SPICE AND HERBS PROCESSING
Level-II

Based on May 2019, Version 2 Occupational standards

Module Title: - Operating Drying Process

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LG #63	LO #1- Prepare the drying process for operation

Instruction sheet

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

- Confirming materials to meet operating requirements
- Identifying and confirming cleaning and maintenance requirements
- Entering processing and operating parameters to meet safety and production
- Checking and adjusting drying equipment performance
- Carrying 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 materials to meet operating requirements
- Identify and confirm cleaning and maintenance requirements
- Enter processing and operating parameters to meet safety and production
- Check and adjust drying 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.
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4. Accomplish the “Self-checks” which are placed following all information sheets.
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Information Sheet 1- Confirming material to meet operating requirements

1.2. Introduction

Drying remains the most important operation under post harvest technology of spices. At the time of harvesting, spices like all other agricultural commodities invariably contain high moisture that must brought down into the desired level at which attack of micro-organisms would be minimum. However the percentage moisture content of spices contains high moisture (55-85%) at the time of harvest, which must be reduced in to 8-12%. Exceptionally, some spices like garcinia contains more than 90% of moisture content at harvest. The period between initial moisture level and final moisture level, however, is more crucial while practicing post harvest technologies.

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. 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 aims to provide trainees the knowledge, attitudes and skills required to set up, operate, adjust and shut down a drying process.

1.2. Confirming materials to meet operating requirements

Herbs are fragrant leaves of plants that grow in temperate climates. Herbs, such as thyme, can be used fresh or dried. **Spices** are seeds, fruits, roots, buds, stems or bark of tropical plants and trees. They are usually dried. Culinary herbs are leaves, while spices are obtained from the bark, berries, buds (and even flower stigmas), fruit, roots and seeds of plants. Spices are almost always used in dried form,

whereas herbs can be used fresh or dried. There are more herbs and spices on this planet than we could possibly list here-the following are commonly grown in home gardens and are good candidates for drying. Some herbs, although they can be dried, retain their flavor better if frozen. These include basil, borage, chives, cilantro, lemongrass, mint and parsley.

- Spices and herbs are classified by the plant parts used:
  - ✓ **Leaves**: Bay, celery, chervil, dill, geranium, lemon balm, lemon verbena, lovage, marjoram, oregano, rosemary, sage, summer savory, tarragon, thyme
  - ✓ **Seeds**: Anise, caraway, celery, chervil, coriander, cumin, dill, fennel, mustard, juniper
  - ✓ **Flowers**: Bee balm, chamomile, chive, dill, geranium, lavender, linden, marigold, nasturtium, thyme, yarrow
  - ✓ **Fruits**: Hot peppers
  - ✓ **Roots**: Garlic, ginger, horseradish (these take much longer to dry than seed spices and leaf herbs. It is useful to cut them into thin slices first.
- Herbs are also categorized as annuals and perennials:

Perennials	**Annuals**
Rosemary	Basil
Oregano	Dill
Mint	Parsley
Thyme	Cilantro
Sage	

Produce being received for drying process should be sampled and tested for receiving temperature. Incidence of defects such as, bruising, blemishes, freeze damage in facilities transit and infestation of insects should be inspecting. 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. Treating whole bulk commodities and intermediate fresh peel, slice and chop products as gently as possible during processing is important to minimize

unnecessary bruising and stress which may reduce product quality and shelf life. Bulk commodities should be segregated from finished products to prevent cross contamination. All confirmed and available spices and herbs could be cleaned and qualified and ready to drying 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.

Quality of spices is assessed by its intrinsic as well as extrinsic characters. The former consists of chemical quality. 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.

- The following list represents a few of the most important tests we conduct to prepare clean and qualified raw spices and herbs.
  a. **Appearance:** Samples of each product are evaluated based upon their general appearance and uniformity and are compared, to ensure conformance, to a known standard.
  b. **Color:** Used to identify products based upon conformance, of color, to a known standard.
  c. **Aroma:** Used to identify products based upon conformance, of aroma, to a known standard.
  d. **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.

e. **Particle Size:** A sieve analysis is used to measure the total particle size distribution of a prepared sample.

f. **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.

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 not classified under seed spices?
   a. Coriander b. mustard c. anise d. ginger
2. Among the following one is not an annual herb
   a. Rosemary b. mint c. thyme d. all e. none
3. Which one is/are included under extrinsic spice and herb quality indicator
   a. Texture b. appearance c. shape and color d. all

Test II: Matching (6 point)

Column A	Column B
____1. Appearance	a. basil
____2. Flavor	b. detected based on general uniformity
____3 Particle size	c. rosemary
____4.Foreign matter	d. measurement of the purity of spices and herbs
____5. Annual herb	e. Determined by using sieve
____6. Perennial herb	f. detected by tasting

Note: Satisfactory rating-≥9 points Unsatisfactory-<9 points

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

Information Sheet 2- Identifying and confirming cleaning and maintenance requirements

- Cleaning is the process of removing unwanted substances, such as dirt, infectious agents, and other impurities, from an object or environment..
- Why a food processing industry must be cleaned?
  - ✓ To reduce the risks from food hazards-food poisoning and foreign body contamination
  - ✓ To comply with local and international legislation
  - ✓ To meet specific customer requirements,
  - ✓ To meet the requirements of national and global food safety standards (GFSI)
  - ✓ To maintain positive audit and inspection outcomes
  - ✓ To allow maximum industry productivity
  - ✓ To present a hygienic visual image
  - ✓ To promote safe working conditions for staff, contractors and visitors
  - ✓ To maintain product shelf-life
- Cleaning costs money. The typical cost elements of a cleaning programme include:
  - ✓ Labor and supervision
  - ✓ Water supply, treatment and purchase
  - ✓ Water heating
  - ✓ Cleaning equipment
  - ✓ Chemicals
  - ✓ Effluent
  - ✓ Downtime

There are a number of methods which can be used to apply detergents and disinfectants. Manual cleaning using cloths, mops, brushes, pads, etc. It is normally used in small areas, equipment that is non-water proof or requires dismantling or areas which are difficult to clean by other methods. It is a labor intensive method and may limit the use of certain chemicals for safety reasons.

Foam cleaning is the common method for cleaning most food operations. A foam blanket, created using a wide range of available equipment is projected from a nozzle and allowed time to act on the soil. It is then rinsed off with the released deposits. Large areas such as floors, walls, conveyors, tables and well-designed production equipment are ideal for foam cleaning.

Spray cleaning uses a lance on a pressure washer with chemical induction by venture. This method can be wasteful of chemical and can be slow to produce foam. It should be used where foaming properties are not essential for the cleaning action.

Aerial fogging uses compressed air or other equipment to generate a fine mist of disinfectant solution which hangs in the air long enough to disinfect airborne organisms. Washing machine is normally an automatic or semi-automatic washing process conducted within a purpose built machine. There are many machine designs depending on the application,

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 machine. 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.

When identifying and confirming maintenance requirements of the equipment it is important to assess the overall equipment effectiveness because it helps to determine looses due to equipment failure. 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)

Six 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).

a. Breakdown losses:-sudden or unexpected equipment failures that make the machine less available. Contributing factors include:

- ✓ Major mechanical failures
- ✓ Electrical system failures
- ✓ Structural failure

b. Set-up and adjustment losses**:-**downtime and defective product that happen, 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
- ✓ Tools consistency and quality
- ✓ Operator skill level
- ✓ Machine to machine standardization

c. 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

d. 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, "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
- ✓ Raw Material
- ✓ Operator skill level

e. 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

f. 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
- ✓ Tools
- ✓ Raw Material
- ✓ Operator skill level

Self-Check – 2	**Written test**

Name…… ID…… Date…….

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

Test I: Short Answer Questions

1. List and explain the big losses of the equipment and machineries. (2 point)
2. Why a food processing industry must be cleaned? (4 point)
3. Explain mechanical failure of the equipment. (2 point)
4. List examples for preventive maintenance of equipments. (2 point)

Test II: Fill the blank space (10 points)

1. _____uses compressed air or other equipment to generate a fine mist of disinfectant solution which hangs in the air long enough to disinfect airborne organisms.
2. _____is normally an automatic or semi-automatic washing process conducted within a purpose built machine.
3. _____uses a lance on a pressure washer with chemical induction by venture.
4. _____is the common method for cleaning most food operations.
5. _____is a labor intensive method and may limit the use of certain chemicals for safety reasons.

