BEE PRODUCT PROCESSING- LEVEL- II

Based on October 2019, Version 2 Occupational standards (OS)

Module Title: - Performing Honey Fermentation Operation

LG Code: **IND BPP2 M13** LO (1-4) LG (42-45)

TTLM Code: **IND BPP2** TTLM 0920v1

September, 2020
Bishoftu, Ethiopia

United Nations
Educational, Scientific and
Cultural Organization

Table of Contents

LG #42	LO #1- Prepare for fermentation operations

Instruction sheet

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

- Confirming product and materials availability
- Preparing product and materials as work policies and procedures
- Confirming services availability
- Checking and confirming equipments
- Setting the process

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

- Confirm product and materials availability to meet production requirements.
- Prepare product and materials to meet work policies and procedures and production requirements.
- Confirm services as available and ready for operation.
- Check equipment to confirm readiness for use.
- Set the process to meet production requirements.

Learning Instructions:

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

Information Sheet 1- Confirming product and materials availability

1.1 Introduction

Honey is extracted not only to get the clear honey but it also changed in to different products from the clear/extracted honey or from byproducts. The first product of extraction from raw honey (it may from the traditional or modern hive) is pure honey and beeswax. From the pure honey and beeswax also produce other products like mead or honey wine, Birze, Te'j, candle and other products. This unit covers the skills and knowledge required for operating equipment associated with preparing honey mead. It includes operating and monitoring steeping, fermentation and cleaning equipment.

Fermentation is a metabolic process in which an organism converts a carbohydrate, such as starch or a sugar, into an alcohol or an acid. For example, yeast performs fermentation to obtain energy by converting sugar into alcohol. Bacteria perform fermentation, converting carbohydrates into lactic acid. The honey is fermented to produce the beverage which called mead or honey wine.

1.2 Mead

Mead or honey wine is the oldest alcoholic drinks known to man. It is made from honey and water via fermentation with yeast. It may be still, carbonated, or sparkling; it may be dry, semi-sweet, or sweet. Depending on local traditions and specific recipes, it may be brewed with spices, fruits, or grain mash. It may be produced by fermentation of honey with grain mash; mead may also be flavored with to produce a bitter, Beer-like flavor.

Mead is containing an alcoholic strength, by volume, between 8% and 18%, which results from the alcoholic fermentation of diluted honey by yeasts. It is a popular beverage in eastern Europe (Poland, Slovenia) and in the Baltic states, being also widely consumed in England, Germany, and, especially, in the African countries, for instance, Ethiopia and South Africa. In Portugal mead is still homemade, produced according to the traditional and empirical procedures.

The traditional beverages are grouped in to beers or wines depending on the fermentable food source. ***Tej*** is known which is an Ethiopian mead, fermented with wild yeasts (and bacteria), and with the addition of *gesho*. However, recipes vary from family to family.

1.3 Advantages of Mead

Actually, mead seems to be a good option for increasing the income of honey producers, allowing the development of a beverage little known in some countries but possessing great commercial potential. This is also in line with the present situation of consumers demanding more options and a willingness to try new products. Indeed, the great potential of mead is already evident in some countries, for example in the United States, were there are currently more than 45 commercial mead industries, a number that is continuing to increase.

The scientific advances conducted on mead include the development of additive formulations and fermentation conditions and processing improvements via ultrafiltration and flash pasteurization. Concerning cells' immobilization process, it was first applied to this beverage in the 1980s.

1.4 Materials and products for mead production

Since mead is made from a mixture of honey and water via fermentation with yeast, Honey is the main products to be made available in order to made mead. Water and yeast are the next main materials and products respectively used to in dilution and fermentation process. Let us see the required materials and products and also their contribution for honey fermentation or mead production.

1. **Honey**: the term honey includes natural honey intended for use in mead production, distilling honey drink, specialty honey for food production. A range of pressed honey varieties and must is used for mead production.
2. **Yeast:** those that are used for white wines, especially *sauterneyeast* work well. The yeast commonly used for wine and mead fermentation is *Saccharomyces cerviseae*.
3. **Water**: Un-chlorinated water or bottled or spring water but not distilled water.

4. **Other ingredients or additives** (Acids, Sulfites, Stabalizers, diammonium phosphate, bentnite, oak chips, Fruits, Spices and Herbs, Hopes).

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: Short Answer Questions

1. What is mead? (2 points)
2. What is the amount of alcohol in fermented honey (mead)? (2 points)
3. Mention the main products and materials used for mead processing (3 points)
4. Mention at least three of other ingredients used for mead production? (3 points)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

   _____

2. _____

   _____

3. _____

   _____

4. _____

   _____

Information Sheet 2- Preparing product and materials as work policies and procedures

When preparing products and materials, we should consider work policies and procedures. Work is carrying out in accordance with workplace procedures, licensing requirements and legislative requirements.

2.1 Preparing materials and products

a) Honey

Honey is the first ingredient to consider when making mead. The flavor and color of the final product are dependent on the variety of honey used. In general, a light honey yields lighter colored and flavored mead and a dark honey, darker colored and more robust flavored mead.

Table 1: Basic chemical parameters of media for fermentation

Basic Chemical Parameters of media	Diluted honey	Grape juice
density	1.0678	1.0672
dried extract (g/l)	176.4	176.6
fructose (g/l)	78.7	75.3
glucose (g/l)	71.4	78.8
titratable acid (g/l)	0.6	5.7
yeast assimilable N (mg/l)	13	107
pH	3.87	3.33

The above table mentioned by the study to prove metabolic power of yeasts during honey fermentation we investigated the basic chemical parameters which are either products or educts of the fermentation process (e.g. CO_2 is products, glucose and fructose are educts).

b) Yeast

Yeast is the next ingredient to consider and once again, there are several choices. Yeast is living organism that metabolizes sugars in honey to carbon dioxide and ethyl alcohol. Cultured wine yeast is commonly used to make mead. In general, those that are used for white wines, especially *sauterneyeast* work well. The yeast used for wine and mead fermentation is *Saccharomyces cerviseae*.

c) Water

The third basic ingredient used to make mead is water. The quality and chemical composition of the water used to make mead is critical. For example, water that has high chlorine content may produce off-flavors. Most mead makers recommend bottled or spring water but not distilled water since it lacks sufficient minerals for the yeast.

d) Other Ingredients/Additives

Acids: Small amounts of acids, such as malic, tartaric and citric acid, are added to balance the flavor. Their tartness offsets the sweetness of the honey while combining with the alcohol to give a degree of stability against spoilage. Some experts recommend an acid blend composed of twenty-five percent citric, 30% malic and 45% tartaric acids.

Sulfites: Sodium *bisulfite* or potassium *metabisulfite* in tablet or powder form are commonly used for sanitation in wine making.

Stabalizers: When making still mead, potassium *sorbate*, or wine stabilizer, can be added at the bottling stage to prevent a second fermentation by killing remaining yeast cells.

Fruit: To create the fruit-containing mead, ten to twenty percent fruit juice or purees are added to the honey-water mixture. Whole, pitted fruit can also be used. Twelve to fifteen pounds of fruit with twelve to fifteen pound of honey in five gallons are recommended.

Spices and Herbs: Almost any spice or herb can be added to mead either as an extract or directly at almost any time during the mead making process. Blends of two or more

spices and herbs are commonly used. If added directly, they should not remain in the mix for longer than twenty-four hours because bitter components may be extracted. A strong extract of mixed herbs, can be added at bottling time. Or, a strong extract of each spice can be prepared and added at any time after fermentation but before fining. To make an extract, boil the spices in a small amount of water for 15 minutes.

Hops: Adding hops to mead will add a distinctive flavor, but more importantly, its resins, oils, tannins and pectin can help to clarify the mead and preserve its freshness. Tannin is sometimes used by itself to add astringency and aid in brewing and clarification.

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. Discus the materials and products used for mead preparation (5 points)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

_____

_____

_____

_____

_____

Information Sheet 3- Confirming services availability

When preparing for processing work confirming the availability of services for that process is very important. For mead production basically power, gas, water, Steam and compressed air should be checked their availability and their effective performance.

Power

Power is the very important service for a lot of works. If the equipments are working with power should identify, check the availability and make it appropriate for the specific process.

Gas

Gas is used as a source of power for cylinder if there is not electrical power. But in beverage processing, gas is used as an ingredient for yeast fermentation. The other purpose is used in fire distinguisher. The gas oxygen (O_2) is used in fermentation production as ingredient and carbon dioxide (CO_2) is produced due to fermentation process.

Water

The quality and chemical composition of the water used to make mead is critical. For example, water that has high chlorine content may produce off-flavors. Most mead makers recommend bottled or spring water but not distilled water since it lacks sufficient minerals for the yeast. In addition to mead processing the potable water may use to keep the personal hygiene and sanitation of the work place and equipment.

Steam

Steam is an efficient and effective energy medium which is widely used in industry worldwide to produce everything from food to chemicals to paper and building materials. Steam heat plays an integral role in food production in numerous ways. Let’s explore the most common and essential applications. Various industry sectors, such as food

processing, brewing & beverage, dairy, pharmaceuticals, chemicals & building materials, require steam in their processes. The consumers don't often realize it, but the products we use daily, often go through processes utilizing high temperatures.

