TVET CERTIFICATE IV FOOD PROCESSING

TROPICAL WINE MAKING

FOPTW401

MAKE TROPICAL WINE

Competence

Credits: 8

Learning hours: 80

Sector: AGRICULTURE AND FOOD PROCESSING

Sub-sector: FOOD PROCESSING

Module Note Issue date: August, 2020

Purpose statement:

There has been an increasing demand of tropical wine both locally and internationally. Additionally, raw materials for processing tropical wine are available. This resulted in creation of wineries that need many skilled personnel. This module is for learners who have successfully completed the certificate III. These learners will be equipped with skill necessary to work in wineries or fruits processing cooperatives that produce wine. Upon completion of the competence, the learner will be able to process tropical wine from crude juice of different fruits. While processing the tropical wine, the learner will be able to perform tasks with high level of efficiency assuring food quality and safety measures.

Table of Contents

LU & PC is linked in LO inside the content

Learning Unit 1: Prepare the working area for processing wine

LO 1.1: Describe work area

- **Topic 1:** Introduction

Wine is any alcoholic beverage produced from juices of variety of fruits by fermentative action of microorganisms either spontaneously or seeding with a particular strain mainly of yeast species to adopt a particular quality of wine.

Wines are classified according to the following criteria:

- ✓ Alcohol content (Strong and Weak wine
- ✓ Sugar content (Sweet and Dry wine)
- ✓ Color (Red; Rose and White wine)
- ✓ Presence of CO_2(Sparkling wine or Champagne)

Different types of wine

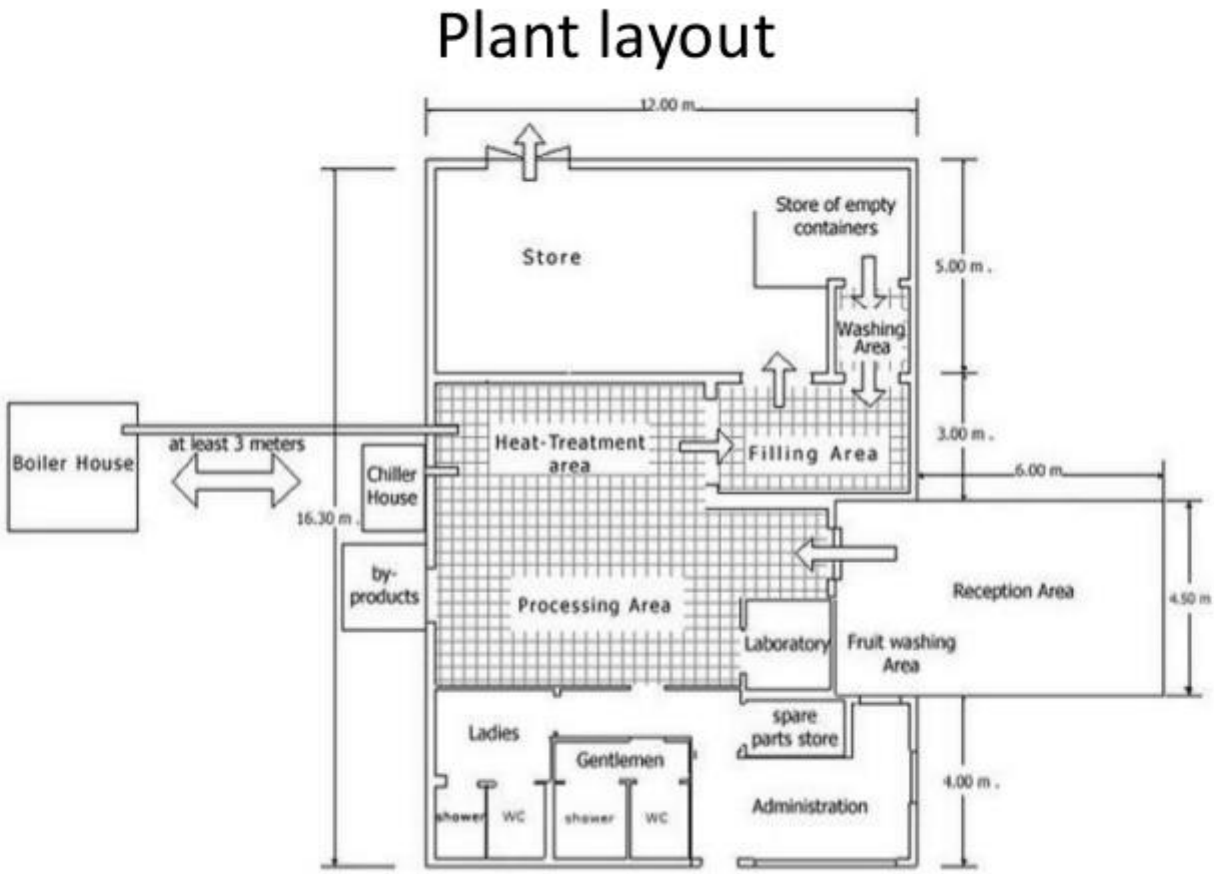
- **Topic 2:** Site requirements for wine making