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

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

Information Sheet 3- Entering processing and operating parameters to meet safety and production

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 before entering the processing operation. A spice and processing technician must have the ability to plan, organize, prioritize, calculate and handle pressure. The individual must possess reading, writing and communication skills. In addition, the individual must have personal and professional hygiene.

During operate primary processing of spice and herbs, enterprise work procedures describe how to do the various operations / tasks on primary processing of spice and herb to be used is based on good practice. In some case these processers are handed down by 'word of mouth' but now in most large processing area the procedures are documented to ensure that all operators know what to do and that work is done using the correct procedures. Your supervisor or line manager will be able to provide advice and guidance about the procedures to use and your role will be organizing activities and ensuring that all the enterprise work procedures are followed correctly by yourself and your supervisor.

The requirements of the client and the target market will determine the standards to be used for various primary processing operations, e.g**.** quality of raw materials, produce accepted and type of processing to be used. For some markets these requirements may be defined in Law but for others buyer preference dictates the price and raw material producer respond to their requirements to secure good price. For contract sales, client requirements will be listed in the contract.

In a large processing area the owner of manager will meet with the buyers and the processer manager will be informed of the standards to be used for produce processing.

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 (9 points)

1. The requirements of the client and the target market will determine the standards to be used for various primary processing operations such as:
   a. produce accepted
   b. quality of raw materials
   c. type of processing to be used
   d. all
2. One is not used as inspection parameter when confirming raw materials.
   a. Foreign mater b. odor c. appearance d. All e. None
3. When the amount harvested exceeds processing capabilities, the excess should be _____ under appropriate conditions.
   a. Store b. Remove c. A&B e. None

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

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

Information Sheet 4- Checking and adjusting equipment performance

4.1 Checking equipment performance

Drying equipments are properly checked and adjust properly to meet great achievement. Equipments should not have pits, cracks, corrosion, crevices, recesses, open seams, gaps, lap seams, protruding ledges, inside threads, bolt rivets, or dead ends. 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.

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

1. **Visual inspection** practices are the oldest and most common condition monitoring 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 connections, over heating; burned component 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.

2. **Audio inspection** practices are common condition monitoring 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.

3. **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.
   - ✓ The inspection can be enhanced through the use of directional microphones.

- 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 drying 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.

4.2 Adjusting equipment performance

In view of the enormous choice of dryer types one could possibly deploy for most products, selection of the best type is a challenging task that should not be taken lightly. The first consideration in selecting a dryer is its operability. Above all else, the equipment must produce the desired product in the desired form at the desired rate. The quality required in a finished product, and its necessary physical characteristics, are determined by its end use. A wrong dryer for a given application is still a poor dryer, regardless of how well it is designed. The final choice is then made on the

basis of capital and operating costs and equipment performance. Attention must be paid, however, to the costs of the entire drying system, not just the drying unit alone.

Performance adjustment varies with equipment type, design, precision and its overall effectiveness. For instance, ovens with number pads can be calibrated as follow: If the gas or electric oven temperature does not match with the expectations, can calibrate (adjust) the oven temperature. The steps for oven calibration depend on the type of oven controls. For models with a digital pad (number pads):

- ✓ Press the BAKE and BROIL HI/LO pads at the same time for 2 seconds until the display shows SF.
- ✓ Press the BAKE pad. A two digit number shows in the display. Press the BAKE pad once to increase (+) the oven temperature, or twice to decrease (–).
- ✓ The oven temperature can be adjusted up to (+) 35°F. Hotter or (–) 35°F. Cooler. Press the number pads the same way you read them. For example, to change the oven temperature 15°F, press 1 and 5.
- ✓ When you have made the adjustment, press the START pad to go back to the time of day display. Use your oven as you would normally. This adjustment will not affect the broiling or self-cleaning temperatures. It will be retained in memory after a power failure.

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 (8 point)

1. Performance adjustment varies with;
    a. equipment type
    b. design
    c. precision
    d. Overall effectiveness.
    e. all
2. Testing intervals of equipment performance will depend on the following factors except.
    a. the frequency of use
    b. the environment in which it is being
    c. Manufacturer's advice
    d. All
    e. None
3. Performing maintenance on mechanical equipment can be hazardous.
    a. True B. False
4. Off the following which one is correct?
    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-≥4 points Unsatisfactory-<4 points

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

Information Sheet 5-Carrying out pre-start and service checks

5.1. Carrying out pre-start check

Before starting a processing 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 processing 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.

Conducting pre-start checks, such as inspecting equipment condition to identify any signs of wear, selecting appropriate settings and/or related parameters, confirming that required screens are fitted and related equipment is clean and correctly configured for spices and herbs drying process requirements and positioning sensors and controls correctly. The operators in processing industry should ensure any scheduled maintenance has been carried out and confirming that all safety guards are in place and operation are very important prior to starting the operation.
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?

All service/maintenance should be conducted only by qualified individuals who are knowledgeable of the machinery/equipment and in accordance with manufacturer's specifications and/or industry standards, as applicable. 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 ensure all equipment is in a safe and operational condition for startup.
- 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.

5.2. Carrying out service check

The facilities are essential services that play a vital role to industry. Quality facilities and utilities provided like water, light/power, hygiene facilities etc. are prerequisite for an effective food safety. Adequate natural or artificial lighting should be provided throughout the factory to enable personnel to operate in a hygienic manner. Only potable water should be used for all process related activities are including washing and cleaning of machines/equipment that come in contact with food and hand washing.

Self-Check 5	**Written test**

Name…… ID…… Date…….

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

Test I: Chose the best answer

1. Services in spice and herbs include:
   a. Power b. water hygiene facilities d. all
2. Benefits from prestart-up check include:
   a. Reduce time loose due to equipment failure
   b. Increase equipment precision
   c. Reduce risks to be occurred
   d. All
3. Off the following which one is **not** necessary when performing pre-startup check?
   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
4. Equipment startup checks are needed to prevent
   a. Equipment damage c. Injury to personnel
   b. 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?
2. List equipment components required prestart-up check before drying of spices and herb.

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

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

LG #64	LO #2- Operate and monitor the drying process

Instruction sheet

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

- Carrying out spice and herbs drying operation
- Monitoring and controlling optimum drying condition
- Monitoring equipment to identify variation in operating conditions
- Identifying variation of equipment and processes and reporting maintenance requirements
- Identifying, rectifying and reporting out-of-specification product
- Maintaining the work area
- Conducting the work
- Maintaining workplace records
- Following workplace information 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**:

- Carry out spice and herbs drying operation
- Monitor and control optimum drying condition
- Monitor equipment to identify variation in operating conditions
- Identify variation of equipment and processes and reporting maintenance requirements
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Information Sheet 1- Carrying out spice and herbs drying operation

Drying is a process in which the transfer of moisture to the surrounding medium takes place by the evaporation of surface moisture, as soon as some of the surface moisture vaporizes; more moisture is transported from interior of the solid to its surface. Spices undergo various pretreatment procedures before drying or other processing techniques.

Spices	Herbs
Harvest	Harvest
Drying	Transport
Winnowing	Sorting
Transport	Washing
Finish drying	Cutting
(Grinding)	Drying
Packing	Winnowing
Storage	Packing
Distribution	Storage
	Distribution

Figure 1.1: The processing stages of spices and herbs

Drying is considered to be the most important step in the primary processing of spices. It is the most commonly used method for the preservation of agricultural products. The major objective of drying is conservation by reducing the moisture level of the raw material to a safe limit (e.g. 8-10%), to retain the original color, and to prevent or minimize the action of spoilage organisms without great loss of the flavor characteristic to the spice product. Drying inhibits the activity of intrinsic enzymes and prevents other chemical reactions that can reduce the quality of spice during storage. Cost of storage and shipping is also minimized, since the weight of the dried material is only 10-25% of that of the fresh material. The removal of moisture is attained naturally or artificially by heat of pressure.

