SPICE AND HERBS PROCESSING Level-II

Based on May 2019, Version 2 Occupational standards

Module Title: - Operating Peeling, Slicing & Chopping Process

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LG #27	LO #1- Prepare peeling, slicing and chopping equipment and process for operation

Instruction sheet

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

- Confirming spice and herbs products.
- Fitting and adjusting spice and herbs peeling, slicing and chopping machine components and related attachments.
- Identifying and confirming cleaning and maintenance requirements and status.
- Entering processing/operating parameters
- Checking and adjusting equipment performance.
- Carying out pre-start and service checks

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 spice and herbs products.
- Fit and adjust spice and herbs peeling, slicing and chopping machine components and related attachments.
- Identify and confirm cleaning and maintenance requirements and status.
- Enter processing/operating parameters
- Check and adjust equipment performance.
- Carry out pre-start and service checks

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
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Information Sheet 1- Confirming spice and herbs products

1.1 Introduction

Processing produce to a fresh-cut or preserved state can add value to produce that commonly sells for a low price in its fresh state. Starting a small-scale processing operation provides new jobs for your community, requires only a small capital investment in equipment and supplies, and can result in a fast return on investment. When conditions are not suitable for storage or immediate marketing of fresh produce, processing reduces perishability.

You can avoid selling your fresh produce at the lower prices offered during glut periods or during the usual season for fresh market, and decrease some of the costs associated with fresh handling, storage and transport. Processed products can then be offered for sale during periods when the fresh produce is not available or is in short supply, or during holiday periods when people purchase food gifts and use specialty processed foods for their celebrations. This learning guide covers the knowledge and skills required to set up, operate, adjust and shut down a peeling, slicing and chopping process of spice and herbs to achieve required product standard.

1.2. Confirming spice and herbs products

A spice is a seed, fruit, root, bark or other plant substance primarily used for flavoring, coloring or preserving food. Spices are distinguished from herbs, which are leaves, flowers, or stems of plant used for flavoring or as a garnish. **Herbs:** Herbs are the second category of flavoring agents used in the food, the term herbs come from Latin meaning ***'Grass'***. Herbs are defined as the leaves and stems of soft-stemmed, non-woody plants. Example Savory, Sage, Thyme, Rosemary, Oregano etc.

- Five **categories** of spices
    1. **Major spices**:- Black pepper, Cardamoms, chilies, Ginger and Turmeric
    2. **Seed spices**:- Coriander, celery, funnel, cumin
    3. **Tree spices**:- Clove, nutmeg, kokum
    4. **Herbal spices**:-thyme, marjoram
    5. **Misc spices**:- garlic, saffron, pepper long

Table 1: List of common spices and herbs

Basil	Laurel (Bay) Leaves
Anise	Mace
Annatto	Marjoram
Sweet Basil	Nutmeg (Broken)
Caraway	Nutmeg (Whole)
Cardamom	Oregano
Cassia/Cinnamon	Parsley
Celery Seed	Pepper, Black
Chillies whole	Pepper, White
Chillies crushed	Poppy Seed
Cloves	Rosemary Leaves
Coriander	Sage
Cumin Seed	Savory
Dill Seed	Sesame Seed(Natural & Hulled)
Fennel Seed	Tarragon
Fenugreek	Thyme
Ginger (Whole & Split)	Turmeric

Figure 1: Figurative illustration of spices and herbs

Quality assurance systems such as hazard analysis critical control point (HACCP) are highly relevant in the production of quality spices. Decontamination techniques and proper packaging and storage techniques also play a major role in maintaining the quality of spices. Produce being received for processing should be sampled and tested for receiving temperature. Incidence of defects i.e. bruising, blemishes, freeze damage in facilities transit, etc. and insect infestation must inspect**.** Written specifications and sample plans should be used to inspect incoming bulk commodities and any variance from the specified quality should be immediately noted and brought to the attention of the processing management personnel.

Bulk commodities should be segregated from finished products to prevent cross contamination. Treating whole bulk commodities and intermediate fresh-cut products as gently as possible during processing is important to minimize unnecessary bruising and stress which may reduce product quality and shelf life. No raw material or ingredients should be accepted by an industry if it is known to contain parasites, undesirable pathogens, pesticides, drugs, or toxic ,decomposed or extraneous substances that would not be reduced to an acceptable level by normal sorting and / or processing where appropriate specifications for raw materials and ingredients should be identified and applied.

The accepted raw materials stored in a spice and herb processing industry shall be:

A. maintained under conditions that will prevent spoilage,
B. protected against contamination by pests, physical, chemical or microbiological hazards and other objectionable substances;
C. protected from detrimental changes to temperature and or other physical parameters that may be caused by crushing, abrasion and vibration;
D. Not processed or used unless inspected for contamination, spoilage and moulds before processing and found to be in compliance with the accepted criteria in this Standard.
E. Clearly labeled with all the relevant details to ensure traceability.

SELF-CHECK 1	**Written test**

Name…… ID…… Date…….

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

Test I: Choose the best answer (6 point)

1. Which is rhizome spices among the following
   A. Basil B. Rosemary C. A & B D. Ginger
2. Starting a small-scale processing operation provides new jobs for your community.
   A. True B. False
3. Raw material or ingredients should be accepted by an industry if, they are free from:
   A. Stones B. undesirable pathogen C. Parasites D. All

Test II: Short Answer Questions

1. List advantages from small scale processing industry in your local area (2 point)
2. Differentiate spices and herbs (2 point)
3. Write some examples for spice and herb (3points)
4. List some parameters which help to confirm raw materials? (3point)

Note: Satisfactory rating-≥8 points Unsatisfactory-< 8 points

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

Information Sheet 2- Fitting and adjusting spice and herbs peeling, slicing and chopping machine components and related attachments

- Requirements for a small processing plant include sharpened knives, plastic cutting boards, stainless steel, slicing machines, micro plane, and pulpers.
- Some examples of peeling, slicing and chopping equipments and machines include:

Chopping knives

Chopping board

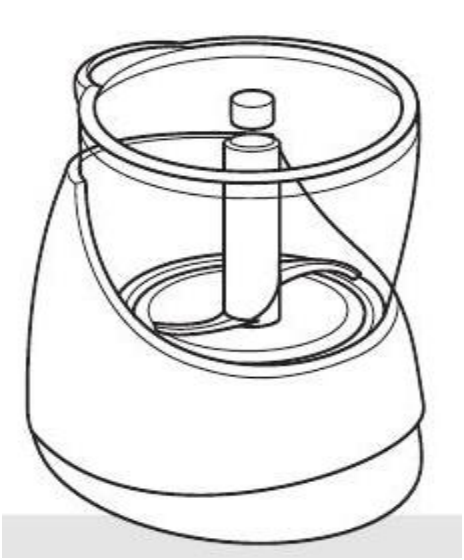
'Y' peeler

Figure 2: Peeling, slicing and chopping equipments

Electric spice chopper

Electric chopper

Figure 3: Chopping equipments



Garlic and herb chopper dual compartment ginger slicing machine

Figure 4: chopping machineries

Cutting and slicing machine Turmeric slicing machine

Figure 5: Slicing machineries

An operator should be check the fitness and suitability of peeling, slicing and chopping equipments with received spices and herbs. There is no single piece of equipment that can do all jobs. Properly operated, these machines allow the peeling, slicing and chopping operation, which differ from the desired product in size and dimension, shape, specific gravity, different behavior in air currents, and magnetic properties.

To use the machines effectively, the processor must understand the working principle of each equipment and machine with its maintenance requirement, its capacities, and its proper place in the overall processing operation. Equipment should be subject to a program of planned maintenance that ensures it is kept in safe and effective working condition. Selecting the best equipment for the processing industry is a very important part of equipment management.

- Some criteria to consider when selecting processing industry equipment are listed below.
    - Why and how will the equipment be used?
    - The instrument should be matched against the service the industry provides.
    - What are the performance characteristics of the equipment?
    - Is it sufficiently accurate and reproducible to suit the needs of the processing to be done?
    - What are the facility requirements, including the requirements for physical space?
    - Will the cost of the equipment be within the processing industries' budget?
    - How easy will it be for staff to operate?
    - Will instructions be available in a language that is understood?
    - Is there a retailer for the equipment in the country, with available services?
    - Does the equipment have a warranty?
    - Are there any safety issues to consider?

- Before equipment is installed, verify that all physical requirements (electrical, space, doors, ventilation, and water supply) have been met. Other things to consider are:
    - The vendor's responsibilities for installation should be confirmed in writing prior to beginning the installation process
    - A checklist of the expected performance specifications should be developed, so that performance can be quickly verified as soon as the equipment is installed.
- Whenever possible, it is best to have the manufacturer install processing equipment; this will likely improve the conditions of the warranty, and also may ensure that the installation is done properly and quickly.
- If equipment is installed by the industry:
    - check that the package contents contain all of the parts;
    - make a copy of any software that is part of the system;
    - Do not allow the equipment to be used before it is completely installed, performance is verified, and testing personnel are trained.

SELF-CHECK-2	**Written test**

Name…… ID…… Date…….

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

Test I: Choose the best answer

1. Which one not necessary during fitting and adjusting spice and herbs peeling, slicing and chopping machine components. (2points)
    a. Size and dimension of equipment,
    b. Shape,
    c. Trained testing personnel
    d. All
    e. None
2. Which one is true among the following statements? (2points)
    a. An operator should be check the fitness and suitability of peeling, slicing and chopping equipments with received spices and herbs.
    b. There is no single piece of equipment that can do all jobs.
    c. Selecting the best equipment for the processing industry is a very important part of equipment management.
    d. All
    e. None

Test II: Short Answer Questions

1. Write down peeling, splicing and chopping equipment and machineries (2 points).
2. What are the physical requirements verified before equipments installed? (2 points).
3. List some criteria to consider when selecting processing industry equipment (2 points).

