: Transferring powdered or small particles during processing.



Figure 1.5 Pneumatic conveyor

Sorting and Grading Machines: Automated sorting and grading machines use conveyors and sensors to categorize fruits and vegetables based on size, color, and quality.

- Applications: Sorting and grading fruits and vegetables before further processing.



Figure 1.6 Sorting and grading machine

https://youtu.be/S6v27nUONvE?t=59 (Access date: November 1/2023)

1.2.2. Flumes pumped system

Conveying foods in water using shallow inclined troughs (or flumes) and pipes finds application for the simultaneous washing and transporting of small particulate foods, such as peas, sweet corn, etc. The main advantage is reduced power consumption as water flows under gravity, especially at factory sites located on hillsides. Water is re-circulated to reduce costs and is filtered and chlorinated to prevent a buildup of micro-organisms.

1.2.3. Mechanical or pneumatic system

Every pneumatic system makes use of pipes or ducts called transportation lines that carry mixture of materials and a stream of air. These materials can be transported conveniently to various destinations by means of a stream of high velocity air through pipe lines. Products are moved through various tubes via air pressure, allowing for extra vertical versatility. Pneumatic conveying is routinely used to move solids of all sizes within process plants. On account of the compressibility of the conveying gas, the pneumatic conveying of solids is quite different from the pumping of liquids or slurries The selection of many of the components that comprise a conveying system such as rotary valves, feed chutes, conveying pipe, and air movers is examined, especially as it relates to reliable operation of a conveying system.

1.2.4 Storage equipment

The storage of fruits and vegetables is a critical aspect of preserving their quality, extending shelf life, and preventing spoilage. Proper storage is crucial for maintaining the quality and freshness of fruits and vegetables. The ideal storage conditions for fruits and vegetables depend on the specific type of produce, but there are some general guidelines that can be followed to extend shelf life and minimize spoilage. Proper storage conditions vary depending on the type of fruit or vegetable, as each has unique requirements. Here are common storage materials and methods for fruits and vegetables:

i. Temperature and Humidity Control

Fruits and vegetables are living organisms and continue to respire, or breathe, after harvest. Respiration produces ethylene gas, which can accelerate ripening and spoilage. Therefore, it is essential to store fruits and vegetables at the correct temperature and humidity levels to slow down their respiration rate and extend their shelf life.

- Refrigeration: Most fruits and vegetables require refrigeration to maintain their freshness. The optimal storage temperature for most fruits and vegetables is between 32°F and 40°F. However, some fruits, such as bananas and tomatoes, are sensitive to cold and should be stored at slightly higher temperatures.
- Humidity: The ideal humidity level for storing fruits and vegetables is between 90% and 95%. High humidity helps to prevent moisture loss and wilting.

ii. Storage Containers

The type of storage container used can also affect the shelf life of fruits and vegetables. Perforated bags or containers allow for air circulation, which helps to prevent the build up of ethylene gas and moisture. Plastic bags can be used for short-term storage, but they should be punctured to allow for some air circulation.

Various containers can be used to store fruits and vegetables, including:

- Plastic crates: These are lightweight, durable, and easy to clean, making them a popular choice for storing a wide variety of fruits and vegetables.
- Wooden crates: These are often used for storing heavier fruits and vegetables, such as pumpkins and melons.

- Cardboard boxes: These are lightweight and inexpensive, but they are not as durable as plastic or wooden crates.
- Pallets: These are used to stack and transport containers of fruits and vegetables.

iii. Ethylene controller

Ethylene gas is a natural plant hormone that plays a role in ripening and senescence. Some fruits and vegetables produce more ethylene than others, and these fruits are known as "climacteric fruits." Climacteric fruits include apples, bananas, avocados, tomatoes, and pears.

Ethylene gas can be controlled in storage by:

- Separating ethylene-producing fruits from ethylene-sensitive fruits: Store ethylene-producing fruits separately from ethylene-sensitive fruits to prevent premature ripening of the sensitive fruits.
- Using ethylene absorbers: Ethylene absorbers are packets that contain materials that absorb ethylene gas. These can be placed in storage containers with fruits and vegetables to slow down their ripening.

Specific Storage Guidelines for Fruits and Vegetables

Here are some specific storage guidelines for different types of fruits and vegetables:

- Apples: Store apples in a cool, dark place with a humidity level of around 90%. Apples can be stored for several weeks under these conditions.
- Bananas: Bananas should be stored at a temperature of around 55°F to 60°F. Avoid storing bananas in the refrigerator, as this can cause them to darken and their skin to turn black.
- Berries: Store berries in the refrigerator in a single layer to prevent them from crushing. Berries can be stored for a few days under these conditions.
- Citrus fruits: Citrus fruits, such as oranges, grapefruits, and lemons, can be stored at room temperature for several weeks.
- Green leafy vegetables: Green leafy vegetables, such as spinach, kale, and lettuce, should be stored in the refrigerator in a damp paper towel to prevent wilting.

- Root vegetables: Root vegetables, such as carrots, potatoes, and onions, can be stored in a cool, dark place with a humidity level of around 80%. Root vegetables can be stored for several weeks under these conditions.
- Tomatoes: Tomatoes should be stored at a temperature of around 60°F to 65°F. Avoid storing tomatoes in the refrigerator, as this can cause them to lose their flavor and texture.

By following these general guidelines and specific storage recommendations for different types of fruits and vegetables, you can extend their shelf life, minimize spoilage, and enjoy their fresh flavours for a longer period.

The storage material of fruits and vegetables includes containers, packaging materials, and environmental conditions. The choice of storage material depends on the specific type of fruit or vegetable, the desired storage conditions, and the length of storage time.

1.2.5 Packaging Materials

Packaging materials can be used to protect fruits and vegetables from damage and extend their shelf life. Common packaging materials include:

- Plastic bags: These are lightweight and inexpensive, but they can trap moisture and promote the growth of bacteria.
- Paper bags: These are more breathable than plastic bags and can help to prevent moisture build-up.
- Mesh bags: These allow for good air circulation and are often used for storing onions and garlic.
- Wax coatings: These can be applied to fruits and vegetables to help seal in moisture and prevent spoilage.

Environmental Conditions: the following environmental conditions are important for storing fruits and vegetables:

- Temperature: Fruits and vegetables should be stored at the proper temperature to maintain their freshness. The specific temperature will vary depending on the type of fruit or vegetable.
- Humidity: The humidity level should be kept at a moderate level to prevent fruits and vegetables from drying out or becoming overly moist.

- Ventilation: Fruits and vegetables need adequate ventilation to prevent the buildup of carbon dioxide and other gases that can promote spoilage.
- Ethylene: Ethylene is a gas that can cause fruits and vegetables to ripen and spoil prematurely. Fruits and vegetables that are sensitive to ethylene should be stored away from sources of ethylene, such as bananas and apples.

Storage Methods: there are a number of different storage methods for fruits and vegetables, including:

- Cold storage: This is the most common method of storing fruits and vegetables. Cold storage slows down the metabolic processes that cause fruits and vegetables to ripen and spoil.
- Controlled atmosphere storage (CAS): This method involves storing fruits and vegetables in an atmosphere with reduced levels of oxygen and increased levels of carbon dioxide. CAS can extend the shelf life of many fruits and vegetables.

Self-check 1	Written test

Name…… ID…… Date…….

Part 1.Chosse the Best answer

1_____ are not the quality requirement of raw material of fruit and vegetables?

A. appearance B. x-bar chat C ripeness D texture

2 _____to avoid defects or errors before they occur in the production process.