Compressed air

Compressed air has a wide variety of applications across industries. In the food and beverage industry, air compressors are used in production chains, packaging and cleaning. Generally, there are three different types of compressed air systems in the food and beverage industry:

- **Contact**:-compressed air that comes in direct contact with food products is categorized as a contact system.
- **Non-Contact High-Risk:** When compressed air is used in the production environment but does not come in direct contact with food products, it is considered a non-contact high-risk system
- **Non-Contact Low-Risk:** In some instances, compressed air does not come in direct contact with any food products or food contact surfaces.

Lighting

"Adequate lighting" means there is enough light to allow ease in cleaning and provide a safe, well-lit work place. All light fixtures above equipment or areas where food is exposed must be break-proof. Tuff-skin or plastic coated incandescent bulk sheets that fit around fluorescent tubes are satisfactory for this purpose.

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: Short Answer Questions

1. Mention and discuss services required for fermentation process (5 points).

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

_____

_____

_____

_____

_____

Information Sheet 4- Checking and confirming equipments

Checking and confirming equipments is the first operation to be done for the preparation of the main processing. This operation is considered the equipments used the processes from receiving materials and products to the final products. Checking and confirming of equipments is the process that include hygiene and sanitation standards, safety standards and pre-start requirements are met and that equipment is operational checking the operation and calibration of measuring instrumentation.

4.1 Checking and confirming Equipments used Honey fermentation

Here are the most important equipments needed to be checked and confirmed in honey fermentation in large industry. Since the principle of honey fermentation is similar, equipments listed below may used to produce mead in homemade as well as in industry.

- Storage:- The extracted honey for mead for fermentation may store in different types of container such as air tilted plastic, ceramic, glass and stainless steel. Here are some of examples of honey storage before fermentation.

Figure 1:- Honey storage

- Conveyors, blowers, chutes are some of equipments used to transport honey on site in large industry. This type of equipments are used the transport of liquids, semi-fluids, and suspensions, pumps are used. The transport of honey by pumping in process pipelines is a well-developed technology, based on the theory of fluid mechanics, and applied extensively in the chemical process industries.

The mechanical transport equipment is often used in combination with other food processing equipment, such as heating and cooling of water, air or steam, and fluidization and transport of particles.

- Weighing Equipments: depending on the industry level the capacity of weighing equipments /balances should be prepared.
- Refract meter are used to detection the moisture content of honey such as pocket refract meter
- Steeping vessels or towers: equipments used to steeping honey for fermentation.
- Pumps, hoses and other wetting equipment: used such equipments for dilution the honey for fermentation.
- Fermentation vessels including circular or rectangular vessels or boxes: used for the fermentation processes. The may be food graded plastic, stainless steel pot and glass pucket.
- Mechanical turning: equipments used to transport the bulk materials, products and heavy equipments.
- Combined steeping and fermentation vessels: Vessels used to the purpose of the combination process of steeping and fermentation. Such type of equipments should be heat and fermentation shock resistance.
- Cleaning of honey (de-culming): Honey is cleaned by filtration process using the sanitized sieve or Muslin cloth. It is used to filter the Must to make a clear mead.
- Depending on the availability and the scale of industry there are different types of fermenters are among them rotary fermenters, open fermenters, potter fermenters, and swept-arm fermenters are use
- Small oak, jetting tanks, hoses and fittings and pumps are used transfer the honey from primarily storage and also from primary fermentation vessel.

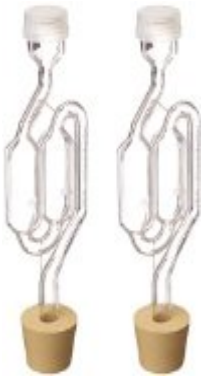
4.2 Equipments used commonly for mead preparation /Homemade mead/

Most recipes found as a reference is the process of homemade mead. The critical control to be inspecting is similar with industry of wine production. The mead is prepared in small scale industry level. Here basic equipment needed to produce five-gallon batch

- 1 (four-gallon or 15.28 litre) enameled or stainless steel pot - NOT PLASTIC, plastic can leach into your brew, even the smallest scratch will harvest bacteria even after being sanitizing)- for boiling honey-water mixture
- 2 (five-gallon or 17 litre) glass carboys (a Carboy is a glass container with a narrow neck)- used for steeping and fermentation process. Some articles it is called demijohns.
- 1 fermentation lock with rubber cork to fit carboy – putting on the top of fermenting vessel for fermentation
- 7 feet clear plastic siphoning hose, 5/16-inch diameter – used to transfer the mead from the primary fermenter in to secondary and from secondary fermenter in to bottles to be bottled.
- 3 feet plastic blow-out hose, 5/16-inch diameter
- Detergent and chlorine bleach-used for sanitize all equipments used for mead processing.
- Large funnel- used to transfer honey or other ingredients in to glass carboys
- Airlock- A simple device that allows carbon dioxide inside the fermenter to escape, without letting the contaminated air in.
- Spoon or Stirrer (not wood, wood is to porous) used to stir or mix the honey with water
- Screen or Cheese cloth- used to filter the mead (optional)
- Corker or bottle capper – used to cap bottle.
- Corks or bottle caps
- Bottles
- Wine hydrometer
- Thermometer
- Acid-testing kit

And when we want produce mead at home or at small scale you need also equipments for cleaning. These are For Cleaning:

- Sanitizer *(odorless and tasteless is better)*
- Spray bottle *(for easier for Sanitizing some items)*
- Bottle Brush



1) 5 gallon glass carboy 2) Carboy Cap 3) twin bubble airlock and carboy bung

4) Plastic fermenter with drilled lid (2 galon)

5) Swing Top Clear Italian Glass Bottle

6) Hydrometer

7) Thermometer

8) Hydrometer Test Jar

9) Corker

Figure 2: Equipments and products used in small-scale industry

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: Short Answer Questions

1. Mention at least 5 equipments used in honey fermentation in large industry (5 points)
2. List all the necessary equipments used to prepare mead (15 points)
3. What are equipments used for cleaning in mead production (3 points)

Note: **Satisfactory rating - 23 points** **Unsatisfactory - below 23 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

   _____

   _____

2. _____

   _____

   _____

3. _____

   _____

   _____

Information Sheet 5- Setting the process

Setting is come before starting the fermentation process. Process set up, operation and monitoring functions are performed at setting process and it includes manual or involve the use of a process control system and monitoring equipment's and operation process. Setting the process before starting the operation may minimize the defect expected from equipment, processing and product.

5.1 Setting Your Recipe to set up the process

There are so many recipes to be used depending on the scale you choose. We can search and get homemade brew or homemade mead recipe. The appropriate manual with the required information used to follow the correct procedure and control the quality. This can meet the required product with the required quality.

5.2 Setting Equipment and operation process

Monitoring equipment before the processing is required to be assured and set the performance of the equipment. It may consider the functionality of the equipment and its accessory or fittings, the sanitation condition and equipments used for sampling and testing the required parameters. Before you begin your mead making process, you will start out making sure all your equipment is cleaned and sanitized. Check the cleaning and sanitizing conditions.

Figure 3: Sanitizing equipments

Anything that touches the must (unfermented honey and water mixture) should be sanitized; this will of course include the brew pot. If you are a homebrewer, you may depend on the boil to "sanitize" your brew pot. But with mead, we will not be boiling. So, it is important to clean and sanitize everything.

The figure (figure 4) below clearly show that the general scheme of modern mead production. Setting the flow of process used to know the correct procedure of honey fermentation process. The fermentation process is started after must preparation.

The honey must is prepared by diluting the honey in commercial bottled water (You can refer the detail processing **LG# 33-36**)**.** The oenological analysis of Must include the determination of parameters pH, titratable acidity, tartaric acid, volatile acidity, total sulphur dioxide and alcohol content were determined as previously described.