- Factors influencing the rate of evaporation are:
  - ✓ ambient temperature,
  - ✓ relative humidity,
  - ✓ pressure and velocity of air,
  - ✓ size and shape of the wet material, and
  - ✓ Direction air movement.
- There are different spice and herb drying methods

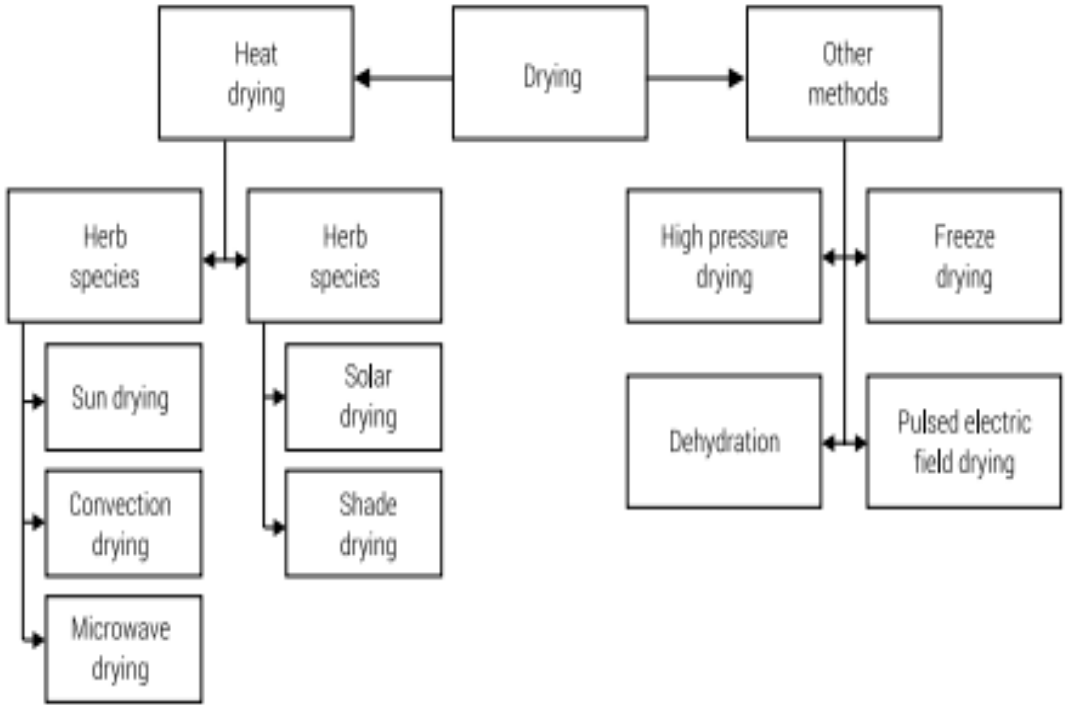

Figure 1.2: Methods of drying

1.1. Sun drying

Traditionally, and mainly for economic reasons, most spices are sun-dried. It is the cheapest method for bulk production and is employed when quality or appearances are not greatly affected by the action of direct sunlight. Sun-drying is done on concrete platforms, floors, grass or straw mats or simply by leaving the raw material to dry in the field. The spice product is often exposed to microbial contamination from the soil. Using raised platforms or racks not only circumvents this problem but also allows for a faster rate of drying because of the draugh of air circulating through the bottom and the sides. Sun-drying may take 2-14 days, depending upon the nature of the raw spice, the pretreatment applied, and the duration and intensity of sunlight.

Harvested spices are spread on mats, cement floors, roof tops or even on soil along the roads so as to expose to solar intensity until the completion of drying. In this method the spices are exposed to direct sun light and consequently the spice pieces heat up and internal temperatures rise without regulation. Drying is therefore uneven, and caramelized and crusted pieces result. The direct exposure to the sun also destroys color, vitamins, and flavor, and there is chance of contamination with dust, dirt, insect infestation, and contact with other pests. In fact sun drying reduces microorganism growth in general, but its effectiveness varies with the kind and number of microorganisms originally present in the commodity. If the drying process is not rapid enough, respiration continues in the tissues cells, and this leads to the utilization of sugar and the production acids which account for the sour taste present in most traditionally dried products.

The main **advantages of sun drying** are:

- ✓ The low capital and operating costs (because drying equipment and fuel are not used)
- ✓ Little expertise is required

The main **problems** with this method are as follows:

- ✓ theft or attack by insects, rodents and birds
- ✓ Contamination with dust, dirt, dropping etc.
- ✓ no protection from rain
- ✓ time taking due to slow drying process
- ✓ slow or intermittent drying which increases the likelihood of spoilage
- ✓ relatively low quality products and variable quality due to over/under drying
- ✓ relatively high final moisture content and spoilage during storage
- ✓ large areas of land needed for the shallow layers of spice and herbs
- ✓ laborious because the crop must be turned, moved if it rains, and animals must be kept away while drying takes place
- ✓ Direct exposure to sunlight reduces the quality (color and vitamin content) of some spices and herbs.

The quality of sun dried spices and herbs can be improved by the following methods:

- ✓ Sort, grade and clean the food
- ✓ Reduce the size of pieces
- ✓ Cover to prevent insect damage
- ✓ Shade if necessary to protect color or flavor of food
- ✓ Protect from animals
- ✓ Cover for rain or dew at night

Figure 1.1.1: Sun drying

1.2. Air-Drying

For air-drying to be successful, humidity must be low and good air circulation must be available. Stems of herbs such as mint, sage, or thyme can be tied in a small cluster and hung in a dry area with good air circulation. If you use a rubber band to tie them, it will tighten as the stems dry and stems will not fall out of the cluster. Hang herbs away from the sink, stove, or dishwasher where there is a lot of moisture. Keep dust off herbs by covering them with a paper bag punched with holes. The holes will allow air to circulate. If drying seedy herbs, place them in the bag so that the bag can catch the falling seeds.

When, drying leafy herbs, place the bag over the herbs as a dust shield. Herbs with small leaves can be laid out on a fine stainless steel or food-safe plastic screen or paper towels to air-dry. When dried, just strip the leaves from the stem to store. For herbs with larger leaves, remove the leaves from the stems and lay them on screens or paper towels without allowing the leaves to touch. Up to five layers of herbs and paper towels can be dried by this method. It may be necessary to change paper towels as they absorb moisture from the herbs.

1.3. Shade-drying

It is resorted to for some spices that tend to discolor or lose a considerable amount of essential oil under direct sunlight, e.g. cardamom, sage and most culinary herbs. This kind of method is used for spices and herbs which lose their color when exposed to direct sunlight for drying. Generally herbs, green and red chillies etc. are dried under shaded area with good air circulation. Shade-drying permits the crop to be dried more slowly and uniformly. Fully dried herbs and spices are safe from bacteria, mold and yeast, and will remain potent for at least six to 12 months. The drying of certain spices requires special conditions. For example, cardamom has to be dried in the dark so that the green color is retained.

Indoor air-drying-to air-dry herbs on stems, tie stems in bundles and hang the herbs upside down in a warm, dry place (avoid the kitchen, a source of steam and cooking vapors). Use twist-ties or thin-gauge wire so you can easily tighten the bundles as the drying stems shrink. Wrap bundles with muslin, a mesh produce bag or a paper bag with several holes, and tie it at the neck.

Figure 1.3.1: Indoor (shade) drying

Drying can also be accomplished by mechanical or artificial means, using natural convection dryers or forced-draugh dryers. It not only eliminates the disadvantages associated with sun-drying (e.g. microbial contamination, discoloration, dependence on the weather), but also provides controlled conditions of temperature, relative humidity and air flow, yielding a high-quality product.

1.4. Dehydrator

Herbs can be dried in a dehydrator if the temperature can be set between 95 and 110°F (35-43°C). Place stems on drying trays so they do not touch. Larger leaves can be dry separately. Do not dry herbs with fruits or vegetables because the flavors may mix and the moisture contents are different. Quality dehydrators have handy features such as timers and adjustable temperature control. Most dehydrators have a temperature-control mechanism-ideally one you can adjust-and a fan to circulate air. Round models with multiple stacking trays are the most energy-efficient. Box-type models that allow you to remove some of the trays can be handy for drying large items and can serve other purposes.