A. corrective control B. preventive control C. Detective control D.100%inspection

3_____is the important of quality control

A. customer satisfaction B. brand reputation C. risk management D. all

4. _____ common piece of mechanical handling equipment that moves materials from one location to another

A. conveyor B. sorting machine C. bladder D. refrigerator

Directions: Answer all the questions listed below.

Part 2: Short Answer Questions

1. List and define the storage methods?
2. What is the advantage of using conveyors?
3. Write three quality attributes of fresh produce?
4. Define quality control and quality assurance?

LG #15	LO #2- Sort materials

Instruction sheet

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

- Meeting material inspection and sorting
- Identifying and reporting unacceptable quality requirements
- Maintaining work area
- Conducting work

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:

- Meet material inspection and sorting to confirm quality requirements.
- Identify and report unacceptable quality requirements
- Maintain work area according to housekeeping standards.
- Conduct work in accordance with workplace environmental guidelines

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
4. Accomplish the Self-checks

Information Sheet 2

2.1. Raw Material inspection and sorting

All food raw materials are inspected and sorted before processing. The purpose is obviously to remove contaminants, which range from innocuous to dangerous. It is important to note that the removal of contaminants is essential for the protection of process equipment as well as the final consumer. At the time of harvest, most foods are likely to contain contaminants.

Benefits and Applications for Sorting and Inspection

Sorting and inspection play crucial roles in various industries, offering numerous benefits and applications. Here are some of the key advantages and applications for sorting and inspection processes:

Benefits of sorting and inspection

- Quality Assurance: Ensures that only materials meeting specified standards and quality criteria are used in production, resulting in higher-quality end products.
- Cost Reduction: Identifies and eliminates defective materials early in the production process, reducing waste and minimizing the need for rework.
- Compliance with Standards: Helps companies adhere to industry standards and regulations by ensuring that materials meet required specifications.
- Customer Satisfaction: Enhances customer satisfaction by delivering products that meet or exceed quality expectations, reducing the likelihood of product recalls or customer complaints.
- Operational Efficiency: Improves overall efficiency by preventing the incorporation of substandard materials into the manufacturing process, reducing downtime and enhancing production flow.

- Traceability: Enables traceability of materials throughout the supply chain, making it easier to identify and address issues related to specific batches or suppliers.
- Data-Driven Decision-Making: Provides valuable data on the quality of materials, enabling informed decision-making for process improvement and optimization.
- Brand Reputation: Protects and enhances the reputation of a brand by ensuring consistent quality and reliability of products
- Reduced Rework Costs: Minimizes the need for rework or repairs on finished products, saving both time and resources.

Applications of sorting and inspection

- Food and Beverage Industry: Inspecting and sorting raw materials, ingredients, and finished products to ensure food safety, quality, and compliance with regulatory standards.
- Pharmaceutical Industry: Verifying the quality and consistency of pharmaceutical ingredients, ensuring compliance with regulatory requirements and maintaining product efficacy.
- Textile Industry: Sorting and inspecting fabrics and garments to ensure they meet quality standards, including colour consistency, size accuracy, and defect detection.
- Agriculture: Sorting and inspecting harvested crops to remove damaged or contaminated produce, ensuring only high-quality products reach the market.
- Mining and Minerals Processing: Sorting and inspecting ore and minerals to separate valuable materials from waste, improving efficiency in mineral processing.
- Logistics and Warehousing: Sorting and inspecting incoming goods in warehouses to ensure accurate inventory, prevent stock outs, and identify damaged or non-compliant items.
- Packaging Industry Inspecting packaging materials for defects and ensuring proper labelling to meet regulatory requirements and enhance the visual appeal of products.

These benefits and applications highlight the diverse ways in which sorting and inspection processes contribute to the overall success and sustainability of various industries
Lot numbers or date codes from the defective parts can be recorded and problem parts can be quarantined for return to the vendor. Acceptable parts can be packed into the original containers, then corrected for count with makeup parts or specially packaged according to customer.

To perform one or more of the unit operations such as cleaning, sorting, and grading.

- **Cleaning**

Cleaning is the unit operation in which contaminating materials are removed from the food and separated to leave the surface of the food in a suitable condition. Cleaning fruits and vegetables is a crucial step in food preparation to remove dirt, pesticides, bacteria, and other contaminants. Proper cleaning helps reduce the risk of foodborne illnesses and ensures that the produce is safe to eat.

- **Grading**

It strictly means "the assessment of overall quality of a food using a number of attributes". For example, apples are graded with the assistance of color cards that show the required characteristics of different grades in terms of color distribution across the fruit, surface blemishes and size and shape of the fruit.

- **Sorting**

A preliminary sorting of produce should remove unmarketable pieces and foreign matters, such as plant debris, soil and stones, before the produce passes on to further operations. All discarded material should be quickly hauled away from the packing place. Raw materials are sorted on the basis of:

- **Visual Inspection**:

Description: Trained inspectors visually examine fruits and vegetables for external characteristics such as colour, size, shape, and signs of damage or disease.

Applications: Common in grading and sorting processes to assess overall quality.

Visual inspection locates surface defects and is among the most common inspection methods used by manufacturers. This method identifies and separates parts that show surface cracks, corrosion, contamination, discontinuities, and finishes which may lead to the structural or mechanical failure of the part. Visual inspection includes both naked eye and magnified inspection processes.

2023 https://www.youtube.com/watch?v=5-7hRG5R7D0 (Access date November 2023)

- ✓ **Size Sorting by Hands:** Size sorting is less precise than weight sorting, but is considerably cheaper. The size and shape of food units are difficult to define precisely. Size categories could involve several physical parameters, including diameter, length or projected area. The diameter of spheroidal units such as tomatoes or citrus fruits is conventionally considered to be orthogonal to the fruit stem, while the length is coaxial. Therefore, rotating the units on a conveyor can make size sorting more precise. The main categories of screens are fixed aperture and variable aperture designs. Flatbed and rotary screens are the main geometries of the fixed bed screen, and a number of screens may be used in series or in parallel to sort units into several size categories simultaneously. The problem with fixed screens is usually contacting the feed material with the screen, which may become blocked or overloaded. Fixed screens are often used with smaller particulate foods such as nuts or peas. Variable aperture screens have either a continuous diverging or stepwise diverging apertures. These are much gentler and are commonly used with larger, more delicate items such as fruit. In our homes fixed aperture screen (sieve) are used for size sorting and in food industry screens of different dimensions are used

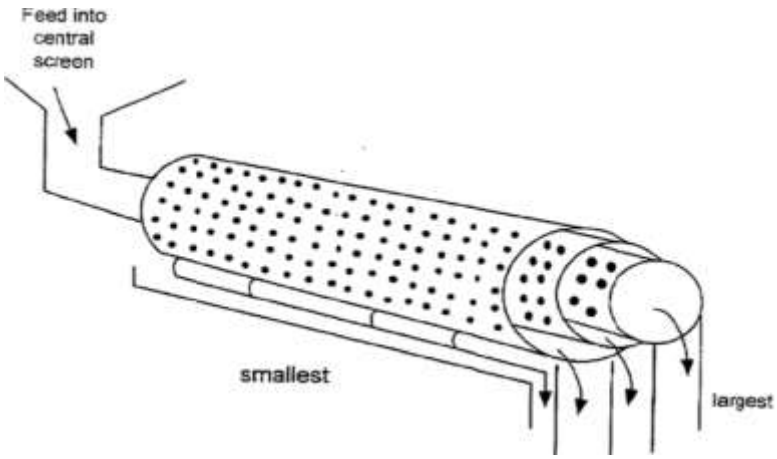


Figure 2.2 Fixed screens machine



Figure 2.3. Manually size sorting by hands

- ✓ **Colour Sorting:** Extremely high throughputs have been reported. By using more than one photocell positioned at different angles, blemishes on large units such as potatoes can be detected. Colour sorting can also be used to separate materials which are to be processed separately, such as red and green

tomatoes. It is feasible to use transmittance as a basis for sorting although, as most foods are completely opaque, very few opportunities are available. The principle has been used for sorting cherries with and without stones and for the internal examination, or 'candling', of eggs.