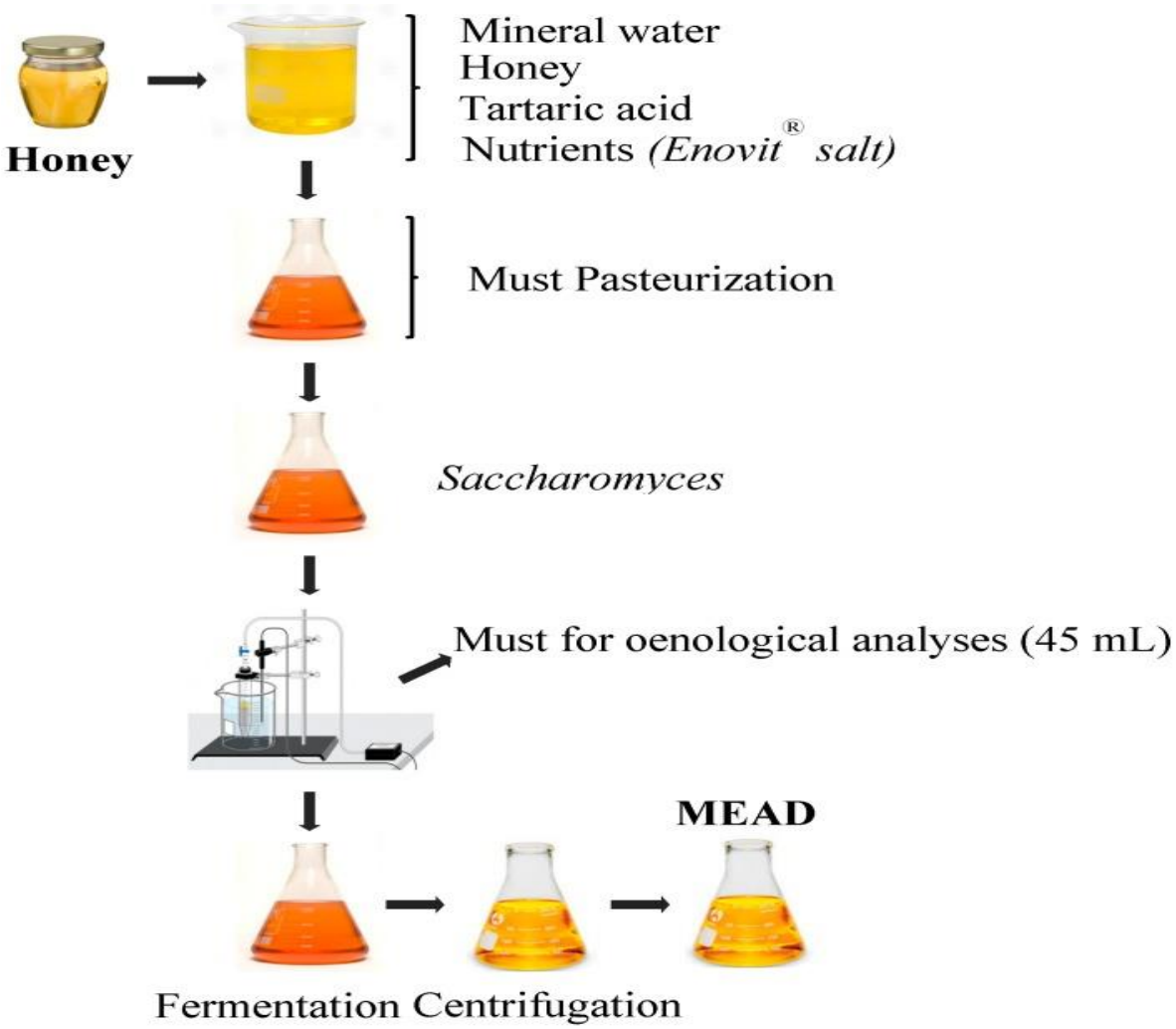


Figure 4: flow of diagram of Fermentation process of honey

Self-check 5	Written test

Name…… ID……. Date…….

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

Test I: Short Answer Questions

1. What are considered under the process set up, operation and monitoring functions are performed at setting process? (2 points)
2. What is the purpose of choosing the recipe? (2 points)
3. What is the purpose of choosing the equipment (2 points)
4. Draw the flow of diagram of honey fermentation (4 points)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

   _____

2. _____

   _____

3. _____

   _____

4. _____

   _____

LG #43	LO #2- Steep honey

Instruction sheet

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

- Transferring honey from storage into steeping equipment
- Placing hoses or other wetting equipment
- Immersing, draining and resting of honey
- Monitoring moisture content of honey
- Availing workplace information

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:

- Honey is transferred from storage into steeping equipment.
- Hoses or other wetting equipment are placed correctly to ensure uniform services like hydration and to avoid damage to honey.
- Honey is immersed, drained and rested for the specified number of cycles.
- Moisture content of honey is monitored during air resting to determine when it is ready for transfer to fermentation equipment (vessels).
- Workplace information like Standard Operating Procedures (SOPs); specifications and production schedules are availed.

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- Transferring honey from storage into steeping equipment

1.1 Introduction

Steeping is the soaking in liquid (usually water) of a solid, usually so as to extract flavors or to soften it. Steeping of honey in to water is one of the processes of mead preparation. The honey to be transfer in to steeping tank includes natural honey intended for use in mead production, distilling honey drink, specialty honey for food production. Honey is mainly composed of carbohydrates, lesser amounts of water, and minor components such as minerals, proteins, vitamins, lipids, organic acids, amino acids, phenolic compounds, enzymes, and other phytochemicals. Nevertheless, honey composition is rather variable and dependent on the floral source, climate, environmental and seasonal conditions, as well as the handling and processing practices.

1.2 Transferring honey

Figure 5: Purring Honey in to boiled water at 120^0F (49^0C) for steeping

We can use an open-top pot/milk tank with a mixer and fill it to a given level with water, then add the honey. Even with the mixer going, the honey is so dense that it tends to settle to the bottom. We use wooden paddles to coax it into solution. Using warm water helps. However in large scale transferring of honey from storage in to steeping vessel is automatic. The transferring process will be conducted by a conveyer and using automatic force.

During the transferring honey from storage in to the primary fermenting vessel required the care. The bacteria pathogenic may occur. The other important consideration is the contamination due to poor hygiene of both equipments and personnel who transfer the honey. Sanitization with appropriate methods is the first work to be perform based on the standard.

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: Short Answer Questions

1. Define honey prepared for fermentation (1 points)
2. Discuss the transfer /pour/ the honey from storage in to steeping vessel in small scale industry (2 points)
3. Discuss the transfer /pour/ the honey from storage in to steeping vessel in large scale industry (2 points)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

   _____

2. _____

   _____

3. _____

   _____

Information Sheet 2- Placing hoses or other wetting equipment

Hoses or other wetting equipment are placed correctly to ensure uniform services like hydration and to avoid damage to honey. Honey is exposed to damage when placing hoses or other wetting equipment. Hose lines are often wrongly classified as a weak machine component, though in many cases they do more than tubing lines and their maneuverability is what makes operation truly flexible. In certain areas, hose lines are indispensable; however they may become a hygienic and safety risk under some circumstances. To prevent this, certain key elements must be taken into consideration when dealing with hose lines under hygienic transfer as below.

2.1 Hygienic transfer in food & beverage production

Food safety and hygiene play a key role in the food industry in production as well as regarding the machines, systems and hose lines that are indispensable as a flexible transport link for conducting diverse media. Not all hoses are the same, so care is necessary when it comes to choosing the right one, especially considering that many types of rubber, fillers, plasticizers and other anti-aging agents marketed are not suitable for foodstuffs.

End users should ensure that hoses used in the transfer of consumables have quality control reports, or certificates of conformity, from reputable institutes guaranteeing that the material conforms to globally recognized directives of the US Food and Drug Administration (FDA); the material must also not transfer odor or taste to the media being processed and thus the food.

2.2 Critical points when it comes to hygiene

Besides selecting the right hose material, there are four critical points to be observed when it comes to ensuring safe and hygienic hose lines, including:

- The fitting;
- Cleaning and disinfection of the hose lines;
- Regular inspections and;

- Protection against mechanical damage.

The hose lines should also be integrated as part of an internal Hazard Analysis and Critical Control Points (HACCP) system. HAACP, an internationally recognized approach to food safety that is systematic and preventive, is recommended by the *Codex Alimentarius Commission*, the United Nations' international standards organization for food safety.

Control point I: The fittings

Quick-connect hose clamps are a popular and widely used fitting type, despite presenting a particularly high risk to hygienic transfer. This is because the hose nipple can become separated from the fitting; if the line becomes severely bent at the hose end, it can form a "dead space" in which the medium can be collected. This can lead to the formation of dirt cavities, which are difficult to clean even after they have been located.

Figure 6: Fittings

By contrast, swaged fittings do not allow the creation of unhygienic "dead space", especially if the outer sleeve of the fittings is longer than that of the inner supports. Connections that are made with swaged and clamp fittings are also stronger than the bursting pressure of the hose, which eliminates the risk of a pressurized hose becoming loose, potentially injuring nearby personnel or damaging equipment.

Control point II: Cleaning and disinfection

It is necessary to keep equipment that comes in contact with foodstuffs clean, maintained, and, if necessary, disinfected. End users should therefore ask hose suppliers for documents specifying hose resistance properties with regards to cleaning agents and disinfectants. Hose specifications that include remarks such as “for brief periods” or lists of temperature possibilities or exposure times are very helpful to users. In order to prevent the hose material from suffering damage, it is necessary that documents specifying cleaning agent and disinfectant resistance include basic cleaning agents such as water, steam, and sodium hydroxide solutions, plus various combination preparations; they should also include information on the maximum duration of exposure, working temperature and concentration.

Figure 7: Cleaning and disinfection

It is important in this context to inform users that the concentration of many disinfection agents should only be as high as that recommended by the manufacturer when they are being used for extended disinfection, for example over the weekend.

Control point III: Regular inspection

Hose lines made of rubber and plastic-rubber composites are subject to natural aging. This can be accelerated by strong mechanical stressing such as bending or motor-driven reeling, as well as thermal factors, including water temperatures exceeding 85°C, steam temperatures over 130°C and exposure to steam exceeding the maximum permissible time.