Figure 1.4.1: Dehydrator

1.5. Solar Drying

Solar drying technique uses the energy from the sun to heat a steam of, which in turn flows by natural or forced convection through a bed of the commodity to be dried. This method is ideal for warm, dry weather around 100 degrees and 60 percent humidity or less. In these conditions, you can use the sun's heat to dry herbs. The rate of drying is faster in solar dryer, and the quality of the product superior in intrinsic and extrinsic factors. The higher temperature deters insects and the faster drying rate reduces the risk of spoilage by microorganisms.

- Situations where solar driers may be useful:
  - ✓ Where fuel/energy is expensive or erratic
  - ✓ To supplement existing artificial driers and/or reduce fuel costs
  - ✓ Where land for sun drying is in short supply or expensive
  - ✓ Where sunshine is plentiful but humidity is high

- Situations where solar drying is not likely to be useful:
  - ✓ Where the quality of sun dried foods is acceptable
  - ✓ Where fuel is plentiful and cheap
  - ✓ Where the additional costs of a solar drier are not recovered from increased value of the food/product and there is no incentive for producers to risk higher amounts of money in a drier when there is not a greater return

- Solar dryer can broadly classified into two:
  a. Direct type
  b. Indirect type

a. Direct type

Direct drying systems consist of a transparent cover, a kind of enclosure, which permits light and heat directly on to the produce. The product gets heated up due to direct absorption of heat or due to high temperature in the enclosure. As a result moisture from the product evaporates and goes out by natural circulation of air current. The types of direct dryers in use are solar cabinet dryer, small holder capra dryer, low cost poly solar dryer, cabinet type solar dryer, solar air-drying system and low cost solar dryer.

Figure 1.5.1: Solar cabinet dryer Figure 1.5.2: chillies under solar dryer (Poly Carbonate Sheet)

b. Indirect type

It consists of solar collector, blower, drying chamber, supplementary heating system and energy storage systems. The drying chamber is completely protected from direct sunlight. Heat generated at solar collector is forced to the drying chamber in the form of hot air current, with the help of blower, which works mechanically or electrically. During drying the evaporated moisture goes out fast because of high pressure due to the forced circulation of air. The types of indirect dryers in use are solar water heater dryer, solar air heater dryer, forced flow dryer etc. It is recommended that indirect type dryers are better for spices, because retention of color, texture and volatiles is maximum in indirect drying.

The solar tunnel dryers combine the features of direct and indirect dryers. Solar tunnel was developed at the University of Hohenheim, Germany and it consists of a flat plate air heating collector and a tunnel drying with a small fan to provide the required air flow over the product to be dried. The collector and the drying unit are covered with UV stabilized plastic sheet and these are connected in a series as shown in Figure 7. Solar tunnel dryer can be operated by one 40 Watt photovoltaic module independent of electrical grid. The photovoltaic system has the advantage that temperature of the drying air could be automatically controlled by the solar radiation.

Figure 1.5.3: Drying conditions under the tunnel drier

- Solar dryers have many advantages over open traditional drying.
  - ✓ Safe & hygienic
  - ✓ Free from insect and bird contamination
  - ✓ Clean & dust free products
  - ✓ More uniform quality products
  - ✓ Uniform in color, texture, appearance of the product
  - ✓ Evenness in drying Moisture control to optimum levels
  - ✓ Nutrient retention

1.6. Oven Drying

Although drying herbs and spices in an oven sounds easy, this is actually the most labor-intensive and least energy-efficient method. Herbs need to be dried at about 100 degrees, but most ovens don't go that low. They also need air circulation, and some ovens don't have vents. If you wish to dry your herbs this way, it's best to get an oven thermometer and experiment. Herbs are far easier than fruits and vegetables to oven-dry because they dry more quickly and are more forgiving. Spice drying oven also used for drying fruits and vegetables, such as apple, pineapple, coconut, banana, mango, pawpaw, apricot, persimmon, plum, chili, onion, pepper, carrot, cabbage, mushroom, garlic, ginger, spice, tea, herbs and fish. Most of hot air circles in the sealed oven, high heating efficiency and energy saving.

Having forced ventilation function and equipped with adjustable wind separator plates , high drying evenness.

Figure 1.6.1: Spice drying oven

1.7. Microwave Drying

The microwave can successfully dry herbs, but note that food-drying experts do not recommend it for drying spices and herbs that have more moisture. It's not as easy as air-drying or using an electric dehydrator. It is fast way to dry herbs when in small quantities. Always observe safety precautions when drying herbs in a microwave and check manufacture's recommendations for using their product when drying herbs as the risk of scorching herbs and the possibility of starting fires exists.

Figure 1.7.1: Microwave dryer

1.8. Freeze drying

Freeze dryers are machines that consist of two main components, a vacuum pump and a condenser. Temperature control may also be incorporated into the drying shelves. Each component plays a role in each stage of freeze drying. There are three main stages in freeze-drying: freezing, primary drying and a secondary drying. During the freezing stage, fresh material may be placed in trays and loaded onto the cooling racks of the freeze-dryer. Alternatively, the material may be pre-frozen in a conventional freezer. It is crucial that the temperature remain very low and the material/spice doesn't begin to thaw, this will ensure that sublimation will occur during the drying phase instead of melting. The prevention of liquid-water formation is critical to the drying process and distinguishes freeze-drying from other methods.

During the primary drying stage, vacuum is introduced to the vessel which lowers the pressure to below the triple point of water. The cold temperatures and low pressures inside the freeze-dryer result in removal of water by sublimation, the transition of a solid directly to a gas without going through a liquid phase. This is the gentlest way to remove water from the product. The freeze-dryer shelves may provide gentle heat to the product to accelerate the drying process. Secondary drying is not always performed, however to ensure the driest, best preserved product, it is an essential step. During primary drying it is not always possible to remove every water molecule; some water remains physically bound to the material's surface. In order to release this bound water, the temperature is raised for a short time to about 40 ℃. Freeze-drying is by far the best way to dry and preserve, essentially remaining fresh and natural, the same as it was before drying. What distinguishes freeze-drying from traditional drying is the quality, benefits and properties displayed by the finished product, obtainable only through freeze-drying. The difference is heat from traditional methods degrades essential and structural proteins, whereas freezing gives the product rigidity and minimizes degradative reactions. This is why freeze-drying has become such an important method in many industries.

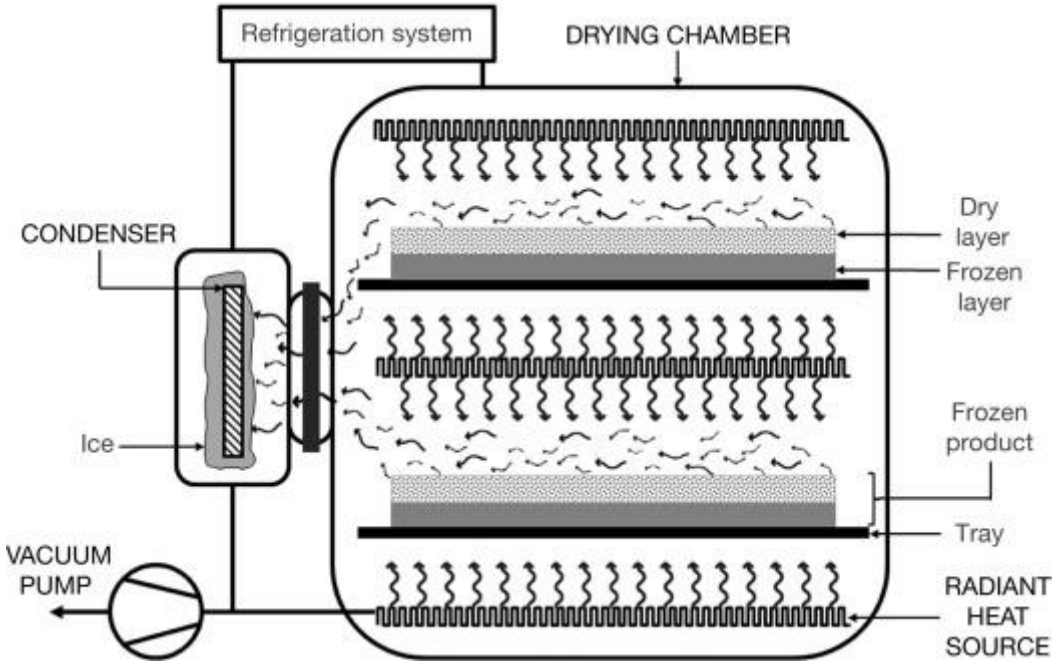

Figure 1.8.1: Freeze dryer

1.9. Fluidized Bed Dryer

Fluidized bed dryer consist of a steel shell of cylindrical or rectangular cross section. A grid is provided in the column over which the wet material/spice and herb is rests. In this type of dryer, the drying gas is passed through the bed of solids at a velocity sufficient to keep the bed in a fluidized state. Mixing and heat transfer are very rapid in this type of dryers.