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

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

Information Sheet 3- Identifying and confirming cleaning and maintenance requirements

There are a number of equipment manufacturers and their marketing materials, available on-line, includes photographs and diagrams detailing the function of the equipment. So the operator must be understood the cleaning and maintenance requirements of equipment and machineries. Equipment should be designed to facilitate cleaning and disinfection with little or no water and, when wet cleaning is required, to allow thorough drying before reusing the equipment for spices and herbs. Alternatively the design should allow disassembly such that parts can be taken to a room designed for cleaning and disinfection, when applicable.

The equipment design should be as simple as possible, with a minimal number of parts and with all parts and assemblies easily accessible and/or removable for inspection and cleaning. Overall Equipment Effectiveness (OEE) is a measurement used in total productive maintenance programs. The measure includes machine effectiveness and efficiency.

- It helps answer three questions:
    1. How often is the machine available to run
    2. How fast does it run when it's running?
    3. How many acceptable parts were produced?

The formula is shown below:

Availability x Performance x Quality or (A * P * Q)

- Sex big losses: These six areas of losses impact OEE and its three components.
    - Breaking down the losses to these categories helps the Six Sigma team prioritizes improvements.
    - The losses affect one of the three products (A, P, or Q).

- Breakdown losses-is sudden or unexpected equipment failures that make the machine less available. Contributing factors include:
  - Major mechanical failures
  - Electrical system failures
  - Structural failure
- Set-up & adjustment losses-is the downtime and defective product that occurs when production of one part stops and the equipment is set-up/adjusted to meet the requirements of another part. The degree of loss depends on factors such as:
  - Process standards
  - Maintenance level of equipment
  - Tooling consistency and quality
  - Operator skill level
  - Machine to machine standardization
  - Idling & minor stoppages
- Idling & minor stoppages-production is interrupted by a temporary malfunction or when the machine is idling. Contributing factors include:
  - Defective products that result in line shut line down
  - Disruption of production flow, lack of product or raw material, tools
  - Dependence on assembly components or other inputs
  - Operator on other machine or other tasks
  - Temporary equipment malfunction

- Start up losses-this type of loss is a yield loss that occurs during the early stages of production from machine start-up, warm-up, and “learning phase" to the point where the machine is producing regular, quality production. The degree of loss depends on factors such as:
  - Maintenance of equipment
  - Tooling
  - Raw Material
  - Operator skill level

Reduced speed losses-refers to the difference between equipment design speed and the actual operating speed. Some parts may not be able to run at a machines maximum rate Factors include:

- Mechanical problems
- Risk of making unacceptable parts at higher speeds
- Operator training

- Quality defects (scrap & rework)-losses in quality caused by malfunctioning equipment or tooling. The degree of loss depends on factors such as:
  - Maintenance of equipment
  - Tooling
  - Raw Material
  - Operator skill level

Establishment of a preventive maintenance program helps to ensure proper functioning of all equipment. Failure of equipment during production may increase the risk of microbial contamination, particularly from. Preventive maintenance includes the periodic examination and maintenance of equipment such as valves, gaskets, O-rings, pumps, screens, filters and heat exchanger plates. Appropriate action plans should be developed by small processers in the event of malfunctioning of important equipment, such as refrigeration equipment, disinfectant delivery systems, power systems or alarm systems.

- The following practices are also recommended:
  - Maintenance and calibration of equipment by appropriately trained personnel.
  - Maintenance personnel who work in the processing or packaging areas should be knowledgeable of, and comply with the hygiene requirements for production staff.
  - Frequent sharpening of knives, if used, including retractable knives, and disinfecting them prior to use.
  - Knives should be replaced if damaged or if they cannot otherwise be maintained in a sanitary condition.

- Frequently inspecting cutting blades and belts during processing operations for damage, product residue build-up or cleaning needs.
- Blades should be removed and separately cleaned.
- Remaining equipment parts must be disassembled (if possible) and cleaned on a regular basis.
- Installation, calibration and maintenance of temperature measuring or recording devices to ensure their accuracy.
- Operating of metal detectors in accordance with manufacturers' instructions and checking for proper functioning at least on a daily basis to ensure effective detection of metals and removal of affected products.
- Procedures should be in place, such as the use of metal detectors during packaging operations, to minimize the possibility of metal entering finished product packages.
- Calibration of safety control devices that are essential for maintaining the proper level and activity of wash water disinfectant, at a frequency recommended by the manufacturer and documentation of this activity on instrument calibration forms/logs.
- Examination of air filters for both intake air and compressed air and changing at least as often as the manufacturer specifies, or more frequently if a problem is indicated, such as evidence of filter fouling or perforation.

SELF-CHECK-3	**Written test**

Name…… ID…… Date…….

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

Test: Short Answer Questions

1. How you identify equipments are available or not? (2 point)
2. List and explain the big losses of the equipment and machineries. (2 point)
3. _____refers to the difference between equipment design speed and the actual operating speed. (2 point)
4. Explain mechanical failure of the equipment. (2 point)
5. List examples for preventive maintenance of equipments. (2 point)

Note: Satisfactory rating-≥5 points Unsatisfactory-<5 points

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

Information Sheet 4- Entering processing/operating parameters

Plant matter that is damaged or other plant waste material should be disposed of properly and removed from the growing/harvest area in order to minimize the potential for it to serve as a source of mycotoxin-producing moulds. If possible, only the amount that can be processed in a timely manner should be picked in order to minimize growth of mycotoxin-producing moulds prior to processing/sending to peeling, slicing and chopping processing.

When the amount harvested exceeds processing capabilities, the excess should be stored under appropriate conditions. Confirmed raw materials should be inspected and sorted prior to processing (foreign matter, odor and appearance, visible mould contamination). Laboratory tests, e.g. for moulds or pathogens such as,*Salmonella*, should be conducted when necessary and ready to processing based on the parameters. Environmental monitoring should be conducted under normal operating conditions.

SELF-CHECK-4	**Written test**

Name…… ID…… Date…….

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

Test: Choose the best answer

1. When the amount harvested exceeds processing capabilities, the excess should be _____ under appropriate conditions. (5 point)

   A. Store B. Remove C. A&B E. None

2. One is not used as inspection parameter when confirming raw materials. (5 point)

   A. Foreign mater B. odor C. appearance D. All E. None

Note: Satisfactory rating-≥5 points Unsatisfactory-<5 points

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

Information Sheet 5- Checking and adjusting equipment performance

Peeling and slicing equipments are properly checked and adjust properly to meet great achievement. Performance checking involves collecting and analyzing data on some or all of the variables such as, pressure, temperature, flow rate, electrical power consumption, fuel consumption and equipment/system power production or capacity for the equipment/system of interest. Data are often collected by operations personnel for other reasons (i.e., energy management, maintenance program effectiveness) and may already be available for analysis.

Performance checking data are often coupled with other test results to confirm the identification of problems (i.e., equipment degradation, performance deterioration). Monitoring the performance indicators over a long period of time can provide indications of improper maintenance or poor operations practices. Virtually all industrial machines can be monitored in this fashion, and targets for data collection include diesel and gasoline engines, pumps, motors, compressors, peelers, choppers, etc. Test data can also be used to optimize performance. In addition, most of the computer control equipment (i.e., distributed control systems, programmable logic controllers) has data analysis and alarming features that can be used to trend equipment performance.

- Inspections/checking performance of equipment can be in three ways:

- **Visual inspection** practices are the oldest and most common condition monitoring (CM) techniques employed in industry.
  - Human observation helps identify a broad range of potential problems, including loose or worn parts; leaks of lubricating oils, hydraulic fluids and process liquids; missing parts; poor electrical or pipe connections; etc.
  - Inspection standards are easy to establish and communicate to assigned personnel. Essentially, all machines and equipment in the industrial setting can be monitored with this technique.

- **Audio inspection** practices are common CM techniques employed in industry.
  - The monitoring of machinery and equipment by listening to it operate helps identify a broad range of potential problems, including worn high-friction bearings, steam leaks, pressure relief valve leaks or discharges, coupling leaks, poor mechanical equipment alignment, etc.
  - Humans are particularly sensitive to new or changed sounds and are easily taught to report and investigate unusual sounds.

- **Touch inspection**: using touch as an inspection technique can be extremely useful. Heat, scaling, and roughness changes can all be detected by touch.
  - Human touch is extremely sensitive and able to differentiate surface finish differences not discernable by eye.
  - This technique is often a supplemental inspection to visual inspections.
  - This technique is often a supplemental inspection to visual inspections.
  - The inspection can be enhanced through the use of directional microphones.

Equipments should not have pits, cracks, corrosion, crevices, recesses, open seams, gaps, lap seams, protruding ledges, inside threads, bolt rivets, or dead ends. Hollow areas of equipment as well as cracks and crevices should be eliminated whenever possible or permanently sealed. Items such as bolts, studs, mounting plates and brackets should be continuously welded to the surface and not attached via drilled and tapped holes. Welds should be ground and polished smooth. Push buttons, valve handles, switches and touch screens should be designed to ensure product and other residues (including liquid) do not penetrate or accumulate in or on the enclosure or interface.

The risk of contamination from equipment should be assessed and controlled. Testing equipment should be checked for damage to insulated leads and probes and needs to be confirmed as working before use. Performing maintenance on mechanical equipment can be hazardous. Electrical and mechanical energy can cause injury and death if not managed properly. Equipments should be tested regularly to ensure it provides the level of protection required.