End users are therefore encouraged to inspect the condition of the hose lines on a regular basis. Specialized companies that assemble fittings and hoses into functioning hose lines offer a wide range of services in this regard. As a rule, these companies have staff trained in this area as well as mobile inspection equipment. This usually includes an endoscope, with which damaged areas can be documented using digital electronic recording technology, providing valuable information that aids the hose line operator's decision-making.

One of the tests that should be carried out as part of the regular inspection is a pressure test with water. This test is run for five minutes at 1.5 times the permissible operating pressure. In addition, the hose should be checked visually for dried leaks in the area of the fittings as well as for creases in the hose cover from bending. It should also be inspected for cracks and blisters.

The safest way to monitor hose lines is with an identification and documentation system in which the lines are clearly labeled with identification numbers, which are in turn documented. These preventative measures can indicate damage early before the line fails, prevent the lost of media and personal injuries, and help to extend the service life of the hose line considerably.

Control point IV: Protection from mechanical damage

With respect to regular checks, "a stitch in time saves nine." Practical hose recoilers and hose line holding brackets, as well as protective rubber rings on the fittings, help prevent damage caused by mechanical stressors to hose lines. Differences in quality and durability of materials for hoses used in the food industry usually cannot be seen at

first glance. If hose lines are inspected and documented regularly, it quickly becomes clear that a seemingly expensive material turns out to be a better deal when considering its service life, reliability and safety. When selecting a hose and fitting system, purchasers should consider not only the initial purchase price but also possible follow-up costs resulting from a lack of hygiene, production stoppages or insufficient industrial safety.

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. What considerations should be taken under hoses or other wetting equipment? (2 points)
2. What are the critical points to be observed when it comes to ensuring safe and hygienic hose lines besides selecting the right hose material? (4points)
3. Discuss each of them in detail (8 points)

Note: **Satisfactory rating - 14 points** **Unsatisfactory - below 14 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

   _____

2. _____

   _____

3. _____

   _____

   _____

Information Sheet 3- Immersing, draining and resting of honey

The honey is immersed, drained and rested for the specified number of cycles. This process is including mixing the honey and water before yeast pitching for fermentation. However the mixing process was discussed under Must preparation process. Sanitizing is the other operation step using different mechanism based on the required standard and let us discuss in detail below.

Sanitizing the Must

Place two gallons of water into your pot and heat using medium heat. Add fifteen pounds (6.8 kg) of honey, stirring constantly to avoid scorching. Once the honey is dissolved, add the remaining water to a total volume of 5 gallons (19 L). Honey is heavier than water and will sink to the bottom, so keeps stirring it until the honey and water mixture is uniformly mixed. Maintain the heat on low to medium and stir every five minutes. This process takes time, so plan on it taking at least an hour to reach 160 °F (71 °C). This is Pasteurization temperature and any bacteria or wild yeasts that may be present in the unfermented mead (or must) will be destroyed. When the temperature has reached 160 °F (71 °C), place the lid on the pot and let it sit for fifteen minutes.

Some mead makers, especially those with a home winemaking background, sanitize their unfermented meads by adding one Campden tablet (or 0.33 g of potassium metabisulphite powder) per gallon (3.8 L) of liquid. When doing this, let the unfermented mead sit overnight. Cover the bucket loosely with aluminum foil, so the sulfur dioxide gas released from the tablets or powder can evaporate from the mead. Pitch your yeast the next day.

Cooling the Must

After this fifteen minute rest period, immerse the entire covered pot into a sink full of cold water. You will have to change the water in your sink a few times to cool the must down sufficiently. A few trays of ice cubes added to the sink will hasten the chilling effect. You must cool the mixture to a temperature below 80 °F (27 °C) before you can pitch your yeast. There are steps to follow in order to immersing, draining and resting of honey before yeast pitching. These are:

- **Place the pot of Must in an ice water bath:** As soon as the hop boil is complete, transfer the pot of hot wort to your kitchen sink. Place the stopper in the sink and fill it up with cold tap water. Be careful not to splash water in the pot. Add as much ice as you have to make a cold ice bath.

Figure 8:-Cooling Wort/Must

- **Cool the Must to at least 75°F in 20 to 30 minutes:** Change out the ice water as the ice melts and the water becomes warm. (If you had a lot of ice, you might not need to do this.) Occasionally, stir the wort with a sanitized spoon and check the temperature with a sanitized thermometer (see next step).
- **Meanwhile, sanitize all your equipment:** Fill your fermentation bucket with sanitizer and place its lid, the airlock, a small strainer, a measuring cup, the hydrometer, the hydrometer tube, and a whisk inside. Once sanitized (following the directions for your sanitizer), lay the equipment on clean dish towels. Save a little

sanitizer solution in a separate container to use for any last-minute sanitizing (or re-sanitizing!) before pouring it out.

- **Transfer the cooled Must to the fermentation bucket:** Place a sanitized strainer over the sanitized fermentation bucket and pour the cooled wort through the strainer into the bucket. This filters out hop sediment and other solids.
- **Check the volume of your wort**: Check the volume of your wort against the measurement markings on the side of the bucket. If you're a little under a gallon, add tap water or filtered water as needed to make a gallon.

Take a hydrometer reading: Scoop out a little wort with the sanitized measuring cup and pour it into the sanitized hydrometer tube.

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 I: Short Answer Questions

1. Discuss the mixing process of honey with water (2 points)
2. Mention the three mixing methods and their methods and warning of the Must (10 points)
3. What does mean sanitize the must? (3 points)
4. Mention and discuss the steps of cooling the Must (5 points)

Note: **Satisfactory rating - 20 points** **Unsatisfactory - below 20 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

   _____

2. _____

   _____

3. _____

   _____

4. _____

   _____

Information Sheet 4- Monitoring moisture content of honey

4.1 Moisture Content of Honey

We know that water content determines maturation and storage state of honey. It is the best indicator of quality and sustainability of the latter for storage and processing. Monitoring the moister content of honey should be done before using as a raw material. The method is based on the principle that refractive index increases with solids content. The table was constructed from a plot of the logarithm of the refractive index minus unity plotted against the water content as determined by vacuum drying, a technique which requires much greater manipulative skill.

4.2 Determination of Moisture Content of Honey

Different studies showed that the moisture content of samples honey taking from different sources and analyzed varies between 16.2% and 21.5% with an average value of 17.91%. Under the EU standards a maximum of 21% has been set. (All procedures needs to be follow is mentioned inLG#19, LO#3, Information Sheet 1). Analyzing the Must is used to determine the water content of the mead.

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: Short Answer Questions

1. Discuss the reason of monitoring moisture content of honey. (4 points)
2. What is the average value of moisture content of honey from the point of different studies? (2 points)
3. What is the maximum value of moisture content which set by EU standards? (2 points)

Note: **Satisfactory rating - 8 points** **Unsatisfactory - below 8 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

   _____

2. _____

   _____

3. _____

   _____

   _____

Information Sheet 5- Availing workplace information

Availing workplace information may include Standard Operating Procedures (SOPs); specifications and production schedules and Information systems may be print or screen based. All the workplace information needs to be avail should be related to the product (honey and other ingredients used for fermentation) and the fermentation process.

5.1 Standard Operating Procedures (SOPs)

Standard Operating Procedures are sets of instructions having the force of a directive, covering those features of operations which lend themselves to a definite or standardized procedure without loss of effectiveness. The purpose of a SOP is to reach out the operations correctly and always in the same manner. A SOP should be available at the place where the work is done". Standard operating procedures or SOPs are written step-by-step procedures that quality control (QC), quality assurance (QA), and production units use in order to assure the accuracy and precision of the quantitative experimental results and materials that they generate and provide in support of other units. SOP's are needed to guarantee the continuity of processes to obtain quality performance and quality products/preparations (Natural Resources Management and Environment Dept.). SOP's are alive documents that detail written instructions describing specific steps to follow in all activities under defined conditions

5.2 Mead Quality Procedures

The most informative parameters in evaluating mead quality are the hydroxymethylfurfural (HMF) and phenolic contents. HMF is a cyclic aldehyde formed by the sugars degradation resulting in the reduction of the nutritional value of the product. The use of HMF as a quality index is based on the fact that, as this compound is absent in fresh honey, its final concentration in honey is only due to storage and/or heating. This is particularly important for multifloral honeys when compared with unifloral ones, since these two types of honey have a very different chemical composition. The presence of HMF directly influences the color, flavors and bud odor;

hence, it is used as a critical parameter of quality of honey. According to the Codex Alimentarius Commission, the HMF concentration in honey should not exceed 40mg/kg or 80mg/kg for tropical honey. High concentrations of HMF in honey indicate overheating, poor and prolonged storage conditions or aged honey.