Mostly, Food colors that's his appearance attract the consumers so there is a higher price for the product. Manually labor on inspection belts or electric color sorter that scan the color are used in industry. Color sorters are used for food processing industry, such as coffee, nuts, and oil crops. The goal is the separation of items that are discolored, toxic (such as ergot), not as ripe as required, or still with hull after dehulling such as sunflower seed. Compared with manual sorting: machines saving labor and time, with higher high efficiency, and lower processing costs



Figure 2.4 Colour sorting

- ✓ **Shape Sorting:** Shape sorting is useful in cases where the food units are contaminated with particles of similar size and weight. Shape sorting is mostly done for the removal of contaminants from the raw material. For

example: Wheat is passed through shape sorters, so that all the contaminants must remove having the same size or weight but different shape.

- **Weight sorting:** Weight is usually the most precise method of sorting, as it is not dependent on the geometry of the products. Eggs, fruit or vegetables may be separated into weight categories using spring-loaded, strain gauge or electronic weighing devices incorporated into conveying systems. Using a series of tipping or compressed air blowing mechanisms set to trigger at progressively lesser weights, the heavier items are removed first, followed by the next weight category and so on. These systems are computer controlled and can additionally provide data on quantities and size distributions from different growers. An alternative system is to use the 'catapult' principle where units are thrown into different collecting chutes, depending on their weight, by spring-loaded catapult arms. A disadvantage of weight sorting is the relatively long time required per unit, and other methods are more appropriate with smaller items such as legumes or cereals, or if faster throughput is required. Fruits such as apples, pears and citrus fruits, and vegetables such as potatoes, carrots, and onions are sorted by weight.



Figure 2.1 Weight sorter

- **Brix Measurement:**

Description: Measures the sugar content (soluble solids) of fruits, often using a refractometer.

Applications: Common in assessing fruit ripeness and sweetness.

- **Firmness Testing:**

Description: Measures the firmness or texture of fruits and vegetables using handheld devices or penetrometers.

Applications: Important for assessing ripeness and shelf life.

- **Colorimeter Analysis:**

Description: Measures the colour of fruits and vegetables to assess ripeness and quality.

Applications: Common in assessing colour consistency and ripeness.

- **Internal Quality Inspection:**

Description: Non-destructive methods like ultrasound or near-infrared spectroscopy to assess internal quality parameters without damaging the product.

Applications: Useful for detecting internal defects or ripeness without cutting open the fruit.

- **Electronic Nose Technology:**

Description: Analyses the aroma of fruits and vegetables to assess freshness and flavor.

Applications: Important for evaluating sensory attributes.

- **Pesticide Residue Testing:**

Description: Laboratory analysis to detect and quantify pesticide residues on fruits and vegetables.

Applications: Ensures compliance with food safety standards.

- **Microbiological Testing:**

Description: Detects the presence of harmful microorganisms such as bacteria or pathogens.

Applications: Critical for assessing the safety of fresh produce.

- **Packaging Integrity Inspection:**

Description: Ensures that the packaging materials for fruits and vegetables are intact to maintain product freshness.

Applications: Important for preventing contamination and extending shelf life.

- **Cold Chain Monitoring:**

Description: Monitors and ensures that fruits and vegetables are stored and transported within specified temperature ranges.

Applications: Critical for maintaining product quality and preventing spoilage.

These inspection methods are essential in the entire supply chain of fruits and vegetables, from the farm to distribution and retail. They help maintain quality standards, ensure food safety, and meet consumer expectations.

2.2. Identifying and reporting unacceptable quality requirements

Identifying and reporting unacceptable quality requirements in fruit and vegetable processing is crucial to ensure that the final products meet safety standards, regulatory requirements, and consumer expectations.

Here are steps you can take in this specific context:

- **Understand regulatory standards:** Familiarize yourself with local and international regulations and standards for fruit and vegetable processing. This includes standards related to hygiene, contamination limits, labeling, and packaging.
- **Quality standards and specifications:** Review and understand the quality standards and specifications set by industry organizations or your company. This may include guidelines for processing methods, packaging materials, and permissible levels of contaminants.
- **Incoming quality inspection:** Implement thorough inspections of incoming raw materials. Check for factors such as freshness, ripeness, size, and any visual defects. Non-compliance with these criteria can lead to unacceptable quality in the final product.
- **Production process monitoring:** Monitor the processing stages to ensure that the specified procedures are followed. This includes temperature control, sanitation practices, and adherence to processing times.
- **Quality control checks**: Integrate quality control checks at critical points in the processing line. This may involve visual inspections, sensory evaluations, and the use of testing equipment to measure factors like acidity, sweetness, and moisture content.
- Contaminant testing: Implement regular testing for contaminants such as pesticides, heavy metals, and microbial pathogens. Set clear limits for acceptable levels and take immediate action if any results exceed these limits.
- **Documentation of specifications**: Document the specifications for each processed fruit or vegetable. Include details on acceptable ranges for attributes like color, texture, flavour, and any other relevant quality parameters.
- **Employee training**: Ensure that employees involved in the processing are well-trained on quality standards and procedures. This includes proper handling of equipment, hygiene practices, and recognizing potential quality issues.
- **Equipment maintenance:** Regularly maintain and calibrate processing equipment to ensure accuracy and consistency in product quality. Malfunctioning equipment can lead to deviations from quality requirements.

- Sampling and testing: Implement a robust sampling plan for finished products. Test samples for various quality attributes and compare the results against established standards.
- Immediate actions for non-conformities: If unacceptable quality is identified at any stage, take immediate corrective actions. This may include segregating affected batches, adjusting processing parameters, or implementing additional quality checks.
- Supplier quality assurance: Work closely with suppliers to ensure they meet the required quality standards for raw materials. Establish clear communication channels to address any quality concerns promptly.
- Documentation of non-conformities: Document any instances of non-conformities thoroughly. Include details on the nature of the issue, the quantity affected, and any corrective actions taken.
- Internal reporting: Internally reporting quality issues to relevant departments, including quality assurance, production, and management. This facilitates a coordinated effort to address and resolve the problems.
- Continuous improvement: Use data from quality reports to identify trends and patterns. Implement continuous improvement measures to prevent similar issues in the future and enhance overall processing efficiency.

By following these steps, you can systematically identify and report unacceptable quality requirements in fruit and vegetable processing, ensuring that the final products meet the necessary standards for safety and consumer satisfaction.

2.2.1. Quality of fruit and vegetable

Quality is fitness for purpose or use. Features like shape, dimension, composition, finish and colour. Quality control is systematic control of these variables encountered in manufacturing process which affect the excellence of the end product. Quality control is that technique or group of techniques of industrial management by means of which products of uniform acceptable quality are manufactured.

2.2.2 Quality variation

When the quality of any fruit and vegetable is given by industry, then it is responsible for any variation from the standard. Quality variation occurred when contaminants with:

- Unwanted parts of the plant, such as leaves, twigs, husks;
- Soil, sand, stones and metallic particles from the growing area;

- Insects and their eggs;
- Animal excreta, hairs etc.;
- Pesticides and fertilisers;
- Mineral oil;
- Microorganisms and their toxins.