- Testing intervals will depend on several factors including:
  - the frequency of use
  - the environment in which it is being
  - Manufacturer's advice.

Prior to starting peeling and slicing operation, it is important to evaluate the performance of new equipment to ensure it is working correctly with respect to accuracy and precision. In order to verify that equipment is working according to the manufacturer's specifications, it is necessary to monitor equipment parameters by performing periodic function checks. This should be done before using the instrument initially, then with the frequency recommended by the manufacturer.

SELF-CHECK-5	**Written test**

Name…… ID…… Date…….

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

Test: Choose the best answer

1. Testing intervals of equipment performance will depend on the following factors except. (2 points)
   a. the frequency of use
   b. the environment in which it is being
   c. Manufacturer's advice
   d. All
   e. None
2. Performing maintenance on mechanical equipment can be hazardous. (1 points)
   A. True B. False
3. Off the following which one is correct? (2 points)
   a. Performing maintenance on mechanical equipment can be hazardous.
   b. Evaluating the performance of new equipment ensures helps to work correctly with respect to accuracy and precision.
   c. Equipments should be tested regularly
   d. All

Note: Satisfactory rating-≥2.5 points Unsatisfactory-<2.5 points

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

Information Sheet 6- Carrying out pre-start and service checks

Before starting a plant in your work place refer to the standard operating procedure. Equipment start up is a potentially difficult process. The processing equipment must be thoroughly checked, and Standard Operating procedures must be followed for safe startup. The operator may be required to coordinate startup with other plant areas. Like any task you are about to perform, preparation is the key to success. Before starting any task of work you should go through each step to make sure you know what is expected. This will allow you to be prepared for the job and have all the required paperwork, tools and equipment and any PPE ready. Check workspaces and walkways to ensure no hazards are present. Ensure all guards and safety shields are in position before starting the peeling operation.

Conducting pre-start checks, such as inspecting equipment condition to identify any signs of wear, selecting appropriate settings and/or related parameters, cancelling isolation or lock outs as required, confirming that required screens are fitted and related equipment is clean and correctly configured for spices and herbs peeling, slicing and chopping process requirements, positioning sensors and controls correctly, ensuring any scheduled maintenance has been carried out, and confirming all safety guards are in place and operation are very important prior to starting the operation.

- The operators in processing industry should ensure any scheduled maintenance has been carried out, and confirming that all safety guards are in place and operational confirm settings in the machine, such as:
  - conveyor speed/track position
  - humidity
  - air flow/fan settings
  - product layout/spacing
  - settings in the slicing/bagging equipment:
  - knife condition
  - machine speed and height/width settings and air pressure

If pre-start inspections are a critical safety element, then the process should be investigated every time there is an incident, regardless of whether there was any equipment failure. A pre-start-up can include several other considerations besides sanitation and proper assembly. Pre-startup check would be a significant benefit and can perform by ask some questions:

- Have all product contact areas been properly cleaned?
- Have all tools used for sanitation or maintenance been removed?
- Is all equipment that was removed for cleaning put back in place and properly aligned?

➢ The following details need to be addressed before putting the equipment into service:

- assign responsibility for performing the maintenance and operation programs;
- develop a system for recording the use of parts and supplies;
- implement a written plan for calibration, performance verification, and proper operation of the equipment;
- establish a scheduled maintenance program that includes daily, weekly, and monthly maintenance tasks;
- Provide training for all operators; only personnel who have been trained specifically to properly use the equipment should be authorized as operators

If repairs need before starting, manufacturers may provide service and repair of equipment that is purchased from them. Be sure to set up a procedure for scheduling service that must be periodically performed by the manufacturer. When equipments need repair, remember that some warranties require that repairs be handled only by the manufacturer. Pre-startup checks must be carried out to minimize problems during startup that could:

- waste raw materials and energy
- produce excessive amounts of product that is off-specification
- cause equipment damage and lost production time
- Cause injury to personnel.
- Waste time due to failure in identifying the requirements for the work.

➢ Pre-startup checks ensure all equipment is in a safe and operational condition for startup.

SELF-CHECK-6	**Written test**

Name…… ID…… Date…….

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

Test I: Chose the best answer

1. Off the following which one is **not** necessary when performing pre-startup check? (2 points)
   a. Have all product contact areas been properly cleaned?
   b. Have all tools used for sanitation or maintenance been removed?
   c. Is all equipment that was removed for cleaning put back in place and properly aligned?
   d. All E. None
2. Benefits from prestart-up check include:- (2 points)
   a. Reduce time loose due to equipment failure
   b. Increase equipment precision
   c. Reduce risks to be occurred
   d. All
3. Equipment startup checks are needed to prevent
   a. Equipment damage
   b. Injury to personnel
   c. Excessive off specification product.
   d. All

Test II: Short Answer Questions

1. What are the details need to be addressed before putting the equipment into service? (3 points)
2. List equipment components required prestart-up check before peeling, slicing and chopping spices and herb. (3 points)

Note: Satisfactory rating-≥5 points Unsatisfactory-<5 points

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

LG #40	LO #2- Operate and monitoring the Peeling, Slicing & Chopping process

Instruction sheet

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

- Preparing clean and quality raw spice and herbs.
- Performing peeling, slicing and chopping of spice and herbs.
- Monitoring equipment to identify variation in operating conditions
- Identifying variation and reporting maintenance requirements.
- Monitoring the process to confirm the product is cooled and packaged.
- Identifying, rectifying and/or reporting out-of-specification product/process outcomes.
- Conducting work.
- Maintaining workplace records.
- Following workplace information requirements and procedures.

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

- Prepare clean and quality raw spice and herbs.
- Perform peeling, slicing and chopping of spice and herbs.
- Monitor equipment to identify variation in operating conditions
- Identify variation and reporting maintenance requirements.
- Monitor the process to confirm the product is cooled and packaged.
- Identify, rectify and/or report out-of-specification product/process outcomes.
- Conduct the work.
- Maintain workplace records.
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Information Sheet 1- Preparing clean and quality raw spice and herbs

Quality of spices is assessed by its intrinsic as well as extrinsic characters. The former consists of chemical quality, i.e. the retention of chemical principles like volatile oil, alkaloids and oleoresins while the later emphasizes physical quality. This include appearance, texture, shape, presence or absence of unwanted things, color etc. in addition certain health requirements are also implemented as quality standard viz. pesticide residue, aflatoxin, heavy metal, sulphur dioxide, solvent residues, and microbiological quality.

Cleanliness specifications for spices of American Spices Trade Association (ASTA) are a universally adopted manual for assessment of physical quality of spices. All confirmed and available spices and herbs could be cleaned and qualified and ready to peeling, slicing and chopping operation. Sieves, grading tables, flotation tanks and screens can all be used to ensure that the quality standards are met and an even line of high quality spice is obtained.

- The following list represents a few of the most important tests we conduct to prepare clean and qualified raw spices and herbs.
  1. **Appearance:** Samples of each product are evaluated based upon their general appearance and uniformity and are compared, to ensure conformance, to a known standard.
  2. **Color:** Used to identify products based upon conformance, of color, to a known standard.
  3. **Aroma:** Used to identify products based upon conformance, of aroma, to a known standard.
  4. **Flavor:** Used to identify products based upon conformance, of flavor, to a known standard. Small and medium scale producers are not able to chemically analyze the flavor-bearing essential oils in the product. With experience however, abnormalities may be detected by tasting.
  5. **Particle Size:** A sieve analysis is used to measure the total particle size distribution of a prepared sample.

6. **Foreign Matter:** Measures the amount of a prepared sample that is of a foreign nature. This is a measurement of the purity of the product and, thus, the quality of the product

- There are also various types of test which make up the range of international standards:

❖ **Cleanliness:** This is a measure of the amount of foreign and extraneous matter, for example insect contamination, excreta or foreign bodies. Measurement is by physical determination (using microscopic analysis (x30)) of contamination within aliquots (samples) of the product).

❖ **Ash level:** This is a measure of the level of impurities in a product, obtained by burning off the organic matter and measuring the residue of ash.

- This measurement is carried out by incinerating the herb or spice at 550 ºC to constant weight.
- Characteristic maximum figures exist for most herbs and spices.

❖ **Acid insoluble ash (AIA) (or sand content):** This is a classic determination of the cleanliness of the herb or spice.

- The measure is usually made in conjunction with the ash content by boiling the ash in 2N HCl and incinerating the residue (again at 550 ºC) to a constant weight.
- Again, maximum figures exist for most herbs and spices.
- Prosecutions have in the past been based on high AIA levels within Europe, which are seen as indicating an unacceptably high level of gross contamination.

❖ **Volatile oil (V/O) determination:** This measure helps to identify whether the herb or spice has been adulterated, perhaps by addition of foreign materials, low-quality materials or spent herb or spices (by product of essential oil or oleoresin production).

- The herb or spice is boiled with water under reflux conditions.
- The oil separates on top of the water and is reported as a proportion of the mass of the product under test.
- Minimum percentage levels of oil exist for most major herbs and spices.

❖ **Moisture content:** This measure is important since moisture content determines weight, and weight is used in pricing.

- With highly priced commodities traded on weight, a 1 % moisture increase in the product as shipped can result in increased weight and increased profits for the original exporter.
- Maximum moisture contents are set for all herbs and spices, based on the maximum allowable amount of moisture for the product to remain stable.
- Moisture content is generally determined within the herb and spice industry using the Dean and Stark methodology.
- This involves refluxing a known weight of the herb or spice in petroleum spirit and measuring the water that condenses at the bottom of the reflux chamber from the known weight of herb or spice.
- Generally the level is 12 % max.