The dryer can be operated in batch or continuous mode (figure 11). Fluidized bed dryer are suitable for granular and crystalline materials. If fine particles are present, either from the feed or from particle breakage in the fluidized bed, there may be considerable solid carryover with the exit gas and bag filters are needed for fines recovery. Fluidized bed dryers use an upward flow of heated air and mechanical shaking to create a fluidized effect. The main advantage of this type of dryer are: rapid and uniform heat transfer, short drying time, good control of the drying conditions.

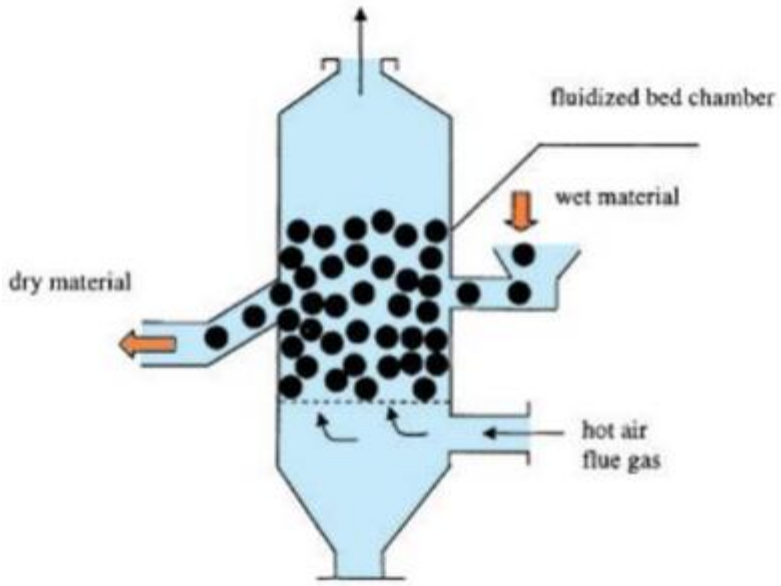

Figure 1.9.1: Continuous fluidized bed dryer

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. Factors influencing the rate of drying are:
   a. ambient temperature
   b. relative humidity
   c. pressure and velocity of air
   d. all
   e. none
2. Situations where solar driers may be useful:
   a. Where fuel/energy is expensive or erratic
   b. To supplement existing artificial driers and/or reduce fuel costs
   c. Where land for sun drying is in short supply or expensive
   d. Where sunshine is plentiful but humidity is high
   e. All
3. The quality of sun dried spices and herbs can be improved by the following methods:
   a. Sort, grade and clean the food
   b. Reduce the size of pieces
   c. Cover to prevent insect damage
   d. all

Test II: Short Answer Questions (6 points)

1. What are the main problems arise from sun drying?
2. Mention the advantages of solar drying over sun drying.
3. List main advantages of sun drying.

Test III: Matching (12 points)

Column A	Column B
____1. Sun drying	a. consist a vacuum pump and a condenser
____2. Shade drying	b. suitable for granular and crystalline materials
____3 direct solar dryer type	c. Forced flow dryer
____4.freeze drying	d. cheapest drying method
____5. Fluidized bed dryer	e. Solar cabinet dryer
____6. Indirect solar dryer type	f. suitable to cardamom drying

Note: **Satisfactory rating-≥12 points** **Unsatisfactory-<12 points**

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

Operation sheet 1- Techniques of drying rhizomes (ginger and turmeric) by sunlight

Steps / Procedures for drying rhizomes (ginger and turmeric) by sunlight

1. Purchase or harvest fresh rhizome at between 8 to 9 months of age, remove roots and leaves, then wash.
2. Kill or inactivate the rhizomes. This is done by peeling, rough scraping or chopping the rhizome into slices (either lengthwise or across the rhizome). The skin should be peeled off using a wooden scraper made from bamboo to prevent staining the rhizome.
3. After peeling and washing, soak the rhizomes for 2-3 hours in clean water
4. Spread the rhizomes on clean bamboo mats or on a concrete floor and sun-dry until a final moisture content of 10%.
5. Drying may take from 7 to 14 days depending upon the weather conditions. During drying, the rhizomes lose between 60 and 70% in weight.
6. After drying, clean the rhizomes to remove any dirt, pieces of dried peel and insects. An air separator can be used for large quantities, but at the small scale it is probably not cost effective.
7. The dried rhizomes should be packaged into air-tight, moisture proof packaging for storage or ready to further processing.

Operation sheet 2- Techniques of drying fresh herbs through shade drying method

Steps / Procedures for drying herbs through shade drying method

1. Chose the herbs, this process works best with low moisture herbs like: Dill, Marjoram, Rosemary, Summer savory and Thyme.
2. Bundle the herbs into a bunch**.**
3. Tie a rubber band around the stems of the herbs. Any flowers on the herbs should face downward. Drying times will likely vary if bundling together different types of herbs, so consider only making bundles of a single type of herb until you're more experienced and can mix the herbs knowing the drying times specific to each.

Figure 1.3: Tied stems

4. Choose whether or not to use a paper bag. The paper bag can speed up the drying process and catch falling seeds, leaves, etc. On the other hand, having no bag means you can have some lovely bunches of herbs on display in your drying room.

Figure 1.4: Paper bag

5. Select a suitable drying hanger**.** All sorts of items can be used to hang herbs from, including ladders, ceiling beams, coat hangers, a nail, etc.
6. Leave to dry**.** Herbs should dry away from direct sunlight and moisture or they will spoil. Drying times will take anywhere from 5 days to a few weeks, depending on the types of herbs you're drying.

Figure 1.5: Dried herb

7. Remove when dried. The herbs are dried when they just become crisp and no moisture can be felt

Operation sheet 3- Techniques of drying fresh herbs in the sun or outdoors

Steps / Procedures for drying herbs in the sun or outdoors

1. Choose herbs for drying. Some herbs are easier to dry than others owing to their stronger leaves and oils. Strong leaved herbs tend to be the easiest herbs to dry. These include bay leaves, rosemary, thyme and sage.
2. Cut the herbs when the dew has dried off them.

Figure 1.6: Cutting herbs

3. Tie into a bundle with a rubber band. Keep the leaves and flowers facing downward

Figure 1.7: Herb tying

4. Hang somewhere on the porch or off a hanger in a spot that gets full sun. Leave for several days to dry, checking every now and then. Be sure to tie on securely in case of windy days.

Figure 1.8: Herb hanging

5. Dry outdoors inside a paper bag. After bundling, tie a paper bag around the bundle. Hang the whole bag outside. The bag will provide more protection against the sunshine. It will also catch any seeds that dry too, if you want to collect them.

Figure 1.9: Drying herbs inside bags

6. Remove when dried. The herbs are dried when they just become crisp and no moisture can be felt.

Figure 1.10: Dried herbs

Operation sheet 4- Techniques of drying fresh herbs in the Oven

Steps / Procedures for drying herbs in the Oven

1. Select and prepare the leaves of herbs such as sage, mint, rosemary, thyme and parsley, stripped from their stalks
2. Set the oven to a very low temperature, the lowest it will go**.** Leave the door open. For about one to two hours with the oven door open at about 180 °F (82 ℃)

Figure 1.11: An electric oven

3. Arrange the picked herbs across a baking sheet.

Figure 1.12: Herbs across baking sheet

4. Place the sheet in the lowest level of the oven. Let dry but turn the herbs frequently. Check temperature often (between 100-120 °F is optimal) and adjust as needed.