Regarding the assessment of mead's quality, high concentrations of HMF and absence of most common phenolic compounds are indicators of excessive heating during the production. Also, it is very likely that some phenolic compounds can be used as indicators of mead composition and quality. Indeed, the detection of abnormally high concentrations of some compounds, for instance, vanillin, or even their presence in other cases, may be indicative of adulteration

Self-Check – 5	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions

1. Mention the workplace information to make available for honey fermentation process? (4 points)
2. What are Standard Operating Procedures? (2 points)
3. What are the most informative parameters in evaluating mead quality? (2 points)
4. Discuss the use of HMF as a quality index (2 points)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

   _____

2. _____

   _____

3. _____

   _____

4. _____

   _____

LG #44	LO #3- Fermenting honey

Instruction sheet

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

- Feeding honey into fermentation vessel or floor
- Monitoring honey for humidity, temperature, moisture and general condition
- Adjusting humidity and temperature
- Monitoring and controlling key control points

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:

- Fed honey into fermentation vessel or floor,
- Monitor honey for humidity, temperature, moisture and general condition.
- Adjust humidity and temperature as required to maintain specifications.
- Monitor and control key control points in the honey process

Learning Instructions:

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

This process is considering the mixture of honey and water or the Must is pouring in to fermentation vessel for fermentation. The pasteurized Must is transferred in to the fermenting vessel according to the process mentioned in 4.2. As we discussed the pervious topic the plastic equipment is not recommended because of it can leach into your brew, even the smallest scratch will harvest bacteria even after being sanitizing. However the primary process is takes place using plastic or stainless metal instead of glass vessel.

1.1 A primary fermentation

Primary fermentation is a process which takes first couple of weeks of fermentation. A primary fermenter can be anything that will hold your liquid while it ferments without imparting any unwanted flavors or harmful chemicals. It must also be easy to clean and sanitize, large enough to hold the desired batch size, and constructed such that it can be sealed and fitted with an air-lock for closed fermentation. Glass and food-grade plastic are both excellent choices and are relatively easy to come by without spending too much money. Metal fermenters are also available, but they tend to be more expensive pieces of specialty equipment.

Figure 9: Glass or plastic Carboy

1.2 Pouring the Must

Add 1/5th of the total volume of water to the fermenter (e.g. 1 gallon of cold water if making a 5 gallon batch). This will help prevent thermal shock on the fermenter that could result in cracking of the glass and spilling of the hot Must. This is not a great problem if using a plastic fermenter, but is still a good habit to get into. Using refrigerated water also helps cool the Must down quicker.

If the fermenter is a plastic bucket, pour the Must in letting it splash as much as possible. If using a glass or plastic Carboy, pour it in through a funnel. Letting the Must mix with as much air as possible will help dissolve oxygen into the liquid.

Figure 10:- Pouring the Must in to fermentation vessel/ 5g Glass Carboy/

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: Short Answer Questions

1. What is the problem of using plastic carboy for fermentation instead of glass? (2 points)
2. What is the advantage of add 1/5th of the total volume of water to the fermenter before pouring the must? (2 points)
3. Discuss the pouring of must in to fermenting vessel (4 points)
4. Discuss the difference between primary and secondary fermentation (2 points)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

   _____

2. _____

   _____

3. _____

   _____

4. _____

   _____

Information Sheet 2- Monitoring honey for humidity, temperature, moisture and general condition

Most of the time humidity, temperature, moisture, specific gravity are monitoring after the pouring Must in to the fermenting vessel. This completes the first phase of this honey transferred in to fermenter vessel; we will use the auto-siphon to draw off a small volume of must for analysis. Moisture content of sample is already the previous learning guide.

Temperature

Necessary if you are boiling or pasteurizing your Must to make sure the temperature has dropped enough to pitch the yeast. Just about any thermometer will do, just make sure that you do not break it in the Must as the mercury will ruin a whole batch. The temperature of the Must will be measured using a clean and sanitized thermometer. We should allow the Must to cool to 65-75°F (18-24°C) prior to adding the yeast.

Figure 11:-Taking a temperature of Must

The Must for heated honey mead is boiled for 2-4hr, is strained and allowed to ferment. The mead should be matured at a temperature below 12^0C and final stage of fermentation should be done at 2-4^0C.

Specific gravity

A hydrometer is a device that measures sugar levels of a liquid by evaluating the density of a given liquid compared to the density of water (called specific gravity). It is very important for a homebrewer to know how much sugar is in the mead at different times in the brewing process. Specifically, it's important to know this when considering:

- How much (if any) sugar to add prior to primary fermentation
- When to start and stop secondary fermentation
- How much sugar to add for carbonation prior to bottling

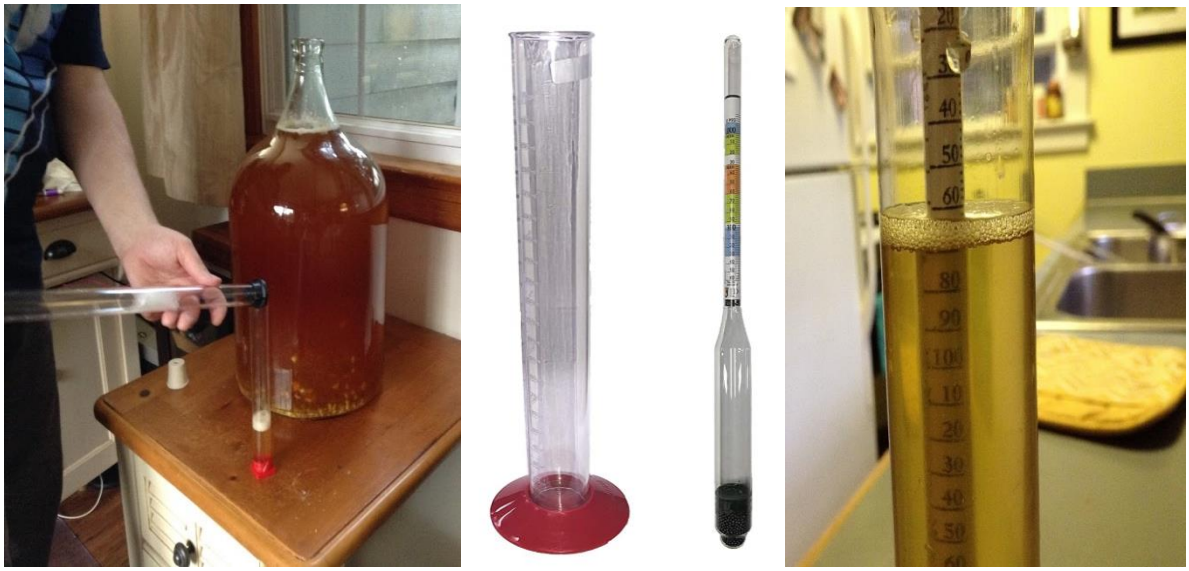


Figure 12:- sample of Must taking for analysis and monitoring specific gravity

Before pitching the yeast, pull a sample of the must and take a gravity reading using a hydrometer. This will allow you to measure the original gravity and calculate the alcohol content after fermentation. Do not return the sample to the fermenter because it can cause infection. If you've never measured gravity before, take a look at how to read a hydrometer.

pH Testing Strips (small spectrum)

It's important to know the specific beginning levels prior to adjusting with acids and tannin. Be sure to set up strips that measure only the lower part of the pH spectrum (approximately 2.8-4.4). If they cover the full spectrum (1 to 14) they will likely be in whole numbers only, and not provide the level of detail you need.

Figure 13:-pH strips and pH measuring

Acid Testing

An acid measuring kit determines the amount of titratable acidity (TA) in the mead. pH strips tell you the acidity level in general, the TA tells you what kind of acid it is. With this knowledge, an advanced mead maker can manipulate a batch with specific adjustments of acids and tannin to meet their needs.

Figure 14:-Acid testing kit and testing acid

Humidity

There are different types of instruments used to measure relative humidity of workplace environment. However the choice will be depending on availability and affordability. Here two instruments used to measure humidity at a specific temperature.

- An electronic temperature/humidity meter is hand-held instrument that uses a calibrated sensor to measure RH at a known temperature. While they are easy to use, many of the models may be accurate only to ±3-5% and may take several minutes to react to humidity changes. These instruments need to be recalibrated periodically (as recommended by the manufacturer).
- Min/max digital hygrothermographs keep a record of the highest and lowest temperature and humidity since the instrument was last reset manually; this can be done at any desired time interval (e.g., once a day, every morning and evening, once a week). Humidity measurements tend to be accurate only to about ±5% (at mid-range temperatures, accuracy may be less at temperature extremes), but these instruments can provide an initial broad outline of climate conditions.

Figure 15:- Humidity meter

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. Mention the parameters to be monitor from honey in to the fermenting vessel? (5 points)
2. Discuss each of the parameters mentioned above (10 points)
3. Mention and discuss the two types of instrument used to relative humidity (5 points)

Note: **Satisfactory rating - 15 points** **Unsatisfactory - below 15 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

   _____

2. _____

   _____

3. _____

   _____

Information Sheet 3- Adjusting humidity and temperature

The rate of evaporation depends on the vapor pressure or amount of water vapor in the air. At 100% relative humidity no water will evaporate from the wet bulb and the readings on both thermometers will be the same. Comparing the two temperatures in a chart will give the relative humidity.