❖ **Water activity:** In recent years, moisture content has been related to the water activity (*A*w) of the herb or spice.

- A level of 0.6 *A*w is generally accepted as a figure below which microbial growth cannot occur.
- However, this figure does not take into account other natural antimicrobial factors, and several herbs and spices may be stored at significantly higher water activity levels without problem due to the preservative effect of other components, especially of the oils they contain.
- Examples are cinnamon, oregano and cloves where the oils have very strong antimicrobial properties.

❖ **Microbiological measures:** There are a range of techniques available for enumerating microorganisms (both spoilage species and pathogens) in herbs and spices.

- Whilst new technologies for microbiological analysis are continually being developed and improved, the standard methods are slow to change (usually described in ISO standards), and it is these standard methods that tend to be used in cases of dispute and which are quoted on specifications.

❖ **Pesticide levels:** Pesticide levels are not seen as a major health problem given the (low) average daily intakes of herbs and spices by consumers.

- Pesticide levels are usually assessed either by gas chromatography (GC) or high-performance liquid chromatography (HPLC), depending on the pesticide in question.

❖ **Mycotoxin levels:** Mycotoxins, particularly aflatoxin and ochratoxin A, have been of increasing concern within the industry.

- The maximum levels of ochratoxin A in capsicum species, piper species, nutmeg,
  mace, ginger and turmeric have been implemented in recent years.
- Within the USA, the maximum limit for aflatoxins is currently 20 ppb and there are no levels for ochratoxin A.
- HPLC linked to immunoaffinity columns is the reference methodology employed in these determinations.

❖ **Bulk density/bulk index:** This is an important measure, particularly in filling retail containers of herbs and spices.

- The herb or spices must be sifted or ground to give a certain density so that retail units not only appear satisfactorily full but also comply with the declared weight.
- Densities may be measured packed down, e.g. after tapping the product so that it assumes a minimum density, or untapped (as it falls into the container without compression).
- This measure is usually reported as grams/litre or ml/100 g.

❖ **Mesh/particle size:** Many spices and herbs are ground to give easier dispersion in the final food product.

- This process also aids the dispersion of flavor.
- Particle size is generally specified and is carried out using standardized sieves. Products are ground to pass through a specified sieve, whilst coarse matter is recycled through the mill until it finally passes through the sieve.
- Sieves are often characterized in ‘micron sizes’ and typical specification requirements will be for a 95 % pass on a specified size of sieve.
- The older method of measuring sieve mesh (hole) sizes was related to the number of holes per inch.
- However, confusing differences exist between US and UK mesh sizes.

- The mesh size depends on the diameter of the wire making up the sieves and this differs between nations. Thus a 25 mesh US sieve is equivalent to a 30 mesh BS (UK) sieve and both are equivalent to a 500 micron aperture size.

Table 2: American spice trade association (asta) cleanliness specification (1999)

Name of spice, seed or herb	▲ Whole insects, dead by count	Excreta, mammalian by mg./lb.	Excreta, other by mg./ lb.	Mould % by wgt.	Insect defiled/ infested % by wgt.	Extraneous/ foreign matter % by wgt.
Allspice	2	5	5.0	2.00	1.00	0.50
Anise	4	3	5.0	1.00	1.00	1.00
Sweet basil	2	1	2.0	1.00	1.00	0.50□
Caraway	4	3	10.0	1.00	1.00	0.50
Cardamom	4	3	1.0	1.00	1.00	0.50
Cassia	2	1	1.0	5.00	2.50	0.50
Cinnamon	2	1	2.0	1.00	1.00	0.50
Celery seed	4	3	3.0	1.00	1.00	0.50
Chillies	4	1	8.0	3.00	2.50	0.50
Cloves*	4	5	8.0	1.00	1.00	1.00*
Coriander	4	3	10.0	1.00	1.00	0.50
Cumin seed	4	3	5.0	1.00	1.00	0.50

Name of spice, seed or herb	▲ Whole insects, dead by count	Excreta, mammalian by mg./lb.	Excreta, other by mg./ lb.	Mould % by wgt.	Insect defiled/ infested % by wgt.	Extraneous/ foreign matter % by wgt.

Dill seed	4	3	2.0	1.00	1.00	0.50
Fennel seed	SF(2)	SF(2)	SF(2)	1.00	1.00	0.50
Ginger	4	3	3.0	SF(3)	SF(3)	1.00
Laurel leaves†	2	1	10.0	2.00	2.50	0.50
Mace	4	3	1.0	2.00	1.00	0.50
Marjoram	3	1	10.0	1.00	1.00	1.00□
Nutmeg (broken)	4	5	1.0	SF(4)	SF(4)	0.50
Nutmeg (whole)	4	0	0.0	SF(5)	SF(5)	0.00
Oregano‡	3	1	10.0	1.00	1.00	1.00□
Black pepper	2	1	5.0	SF(6)	SF(6)	1.00
White pepper¶	2	1	1.0	SF(7)	SF(7)	0.50
Poppy seed	2	3	3.0	1.00	1.00	0.50
Rosemary leaves	2	1	4.0	1.00	1.00	0.50□
Sage†	2	1	4.0	1.00	1.00	0.50
Savory	2	1	10.0	1.00	1.00	0.50□
Sesame seed	4	5	10.0	1.00	1.00	0.50
Sesame seed, hulled	4	5	1.0	1.00	1.00	0.50
Tarragon	2	1	1.0	1.00	1.00	0.50□
Thyme	4	1	5.0	1.00	1.00	0.50□
Turmeric	3	5	5.0	3.00	2.50	0.50

Key:-

* Clove Stems: Less than 5 % allowance by weight for unattached clove stems over and above the tolerance for other extraneous matter is permitted.

† Laurel leaves/sage: 'Stems' will be reported separately for economic purposes and will not represent pass/fail criteria.

‡ Oregano: Analysis for presence of Sumac shall not be mandatory if samples are marked 'Product of Mexico.'

¶ White pepper: 'Percent Black Pepper' will be reported separately for economic purposes and will not represent a pass/fail criteria.

(2) Fennel seed: In the case of Fennel Seed, if 20 % or more of the sub-samples contain any rodent, other excreta or whole insects, or an average of 3 mg/lb or more of mammalian excreta,the lot must be reconditioned.

(3) Ginger: More than 3 % mouldy pieces and/or insect infested pieces by weight.

(4) Broken nutmeg: More than 5 % mould/insect defiled combined by weight.

(5) Whole nutmeg: More than 10 % insect infested and/or mouldy pieces, with a maximum of 5 % insect defiled pieces by count.

(6) Black pepper: 1 % mouldy and/or infested pieces by weight.

(7) White pepper: 1 % mouldy and/or infested pieces by weight.

▲ *Whole insects, dead:* Cannot exceed the limits shown.

Extraneous matter: Includes other plant material, e.g. foreign leaves.

SELF-CHECK – 1	**Written test**

Name…… ID…… Date…….

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

Test: Short Answer Questions

1. List some of the most important tests we conduct to prepare clean and qualified raw spices and herbs. (3 points)
2. List and explain various types of test which make up the range of international standards. (4 points)
3. How foreign matters in spice and herbs can be identified and separated? (3 points)

Note: Satisfactory rating-≥5 points Unsatisfactory-<5 points

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

Information Sheet 2- Performing peeling, slicing and chopping of spice and herbs

2.1. Performing peeling of spice and herbs

- To enhance the rate of drying some spices are peeled or scraped (ginger, cinnamon bark), sliced (ginger, turmeric) or cut into pieces (quills, quillings, featherings and chips of cinnamon and cassia barks).

Spice and herb processing flow

i. Washing: First of all, the spices are washed with water under high pressure to remove impurities.

ii. **Peeling, slicing** & cutting to small Pieces: Some spices require peeling and cutting to small pieces. Such spices are peeled with hand knives.

iii. Drying: Spices are spread on the floor to provide sun drying. At times, mechanical dryers are also used. Tray type dryer is most suitable.

iv. **Chopping/Grinding**/ Pulverizing: Spices are grinded in dry form.

v. Mixing: After all the above operations, various spices for different purposes are mixed together.

vi. Packaging: At the end, spices powder are packaged in automatic form, fill and sealing machine.

vii. Transportation and Marketing: Thereafter, the products are transported and supplied to the bulk purchasers.

Peeling is one of the integral parts of a food processing, and the majority of agricultural crops need to be peeled in order to remove at the initial stage of food processing. Peeling- it is a preparatory unit operation which removes inedible or undesirable material to increase the overall quality and/or appearance of the final food product. Peeling removes inedible portion of spices and herbs.

- The goals of optimum peeling operation are:
  1. Minimizing product losses,
  2. Minimizing energy and chemical usage,
  3. Minimizing the environmental pollution and Increase quality

❖ Peeling operation can be **grouped** under the following categories:

• Manual peeling (knife or blade),

• Mechanical peeling (abrasive devices, devices with drums, rollers, knifes or blades and milling cutters),

• Chemical peeling,

• Enzymatic peeling, and

• Thermal peeling (Flame or dry heat peeling, steam or wet heat peeling, thermal blast peeling, and vapour explosion or vacuum peeling)

a. Manual Peeling

Manual peeling is performed using stationary or rotator hand peelers or knives against the surface of fruits and vegetables. Is limited to small scale processing and is laborious and requires more time.

b. Mechanical Peeling

Mechanical peeling includes different types of process that interact directly with skin and then removes the skin. Common commercial mechanical peelers are abrasive devices, drums, rollers and knives. Mechanical peelers can provide high quality fresh final products and they are environmental friendly and nontoxic. The main factors affecting the peeling process are mechanical and physical properties of spice tissues, such as skin thickness, firmness, toughness, variety and rupture force. It is still preferred among the current methods. This is because it can keep edible portions of products fresh and harmless.