- **Unacceptable quality indication in fruit and vegetable are:**
  - ✓ Sprouting
  - ✓ Water loss and decay
  - ✓ Loss of green colour
  - ✓ Mechanical injury
  - ✓ Water loss and decay
  - ✓ Discoloration
  - ✓ Bruising and other mechanical injury
  - ✓ Water loss and decay
  - ✓ Over-ripeness at harvest

2.3 Maintaining work area according to housekeeping standards

Good housekeeping is the foundation of a safe, healthy and pleasant workplace. It is essential that all areas be kept clean, orderly, and with all necessary things in the proper places. Employees should be aware of hazards arising from poor housekeeping. Good housekeeping improves safety, efficiency and quality at the same time.

Housekeeping activities

- ✓ Keep work areas neat and clean.
- ✓ Place tools, equipment and supplies in their correct places.
- ✓ Implementing cleaning schedules for the area
- ✓ Removing wrapping and packaging waste
- ✓ Storing all product as soon as possible after delivery
- ✓ Remove potential hazards
- ✓ Keep the area clear for future deliveries
- ✓ Keeping stores area well and ventilated to deter pests and allow for easy identification of product items and problem issues
- ✓ Keeping shelves, benches, pallets, bins and other storage containers in good order and inspecting the area and fittings on a regular basis for signs of damage or deterioration or other problems such as stability, security and pest infestation
- ✓ Maintaining all equipment and storage areas in accordance with the relevant occupational health and safety requirements.
- ✓ Checking the temperature of refrigerated food storage areas
- ✓ Initiating preventative maintenance servicing for plant and equipment in the stores area before servicing them
- ✓ Developing and implementing a proper cleaning schedule for the stores areas including ensuring supplies of all necessary chemicals and equipment exist to get the job done

2.4 Conducting work in accordance with environmental policies and procedures

The maintenance of cleanliness in a working area requires frequent or continuous cleaning as well as a clean-up at the end of each day. The purpose of this is to keep waste from accumulating during the operating day. It involves:

- careful organization
- training work scheduling and
- the best available equipment
- method and materials.

Hazard Analysis Critical Control Point (HACCP): HACCP allows processors/regulator to look at what happens during the process to ensure safety.

Major Concepts of HACCP

- A preventive system of control particularly on biological hazards
- A system approach for estimating the risk in producing a food product
- Universally recognized system as the most effective way to prevent food borne illness
- Science - based systematic, identified specific hazards and measures for their control to ensure food safety
- Capable of accommodating change, such as advances in equipment design, processing procedures, or technological developments that can be applied throughout the food chain from the primary producer to the final consumer
- Applicable to establishments that produce, process, treat, pack, trade, transport, serve, or involve in food production

Seven (7) HACCP Principles

- Hazard analysis
- Identify critical control points

- Establish Control limits
- Monitor critical limits
- Establish corrective actions in case of deviation from established critical limits
- Establish verification procedure to ensure that the system is consistent
- Establish record keeping procedures

General Hazards Characteristics

- The product contains sensitive ingredients, which can be assumed as potential sources of contamination under normal circumstances.
- The manufacturing process does not contain controlled processing steps that effectively destroy harmful bacteria.
- There is substantial potential for microbiological abuse in distribution or in consumer handling that could render the product harmful when consumed.
- Product is subject to contamination after processing and before packaging.
- No terminal heat process after packaging.

HACCP Pre-Requisite Programs

1. Good Manufacturing Practices (GMP): GMPs are systems put in place to ensure that food prepared in a plant is sound and free of contamination. GMPs include:
   - ✓ Plant grounds and building facilities emphasize pest control;
   - ✓ Equipment design provides ease in cleaning and maintenance;
   - ✓ Personal hygiene practices and facilities are set;
   - ✓ Storage and warehousing are free from contamination.
2. Sanitation Standard Operating Procedures (SSOP): SSOP are components of GMP that emphasize sanitation procedure. They include:
   - ✓ Safety of water that gets in contact with food and food surfaces;
   - ✓ Measures to prevent contamination;
   - ✓ Employee hygiene practices;

- ✓ Control of employee health conditions that could result in contamination of food and food surfaces;
- ✓ Protection of food and food contact surfaces from adulteration with toxic and other harmful components;
- ✓ Proper labelling and storage and use of toxic; and Control of pests.

Self-check 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Part 1.say true if the statement is correct and false if the statement is incorrect.

1. Brix measurement measures the sugar content (soluble solids) of fruits, often using a refractometer._____
2. Good housekeeping is the foundation of a safe, healthy and pleasant workplace._____
3. Quality is nor fitness for purpose or use._____

Part 2: Short Answer Questions

1. What is HACCP?
2. Write three unit operation used in food processing
3. Write types of sorting of raw materials
4. What are the 7 principle of HACCP?
5. What are Sanitation Standard Operating Procedures (SSOP) include?
6. What is the good housekeeping?
7. List at least 5 housekeeping guideline?
8. Define quality
9. Write the steps of quality controlling

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

LG #16	LO #3- Perform washing activities

Instruction sheet

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

- Performing washing emersion procedures
- Doing rinsing by plate water
- Conducting washing with brushes

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:

- Perform washing by emersion procedures
- Do rinsing by plate water
- Conduct washing with brushes

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
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test” go back to “Operation sheets”

Information Sheet 3

3.1. Performing washing immersion procedures

Washing emersion procedures are a crucial step in the post-harvest handling and processing of fruits and vegetables to ensure their quality, safety, and shelf life. These procedures involve immersing the produce in water or washing solutions to remove dirt, debris, contaminants, and microorganisms.

An immersion washing system consists of a chamber, or multiple chambers, in which parts can be completely submerged in a cleaning solution and subjected to prescribed conditions such as heat, time, agitation and drying.

- **Purpose of Washing Immersion Procedures**

  - ✓ Remove Dirt and Debris: Eliminate visible dirt, soil, and other particles that can affect the appearance and reduce the shelf life of fruits and vegetables.
  - ✓ Reduce Microorganisms: Lower the microbial load on fruits and vegetables, minimizing the risk of foodborne illnesses and extending their shelf life.
  - ✓ Remove Pesticides: Reduce the presence of pesticide residues on fruits and vegetables, promoting food safety and consumer confidence.
  - ✓ Improve Appearance: Enhance the overall appearance and appeal of fruits and vegetables, making them more attractive to consumers.

- **Types of Washing Immersion Procedures**

  - ✓ **Immersion washing**: Simply submerge fruits and vegetables in water to remove surface dirt and debris.
  - ✓ **Agitated washing:** Submerge fruits and vegetables in water and agitate them using paddles, brushes, or water jets to remove more stubborn dirt and debris.
  - ✓ **Detergent washing:** Add a mild detergent to the washing water to enhance cleaning and remove pesticide residues.
  - ✓ **Chlorinated washing**: Add chlorine or chlorine dioxide to the washing water to sanitize fruits and vegetables and eliminate harmful microorganisms.
  - ✓ **Ozone washing**: Utilize ozone gas to sanitize fruits and vegetables without leaving chemical

Factors Affecting Washing Emersion Procedures

- ✓ **Type of produce**: Different fruits and vegetables have varying sensitivities to water and washing solutions. Some may require gentle washing, while others can tolerate harsher conditions.
- ✓ **Degree of soiling:** The level of dirt and debris on the produce determines the intensity and duration of the washing process.
- ✓ **Water quality:** Clean, potable water is essential to prevent contamination and ensure food safety.
- ✓ **Water temperature:** The appropriate water temperature depends on the type of produce and the desired outcome.
- ✓ **Contact time:** The length of time the produce is immersed in the washing solution affects the effectiveness of cleaning and sanitization.
- ✓ **Agitation:** Agitation during washing can enhance the removal of dirt and debris, especially for rough-skinned produce.
- ✓ **Detergent and sanitizer concentration:** The concentration of detergents and sanitizers must be carefully controlled to avoid affecting the taste, texture, and safety of the produce.