The objective of adjusting the temperature is to bring the temperature of the Must below 80°F before the yeast is pitched. In order to adjust temperature, there shall be known of the relative humidity of the environment fermenter vessel. Here are different options to be used depending on whether the boil/pasteurizing/no-heat method was used.

Cool the Must (boil/pasteurize method)

this is the process which takes place after the pasteurization of Must. It is important to cool the Must as quickly as possible to avoid possible contamination from floating bacteria or yeasts. This can be done by the following methods:

- Place the pot into a bath filled with ice-water.
- Add sanitized bags of frozen water to the Must. Remove the bags of melted water when done. Make sure the water in the bags is clean in case there is a leak in one of them.
- Add ice to the Must. Do not use commercial ice as this is not always made of clean water. If you are going to do this method, freeze pure filtered water in bags and take the plastic off the ice before adding them to the Must.
- Use an immersion cooler (available from Homebrew stores).

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 I: Short Answer Questions

1. What should be the temperature of Must before yeast pitching? (2 points)
2. What is the purpose of adjusting temperature? (3 points)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

   _____

   _____

2. _____

   _____

   _____

Information Sheet 4- Monitoring and controlling key control points

4.1 Monitoring Fermentation

Monitoring of the airlock indications of the fermentation process is whether going on correctly or not. Make sure there is water in the airlock so you can monitor the bubbles (the visual bi-product of fermentation) escaping. Wait approximately two weeks and your mead will be ready (the bubbles will have all but stopped). Depending on the type of yeast you use, it may take less or more time. Signs of fermentation should be visible within 24 hours. You should notice the airlock bubbling. This is CO_2, a byproduct of fermentation, escaping through the airlock. If the bubbling slows down or stops, it doesn't necessarily mean fermentation has ceased. The progress of mead fermentation depends on several factors, highlighting the importance of the yeast strain and nutrition, pH's control, mixing during the process, lack of essential nutrients such as a deficiency in available nitrogen, and low mineral concentration. Therefore, optimal growth conditions are required in this process.

4.2 Quality characteristics of Mead

The mead quality is primarily influenced by the honey variety, although the yeast microflora as the main catalyst of alcoholic fermentation also plays a significant role in the organoleptic and chemical quality of the final product. The impact of the indigenous honey *associatedyeasts* on the mead properties has scarcely been investigated. The other quality of mead is determined by additives used. Heating of honey during Must preparation has influenced the aroma and taste of the mead. The adverse effect of heating the diluted honey is the production of undesirable flavor that develops in the resulting mead. Long heating indicated a darkening of the honey and was darker than those receiving short time or no heating. Studies made on mead production in different heating temperature that there is the heating temperature is not affect the pH, acidity and residual sugar contents.

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: Short Answer Questions

1. What is the main indication to monitor in fermentation process of honey? (2 points)
2. What is the observation from notice the airlock bubbling at monitoring? (2 points)
3. Mention factors of mead fermentation (4 points)
4. What are made affect the quality of mead? (2 points)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

   _____

2. _____

   _____

3. _____

   _____

4. _____

   _____

LG #45	LO #4- Operate and monitor fermentation operations

Instruction sheet

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

- Starting the fermentation process
- Monitoring control points to avoid hazards
- Making fermentation
- Monitoring equipment
- Identifying, rectifying and reporting defected product and equipment

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:

- The fermentation process is started up according to workplace procedures.
- Control points are monitored to avoid hazards and to confirm performance maintained within specification.
- Ferment is made to meet specification.
- Equipment is monitored to confirm operating condition.
- Out-of-specification product, process and equipment performance are identified, rectified and/or reported

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- Starting the fermentation process

1.1 Fermentation

Fermentation has to take place in the absence of air (oxygen) in appropriate containers. The figure below shows that the fermentation processing honey. The fermentation process is started after Must pasteurization. Before being fermented into mead, the honey and water mixture is called “must.” You know that Must processing is discussed in learning guide of preparing Must process.

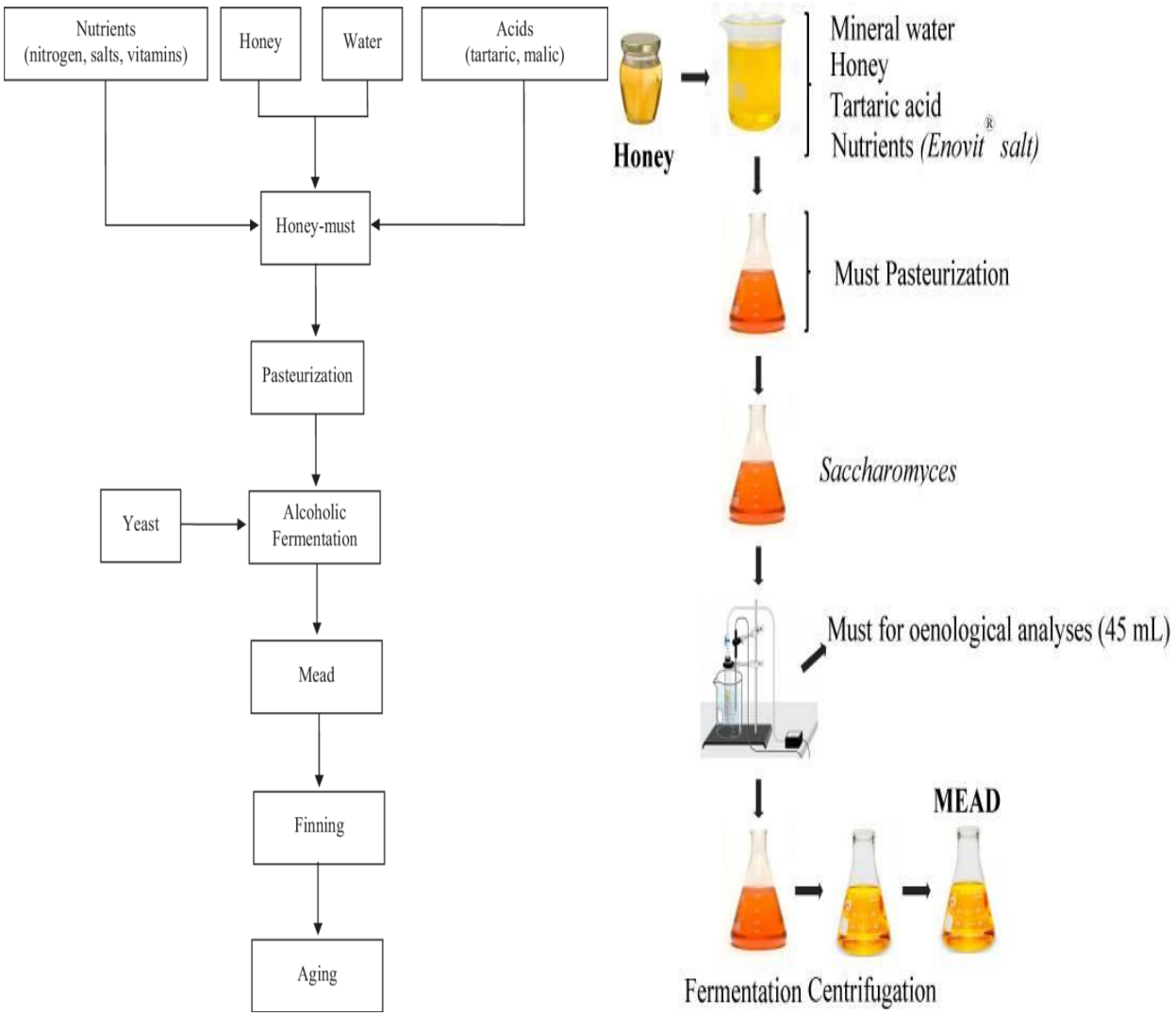


Figure 16: the flow diagram of Honey fermentation (Mead production)

1.2 Basic Steps for Honey Fermentation (Making Mead)

1. Clean and sanitize all equipment and containers.
2. Make the Must (i.e., honey-water mixture).
3. Add the yeast or yeast starter.
4. Ferment until all visual signs of air bubbles disappear.
5. Rack (fine first, if desired) two or more times.
6. Age until clear and good flavor develops.
7. Bottle and cap with bottle caps or corks

As mentioned above, the steps of 1 and 2 is performed under Must production. Knew let us see the steps of 3, 4 and 5 in order to perform the fermentation processing. The steps of 6 and 7 will perform under learning guide of Operating a Mead Maturation Process which will be continuing to this learning guide.

1) Adding the Yeast or Yeast starter

It is time to pitch the yeast. Follow the pitching instructions of your chosen yeast. Typically, the must will need to be below 80°F before the yeast is pitched. Once you pitch the yeast into the must, stir well (with a sanitized spoon) to make sure it is well mixed. Yeast will need oxygen to aid in its reproduction and to get fermentation off to a healthy start. Stir the must vigorously for at least 5 minutes.

Figure 17:-Yeast

Take the 2 packets of Lalvin D47 yeast out of the refrigerator and let them warm to room temperature (Figure). Take off the carboy cap and set it in the Starsan solution. Cut the tops off of the yeast packets and slowly pour the yeast into the carboy where it will dissolve over the next few hours.