Figure 6: Square-mesh drum ginger peeler

c. Lye Peeling

Lye peeling is one of the oldest methods used in the food industry. It involves the immersion of a product in alkaline solution at high temperatures (90–100 °C). In lye peeling, the lye solution dissolves the pectin and hemicellulosic material in the cell walls by cleaving α-(1-4) bond between the individual galacturonic acid units. The removal of the pectin weakens the network of cellulose microfibrils and released the skin by collapsing the skin. Finally, the removed peels were washed after the chemical peeling. The rate of peeling is a function of alkali temperature and concentration, peeling time, geometry, peel thickness, and other characteristics of spice. This method involves both chemical and thermal treatments.

d. Enzymatic Peeling

Enzymatic peeling consists of treatment with a high-activity enzymatic solution containing polysaccharide hydrolytic enzymes, especially pectinases, cellulases, and hemicellulases since pectin, cellulose and hemicellulose are the polysaccharides most responsible for the adherence of the peel to the spice. These enzymatic preparations were obtained by fermentation of genetically modified fungal microorganisms produced by biotechnological industries. The main advantages of enzymatic peeling are its ability to produce good quality product, requirement of the reduced heat treatment and production of low industrial waste. In enzymatic peeling, there are some parameters to be taken into account to obtain good peeling efficiency. The most important ones are temperature, time and the ratio between peel mass and the enzyme solution volume ratio.

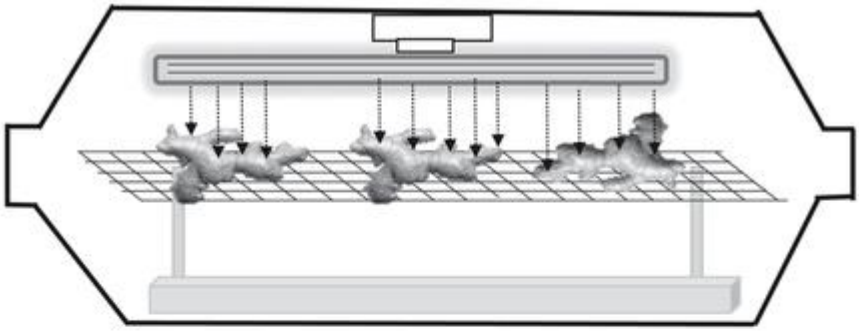
e. Thermal Peeling

Thermal peeling is used for thick-skinned spices and this method can be performed by wet heat (steam) or dry heat (flame, infrared, and hot gases). Steam peeling is one of the most popular among modern methods of peeling. Its widespread application is due to its high automation, precise control of time, temperature and pressure; and reduced environmental pollution as compared to chemical peeling Steam peeling has been explained as a combination of two phenomena. First it builds up internal pressure due to high temperature which causes mechanical failure of the cell, and secondly it affects the tissue resulting the loss of rigidity and reduced

turgor pressure, melting and breakdown or disorganization of the cell wall substances, such as pectin and polysaccharides. The steam peeling has advantages, such as increased production capacity, reduced water consumption, and improved appearance of the product. Dry peeling is has better than wet peeling in reducing microbial populations and preserving ascorbic acid content.

f. Infrared Peeling

Infrared (IR) waves are electromagnetic spectrum with a frequency beyond of visible light. When IR waves hit a material, they are reflected, either transmitted or absorbed. Absorbed waves are transformed into heat and the internal temperature of material is increased. Infrared radiation (IR) shows a rapid surface heating, which allows effective heating of shallow layer of the spices surface and it helps to separate peels while preserving the nutrients and quality of the products.



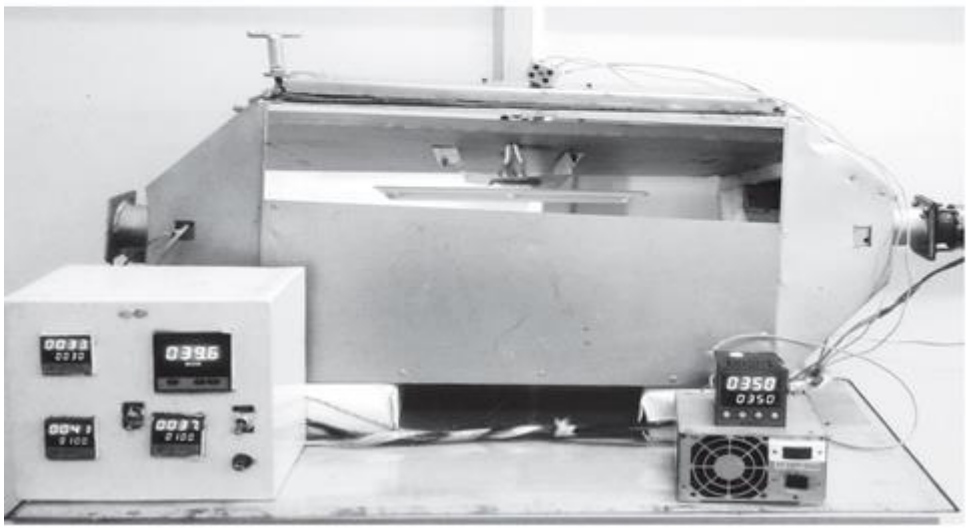


Figure 7: Infrared peeler

2.2. Performing slicing operation

Slicing is the cutting of spice or herbs into thin, relatively broad slices. Guide the knife straight through the spice/food with a sharp knife and cut food crosswise, vertical (perpendicular) to the cutting board.

- **Types of slices**
  - **Chiffonade** cut-Leaves (such as lettuce or herbs) are stacked on top of each other, rolled tightly, and then sliced into thin strips.
  - **Rondelle** cut-Food item (such as a thyme and shallot) is cut into small, thin circles by holding the knife perpendicular to the food and then making slices.
  - **Diagonal** cut-Similar to a rondelle cut, but the knife is held at a slight angle (instead of perpendicular) to the food, creating a diagonal slice.
  - **Cubing**-Food is cut into 1/2-inch strips, strips are lined up, and then cut into equal-sized cubes or square blocks.

2.3. Performing chopping operation

Chopping is cutting food/spice and herb into (more or less) bite-sized pieces using the quick, heavy blows of a knife. Chopping-cutting spices and herbs/food into pieces that are roughly the same size by keeping the tip of the knife in contact with the cutting board while lowering the knife with a firm and rapid motion back.

SELF-CHECK-2	**Written test**

Name…… ID…… Date…….

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

Test: Short Answer Questions

1. Explain and differentiate the peeling, slicing and chopping.(5 points)
2. List down methods of peeling? (5 points)
3. Why you slicing spices such as ginger before drying? (5 points)
4. What is the difference between rondelle and diagonal slicing methods? (5 points)

Note: Satisfactory rating-≥10 points Unsatisfactory-<10 points

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

Operation sheet 2.1.1: Performing ginger peeling operation with a spoon

Steps / Procedures for performing ginger peeling operation with a spoon

a. Purchasing fresh and quality ginger

b. Scrubbing any dirt from the ginger, using a little water and a scrubbing brush, then dry.

c. Start peeling by press your thumb into the base of the spoon ‘bowl’ shape and use the edge of the spoon in firm, downwards.

d. You can either hold the ginger in your other hand or press it onto your counter/chopping board, for leverage.

e. Ready to further processing

Operation sheet 2.1.2: Performing ginger peeling operation with knife

Steps / Procedures for performing ginger peeling operation with knife

1. Use a paring knife to cut off a small piece of ginger (or as much as your recipe requires).

2. Trim the tip off the un-cut end of the ginger so that both ends are flat.

3. Place ginger piece upright on its thicker end. Use your knife to trim away the skin from top to bottom. Keep your knife close to the outer edge so you don't remove too much of the ginger flesh with the peel.

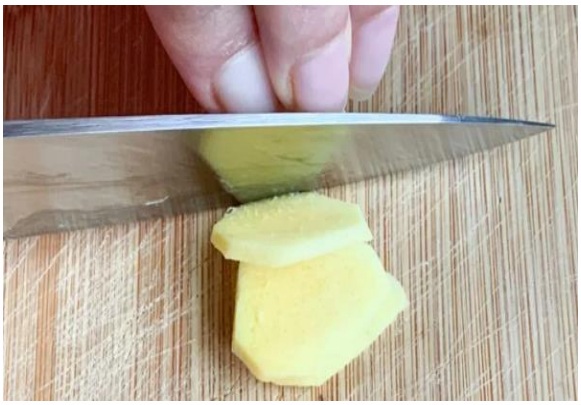
5. The peeled piece of ginger can be cut into large chunks (if adding to something that will be drained off, like chai) or grated (if the ginger is going to be eaten).

6. Check that all traces of peel are removed

Operation sheet 2.2.1: Performing ginger slicing operation with knife

Steps / Procedures for performing ginger slicing operation with knife

1. Use a sharp paring knife to shave away small peels of ginger.
2. Rather than peeling from one side to the other, rotate the ginger as you shave it, peeling away the outside layer entirely before moving onto another layer.
3. This will ensure that your peels are more uniform



Operation sheet 2.2.2: Performing ginger slicing operation with micro-plane

Steps / Procedures for performing ginger slicing operation with micro-plane

1. Choose ginger without too many knobs and bumps, which are harder to peel and cut.
2. Firmly grip peeled ginger in your right hand, using thumb and pointer finger to grasp the ginger.
3. Hold the micro-plane steady with your left hand, then move the ginger back and forth across the grates.
4. Continue until a little bit of ginger remains
5. Don't try to grate the entire ginger piece over the micro-plane, as you could risk cutting your fingers.