  - ✓ An adequate potable water supply must be available nearby to allow the processing line to be carried out under sanitary conditions.
  - ✓ Location in relation to raw material supplies and likely markets.
  - ✓ Plants should not locate near swamp land that would be a source of smells and insects.
  - ✓ Available land for waste disposal away from the building
  - ✓ Electricity supply should be available
  - ✓ Adequate water disposal should be considered
  - ✓ Not be near selvage, water disposal operations
  - ✓ Not be constructed near chemical plant

- **Topic 3:** Construction consideration

  - ✓ Floors and walls should be easily cleaned, impermeable to water and rodent-proof.
  - ✓ Concrete floors should be finished smoothly, but not to the extent of being slippery and sloped towards the open drains along the walls.
  - ✓ Concrete blocks or stone building blocks are preferred for wall construction. All joints should be smoothly finished and wall and floor junctions will be much easier to keep clean if they are finished with a cove.
  - ✓ Steel is prone to rust and stainless steel is generally very expensive. If wood is used for doors, a galvanized steel sheet should be fixed to the bottom of the door on the outside for protection against rodents.
  - ✓ The layout should be designed to permit expansion without basic alterations to the original structure or suspension of operations.
  - ✓ Ceilings: must be tight, smooth and should also be of moisture-resistant materials, well glazed.
  - ✓ Doors and doorways: All doorways, through which the product must pass, whether suspended on rails or lying on hand trucks, should be wide enough to ensure that the products never touch the doorways risking contamination.