3.1.1 Fruit and vegetable washing by immersion method

Emersion is the process of immersing the fruit and vegetables in hot water at 85–95°C.

The procedure of immersion fruit and vegetables are:

- **Selection of fruits and vegetables:** fruits and vegetables should be fresh. Fruits should be ripe, but firm, and uniformly mature. Over-ripe fruits should be rejected because they are infected with microorganisms and give a poor-quality product. Unripe fruits should be rejected because they generally shrivel and toughen on canning. All vegetables except tomatoes should be tender. Tomatoes should be firm, fully ripe, and of deep red color. Fruits and vegetables should be free from dirt. They should be free from blemishes, insect damage, or mechanical injury

- **Grading:** the selected fruits and vegetables are graded according to size and color to obtain uniform quality. This is done by hand or by machines such as screw graders and roller grader. Fruits like berries, plums and cherries are graded whole. While peaches, pears, apricots, mangoes, pineapples, etc., are generally graded after cutting into pieces or slices
- **Washing:** it is important to remove pesticide spray residue and dust from fruits and vegetables. One gram of soil contains 1012 spores of microorganisms. Therefore, removal of microorganisms by washing with water is essential. Fruits and vegetables can be washed in different ways. Root crops that loosen in soil are washed by soaking in water containing 25 to 50 ppm chlorine (as detergent). Other methods of washing are spray washing, steam washing, etc.
- **Peeling:** many fruit and vegetables are peeled and cut by hand with the help of peeling knives. The peeling knife with a curved blade and a special guard to regulate the depth of peeling can be used for uniform peeling in case of irregular fruit shapes. The objective of peeling is to remove the outer layer. Peeling may be done in various ways:
  - ✓ Hand Peeling
  - ✓ team Peeling
  - ✓ Mechanical Peeling
  - ✓ Lye Peeling

- Cutting: pieces of the size required for canning are cut. Seed, stone and core are removed. Some fruits like plum from which the seeds cannot be taken out easily are canned whole.
- Emersion: emersion the fruit and vegetables in hot water following cooling, after emersion the fruit and vegetables are dipped in cold water for better handling and keeping them in good condition.

3.2 Doing rinsing by plate water

Cleaning fruits and vegetables with water is a straightforward and effective method to remove dirt, bacteria, and some pesticides. Here's a step-by-step guide for cleaning fruits and vegetables using water:

3.2.1Washing of fruit and vegetables using plate water

Fruit and vegetables are generally washed with water to remove dust, dirt and adhering surface micro-flora. Fruits like peach, apricot etc. are lye peeled so not washed before peeling. On the other hand, washing after peeling removes vitamins and minerals and should be discouraged. Different methods of washing include soaking or agitating in water, washing with cold or hot water sprays etc.

- Mechanical washers involve agitating or tumbling the commodity on moving belts or revolving screens while they are immersed in water or subjected to water sprays.
- Washing by using high pressure sprays is most satisfactory.
- Detergents are frequently used in the wash or rinse water.
- Vegetables may be soaked in dilute solution of potassium permanganate or chlorine (25-50 ppm) for disinfection.
- The water temperature should be kept low to keep the fruit firm and to reduce leaching losses.
- High pressure sprays should not injure the fruits.

Bacteria and other contaminants can accumulate in the wash water and hence appropriate cleaning and chlorination practices be followed. Packaged fruits and vegetables labelled as being previously washed and RTE are not required to be washed.

3.3 Conducting washing with brushes

Washing with brushes can be an effective and thorough way to clean various surfaces. Whether you're cleaning dishes, cars, outdoor furniture, or other items, using brushes can help remove dirt and grime more efficiently. Here are some general tips for conducting washing with brushes:

- **Select the right brush:** choose a brush with bristles appropriate for the surface you're cleaning. For example, softer brushes are suitable for delicate surfaces, while stiffer brushes work well on tougher stains.

- **Use the right cleaning solution:** depending on what you're cleaning, use an appropriate cleaning solution. Dish soap, car wash soap, or specialized cleaners can be diluted in water to create an effective cleaning solution.
- **Pre-rinse the surface:** before applying the cleaning solution, pre-rinse the surface to remove loose dirt and debris. This helps prevent scratches caused by abrasive particles.
- **Apply the cleaning solution:** apply the cleaning solution generously, ensuring it covers the entire surface. Allow it to sit for a few minutes to break down dirt and grime.
- **Scrub with the brush:** use the brush to scrub the surface vigorously. Pay extra attention to areas with stubborn stains or heavy dirt buildup. Circular or back-and-forth motions can be effective, depending on the surface.
- **Rinse thoroughly:** after scrubbing, thoroughly rinse the surface with clean water. This removes the cleaning solution and any remaining dirt.
- **Repeat if necessary:** for heavily soiled surfaces, you may need to repeat the process to achieve the desired level of cleanliness.
- **Dry the surface:** once the cleaning is complete, allow the surface to dry. Use a clean, dry cloth or allow it to air dry, depending on the material.
- **Maintain your brushes:** clean your brushes regularly to prevent the buildup of dirt and bacteria. If using brushes with detachable heads, replace them as needed.

- **Safety precautions:** be mindful of any safety precautions associated with the cleaning solution you're using. Some solutions may require protective gear such as gloves or eye protection.

Remember to follow specific guidelines for the items you are cleaning, as different materials may have specific care instructions. Whether you're washing dishes, cleaning your car, or tackling outdoor surfaces, using brushes effectively can make the process more efficient and yield better

3.3.1 Fruit and Vegetable Washing Brushes

Washing must be done before the fruit is cut in order to avoid losing high-nutritive value soluble substances (vitamins, minerals, sugars, etc.).

3.4.2Brush Type Vegetable and Fruit Cleaning Machine

Rotary brush roller cleaning machine

The fruit and vegetable raw materials are making irregular rotation under the effect of rotary brush roller to carry out spraying and brushing simultaneously. The brush is made of high temperature resistant nylon wire through two kinds of technologies such as hair planting and stainless steel winding.

- Brush fruit cleaning machine for apple and fruits
- Brush clearing machine for watermelon
- Brush cleaning machine for carrot vegetable
- Brush cleaning machine for citrus fruit



Figure 3.1 Rotary brush roller Machine

Roller with brush cleaning machine

The equipment is mainly composed of water cabinet, material turning device, fan and lifter etc. It is widely used for soft washing of fruit and vegetable raw materials. The lifter can be made of complete stainless steel and engineering plastic. It can be additionally provided with spray cleaning device.



Figure 3.2 Roller with brush cleaning machine

The fruit washing equipment consists of a roller with brush washing (cleaning) machine for washing fruits and vegetables. Roller with brush washing machine is made up of stainless steel tube and brush. The brush is made of polyethylene, and will make revolution as the movement of stainless-steel chain. Fruits are driven to circumvolve and washed by brush. At the same time, the bad or rejected fruits are picked up by manual and then sent away by scrap conveying device.

Rolling drum brush washing machine

The fruit washing equipment consists of a rolling drum brush washing (cleaning) machine for washing root vegetables. Rolling drum brush washing machine is made up of electric motor, water pump, roller drum, supporter, riding wheel, brush, water spraying tubes, feeding funnel, cover board, water box, transmission shaft, supporter for motor, electric control switches, and other parts. Roller drum is driven to rotate by chain wheel of electric motor through stainless steel chain. When materials enter into the rotating roller drum, they are washed by spraying water and brush. There are two water boxes in our rolling drum brush

washing machine. One is used to hold fresh water, and the other with filtering net in it is to recycle water.