2) Fermenting

The process of fermentation is taking place after the processes of the addition of the yeast in to *Must*. Fermentation takes from several weeks to several months. During this step, the sugar in honey is converted to alcohol and carbon dioxide gas. Once the must has been sterilized (by boiling, pasteurization or sulfite treatment), transfer it to the fermentation vessel (carboy) and add the activated yeast. At the onset of fermentation, yeast needs an ample supply of dissolved oxygen. Therefore, it is helpful to cascade the cold must into the carboy prior to adding the yeast. Air is excluded during the remainder of the fermentation process by installing an air lock on the neck of the carboy.

3) Racking

Racking involves siphoning off the clear mead into a second sanitized fermenter, leaving the sediment behind in the first. This step is repeated as many times as is necessary to achieve the desired level of clarity, usually at three-month intervals. Strict sanitation practices must be observed to prevent contamination. (If sulfiting agents are used as a disinfectant, they need to be added at each racking to ensure the desired level of 50 ppm sulfur dioxide.) Care must also be taken to not incorporate oxygen during racking after the onset of fermentation. Excess exposure to oxygen once the process has begun, can cause spoilage. When filling the carboy, headspace should be limited to approximately one inch to minimize the available oxygen.

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: Short Answer Questions

1. Mention the basic steps of mead production (7 points)
2. Discus the three steps of mead production from Must (3 points)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

_____

_____

2. _____

_____

_____

Information Sheet 2- Monitoring control points to avoid hazards

2.1 Hazards

As we discussed previous, a hazard is a biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect. Biological hazards include pathogenic microorganisms (e.g. Salmonella spp., Clostridium spp, Bacillus spp), parasites and viruses. Microorganisms that are non-pathogenic are not considered as hazards. For example, yeast causes fermentation of honey and, therefore, is an undesirable organism in honey, but it is not considered a hazard because it does not cause illness. Chemical hazards include heavy metals, pesticides, veterinary medicines, and biotoxins (e.g. tutin in honey). Some food additives may also be hazardous if present in excessive or toxic amounts. Physical hazards are objects that may cause illness or injury. Examples of these hazards are glass, metal fragments, and plastic.

2.2 Sources of Hazards

Hazards may occur in the:-

1) Materials and product as a result of an input (e.g. raw material, ingredients, packaging);
   - Receiving Bulk honey:- when receiving bulk honey for fermentation and during transferring from the storage in to another storage. It may arise occur bacterial pathogens. Bacterial spores (e.g. B. cereus, Clostridium spp.) are likely to occur in honey.
2) Process itself; or direct or indirect contamination from “other sources” (e.g. personnel, water, pests, wastes, equipment, internal and external environs).
   - Cleaning and Sanitizing:-cleaning and sanitizing of equipments internal and external surface may result in hazards. It may occur due to the cleaning and sanitizing agent. Appropriate sanitizers and detergents should be use according to

standard for the honey. At this time, bacterial pathogens may occur and transfer in to the next step.

- Heating:- when heating the must the temperature measurement should control based on the standard for mead production. Heating using heat exchanger will be a solution in order to control the required temperature.
- Transferring and filtering: transfer and filter of honey into vats/tanks & straining may transfer the bacterial pathogenic from one step in to another. Hygienic practices and cleaning of equipment will minimize contamination.

3) Personnel

The operator is required to apply these HACCP principles to the process, including all inputs. The operator is not required to carry out hazard identification and analysis for "other sources" (e.g. personnel and environmental sources), which are expected to be controlled by GMP (supporting systems).

2.3 Control points on Fermentation to avoid hazard

The following table is clearly showing that HACCP analysis during the process of Honey fermentation to assure the quality of the product (mead). The reason is to control the quality of the product to control the hazard came from the defect related to the quality.

Step of fermentation	Hazard type (C, M, P)	Hazard/reason	Preventive measure (GMP)	Monitoring procedure (analysis)	Critical factor/limit/control	Corrective action	Responsible personnel
CP	Microbiological and Chemical	Presence of chlorine in water to adjust must concentration	Filtration and dechlorination	Analysis of water	NA	Use of filters and demineralization treatment	Quality control manager
CCP	Microbiological and Chemical	n-butanol and sec-butanol formation	Avoid bacterial contamination and long interval before distillation	NA	NA	Control of distillation process	Quality control manager
CCP	Microbiological and	Acetic acid formation by acetic	Avoid equipment and pump	Analysis of cachaça using	Maintenance of pH 4.0-4.5 and	Control of distillation process	Quality control manager

	Chemical	bacteria	contamination, use of GMP (hygiene and aseptic procedures)	potentiometer and titration	acidity 2.5-5.0 g H2SO4/L, long interval before distillation		
CCP	Chemical	Ester and aldehyde excessive formation	Use of proper yeast, avoidance of multiple yeast reuse	NA	NA	Control of distillation process	Quality control manager
CCP	C chemical	Higher alcohol formation	Use of proper yeast, control of fermentation temperature, pH, and excessive oxigenation	NA	Maintenance of pH ≥ 4.0; temperature ≤ 32 °C, long interval before distillation	Rejection of batch	Quality control manager

Keys:- CCP=critical control point, CP=Critical point, GMF=Good Manufacturing Practice, NA=Not Apply

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. Mention and discuss the sources of hazards during honey fermentation processing (6 points)
2. What are the corrective measures to be taken under each hazard? (4 points)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

   _____

   _____

2. _____

   _____

   _____

Information Sheet 3- Making fermentation

Fermentation temperature should be between 65-75°F (15.5-21°C) for the duration of fermentation. We should be sure to keep the fermenter off of cold floors and away from fluctuating temperatures. During fermentation the must should be maintained at a constant temperature of 20° to 25 ^{0}C but not exceeding 28 ^{0}C. The exact temperature is not absolutely critical since fermentation will also take place at other temperatures but at different speeds. The longer the fermentation, the greater the risk of contamination by other bacteria or yeasts will become. At higher temperatures fermentation will be faster, but will produce less alcohol. At lower temperatures fermentation will become progressively slower and eventually stops.

Figure 18:1) Pitching Yeast and 2) Locate the primary fermentation vessel after pitching

With the yeast pitched and the primary sealed, place the fermenter in a location where the temperature will be within the range of 60-70°F, with lower temperatures being more favorable. After the initial aeration of the must at the time of pitching, it is crucial that you prevent the must/mead from splashing because this can cause oxidation, which can instill off flavors and shorten shelf life.

Under fermentation process include the primary fermentation, racking for secondary fermentation and performing the secondary fermentation for maturation of mead.

1. Primary Fermentation

At this time you will be sure that to keep your fermenter off of cold floors and away from fluctuating temperatures. Stirring for 2 minutes twice a day until fermentation will be performing from the beginning, usually within 24 to 48 hours. When fermentation is complete, take a hydrometer reading to confirm the final gravity of the mead. This can sometimes take up to a month so do not rush this step.

Figure 19:-Monitoring the starting of fermentation

Within 24–48 hours the batch should start bubbling, showing that the fermentation has started (Figure 19). This primary fermentation will continue for about 1 month until the yeast action has slowed considerably.

2. **Agitate yeast**

Mead fermentation can go slowly and much of the yeast will settle to the bottom. This yeast layer won't have good access to sugars and nutrients so it's good to shake it up every day or two. Gripping the dry carboy near the bottom with both hands, swirl it gently for 20 seconds to stir up the yeast.

Figure 20:-stir up the yeast

Carbon dioxide will bubble out of the liquid and come out through the airlock probably driving out some of the Starsan with it. Dry the carboy, refill the airlock to half-full, and return it to its dark, cool space. This will reinvigorate the fermentation. Note that from time to time the airlock will dry out. Top it off with new Starsan.

3. **Rack for secondary fermentation**

After 4 weeks, its good practice to rack (transfer) the mead into another sanitized carboy to separate it from the bulk of the yeast sediment, which could break down and harm the flavor of the mead in the long run. The Secondary fermenter is most often a glass Carboy but can also be a 5 gallon bucket. The yeast that's still in suspension will continue to improve the quality and flavor of the mead for another 2 months or so.

Use a sanitized, automatic siphon and about 6′ of ⅜" clear vinyl tubing to avoid getting any mouth-borne bacteria into the mead. Place the full carboy on a sturdy table or countertop and siphon it into a sanitized carboy on the floor. Close the new carboy with a sanitized cap and airlock as before, and return it to the cool, dark space for secondary fermentation.

After 2-3 weeks, the bubbling of the airlock should slow down or cease completely, signifying primary fermentation is nearly complete. At this point, the mead can be transferred off the yeast into a secondary where it can age for a longer period of time.

Figure 21:- Transferring in to secondary fermentation vessel

Transfer the mead to a clean and sanitized secondary fermenter using clean and sanitized equipment, such as an auto-siphon. Little head space is possible in secondary to prevent the presence of oxygen if you want.