Figure 1.13: Herbs at lowest level of oven

5. When they appear a little crisp, remove from the oven.

Operation sheet 5- Techniques of drying herbs with a food dehydrator

Steps / Procedures for drying herbs with a food dehydrator

1. Prepare the herbs, such as, basil, oregano, tarragon, lemon balm, and mints.
2. Place in on the dehydrator tray- cover the dehydrator tray with a fine screen to prevent herbs from falling down into the bottom of the appliance.
3. Remove tray above for good airflow-to allow space for the larger leaves, remove some of the trays. It is important that all leaves receive plenty of air circulation, so remove any trays that aren't necessary.
4. Dry on the lowest setting possible-for the best flavor, dry herbs on the lowest setting possible. A suggested temperature is 95 F to 115 F, but in conditions of high humidity, you may need to use 125 F. Typical drying time is one to four hours.
5. Complete drying. Herbs are dry when the leaves crumble and the stems break when you bend them.

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 2 weeks. The project is expected from each student to do it.

Task-1 Dry rhizomes (ginger and turmeric) by sunlight

Task-2 Dry fresh herbs through shade drying method

Task-3 Dry fresh herbs in the sun or outdoors

Task-4 Dry fresh herbs in the Oven

Task-5 Dry herbs with a food dehydrator

Information Sheet 2- Monitoring and controlling optimum drying condition

Optimum drying condition such as, temperature, relative humidity and other factors must be monitor and control during spice and herbs operations to met specifications. Drying is the most important stage in the process to ensure good quality spices. Inadequately dried produce will lead to mould growth. The sale value of mouldy spices can be less than 50% of the normal value. In addition the growth of food poisoning bacteria on some spices is a real danger if proper washing and drying is not carried out.

The use of a mechanical drier produces a higher quality, cleaner product. The drying conditions can be carefully controlled and monitored and the time taken to dry is considerably reduced. After cleaning and peeling, drying process should be carried out as quickly as possible to prevent the growth of bacteria and mould and to prevent fermentation. For instance, if the drying process takes too long there is a risk of the ginger becoming infected by aflatoxin. An important phenomenon to be considered during drying is critical moisture content.

The mean moisture content of the body at the time when, constant rate drying ends is called the critical moisture content. This will vary according to different spices. But it has colossal importance in drying, because if dried beyond critical moisture level the spice may become over dried or deteriorated. Almost all spices are hygroscopic in nature. Thus during drying, water evaporates at a rate which, in the failing rate phase, becomes smaller as the mean moisture content diminishes. Thus the drying rate falls towards zero as the moisture remaining in the body approaches vapor pressure equilibrium with the surrounding air. During drying, various other processes also takes place, such as cooling effect, shrinkage effect, case hardening, loss of rehydration ability, browning, scorching or heat damage, loss of flavor, and migration of soluble constituents.

The moisture content is found using the following formula:

$$\%\,\text{moisture} = \frac{(\text{initial weight} - \text{final weight})}{\text{initial weight}} \times 100$$

The method of determining solid content is the same as that described for moisture content above, but the result is expressed as ' % solids'. This is calculated using the following formula:

$$\%\,\text{solids} = \frac{\text{final weight of sample}}{\text{initial weight of sample}} \times 100$$

Table 2.1: Dried herbs and spices moisture contents

Spice	Maximum moisture limit % (wet basis)
Mace	6.0
Nutmeg, cloves	8.0
Turmeric, coriander	9.0
Cinnamon	11.0
Pepper, pimento, chillies, ginger	12.0
Cardamom	13.0
Cumin black whole	10
Mustard	10
Fennel	12
Fenugreek	10
Cassica	12
Aniseed	12
Celery	10

During the early stages of drying, conditions in the dryer (high humidity and moderate temperature) are ideal for the growth of micro-organisms. The quicker the drying time the better the final microbial quality of the product. Drying rates may be increased in two ways:

- by increasing the air flow and
- by increasing the air temperature

However temperatures should not be too high as they cause damage to the product. This is particularly true of herbs and spices as there is the risk of losing delicate flavors or colors. The processor therefore needs to experiment and find the best temperature for each product. Temperature, the most critical factor in artificial drying, should not exceed 75°C, but varies depending upon the type of spice: just under 38°C for leafy and herbaceous spices, cooler for flowers, around 50°C for roots, and over 60°C for bark. Herbs and spices must be dried to a moisture content that is low enough to prevent the growth of micro-organisms such as moulds and bacteria.

Air temperature measurement in drying processes can be conducted using either a thermocouple or a resistance temperature device (RTD). These devices provide a single spot measurement. Care must be given to placement of the probes so the measured temperature is indicative of the average air properties. Probes should be installed in areas of high airflow to ensure a fast response and representative process temperature readings. Manipulating the input to the heat source can control process air temperature. The measurement of the mass ratio of water to air also is important to the dryer's efficient operation. Because the air is used to provide heat to the product, for evaporation of water and to remove water vapor, the level of water vapor in the air will determine the drying rate and process efficiency. Several methods may be used to determine water loading in an airstream.

Dry and wet bulb temperature probes commonly are used to measure humidity. The temperature reading of the wet bulb probe will be lower than the dry bulb probe due to evaporative cooling. The difference between the two readings can be related to the water loading of the air. Wet bulb humidity measurements typically are performed as

spot manual readings because the consistent wetting of a temperature probe can be difficult.

Humidity transmitters also are available to measure water loading. They typically measure the electrical characteristics of a layered polymer film in contact with the air. The probes now have upper ranges of approximately 390^{o}F (200^{o}C), which allows them to be used in food and industrial drying applications.

The control of air humidity for a re-circulating air dryer typically involves changing the ratio of exhausts and recycle airflows. For a properly balanced dryer, the mass flow of the makeup air matches the exhaust flow rate. An increase in the exhaust airflow will tend to lower the process air humidity. Dampers can be installed in the exit air duct to adjust exiting airflow, although the adjustment of fan speed also could achieve a range of exhaust flow rates. In typical operation, dampers are adjusted manually as part of dryer performance audits. However, humidity control can be automated using an online sensor and positioning motors. The adjustment of the exhaust flow rate assumes the evaporation load on the dryer is large enough to generate the humidity level.

The measurement of the airflow rate will determine the drying rate as well as overall process efficiency. In a conveyor dryer, the ratio of the exhaust airflow rate to the recycled airflow rate will determine the humidity level of the air moving through the product and the exhaust. The exhaust airflow through a duct can be easy to measure providing a suitable straight length is available. The overall drying process can be controlled and monitored with control panel. To retain the best flavor of herbs, it is recommended that dry them at the lowest temperature setting, 95°F but can be adjust and control the temperature, time and humidity depends on various conditions.

Table 2.2: Herb drying with dehydrator at 95°F (35°c)

Herb	Average drying time
Basil leaves	10–15 hours
Bay leaves	5–7 hours
Chives	9–15 hours
Cilantro leaves	6–8 hours
Dill leaves	3–5 hours
Fennel	3–5 hours
Marjoram leaves	9–12 hours
Mint leaves	9–14 hours
oregano leaves	9–12 hours
Parsley leaves	6–8 hours
Rosemary leaves	8–12 hours
Sage leaves	12–16 hours
Tarragon leaves	5–7 hours
Thyme leaves	4–6 hours

The major source of moisture is atmosphere. The spices are hygroscopic in nature and hence can absorb moisture from the surroundings and human presence.

Table 2.3: General RH and temperature recommendation for some spices

Spice	RH (%)	Temperature °C
Cardamom	30 – 35%	28°C
Dry Garlic	65 – 70%	0°C
Dry Onion	50 – 55%	10 – 20°C
Cinnamon	40%	15°C
Chillies	18 – 20%	45 – 50°C

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 (4 points)

1. After cleaning and peeling, drying process should be carried out as quickly as possible to prevent:
   a. the growth of bacteria
   b. the growth of mould
   c. to prevent fermentation
   d. all
   e. none
2. Drying rates may be increased by
   a. increasing the air flow
   b. increasing the air temperature
   c. a & b
   d. none

Test II: Matching (12 points)

Column A	Column B
____1. Spice	a. Thermometer
____2. Atmosphere	b. Hygroscopic in nature
____3. Temperature	c. Major source of moisture
____4.himidity transmitters	d. Maximum moisture limit is 11%
____5. Cinnamon	e. Measure water loading

Note: Satisfactory rating-≥7 points Unsatisfactory-<7 points

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

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, drying capacity and performance, 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.
- ✓ Steam turbines-due to blade fouling and numerous other reasons.
- ✓ Air compressors-due to wear, filter blockage, valve leakage (reciprocating)
- ✓ Over heating-due controller failure

Numerous equipment performance parameters are monitored through a series of sensors by the control pane 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.