Figure 3.3 rolling drum brush washing machine

Self-check 3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Part 1: say true if the statement is correct say false if the statement is incorrect

1. Emersion is the process of immersing the fruit and vegetables in hot water._____
2. Washing must be done before the fruit is cut in order to avoid losing high-nutritive value soluble substances____
3. Washing by using high pressure sprays is most satisfactory._____
4. The objective of peeling is not to remove the outer layer.

Part 1 : Short Answer Questions

1. Write two brush type vegetable and fruit cleaning machine
2. Write two fruit and vegetable type that cleaning by brush
3. Define emersion of fruit and vegetable
4. Write the procedure of emersion fruit and vegetable

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

Operation sheet – 1	

Operation title: Perform washing by emersion

Purpose: To perform washing of fruit and vegetable by emersion process

Materials required:

- Materials:
  - ✓ Fruits like tomato, peaches and water
- Utensils:
  - ✓ Measuring cup
  - ✓ Measuring spoon
  - ✓ Weighing scale
  - ✓ Knife
  - ✓ Chopping board
  - ✓ Ladles
  - ✓ Tongs
  - ✓ Colanders
  - ✓ thermometer

Procedures for immersion of fruit and vegetable:

- Wear protective clothing
- Select fruit and vegetable
- Perform washing, peeling, slicing and chopping,
- Use a steamer or make a steamer out of a kettle with a tight-fitting lid.
- Add 5 cm of water to the kettle and heat it to boiling.
- Place the fruit and vegetable on a colander, wire basket, or sieve.
- Putting the container in the steamer and cover it tightly, and continue boiling
- Transfer to an ice bath immediately.
- Cooling
- Make the fruit or vegetable for drain and set aside either to use in a recipe or to process for canning, drying, or freezing.

Lap 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 Perform washing by emersion

LG #36	LO #4- Apply blanching

Instruction sheet

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

- Maintaining blanching and set material.
- Applying blanching procedures
- Following blanching objectives.

Following blanching objectives.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:

- Maintain blanching and set material.
- Apply blanching procedures depends upon specificity vegetables
- Follow blanching objectives and subsequent processing /preservation methods.

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
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”).

Information Sheet 4-

4.1 Maintaining blanching and set material

Blanching is achieved in hot water for a short period of time or in an atmosphere of steam. In water blanching, the product is moved through water usually maintained at a temperature between 88 and 99^{o}C. Blanching is used to destroy enzymatic activity in vegetable and some fruits prior to other processing like freezing or dehydration or canning or thermal processing. It is a pre-treatment by mild heat for a specific time followed by rapid cooling or passing immediately to the next processing stage. The time and temperature combination varies from product to product, the condition and size of product.

The following factors are affecting blanching time:

- The type of fruit or vegetable.
- The size of the pieces of food.
- The blanching temperature and
- The method of heating

4.1.1. Processing Conditions for Blanching

It is essential to control the processing conditions accurately to avoid loss of texture, weight, colour and nutrients. All water-soluble materials, including minerals, sugars, proteins and vitamins, can leach out of the tissue, leading to nutrient loss. In addition, some nutrient loss (especially ascorbic acid) occurs through thermal lability and, to a lesser extent, oxidation.

Ascorbic acid is the most commonly measured nutrient with respect to blanching, as it covers all eventualities, being water soluble and hence prone to leaching from cells, thermally labile, as

well as being subject to enzyme breakdown by ascorbic acid oxidase during storage. Wide ranges of vitamin C breakdown are observed, depending on the raw material and the method and precise conditions of processing.

The following factors must be considered for deciding processing conditions of blanching:

- Fruit or vegetable properties, especially thermal conductivity, which will be determined by type, cultivar, degree of maturity etc
- Overall blanching effect required for the processed product, which could be expressed in many ways including: achieving a specified central temperature, achieving a specified level of peroxidase inactivation, retaining a specified proportion of vitamin C.
- Size and shape of food pieces
- Method of heating and temperature of blanching medium

Time/temperature combinations vary very widely for different foods and different processes and must be determined specifically for any situation. Holding times of 1–15 minutes at 70–100 ºC are normal.

4.1.2 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. There have been substantial developments to blanchers in recent years to reduce the energy consumption and also to reduce the loss of soluble components of foods, which reduces the volume and polluting potential of effluents and increases the yield of product.

4.1.3. Types of blanching in food industry

In the food industry, different types of blanching methods are employed depending on the characteristics of the food product, the desired outcome, and the scale of production.

Here are some common types of blanching methods used in the food industry:

- **Water Blanching:** in water blanching, the food product is immersed in boiling water for a specified duration. This is a widely used method for blanching vegetables, fruits, and some meats. The water temperature and blanching time vary depending on the type of food being processed.



Figure 4.3 water bleaching

- **Steam Blanching:** Steam blanching involves exposing the food product to steam instead of immersing it in water. This method is often used for delicate items or those with high water content. It can help retain water-soluble nutrients better than water blanching.



Figure 4.4 steam bleaching

- **Microwave Blanching:** Microwave blanching utilizes microwave energy to heat the food product quickly. While it is not as common as water or steam blanching, it can be efficient for certain applications. However, it may result in uneven heating.

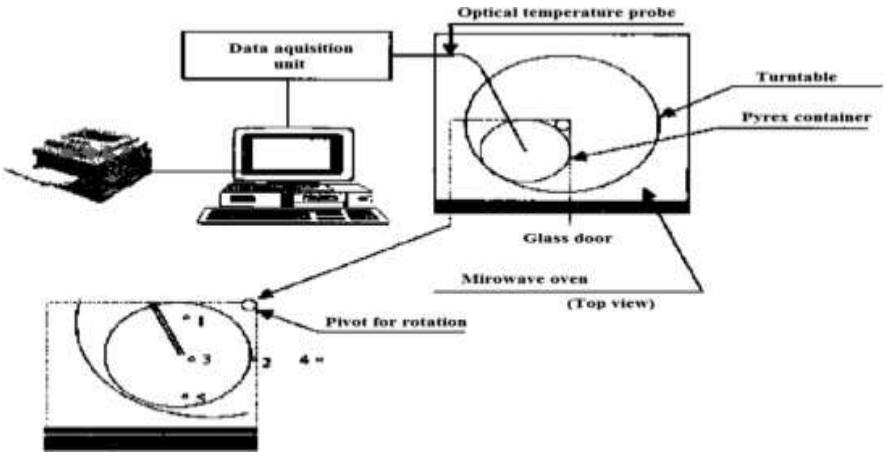


Figure 4.5 Schematic of experimental setup for microwave blanching

- **Hot water dip blanching:** in hot water dip blanching, the food product is briefly submerged in hot water. This method is often used for fruits with delicate skin, such as tomatoes, to facilitate easier peeling.
- **Steam water blanching:** steam water blanching combines both steam and water. The food product is exposed to steam, followed by immersion in hot water. This method is used when a combination of the advantages of both steam and water blanching is desired.
- **Hydro-thermal blanching:** hydro-thermal blanching involves using a combination of hot water and pressure. This method is suitable for certain fruits and vegetables and can result in better preservation of color and texture.
- **Vacuum blanching:** in vacuum blanching, the atmospheric pressure is reduced, lowering the boiling point of water. This method is used to minimize heat exposure and nutrient loss, making it suitable for more heat-sensitive foods.
- **Osmotic blanching:** osmotic blanching involves immersing the food product in a hypertonic solution (usually a sugar or salt solution) to draw out water. This reduces the water content in the food, aiding in subsequent drying processes.
- **Alkaline blanching:** alkaline blanching involves treating vegetables with an alkaline solution before blanching in hot water. This method is used to preserve the green color in vegetables like peas and beans.
- **Enzyme inactivation blanching:** enzyme inactivation blanching involves treating the food product with steam to inactivate enzymes before immersion in hot water. This is commonly used in the processing of fruits and vegetables.