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 I: Short Answer Questions

1. What is fermentation temperature should be for the duration of fermentation? (2 points)
2. What should be the condition of place to be ferment after yeast pitching? (2 points)
3. Mention and discuss each of them processing steps for fermentation of Must? (6 points)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

   _____

2. _____

   _____

3. _____

   _____

Information Sheet 4- Monitoring equipment

Monitoring the equipment during the fermentation of honey include the preparation from adding yeast in to the transferring in to the secondary equipments. The monitoring includes the cleaning and the performance of the equipment used in the process. Equipments are monitoring before and after processing of the operation.

Monitoring equipments before starting operation

Once your equipment is clean, it is time to sanitize it before use. Only items that will contact the wort after the boil need to be sanitized, namely: fermentor, lid, airlock, rubber stopper, yeast starter jar, thermometer, funnel, and siphon. Your bottles will need to be sanitized also, but that can wait until bottling day. There are two very convenient ways to sanitize your equipment: chemical and heat. When using chemical sanitizers, the solution can usually be prepared in the fermenter bucket and all the equipment can be soaked in there. Heat sanitizing methods depend on the type of material being sanitized.

Figure 22:-Sanitizing the equipments using chemical

Heat is one of the few means by which the homebrewer can actually sterilize an item. Why would you need to sterilize an item? Homebrewers that grow and maintain their own yeast cultures want to sterilize their growth media to assure against contamination. When a microorganism is heated at a high enough temperature for a long enough time it is killed. Both dry heat (oven) and steam (autoclave, pressure cooker or dishwasher) can be used for sanitizing.

Monitoring equipments after Operation of the process

Clean all equipment as soon after use as possible. This means rinsing out the fermenter, tubing, etc. as soon as they are used. It is very easy to get distracted and come back to find that the syrup or yeast has dried hard as a rock and the equipment is stained. If you are pressed for time, keep a large container of water handy and just toss things in to soak until you can clean them later.

You can use different methods of cleaning and sanitizing for different types of equipment. You will need to decide which methods work best for you in your brewery. Good preparation will make each of the brewing processes easier and more successful.

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: Short Answer Questions

1. When the monitoring of equipment do? (2 points)
2. What are the methods of sanitizing equipments and discuss each of them (3 points).

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

   _____

2. _____

   _____

Information Sheet 5- Identifying, rectifying and reporting defected product and equipment

5.1 Problems associated with the Mead Production

During the fermentative process, several problems or defects may occur. The following defects are mainly identified in the processing and final product.

- Being the most common the inability to achieve the desired alcoholic content,
- The existence of long and stuck fermentations
- The heterogeneity of the final product
- Yeast re-fermentations and/or bacterial secondary fermentations may occur, resulting in the production of lactic and acetic acid and increasing the production of undesirable volatile esters triggered in undesirable aroma.
- The production of off-taste, described as rubbery and resin like taste is the result of long heat times required for honey pasteurization, was associated with.
- Yeasts remaining on the product after fermentation, due to ineffective filtration procedures, can produce undesirable flavors, among which estery, acidic, phenolic or hydrogen sulphide (odor of rotten eggs).

5.2 Identifying and rectifying the cause of defect and their correction

- Honey presents low levels of nitrogen and mineral substances are others problems usually encountered in mead due to the fact that interfering in the fermentation process make a delays and pouts during fermentation process.
- The inappropriate amount of assimilable nitrogen in the fermentation can lead to poor growth of the yeast, prolonged fermentation, reduced growth rates and consequently decrease productivity. The minimum requirements of nitrogen are interconnected with the growth rate of the yeast and the concentration of ethanol.

  ✓ Tartaric acid helps to prevent pouts during the fermentation process.

- The different types or characteristics of honey also influence the fermentation; dark honey is richer in minerals than light honey, thus there is interference in the fermentation.
    - ✓ the best results were found with dark honey than with clear honey, due to that the dark honey is richer in minerals and higher pH
- Temperatures above 25 °C together with a higher concentration of sugars (glucose and fructose) and other nutrients increase sugars' consumption. On the other hand, lower temperatures (less than 25 °C) and reduced nutrients' concentrations are associated to final glucose and fructose concentrations higher than 3.5 and 10 g/L, respectively, which may promote the occurrence of undesirable re-fermentations. In contrast, Šmogrovičova *et al.* reported that the low fermentation temperature helps to achieve a steady fermentation and a better transformation of the aromatic and taste qualities of the ingredients into the final product.
    - ✓ Depending on the fermentation condition and dilution of honey, mead is usually fermented for 2 to 3 months.
    - ✓ Higher fermentation rates are obtained at temperatures between 20 and 30°C, while temperatures lower than 15 °C are associated with significant decreases on the fermentative performance, involving consequently higher fermentation periods.
    - ✓ In order to optimize mead production, the specified targets as well as ethanol concentration could be between 11.5% to 12.3%, acetic acid 0.10 to 0.65 g/L, glycerol 6.0 to 7.0 g/L, glucose 2.5 to 3.5 g/L and fructose 5.0 to 10.0 g/L.
    - ✓ And also there is a recommendation to produce mead within these limits, the optimum operational temperature is 24 °C and the nutrients concentration of 0.88 g/L (88 g/hL).

5.3 Reporting the defects associated the Mead Production

Reporting will be taking place if the problem or defects is difficult to taking the corrective action by the operator. Simple problems may solved by the operator at the time of facing the product or equipment defect or being the out of the specification. Defects related with mead production, mentioned above may need taking the

correction action or rejected by the quality manager. At such condition reporting the defect which occurred will be required report to the responsible personnel.

Self-Check – 5	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions

1. What are the common problems occur with the mead production? (5 points)
2. Discuss the main causes of the defects mentioned above and their solution (5 points)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

   _____

2. _____

   _____

   _____

   _____

   _____

   _____

Operation Sheet 1- Honey Fermentation	
Operation Title: Honey Fermentation for racking	
Purpose	To acquire knowledge, skill and attitude by performing honey fermentation for racking (siphoning clear mead in to secondary fermentation vessel)
Equipment, tools and materials	Supplies and equipment needed or useful for steeping Honey include: • Carboy/bucket with lock/, fennel, thermometer, refractometer, hydrometer, measuring cylinder, cup and Jag, pH meter, acid tester, humidity meter • Honey, activated yeast, dissolved oxygen & distilled water
Conditions or situations for the operations	• Services, equipment's and materials should be available • Germ free environment /working area for propagation in aseptic condition.
Procedures	1. Wear the appropriate personal protective equipments 2. Prepare all equipments, ingredients and services 3. Transferring the Must in to fermentation vessel 4. Monitor the humidity, temperature, moisture content, specific gravity, acidity and pH of the Must 5. Supply dissolved oxygen in the Must in fermentation vessel 6. Add the yeast or yeast starter 7. Install an air lock on the neck of the carboy 8. Stir for 2 minutes twice a day until fermentation within 24 to 48 hours 9. Ferment until all visual signs of air bubbles disappear. 10. Rack (fine first, if desired) two or more times. 11. Record all the necessary workplace information 12. Report the appropriate personnel
Precautions	• Care should be taken while calibrating and using measuring

	instruments
Quality criteria	• Fermentation within the temperature range of 60-70°F • Accuracy measurements • Fermentation witan • Appropriate temperature and time • Quality report

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 **32** days. The project is expected from each student to do it.

Project title: Honey Fermentation for racking

Task-1: Perform honey fermentation for racking

Task-2: Perform recording and reporting the appropriate personnel

List of Reference Materials

1. https://www.instructables.com/member/lostbord999/, How to Make Mead (Honey Wine),
2. A. P. Pereira, A. Mendes-Ferreira, L. M. Estevinho and A. Mendes-Faia, 2014, Mead production: fermentative performance of yeasts entrapped in different concentrations of alginate, **https://doi.org/10.1002/jib.175**
3. C. Agrárias and A. e Biológica, 1999, Production and characterization of mead from the honey of *Melipona scutellaris* stingless bees, Journal of the institute of Brewing, Universidade Federal do Recôncavo da Bahia, Cruz das Almas, Bahia, Brazil, Volume 124, Issue 2., leticia@ipb.pt
4. Hygienic transfer in food & beverage production, //a.pajkovic@kci-world.com
5. Isin Akyar, 2012, Standard Operating Procedures (What Are They Good For ?), DOI: 10.5772/50439
6. J K Gupta and Rajesh Sharma, 2009, Protection technology and quality characteristics of mead and fruit-honey wines: a review, Natural Product Radiance, Vol. 8(4), 2009, pp. 345-355.

AKNOWLEDGEMENT

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

We would like also to express our appreciation to the TVET instructors and respective industry experts of Regional TVET Bureau, TVET College/ Institutes, Bishoftu Management institute, BEAR II UNESCO project and Federal Technical and Vocational Education and Training Agency (FTVET) who made contributions for the development of this TTLM with required standards and quality possible.

This TTLM was developed on September 2020 at Bishoftu, Management Institute

The trainers who developed the Learning Guide

No	Name	Level	Educational background	Region	E-mail
1	Alemayehu Tolera Gemeda	A	Animal production	Oromia	toleraalex@gmail.com
2	Ayele Mengesha Mosisa	A	Animal nutrition	Oromia	ayelemengesha@ymail.com
3	Kebebush Tessema Beyene	A	Food science and post-harvest technology	Sidama	Kebebush04@gmail.com