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

   a. Temperature b. Fan Systems c. Heat condition d. All e. None
3. Which one is not condition-relevant machine/equipment parameter among the following? (3 points)

   a. Vibration b. Temperature c. Sound d. All e. None
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 of equipment and processes and reporting maintenance requirements

- Identified equipment and machine vibration problems should be reported with respective maintenance requirements.
- The source of variation of equipment and process can be arise from:
  - ✓ Variations can occur, if the raw materials change, that change can create variations in the overall process. There might be a difference in quality from the same supplier, which may fall within the specified limits but is still enough to cause variation in the next process, or material from a different supplier may not be identical to the one from the first supplier.
  - ✓ Variations occur with the use of more than one piece of equipment to complete the same task because even two pieces of equipment bought at the same time from the same company will not always behave exactly the same over time.
  - ✓ Variations are also introduced in the performance of an individual piece of equipment, which can begin to break down or drift from the calibration point.
  - ✓ Humans are by nature variable. Even with the best controls, an individual operator can have a bad day and introduce variations from one day to the next. Two different operators trained in the same way might have slightly different actions or criteria for decision making, which causes variation. Not all variation caused by human action can be considered human error, although that possibility also exists.
  - ✓ Changes in temperature and humidity affect various processes. Also, some processing industries require a clean room environment, and the introduction of particles from outside the clean room can cause variation.
  - ✓ Changes in the environment have the ability to trigger changes in raw materials, equipment and human action, even if the environmental changes do not directly affect the manufacturing process.

- ✓ A manufacturing/drying process is defined by a series of steps. Variation can be introduced if the time between the executions of the steps changes, the order of the steps changes, one is missed or a change is made in carrying out the step-for example, if the step says to heat to a certain temperature but a different one is selected. Some variations in method can be tracked to variations in human action, but others may be approved alternatives.

Maintenance requirements are variable in nature, since the operator should be reported the required maintenance activities properly and timely to the concerned personnel. Preventive maintenance is cost effective method which 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

- 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

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

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. The source of variation of equipment and process can be arise from: (1 points)
   a. Change of raw materials
   b. Use of more than one piece of equipment
   c. Humans (individual operator)
   d. Changes in temperature and humidity
   e. All

1. All are include in preventive maintenance measures, except (1 points)
   a. Systematic and routine cleaning,
   b. Adjustment
   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? (4 point)

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

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

Information Sheet 5- Identifying, rectifying and reporting out-of-specification product

Out of specification implies test results which fall outside specifications or acceptance criteria established by the product manufacturer or the laboratory. It is the test result does not comply with the predetermined acceptance criteria. Out of specification dried spice and herb products should be identified, rectified and reported based on the scientific evolutions and tests. Such out of specification dried spice and herb products may include:

- ✓ Products with extreme moisture
- ✓ Products with live or dead insects
- ✓ Products with extraneous matter (herbs>2%, spices>1% by weight)
- ✓ Products with off odor or off flavor

Out of specification results can result from either of two situations.

- ✓ Laboratory testing error (during drying sample)
- ✓ Product manufacturing errors (e.g. during drying)

- So while doing the sample testing in the laboratory the following points must be confirmed:
  - ✓ Tests were performed under prescribed environmental conditions
  - ✓ Tests were conducted by a validated analyst
  - ✓ Whether validated test methods were adopted and SOP is followed without deviations
  - ✓ Equipment used were calibrated
  - ✓ Reagents used were within their validity
  - ✓ All results were recorded honestly and simultaneously to the analysis

All out-of-specification products must be clearly identified, labeled, and quarantined to prevent unauthorized release. American spice trade association (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

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 contaminants that may not have been noticed during the incoming produce inspection is a crucial task. 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.

The European Spice Association (ESA) quality minima document specifies the chemical and physical parameters of dried culinary herbs before crushing and grinding. This is functional almost in the world including our country Ethiopia.

Table 5.1: European Spice Association dried spice quality minima

Product	Ash % W/W maximum	Acid insoluble% W/W ash maximum	Moisture % W/W maximum	Volatile oil ml/100g minimum
Bay leaves	7	2	8	1
Thyme	12	3.5	12	1
Oregano	10	2	12	1.5
Marjoram	10	2	12	0.7
Basil	16	2	12	0.5
Anise	9	2.5	12	1
Celery seed	12	3	11	1.5
Chilli	10	1.6	11	-
Cinnamon	7	2	14	0.7-1
Cloves	7	0.5	12	14
Coriander seed	7	1.5	12	0.6
Dill seed	10	2.5	12	1
Ginger	8	2	12	1.5
Parsley	14	1.5	12	2
Rosemary	8	1	10	1
Turmeric (whole)	8	2	12	2.5
Turmeric (ground)	9	2.5	10	1.5
Pepper black	7	1.5	12	2
Pepper white	3.5	0.3	12	1.5
Cumin	14	3	13	1.5

Self-Check-5	**Written test**

Name…… ID…… Date…….

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

Test I: Choose the best answer (4 points)

1. Out of specification results can result from
    a. Laboratory testing error
    b. Product manufacturing errors
    c. A & B
    d. None
2. _____implies test results which fall outside specifications or acceptance criteria established by the product manufacturer or the laboratory.
    a. Specification
    b. Out of specification
    c. Drying
    d. All

Test II: Give short answer (6 points)

1. write the points to be followed while testing drying sample
2. List some examples of out of specifications in drying operation

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

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

Information Sheet 6- Maintaining the work area

Under occupational safety and health administration law, it is required that employers create and maintain a safe work environment. Assessing the workplace and implementing safety measures are an excellent first step, but efforts must be maintained to keep workers safe and healthy. One of the best ways to maintain a safe facility and promote a safe culture is through visual communication. Having visual cues around the facility can be helpful reminders of the safe practices that must be followed. Some ways to do this is to post signs to let workers know when to don PPE, use labels to clearly communicate dangerous equipment, or hang posters reminding workers of safety procedures. Floor marking is another visual tool that can be used in a facility.

Training is also an excellent strategy for maintaining safety in the workplace. Periodic training sessions should be held annually or throughout the year to keep workers up-to-date and refreshed on safety practices and procedures.

Another way to ensure your facility's safety is a priority is to establish a safety committee. Workers from different levels and different departments should be brought together to form a committee dedicated to safety. The committee can meet on a monthly-basis to review safety practices, evaluate safety procedures, assess issues, and to brainstorm safety solutions. If you hold monthly company meetings, have the safety committee prepare to share any safety related news and any employee feedback. This way, managers and supervisors can all be on the same page when it comes to workplace safety.

Importance of a clean workplace

The workplace environment influences employees' productivity, performance and well-being. No matter the industry, maintaining a clean workplace may help keep staff members safe, healthy and efficient. However, busy production schedules and increasing workloads may cause standards to dip. Maintaining a clean workplace is

vital for employers to reduce their workers compensation claims and keep efficiency high.

Essential to safety-When employees work in a messy environment, they may not notice all hazards, which increase the risk of an accident. According to the Occupational Safety and Health Administration (OSHA), an occupational hazard is anything in the workplace that may cause harm. An occupational hazard is commonly caused by neglect on the part of the employer or a lack of awareness by workers.

Crucial to health-Flu season is rapidly approaching and workplaces may see an increase in the number of employees using sick days if they become ill. Germs can spread quickly through the workplace if supervisors and employees don't adequately sanitize their hands and their workspaces. Another common health hazard of unclean workplaces is the germination of mold.

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: Choose the best answer (4 point)

1. Importance of a clean workplace
    a. Crucial to health
    b. Essential to safety
    c. A & B
2. One of the best ways to maintain a safe facility and promote a safe culture is
    a. visual communication
    b. Training
    c. establish a safety committee
    d. all

Test II: Short Answer Questions (4 point)

1. List and explain the importance of clean workplace

Note: Satisfactory rating-≥4 points Unsatisfactory-<4 points

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

Information Sheet 7- Conducting the work

- OHS measures and procedures while conducting the work

When performing during operation good manufacturing practices should be practice. 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 programmes;
  - ✓ 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 should be implemented during drying operation which includes the following:
  - ✓ 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: 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)

Test II: 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

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/drying/, 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.