Each type of blanching method has its advantages and is chosen based on factors such as the nature of the food product, desired end results, and production efficiency. The selection of the appropriate blanching method is crucial to achieving the desired product quality and safety in the food industry.

Conventional steam blanching consists of conveying the material through an atmosphere of steam in a tunnel on a mesh belt. Uniformity of heating is often poor where food is unevenly distributed; and the cleaning effect on the food is limited.

However, the volumes of waste water are much lower than for water blanching. Fluidised bed designs and 'individual quick blanching' (a three-stage process in which vegetable pieces are heated rapidly in thin layers by steam), held in a deep bed to allow temperature equilibration, (followed by cooling in chilled air) may overcome the problems of no uniform heating and lead to more efficient systems.

The two main conventional designs of hot water blancher are reel and pipe designs. In reel blanchers, the food enters a slowly rotating mesh drum which is partly submerged in hot water. The heating time is determined by the speed of rotation. In pipe blanchers, the food is in contact with hot water recirculating through a pipe. The residence time is determined by the length of the pipe and the velocity of the water. There is much scope for improving energy efficiency and recycling water in either steam or hot water systems. Blanching may be combined with peeling and cleaning operations to reduce costs.

Following the microwave heating, the vegetable material is subjected to blanching comprising heat treating in a current of hot air at temperature 100 to 150ºC. The heating is conducted in an environment which prevents loss of water from the vegetable material and this may readily achieved by introducing steam in to the oven.

4.2 Applying blanching procedures

Applying blanching procedures to fruits and vegetables involves a systematic process to ensure that the produce is properly prepared for further processing or storage. Here's a step-by-step guide on how to apply blanching procedures:

Equipment and Materials used for blanching: these material are used for blanching purpose

- **Large Pot or blanching unit:** use a pot with enough capacity to submerge the quantity of produce you are processing or a specialized blanching unit.
- **Water:** Sufficient water to fully cover the fruits or vegetables during blanching
- **Boiling water or steam:** Bring the water to a rapid boil or set up a steam blancher, depending on the type of produce.
- **Blanching basket or strainer:** blanching basket or strainer makes it easier to immerse and remove the produce quickly.
- **Ice water bath:** Prepare a large bowl or basin filled with ice water for immediate cooling after blanching.

Blanching is scalding vegetables in boiling water or steam for a short time. It is typically followed by quick, thorough cooling in very cold or ice water. Blanching stops enzyme actions which otherwise cause loss of flavor, color and texture.

Why blanch vegetables before freezing? Blanching vegetables before freezing them is critical to their quality, but not their safety. Blanching is scalding vegetables in boiling water or steam for a short time. It is typically followed by quick, thorough cooling in very cold or ice water.

Blanching stops enzyme actions which otherwise cause loss of flavor, color and texture. In addition, blanching removes some surface dirt and microorganisms, brightens color and helps

slow vitamin losses. It also wilts greens and softens some vegetables (broccoli, asparagus) and makes them easier to pack.

It is critical to use the correct blanching time for the vegetable and size (see table below). Under-blanching stimulates enzyme activity and thus is worse than no blanching. Over-blanching leads to partial cooking and causes loss of flavor, color, vitamins and minerals.

For home freezing, the most satisfactory way to blanch all vegetables is in boiling water. General instructions for water blanching follow:

Use a blancher with a blanching basket and cover, or fit a wire basket into a large pot with a lid.

Use one gallon water per pound of prepared vegetables.

Put vegetable in blanching basket and lower into vigorously boiling water. Place lid on blancher.

The water should return to boiling within 1 minute, or too much vegetable is being used for the amount of boiling water. Start counting blanching time as soon as the water returns to a boil.

Keep heat high for the time given in the directions for the vegetable you are freezing.

Immediately plunge basket of vegetables into a large quantity of cold water, 60ºF or below.

Change water frequently or use cold running water or ice water. If ice is used, about one pound of ice for each pound of vegetable is needed.

Cooling vegetables should take the same amount of time as blanching.

Drain vegetables thoroughly after cooling. Extra moisture can cause loss of quality when vegetables are frozen.

4.3 Following blanching objectives

Blanching is a cooking process that involves briefly immersing fruits and vegetables in boiling water or steam, followed by rapid cooling in ice water or under cold running water. The purpose of blanching is primarily to prepare the produce for preservation, whether it be freezing, canning, or drying. The process is named after the French word "blanchir," meaning "to whiten," as blanching often helps to maintain the natural color of the fruits and vegetables.

The primary objective of blanching is to prepare fruits and vegetables for preservation by briefly exposing them to boiling water or steam, followed by rapid cooling. The key purposes and objectives of blanching include:

4.3.1 Purpose and Objective of Blanching

The purpose of blanching is to achieve several objectives.

- To soften the tissue to facilitate packaging.
- To avoid damage to the product.
- To eliminate air form the product.
- To preserve the natural colour.
- To destroy or retard certain undesirable enzymes.
- To help preserve natural flavour.

The major purpose of blanching is frequently to inactivate enzymes, which would otherwise lead to quality reduction in the processed product. For example, with frozen foods, deterioration could take place during any delay prior to processing, during freezing, during frozen storage or during subsequent thawing. Similar considerations apply to the processing, storage and rehydration of

dehydrated foods. Enzyme inactivation prior to heat sterilization is less important as the severe processing will destroy any enzyme activity, but there may be an appreciable time before the food is heated to sufficient temperature, so quality may be better maintained if enzymes are destroyed prior to heat sterilisation processes such as canning.

It is important to inactivate quality-changing enzymes that is enzymes which will give rise to loss of colour or texture, production of off odours and flavours or breakdown of nutrients. Many such enzymes have been studied, including a range of peroxidases, catalases and lipoxygenases. Peroxidase and to a lesser extent catalase are frequently used as indicator enzymes to determine the effectiveness of blanching. Although other enzymes may be more important in terms of their quality-changing effect, peroxidase is chosen because it is extremely easy to measure and it is the most heat resistant of the enzymes in question. More recent work indicates that complete inactivation of peroxidase may not be necessary and retention of a small percentage of the enzyme following blanching of some vegetables may be acceptable.

Blanching causes the removal of gases from plant tissues, especially intercellular gas. This is especially useful prior to canning where blanching helps achieve vacuum in the containers, preventing expansion of air during processing and hence reducing strain on the containers and the risk of misshapen cans and/or faulty seams. In addition, removing oxygen is useful in avoiding oxidation of the product and corrosion of the can. Removal of gases, along with the removal of surface dust, has a further effect in brightening the colour of some products, especially green vegetables.

Shrinking and softening of the tissue is a further consequence of blanching. This is of benefit in terms of achieving filled weight into containers, so for example it may be possible to reduce the tin plate requirement in canning. It may also facilitate the filling of containers. It is important to control the time/temperature conditions to avoid over processing, leading to excessive loss of texture in some processed products. Calcium chloride addition to blanching water helps to

maintain the texture of plant tissue through the formation of calcium pectate complexes. Some weight loss from the tissue is inevitable as both water and solutes are lost from the cells.

A further benefit is that blanching acts as a final cleaning and decontamination process. It also removes pesticide residues or radionuclides from the surface of vegetables, while toxic constituents naturally present (such as nitrites, nitrates and oxalate) are reduced by leaching. Very significant reductions in microorganism content can be achieved, which is useful in frozen or dried foods where surviving organisms can multiply on thawing or rehydration. It is also useful before heat sterilization if large numbers of microorganisms are present before processing.