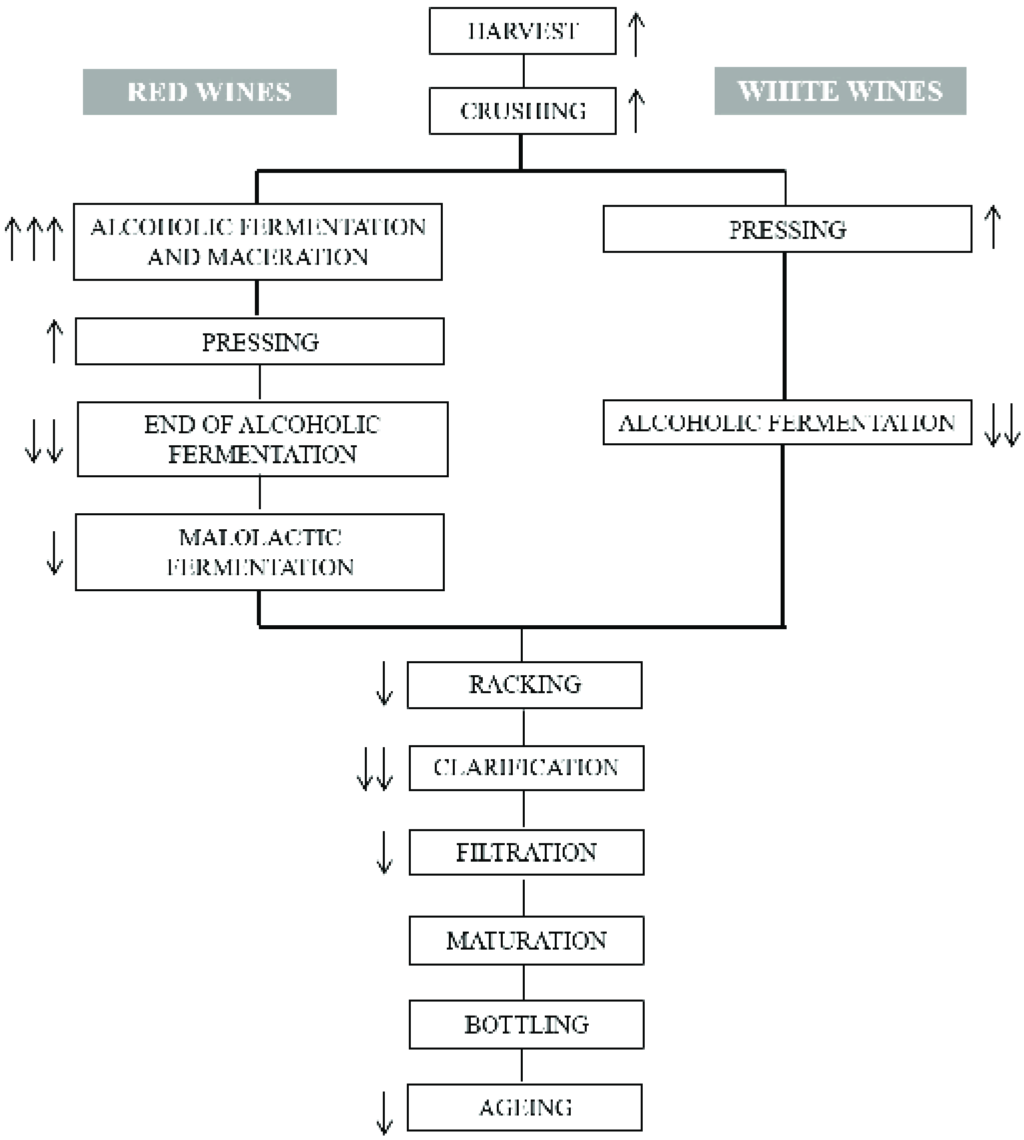
- **Topic 4:** Layout of a wine processing plant



An example of a wine processing plant layout

- **Topic 5:** Processing flowchart for wine making

Processing of wine



Processing of red and white wine

LO 1.2 Select cleaning products

- **Topic 1:** Definition of terms

Cleaning is a critical step within the food production industry to maintain and further ensure food safety and quality standards. As mentioned above, it is generally considered as part of the Pre-Requisite Programs (PRPs) or preventative controls. Cleaning can include the use of detergents and can be combined with disinfectants / sanitizers Various methods of cleaning, with or without disinfection / sanitation are typically practiced.

- ✓ **Cleaning** is removes soils from surfaces
- ✓ **Sanitizing** is process of killing 99.9% of basic germs and bacteria such as E.coli and salmonella in place such as food contact surface.(kill 99.9 of germs and bacteria)
- ✓ **Disinfecting:** is the process of killing harmful pathogenic organism or rendering then inert. Inert: it is means to slow or make stable, having no action or power to move, or being unreactive. (Kill 100% of germs, bacteria and viruses)

- **Topic 2:** Types of cleaning products (Agents)

Cleaning agents are substances (usually liquids, powders, sprays, or granules) used to remove dirt, including dust, stains, bad smells, and clutter on surfaces. Purposes of cleaning agents include health, beauty, removing offensive odor, and avoiding the spread of dirt and contaminants to oneself and others. Some cleaning agents can kill bacteria and clean at the same time.

Cleaning agents are normally water solutions that might be **acidic**, **alkaline,** or **neutral**, depending on the use. Cleaning agents may also be solvent-based or solvent-containing and are then called **degreasers**.

- ✓ **Acidic:** Acidic cleaning agents are mainly used for removal of inorganic deposits like scaling; hard water deposits and rust stains. **Hydrochloric acid** (also called muriatic acid) is a common mineral acid typically used for concrete. **Vinegar** can also be used to clean hard surfaces and remove calcium deposits.
- ✓ Alkaline: Alkaline cleaning agents contain strong bases like sodium hydroxide or potassium hydroxide. Alkaline cleaners dissolve fats, oils and protein-based

substances. **Bleach** (pH 12) and **Ammonia** (pH 11) are common alkaline cleaning agents.