Operation sheet 2.3.1: Performing spice and herb chopping operation with mini chopper

Steps / Procedures for performing ginger slicing operation with minim chopper

1. Place the chopping bowl onto the top of the motor base.
2. Place the chopping blade in the centre of the chopping bowl. Ensure it is correctly located on the drive fi.
3. Place the sliced spices/ food items to be chopped into the bowl
4. Place the lid／onto the bowl and turn clockwise until the lid is locked into place
5. Connect to electric power
6. Push down firmly onto the lid to operate the chopper
7. Collect carefully the chopped spice
8. Ready to further processing

LAP TEST	**Performance Test**

Name…… ID……..
Date……

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 3 hour. The project is expected from each student to do it.

Task-1 Perform peeling of spices (ginger, turmeric e.t.c.) with spoon

Task-2 Perform peeling of spices (ginger, turmeric e.t.c.) with knife

Task-3 Perform slicing of spices (ginger, turmeric e.t.c.) with knife

Task-4 Perform slicing of spices (ginger, turmeric e.t.c.) with microplane

Task-5perform chopping of spices and herbs with mini chopper

Information Sheet 3- Monitoring equipment to identify variation in operating conditions

- Monitoring equipment and systems process variables and performance is a condition-monitoring technique that predicts problems by monitoring changes in any combination of these variables such as:
  - Pressure
  - Temperature
  - Flow rate
  - Electrical power consumption
  - Fuel consumption
  - Equipment/system power production or capacity

By collecting time associated with the operation, unavailability and maintenance, and costs associated with labor for operation, maintenance, repair, and spare parts procurement and storage, for the equipment and systems additional performance measures may be assessed and trended. This data can be used to assess additional aspects of performance such as specific fuel oil consumption, mechanical or thermal efficiency of targeted equipment, equipment availability, system availability and revenue generation and costs associated with maintenance and repair and investments.

Monitoring task is a scheduled task used to detect the potential onset of a failure so that action can be taken to prevent such failure. Condition-monitoring tasks may be applied to any equipment and machinery systems for which they are applicable. Condition-monitoring tasks are scheduled activities used to monitor machine condition and to detect a potential failure in advance so that action can be taken to prevent that failure. Condition monitoring involves the regular measurement of parameters such as vibration, temperature and sound in and around machines and equipment. Condition monitoring typically occurs in manufacturing environments and is considered to be a safer, more efficient alternative to preventative maintenance.

In preventive maintenance, there are fixed maintenance intervals during the course of which sometimes intact components such as bearings or shafts are replaced too early. This means that runtimes are shortened unnecessarily and assets are wasted. Furthermore, with preventative maintenance, it is not always possible to recognize and locate defective components before failure. Defective components in running machines can cause considerable damage and downtime.

In condition monitoring the equipment, also known as condition-based maintenance, component defects are recognized at an early stage and the remaining runtimes of bearings, shafts, etc. are utilized to the maximum. This helps prevent costly downtime. Moreover, costs are saved due to the complete utilization of the runtimes of important machine components. Thanks to the intelligent sensor technology used in many of today's condition monitoring practices, condition-relevant machine parameters such as machine vibration, temperature and sound are measured directly at the source and analyzed by software designed to employ proven mathematical methods.

Condition-based maintenance can allow for consistent monitoring of general machine conditions as well as for regular monitoring of the conditions of individual machine components in real time. Machines/equipments such as peelers, slicers and choppers and systems for which monitoring surveys may be required on a routine basis include the following items:

- Fan systems-due to filter blockage, blade fouling or re-cycling.
- Heat exchangers-due to fouling or blockage.
- Electrostatic or bag dust filters – due to fouling, shorting or leakage.

Numerous equipment performance parameters are monitored through a series of sensors by the engine’s control system so as to allow precise control over the principle elements of engine operation such as electric system fuel injection and emissions. By continuous monitoring variation data, performance degradation trends can be detected and corrective action taken to prevent imminent component or equipment failure. This data can also be compared with similar equipmet operating onboard other vessels in an operator’s fleet.

SELF-CHECK-3	**Written test**

Name…… ID…… Date…….

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

Test: Choose the best answer

1. Machines/equipments such as peelers, slicers and choppers and systems for which monitoring surveys may be required on a routine basis include the following items, except. (3 points)

   A. Pumps B. Fan Systems C. Heat Exchangers D. All E. None

2. Which one is not condition-relevant machine parameter among the following? (3 points)

   A. Vibration B. Temperature C. Sound D. All E. None

3. Which one is true about equipment condition monitoring? (3 points)
   a) used to detect the potential onset of a failure
   b) may be applied to any equipment and machinery systems
   c) involves the regular measurement of parameters
   d) all

4. Condition-based maintenance can allow for consistent monitoring of general machine conditions as well as for regular monitoring of the conditions of individual machine components in real time. (1 points)

   A. True B. False

Note: Satisfactory rating-≥5 points Unsatisfactory-<5 points

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

Information Sheet 4- Identifying variation and reporting maintenance requirements

Identified equipment and machine vibration problems should be reported with respective maintenance requirements. Preventive maintenance includes measures such as systematic and routine cleaning, adjustment, and replacement of equipment parts at scheduled intervals. Manufacturers generally recommend a set of equipment maintenance tasks that should be performed at regular intervals: daily, weekly, monthly, or yearly. Following these recommendations will ensure that the equipment performs at maximum efficiency and will increase the lifespan of the equipment. This will also help to prevent:

- inaccurate test results due to equipment failure
- delays in reporting results
- lower productivity
- Large repair costs.

A maintenance plan will include preventive maintenance procedures as well as provision for inventory, troubleshooting, and repair of equipment. When implementing an equipment maintenance program, some of the initial steps will include what follows.

- Assign responsibility for providing oversight.
- Develop written policies and procedures for maintaining equipment, including routine maintenance plans for each piece of equipment.
- The plan should specify the frequency with which all maintenance tasks should be performed.
- Develop the format for records, create logs and forms, and establish the processes to maintain records.
- Train staff on the use and maintenance of the equipment, and assure that all staff understands their specific responsibilities.

➢ Maintenance management involves 4 simple steps to help you carry out faultless maintenance routines:

- Generating a request

- Carrying out maintenance sessions
- Recording information
- Reporting the results

SELF-CHECK-4	**Written test**

Name…… ID…… Date…….

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

Test I: Choose the best answer

1. All are include in preventive maintenance measures, except (1 points)

   a. Systematic and routine cleaning,
   b. Adjustment, and
   c. Replacement of equipment parts
   d. All
   e. None

Test II: Give short answer

1. What are the steps that help you carry out faultless maintenance routines? (4 point)
2. What are the benefits we gain from reporting and timely equipment maintenance? (5 point)

Note: Satisfactory rating-≥5 points Unsatisfactory-<5 points

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

Information Sheet 5- Monitoring the process to confirm the product is cooled and packaged

Peeled, sliced and chopped spice products must monitor regularly for its proper cooling and packing operation until pass to further processing. This helps to prevent product contamination, since it is monitor with hygiene control. Hygiene control in spice processing operations includes effectively control of:

- Temperature-heating, chilling
- moisture (drying)
- Chemical preservation, vacuum or modified Atmospheric packaging.
- Microbiological and physical contamination based on sound scientific principles.

Choice of cooling equipment depends on the products being processed. Their characteristics, (cooling capacity, etc.) should be selected based on the quantities of products produced in order to allow for:

- refrigeration without delay after the peeling and heat treatment, as soon as the internal temperature reaches 60°C and
- an even temperature distribution in the batch/peeled, sliced and chopped product when it is cooled

In all steps of processing, critical temperatures for multiplication of microorganisms (10°C to 60°C) should be avoided or in any case passed through rapidly. If there are delays in manufacture, perishable raw materials and in-process products must be maintained at a temperature which minimizes bacterial growth. This can be achieved by placing the product quickly into refrigerated storage areas and kept at the specified temperature or else kept at ≥60°C until normal production is resumed/ read to further processing operation. Monitor supply and flow of product and packaging consumables to and from the process properly. Product placement and storage should not facilitate cross contamination.

Storage and warehousing of finished fresh herbs should be under conditions that will protect them against physical, chemical, and microbial contamination as well as against deterioration of the product and the container. The packing facility should have a cold storage area with refrigeration that is appropriate for the product. Refrigeration units should be inspected on a regular basis and kept in good operating condition. Monitor and document temperatures in the cold storage using calibrated temperature sensors.Temperature monitoring devices should be placed in the warmest area of the refrigerator unit and calibrated on a regular basis.

Measures should be taken to prevent condensate and defrost water from evaporator-type cooling systems from dripping onto finished product. Non-porous bags/containers should be used to protect the spices and dried aromatic herbs from contamination and the introduction of moisture, insects and rodents. It is recommended that new bags or containers be used for food contact packaging. All bags/containers should be in good condition and particular attention paid to the potential for loose bag fibers that can become potential contaminants. The operator/ peeling technician should be monitor the product is well cooled and packed otherwise make decision to take corrective action.

SELF-CHECK-5	**Written test**

Name…… ID…… Date…….