The main objectives of blanching fruits and vegetables include:

- **Enzyme inactivation:** blanching helps inactivating enzymes present in fruits and vegetables. Enzymes are natural substances that, if not deactivated, can cause undesirable changes in colors, flavor, and texture of the produce. By blanching, these enzymes are partially or completely inactivated, preserving the quality of the food.
- **Color retention:** blanching helps in retaining the natural color of fruits and vegetables. Enzymatic browning, which occurs when the enzymes react with oxygen, is slowed down or prevented through blanching. This is particularly important for preserving the aesthetic appeal of the produce.
- **Texture preservation:** blanching helps to maintain the texture of fruits and vegetables by slowing down the softening process. It can help to preserve the crispness and firmness of certain produce.
- **Microbial decontamination:** blanching can reduce the microbial load on the surface of fruits and vegetables, which helps in extending the shelf life of the produce. Although blanching is not a sterilization method, it does contribute to the reduction of bacteria on the surface.

- **Removal of air:** blanching removes air trapped in the plant tissues, which can contribute to better packaging and preservation. Removing air helps prevent oxidation, which can lead to off-flavors and spoilage.
- **Improving freezing efficiency:** for fruits and vegetables that are intended for freezing, blanching is often a preliminary step. It helps to stop enzyme activity, reducing the likelihood of quality deterioration during frozen storage.
- **Peel removal:** blanching facilitates the removal of the skin or peel from certain fruits and vegetables. This is particularly useful when processing fruits and vegetables for canning or freezing.

It's important to note that the specific blanching times may vary depending on the type of fruit or vegetable being processed. Additionally, the blanched items are typically not meant for immediate consumption but are rather prepared for further processing, such as freezing, canning, or drying.

Self-check 4	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Part 1: **Write true if the statement is right and false if the statement is wrong**

1. Hot-water blanching causes loss of some nutrients and gives rise to large volumes of waste water._____
2. The major purpose of blanching is not frequently to inactivate enzymes.____
3. Alkaline blanching involves treating vegetables with an alkaline solution before blanching in hot water.____

Part 2: Choose the best answer

1. _____The purpose of blanching is to achieve several objectives.

A. To soften the tissue to facilitate packaging.
B. to avoids damage to the product.
C. to eliminate air forms the product.
D. all.

2. ._____ blanching involves treating vegetables with an alkaline solution before blanching in hot water

A. osmotic blanching
B. alkaline blanching
C. vacuum blanching
D. Steam Blanching

3. _____ factors are affecting blanching time

A. The type of fruit or vegetable.
B. The size of the pieces of food.

C. The blanching temperature

D. The method of heating

Part 3:

1. Define blanching?
2. Write method of blanching?
3. Write procedure of steam or hot water?
4. What are the factors which influence blanching time?
5. What are the factors which influence blanching time?
6. What are the factors must be considered for deciding processing conditions of blanching?

Operation sheet 2

2.1 Ensure Blanching of fruit and vegetable techniques

A. Tools and equipment

Large pot or bleaching unit

Water

Fruit or vegetables

Strainer

Ice water bath

B. Steps to blanch of fruit and vegetable

Step 1: Preparation: wash and clean the fruits or vegetables thoroughly before blanching.

Trim, peel, and cut the produce into the desired sizes or shapes.

Step 2: Boiling Water or steam: Bring a large pot of water to a rolling boil or set up a steam blancher, depending on the blanching method suitable for your produce.

Step 3: Blanching time: Refer to recommended blanching times for specific fruits and vegetables. The blanching time can vary, so consult reliable sources such as extension services, food preservation guides, or recipes. Generally, blanching times are short, ranging from 30 seconds to a few minutes.

Step 4: Blanching process: Immerse the prepared produce into the boiling water or expose it to steam. Ensure that all pieces are fully submerged or exposed to steam.

Step 5: T**iming:** Start timing the blanching process as soon as the produce is in the boiling water or steam.

Step 6: Controlled boil or steam: Maintain a controlled boil or steam during the blanching process. Avoid overcooking.

Step 7: Cooling: Immediately transfer the blanched produce to an ice water bath to halt the cooking process rapidly. Ensure thorough cooling to maintain quality and prevent further cooking.

Step 8: Draining: Drain the cooled produce thoroughly. Excess water can affect the quality during freezing or other preservation methods.

Reference

Books

- Dewulf, W., Jancsok, P., Nicolai, B., De Roeck, G., Briassoulis, D., ”Determining the firmness of a pear using finite element model analysis”, Journal of Agricultural Engineering Research, 74 (3), . 217-224, 1999.
- Fernando Mendoza, Petr Dejmek and Jose M Aguilera, “Colour and image texture analysis in classification of commercial of commercial potato chips”, Food Research Internationally. 40(9) , .1146-1154, 2007.
- Gunasekaran, S., Ding, K., 1993 “Using computer vision for food quality evaluation”, Food Technology 6 . 151-154
- Gunasekaran, S., “Computer vision technology for food quality assurance”, Trends in Food Science and Technology, 7(8),. 245-256, 1996.
- Gunasekaran, S., “Non-destructive Food Evaluation Techniques to Analyse Properties and Quality”, Food Science and Technology Series. Marcel Dekker, New York, . 105, 2001.
- Kondo, N., “Quality evaluation of orange fruit using neural networks”, In: Food Processing Automation IV Proceedings of the FPAC Conference. ASAE, 2950 Niles Road , St. Joseph , MI 4 9085-9659, USA, 1995.
- Heinemann, P.H., Varghese, Z.A., Morrow, C.T., Sommer, H.J., III, Crass Weller, R.M., 1995. “Machine vision inspection of Golden Delicious apples”, Applied Engineering in Agriculture Transactions of the ASAE, 11 (6) . 901-906,

Webs

- https://www.youtube.com/watch?v=L1Lol5UAXV0
- https://www.youtube.com/watch?app=desktop&v=yB-P4QFO9Q8
- https://www.youtube.com/watch?v=5-7hRG5R7D0
- https://chat.openai.com/c/44222da0-e23e-496d-b592-6b1471fe92db
- https://chat.openai.com/c/4dc48cf5-dfa6-41e1-949e-533294eb29a6
- https://chat.openai.com/c/f03b4d96-f6b2-47d1-9de3-1adc3ed4d386
- https://chat.openai.com/c/aa8a5459-0587-4765-8c02-dfc937449999
- https://bard.google.com/chat/5d983bfc9d1c7a62
- https://youtu.be/S6v27nUONvE?t=59

ACKNOWLEDGEMENT

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

The trainers who developed the learning guide

	Name	Qualification	Educational Level	Region (College)	Phone number	E-mail
	Mulugeta Alemu	**Horticulture**	**A**	**Nefas Silk Polytechnic College , Addis Ababa**	**09 25322650**	**mulugetaalex44@gmail.com**
	Gadisa Berhanu	Food Science & Technology	B	Negele Arsi Tvet College ,Oromia	0923450658	gadisabe08gmail.com
	Kiros Mezgebo	Food Science	A	FTVI	0921310111	kirosmez@gmail.com
	Habl legese	Food Technology & Process Engineering	B	Nefas silk polytechnic college	0911403703	Habyeleggese88@gmail,com-[
	Alemayoh Araya	Food science	B	Kolfe Industrial College	0987127971	alemayohmr@gmail.com
	Tolina Kebede	Food Science & Technology	A	Oromia	0917241112	tolinakebede2009@gmail.com