Table 8.1: 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

- Workplace records in operating drying of spices and herbs include:
  - ✓ Quantity of raw material received
  - ✓ Quality of raw material received (physical, chemical and microbial)
  - ✓ Drying equipments
  - ✓ Drying methods
  - ✓ Variety of spice dried and production per hour, day, week, month and year
  - ✓ Quality of dried spice (moisture, ash and oil content)
  - ✓ Employee training records
  - ✓ Temperature control records
  - ✓ Equipment monitoring and maintenance records
  - ✓ Calibration records

- ✓ Sanitation records
- ✓ Maintenance to be conducted
- ✓ Corrective action records
- ✓ Distribution records
- ✓ Inspection records (e.g., incoming product, facility, production area)
- ✓ Microbiological contamination records etc.

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 dried spice and herbs, containers and vehicles; employee training; and corrective actions taken. Record the information such as the date and time, name of person(s) who completed the record and the activity being monitored in the documentation.

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 I: Short answer questions (6 points)

1. Write some workplace records in drying 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.

Test II: Choose the best answer (4 points)

1. Off the following one is not include under financial records
    a. Raw materials received
    b. Tax records
    c. Bank statements
    d. Income from sales
2. Which is unnecessary data in spice and herb drying operation
    a. Calibration records
    b. Drying methods
    c. Drying equipments
    d. All
    e. None

Note: Satisfactory rating-≥5 points Unsatisfactory-<3 points

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

Information Sheet 9- Following workplace information and procedures

A workplace is a location where someone works for his or her employer, a place of employment. 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
  - ✓ 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 drying 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 #65	LO #3- Shut down the drying process

Instruction sheet

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

- Identifying the appropriate shut down procedure
- Shutting down process according to workplace procedures
- Identifying and reporting maintenance

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 shut down procedure
- Shut down process according to workplace procedures
- Identify and reporting maintenance

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 shut down procedure

The standard operating procedures for each type of equipment must be adhered to when shutting a processing down. Shut down must be conducted using the standard procedures established for the machine or equipment. Refer to your standard operating procedures for the correct way to operate each type of processing unit/drying in your workplace.

- The types of shutdowns used in a processing industry are:
  - ✓ scheduled shutdown
  - ✓ maintenance shutdown
  - ✓ emergency shutdown

1.1. 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 process 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 drying and other mechanical operations
  - ✓ removing or flushing waste materials from the processing workplace

1.2. Maintenance shutdown

When maintenance to the drying 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 process shutdown will prevent:
  - ✓ plugging of lines or equipment
  - ✓ possible damage to equipment
  - ✓ Possible injury

1.3. Emergency shutdown

An emergency shutdown is initiated in the event of a fire, instrument failure, power failure, unexpected hazard etc. 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. If the machine or equipment is operating, shut it down by the normal stopping procedure or with manufacturer's or industry specifications.

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: Fill blank questions

1. The types of shutdowns used in a processing industry are_____, _____, and _____. (3 points)
2. _____is initiated in the event of a fire, instrument failure, power failure, unexpected hazard or loss of the processes. (2 points)
3. _____ is initiated by the operator during normal operation of the unit when, maintenance is required. (2 points)

Test II: Choose the best answer (4 points)

1. Planned machine/equipment shutdowns will prevent
   a. Possible injury
   b. plugging of lines or equipment
   c. possible damage to equipment
   d. all
   e. none
2. which one is true among the following statements
   a. The shutdown procedure will depend on the type of equipment and the process to be done
   b. The shutdown can be a scheduled or immediate
   c. Shut down must be conducted using the standard procedures established for the machine or equipment

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 process according to workplace procedures

A shutdown is temporary in nature, which means that it has a specific start and finish. There will be a preferred sequence of execution for the shutdown tasks (the schedule). The shutdown is a unique, one-time undertaking; it will never again be done exactly the same way, by the same people, and within the same environment. During normal running of the plant, experienced people usually carry out familiar tasks using well-defined procedures, but during plant shutdown, one could come across hazardous procedures and unfamiliar events. In such situations, the probability of accidents increases.

Major shutdowns in process industries typically happen infrequently (every year or two) and take several days to complete. In general, these shutdowns should have two objectives:

- ✓ To repair problems identified during previous major shutdowns, and
- ✓ To inspect parts of the plant not accessible during operation in order to identify problems that will be repaired during future planned shutdowns.

Of course, problems that must be addressed immediately will be discovered occasionally, but they should be the exception. When these types of issues are found, the inspection process should be updated to avoid similar future surprises. The key to a successful shutdown is to start the planning process early. Allow plenty of time to plan each job in detail, obtain competitive bids on contract work, manage the process inventory to gain access to tanks and other equipment for inspection, etc. A detailed "shutdown countdown" process should also be developed, including a list of essential activities, with a deadline for each one.

The documentation for a major shutdown can be extensive. It may include the list of shutdown work, critical-path schedules, the process inventory plan, permits and other safety documentation, the shutdown budget, all isolation and vessel-entry procedures (complete with detailed schedules and resource plans), as well as a list of the people responsible for all aspects of the shutdown (including their work schedules and 24-hour contact information).

Major shutdowns provide an opportunity for the people in the maintenance department to demonstrate how well they can perform under pressure. A well-planned and well-executed shutdown can be an exciting and satisfying experience. A strong operations/maintenance partnership will be a key. Finally, be sure to include all operations and maintenance activities in an integrated shutdown schedule, which should be under constant review and revision during the shutdown period.

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: Choose the best answer (4 point)

1. objectives of shutdowns:
    a. To repair problems identified
    b. To inspect parts of the plant not accessible during
    c. A & B
2. Which one is not true
    a. Shut down is temporary in nature
    b. Missing procedures during shutdown can cause injuries
    c. Shutdown the process can lost money
    d. All
    e. None

Note: Satisfactory rating-≥2 points Unsatisfactory-<2 points

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

Operation sheet 2.1: Shutting down spice drying oven

Steps / Procedures for shutting down spice and herb drying oven

Step 1. Wear PPE and prepare to shutdown Clean Oven Using Normal Practice.

Step 2. Power the Oven Off. This can be done by turning the Mode Switch to the off position. Electric ovens may have a circuit breaker at the bottom of the control panel, and this should be turned off after powering down.

Step 3. Gas ovens, turn the gas off. At the wall turn the gas supply off. Make sure the gas valve lever is perpendicular to the pipe.

Step 4. Disconnect Power to the Oven. For Gas Oven unplug the 115v cord from the wall outlet. For Electric ovens power it off at the main circuit breaker. This will either be directly behind the oven or at the main Breaker Panel. If the oven has a cord and plug, disconnect from the outlet.

Step 5. Leave the Door(s) Partially Open. This will allow the oven cavity to cool and dry out properly. This will also help keeping the door gaskets in peak shape.

Step 6. Clean and maintain the oven if it requires.

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 half hour. The project is expected from each student to do it.

Task-1 Shutdown the drying oven

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.

The frequency and nature of maintenance should be determined through risk assessment, taking full account of:

- the manufacturer's recommendations
- the intensity of use
- operating environment (e.g. the effect of temperature, RH)
- user knowledge and experience
- the risk to health and safety from any foreseeable failure or malfunction

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 (8 points)

1. _____ 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.
   a. Scheduled maintenance
   b. Corrective maintenance
   c. Preventive maintenance
   d. Emergency maintenance
2. The benefits to be accrued from the implementation of a program of planned maintenance.
   a. Efficient and economical operation of the plant equipment
   b. The utilization of resources
   c. Reduce personnel injury
   d. All
   e. None
3. Maintenance systems depends on:
   a. The location of the plant
   b. The location of the equipment
   c. Company policy
   d. All
4. The frequency and nature of maintenance should be determined through risk assessment such as:
   a. the intensity of use
   b. the manufacturer's recommendations
   c. operating environment
   d. all

Note: Satisfactory rating-≥4 points Unsatisfactory-<4 points

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

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