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

Test: Say true or false (10 points)

1. The packing facility should have a cold storage area with refrigeration that is appropriate for the product._____
2. Monitor and document temperatures in the cold storage using calibrated temperature sensors._____
3. Choice of cooling equipment depends on the products being processed._____
4. Product placement and storage should not facilitate cross contamination._____
5. Regular monitoring of peeling, slicing and chopping process of spices and herbs helps to quality produces at final._____

Note: Satisfactory rating-≥5 points Unsatisfactory-<5 points

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

Information Sheet 6- Identifying, rectifying and/or reporting out-of-specification product/process outcomes

All out-of-specification products must be clearly identified, labeled, and quarantined to prevent unauthorized release. **ASTA recommends** that all of its members, and their suppliers, adhere to the following guidelines for control of non-conforming product.

- Specific individuals should be responsible for decisions pertinent to nonconformance, release, rework, or destruction of product.
- Products that are reported as non-conforming as a result of quality control activities, production, customer complaints, or external audits should be designated as “on-hold” and documented.
- Clearly label and isolate “on hold” products so that they are not accidentally released.
- Products should only be released after necessary controls are made and specification limits are achieved.
- Inform brand owner if applicable.
- Initiate corrective action in response to customer complaints.
- If non-conformance does not affect the use or safety of the product, then corrective action completes the response.
- If non-conformance affects the safety of the product, recall is initiated with management approval.
- Until the recall is completed, products from the same lot cannot be shipped and must be quarantined.
- Determine the corrective action required to eliminate non-conformance of future product, i.e., through re-work or other means. Upon completion, re-check the quality of the product to ensure the elimination of the non-conformance and seek approval for shipment.
- Document any destruction/disposal of non-conforming product.
- Where customer-branded products not meeting specifications are sold to staff or passed on to charities, this shall be with the prior consent of the brand owner, and shall be fit for consumption, meeting the legal requirements.

-
    - When a quality defect is found and documented, the technician assumes the third role of quality control, which is to report the defect.
- This function usually contains four parts:
    - Notification to others of the defect;
    - Follow-up to make sure the defect does not occur again;
    - Documenting how the problem was fixed; and
    - Changing the processing specification as needed.

➢ There are a number of other tests used in the industry, some of which are for specific herbs or spices. Some of the best-known and widely used are:

➢ **Piperine levels:** The test is specifically for peppers of the *Piper* genus.

- This involves extraction and measurement of the characterizing heat portion of the pepper (the piperine content).
- After refluxing in alcohol to extract the piperine, absorbency is compared to a standard using a spectrophotometer at 342–345 nm.

➢ **(ASTA) Color values:** This is a measurement of the extractable color of products of the *Capsicum* genus and is used as a quality indicator for paprika.

- Extraction is in acetone (16 hour ambient extraction), followed by spectrophotometric analysis (against a standard at 460 nm).
- The methodology was developed by the American Spice Trade Association (ASTA) and results are still often expressed as the ASTA colour value.

➢ **Capsaicin content:** Capsaicin is the pungent principle that gives heat to species of *Capsicum*.

- Extraction of capsaicin by refluxing with alcohol is followed by determination by HPLC using acetonitrile/water as the carrier.
- Results can be related to the Scoville test.

➢ **Scoville heat units:** The Scoville heat unit is a measure of the capsaicin content of *Capsicum* species.

- The test involves extraction of the capsaicin in alcohol and tasting of successively stronger dilutions in sugar syrup until the chilli heat (burning sensation) is detected.
- It gives a compatible result to capsaicin content but obviates a need for sophisticated laboratory equipment. A trained tasting panel is required.

➢ **Curcumin content:** this is a test specific to the measurement of the extractive color of turmeric.

- This is carried out by reflux extraction in acetone followed by measurement using a spectrophotometer at 415–425 nm.

➢ **Non-permitted colors:** These colors are sometimes added illegally to spices such as chillies, cassia, fennel, paprika, saffron and star anise to enhance their physical appearance and therefore their value.

- Non-permitted colors are assessed by HPLC with a diode array detector (DAD) or by liquid chromatography, tandem mass spectrometry (LC/MS/MS) dependent on the limit of detection (LOD) required.

Spices and aromatic herbs that have undergone a microbial reduction treatment should be processed and stored separately from untreated spices and aromatic herbs. Equipment should not be used for both treated and untreated products without adequate cleaning and disinfection before use with treated products. Persons handling raw materials or semi-processed products capable of contaminating the end-product should not come into contact with any end-product unless and until they discard all protective clothing worn during the handling of the material at earlier stages of the processing and have changed into clean protective clothing.

Hands should be washed and disinfected thoroughly before handling products at different stages of processing. Out of specification such off flavor, contaminated, discolored products should be report to responsible person. Inspecting fresh produce throughout the processing stream for field contaminants, this may not have been noticed during the incoming produce. Removing from the processing stream

damaged or decomposed produce, extraneous matter, and produce that appears to be contaminated by animal feces, fuel, machine grease or oil.

SELF-CHECK-6	**Written test**

Name…… ID…… Date…….

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

Test: Say true or false (6 points)

1. _____ involves extraction and measurement of the characterizing heat portion of the pepper (the piperine content).
2. _____ is a measurement of the extractable color of products of the *Capsicum* genus and is used as a quality indicator for paprika.
3. _____is the pungent principle that gives heat to species of *Capsicum*.

Note: Satisfactory rating-≥3 points Unsatisfactory-<3 points

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

Information Sheet 7- Conducting the work

- When performing peeling, slicing and chopping good manufacturing practices should be practice.
  - ❖ OHS measures and procedures while conducting the work

Safety is the safe of being free from danger. Occupational health and safety (OHS) information is discussed and shared with colleagues. As always we should be aware of safety requirements and attempt to observe safety rules in order to eliminate serious injury to ourselves or others. Personnel working with machines must be aware of the risks involved and follow safe work practices. Basic cause of accidents is faulty attitude toward safety, failure to recognize danger and emotion. Machine operator should follow safety precautions required in terms of personal safety, work shop safety, and tools and equipment safety to avoid injuries.

The work should be carrying out according to company policies and procedures, regulatory and licensing requirements, legislative requirements, and industrial awards and agreements. Good manufacturing practices (GMPs) are systems put in place to ensure that food prepared in a plant is sound and free of contamination. GMPs include:

- Food safety programs;
- Management systems;
- Operational methods and personnel practices;
- Maintenance for food safety;
- Cleaning practices

A food safety program is a written document indicating how a food business will control the food safety hazards associated with the food handling activities of the business. Food safety programs consider the following points based on HACCP (Hazard Analysis and Critical Control Point) guidelines:

- identify potential hazards that may occur in all food handling operations carried out in the business
- identify where these hazards can be controlled
- monitor these control methods
- provide corrective actions when a hazard is found to be not under control
- establish, document and verify detailed pre-requisite programs
- be regularly reviewed for adequacy

➢ Principles of food safety plans include:

- Conduct a hazard analysis
- Determine critical control points
- Establish critical limits
- Establish monitoring procedures
- Establish corrective actions
- Establish verification procedures
- Establish record-keeping and documentation procedures

SELF-CHECK – 7	**Written test**

Name…… ID…… Date…….

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

Test I: chose the best answer

1. Off the following one is not include in good manufacturing practices. (1 point)
   a. Food safety program
   b. Management systems
   c. Maintenance for food safety
   d. All
   e. None

Test II: Short answer questions

1. Write some considerations in food safety program based on HACCP guidelines. (2 point)
2. Mention and explain the principles of food safety plans. (3 point)

Note: Satisfactory rating-≥3 points Unsatisfactory-<3 points

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

Information Sheet 8- Maintaining workplace records

Records are important to the financial health of your processing plant. Good records do not ensure your industry will be successful; however, success is unlikely without them. Industry records are like report cards students receive in school. With a farm report card, you can tell how well you are managing your operation compared with other producers in your "classes. You also can see the strengths and weaknesses of your processing operation. Besides use as a management tool, records in industry are essential for preparing income tax reports. Also, most banks require extensive records from industry owners to formulate credit ratings. Finally, records are important in establishing eligibility for participation in government programs, determining the proper level of insurance coverage, and negotiating lease arrangements.

Accurate records are essential for evaluating your industry processing performance. Accurate analysis requires accurate data. Operational/ workplace/ records about products and practices can be helpful to firms. First, such records help ensure consistency of production/peeling, slicing and chopping/, packing, and processing operations and end-product quality and safety. They are more reliable than human memory and serve as a useful tool to identify areas where inconsistencies occur in operations and corrective actions or employee training may be needed. Furthermore, maintaining adequate documentation and records could assist in identifying or ruling out potential contributing factors of contamination if product implicated in an outbreak is traced to a particular farm or facility.

Every workplace is different and requires different types of information to keep it running smoothly, efficiently and profitably. Different businesses collect and use different types of information. Workplace records in operating peeling, slicing and chopping of spices and herbs include:

- Quantity of raw material received
- Quantity of raw material received
- Peeling, slicing and chopping equipments
- Peeling, slicing and chopping methods
- Variety of spice peeled and quantity per hour
- Date
- Quality of peeled spice
- Total production per day
- Employee training records
- Temperature control records
- Equipment monitoring and maintenance records
- Calibration records
- Sanitation records
- Product processing batch records
- Corrective action records
- Pest control records
- Distribution records
- Inspection records (e.g., incoming product, facility, production area)
- Microbiological contamination records (e.g., food contact surfaces, equipment)

Maintain records for significant activities performed, such as monitoring of water sources and use; water quality testing; treatment of water; cleaning and sanitation of equipment, quality of peeled, sliced and chopped spice and herbs, containers and vehicles; employee training; and corrective actions taken. Record information such as date and time, name of person(s) who completed the record and the activity being monitored in the documentation

Table 3: Common types of records for a small-scale spice and herbs processing business

Types of record	Information to be recorded
production records	• Raw materials received • Wastage % at different stages of the process • stock levels for raw material and ingredients • production volume and measurements • Maintenance programs and schedules
Quality assurance records	• Measurement made at process control points • Bach numbers and product code numbers • Cleaning procedures and schedules
Sales records	• Name of customers and amounts sold to each • Weekly and monthly sales volume
Financial records	• Income from sales • Costs of all process inputs • Staff records • Cash flow • Profit/loss • Tax records • Bank statements

Source: (Fellows, P., Midway Technology Ltd, Bonsall, UK)

SELF-CHECK – 8	**Written test**

Name…… ID…… Date…….

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

Test: Short answer questions (6 points)

1. Write some workplace records in peeling, slicing and chopping operation of spices and herbs.
2. Why maintain work place records.
3. List and differentiate types of records for a small-scale spice and herbs processing business.

Note: Satisfactory rating-≥3 points Unsatisfactory-<3 points

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

Information Sheet 9- Following workplace information requirements and procedures

A work place procedure explains a specific action plan for carrying out a policy. Procedures tells employees how to deal with a situation and when. Using policies and procedures together gives employees a well-rounded view of their workplace. They know the type of culture that the organization/workplace is striving for, what behavior is expected of them and how to achieve both of these. Information is passed from employee to employee, customer to employee, supervisor to team member, supplier to customer, and so on. Information needs to be sorted into related groups so that it can be stored easily and found when needed. An organization's success depends largely on how well it manages its information. Workplace information requirements also include workplace instructions.

- The workplace instructions shall include safety data sheets and relevant information on workplace such as:
  - first aid measures
  - fire fighting, including information about precautions in case of fire
  - precautions regarding accidental leakage, including information on safety directions by spill handling and storage, including information about safety directions on storage
  - exposure controls/personal protection, including information about measures to be taken in case of exposure to the substance or material and about special working clothes and personal protective equipment, and any bans on solitary working
  - disposal considerations, including information about precautions to be taken on disposal

SELF-CHECK-9	**Written test**

Name…… ID…… Date…….

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

Test: Short answer questions

1. Mention workplace instructions we follow when performing peeling, slicing and chopping operation of spices and herbs. (2 points)
2. Why follow work place information. (2 points)
3. What will be the negative consequences if the employees do not follow workplace information and instructions? (2 points)

Note: Satisfactory rating-≥3 points Unsatisfactory-<3 points

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

LG #41	LO #3-Shut down the slicing process

Instruction sheet

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

- Identifying the appropriate shutdown procedure.
- Shutting down and cleaning the process.
- Identifying and reporting maintenance requirements.

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

- Identify the appropriate shutdown procedure.
- Shut down and cleaning the process.
- Identify and report maintenance requirements.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Identifying the appropriate shutdown procedure

Refer to your standard operating procedures for the correct way to operate each type of processing unit in your workplace. The standard operating procedures for each type of equipment must be adhered to when shutting a processing down.

- The types of shutdowns used in a plant unit are:
  - scheduled shutdown
  - maintenance shutdown
  - emergency shutdown

Scheduled shutdown

A scheduled shutdown is initiated by the operator during normal operation of the unit when, maintenance is required. The shutdown procedure will depend on the type of equipment and the process to be done. Some steps taken in a unit/processing shutdown may include:

- shutting off the feeds to stop processes and heat generation particularly if processes are produce heat
- shutting off heating or cooling to the unit/ processing operation
- shutting off chopping and other mechanical operations
- removing or flushing waste materials from the processing workplace

Maintenance shutdown

When maintenance to the peeling, slicing and chopping equipment is required, the equipment may need to be entered so that work can take place. The shutdown should be a scheduled or planned shutdown as per standard operating procedures where equipment is:

- isolated (process, mechanical and electrical)
- cooled and depressurized
- cleaned
- Electric tested on a continuous basis prior to and during entry.

- A planned unit/plant shutdown will prevent:

- plugging of lines or equipment
- possible damage to equipment
- Possible injury

Emergency shutdown

An emergency shutdown is initiated in the event of a fire, instrument failure, power failure, unexpected hazard or total loss of the processes. Emergency shutdown procedures must be followed during a shutdown sequence. Where a shutdown will affect upstream or downstream process units, advanced warning must be given to the appropriate personnel to allow them to prepare for, and react to, the changing conditions.

SELF-CHECK-1	**Written test**

Name…… ID…… Date…….

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

Test: Fill blank questions

1. The types of shutdowns used in a plant unit are_____, _____, and _____. (3 points)
2. _____is initiated in the event of a fire, instrument failure, power failure, unexpected hazard or total loss of the processes. (2 points)
3. A planned unit/plant shutdown wills prevent_____, _____ and_____. (3 points)
4. _____ is initiated by the operator during normal operation of the unit when, maintenance is required. (2 points)

Note: Satisfactory rating-≥5 points Unsatisfactory-<5 points

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

Information Sheet 2- Shutting down and cleaning the process

The peeling, slicing and chopping operation in spice and herb processing plant should be shut down after completion of work every day according to the standards and procedures of the industry. Cleaning and sanitizing steps are listed below:

- Remove heavy debris from floors with brooms or shovels and dry clean processing equipment, if needed
- Pre-rinse the equipment with adequate quality water
- Clean remaining debris from floor
- Rinse floor and drains with adequate quality water using a low pressure hose
- Use dedicated brushes to scrub floor and drains with an effective cleaner, applying adequate quality water as needed
- Foam and scrub the equipment with an effective cleaner and scrub using dedicated brushes
- Thoroughly rinse the equipment, floors, and drains with adequate quality water using a low pressure hose
- Remove excess water from floors
- Sanitize (according to manufacturer directions) the equipment and floors

➢ Work from top down for cleaning and sanitizing activities. Some equipment may need to be disassembled before cleaning and sanitizing followed by reassembly.

SELF-CHECK-2	**Written test**

Name…… ID…… Date…….

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

Test: Short answer question

1. Write the steps we follow during cleaning and sanitizing processing plant/workplace.(5 points)
2. Why equipments are disassemble before cleaning and sanitizing. .(5 points)

Note: Satisfactory rating-≥5 points Unsatisfactory-<5 points

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

Operation sheet 1: Cleaning and sanitizing work area

Steps / Procedures for performing cleaning and sanitizing operation

1. Remove heavy debris from floors with brooms or shovels and dry clean processing equipment, if needed
2. Pre-rinse the equipment with adequate quality water
3. Clean remaining debris from floor
4. Rinse floor and drains with adequate quality water using a low pressure hose
5. Use dedicated brushes to scrub floor and drains with an effective cleaner, applying adequate quality water as needed
6. Foam and scrub the equipment with an effective cleaner and scrub using dedicated brushes
7. Thoroughly rinse the equipment, floors, and drains with adequate quality water using a low pressure hose
8. Remove excess water from floors
9. Sanitize (according to manufacturer directions) the equipment and floors

LAP TEST	**Performance Test**

Name……. ID……..
Date…….

Time started: _____ Time finished: _____

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

Task: Perform cleaning and sanitizing operation

Information Sheet 3- Identifying and reporting maintenance requirements

- Any activities which require maintenance should be identified properly and reported immediately as soon as possible.
- Maintenance procedures and other work-related documents should identify preconditions and precautions, provide clear instructions for work to be done, and be used to ensure that maintenance is performed in accordance with the maintenance strategy, policies and programmes.
- The procedures should normally be prepared in cooperation with the designers, the suppliers of plant and equipment, and the personnel conducting activities for quality assurance and technical support.

- The benefits to be accrued from the implementation of a program of planned maintenance can be found in the efficient and economical operation of the plant and equipment and the utilization of resources (i.e. plant and equipment and manpower) while also maintaining a sound standard of safe working and environmental conditions for operators, other occupants and employees within the workplace.

- **Maintenance systems vary**, depending on the location of the plant and equipment and/or company policy.
- Systems can range from the complete maintenance of plant and equipment using all available methods to their replacement on failure.
- **Planned maintenance** is work having benefited from information issued by manufacturers and suppliers, the experience and knowledge of the service department staff, and reports and records from previous service visits.
- **Preventive maintenance** is work to be carried out at a specific frequency as indicated by potential failures or known reduction in efficiency of the plant and equipment, thereby avoiding failures or a decrease in performance.
- **Scheduled maintenance** is work based on known information, such as number of operations, hours run, etc., and can therefore be carried out at a predetermined time interval.

- **Corrective maintenance** is work carried out following the failure of the plant and equipment, and is so designed to return the component to its normal operating condition.
- **Emergency maintenance** is that work which is required to be performed without delay due to a failure of a component which, if not implemented, would lead to further failures or even permanent damage, resulting in the total loss of the plant and equipment. Plant and equipment in such a condition may also be dangerous to personnel.

SELF-CHECK-3	**Written test**

Name…… ID…… Date…….

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

Test: Choose the best answer

1. The benefits to be accrued from the implementation of a program of planned maintenance. (2 points)
   A. Efficient and economical operation of the plant equipment
   B. The utilization of resources
   C. Reduce personnel injury
   D. All
   E. None
2. _____ is work carried out following the failure of the plant and equipment, and is so designed to return the component to its normal operating condition. (2 points)
   A. Scheduled maintenance
   B. Corrective maintenance
   C. Preventive maintenance
   D. Emergency maintenance
3. Maintenance systems depends on: (2 points)
   A. The location of the plant
   B. The location of the equipment
   C. Company policy
   D. All
   E. None

Note: Satisfactory rating - 3 points Unsatisfactory - below 3 points

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

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