- ✓ **Neutral**: Neutral washing agents are pH-neutral and based on non-ionic surfactants that disperse different types of dirt.
- ✓ Degreaser: Cleaning agents specially made for removal of grease are called degreasers.

- **Topic 3:** Objectives of cleaning

For all cleaning /disinfection/sanitation activities, the objectives of the cleaning should be clearly defined, e.g.:

- ✓ To control hazardous microorganisms;
- ✓ To control food chemical contamination;
- ✓ To control foreign body contamination;
- ✓ To control allergen cross contact;
- ✓ To control ingredient / residue / colour / flavour at product changeover;
- ✓ To avoid pest infestation;
- ✓ To control chemical residues from cleaning / sanitation regimes;
- ✓ To assure mechanical operations of equipment
- ✓ To improve process efficiency (e.g. heat transfer efficiency);
- ✓ To assure occupational safety;
- ✓ To satisfy local regulatory requirements;
- ✓ To meet specific customer requirements;
- ✓ To meet GFSI (Global Food Safety Initiative) requirements.

LO 1.3 Clean the work area

- **Topic 1:** Cleaning methods and techniques

❖ **Cleaning methods:**

Cleaning can be either:

- ✓ **Dry:**Cleaning without using liquid water like using brushes, hot steam or using high pressure air.
- ✓ **Wet cleaning:** Cleaning using water as a solvent of cleaning agents.

❖ **Cleaning techniques:**

- ✓ **Cleaning in Place (CIP)**: Cleaning in Place (CIP) is system of cleaning the interior surface of pipelines, vessels, filters, process equipment and associated things without dismantling. Juice processing plants that require high level of hygiene rely on CIP. Cleaning-In-Place (CIP) involves the jetting or spraying of surfaces or circulation of cleaning solutions through the plant under conditions of increased turbulence and flow velocity.
- ✓ **Cleaning out of Place (COP):**It is manual washing techniques used for cleaning small equipment, tools and utensils and area of food processing that wouldn't be touched by a CIP system.

- **Topic 2:** Standard Operating Procedure (SOPs) for cleaning

Cleaning is a complex process. A defined and systematic approach is required to ensure it is conducted correctly. This approach takes the form of Standard Sanitation Operating Procedure (SSOP), usually a legal requirement and a fundamental GFSI requirement. The collection of these cleaning procedures forms a Cleaning Plan or Program which is specific to a facility. A typical SSOP includes the following:

- ✓ Cleaning frequency / duration / sequence;
- ✓ Cleaning agents, sanitizers and disinfectants used (ensuring they are food-grade and fit-for-purpose);
- ✓ Cleaning process parameters (equipment used, concentration of chemicals, time, temperature, physical parameters);
- ✓ Safety requirements (assembled / disassembled equipment list requirements to protect adjacent lines / products);

- ✓ Responsibilities, documentation, visual aids, training / qualification requirements;
- ✓ Necessary monitoring or verification activities.

- **Topic 3:** Cleaning procedure

Step	Description
Gross Clean/Preparation	This step is most often omitted by food companies. This prevents effective cleaning of plant surfaces due to food residues remaining. Negative impacts include: Protection of surfaces and bacteria from the action of detergents Reaction with and consumption of the detergent Holding bacteria and resulting in recontamination of the surface A poor gross clean is the single biggest reason for poor or inconsistent bacterial counts on surfaces and for high bacterial contamination in aerosols caused by rinsing. A well designed cleaning procedure will provide for the removal of all food pieces greater than a fingernail before applying detergent. Ideally this should be done dry by hand, scrapping or other physical method. The collected material should be placed in waste receptacles and removed from the area. All ingredients, food and packaging materials should also be removed from the area prior to gross cleaning.
Pre-rinsing	The purpose of this step is to remove deposits which cannot be easily removed by picking, scrapping or other manual form of gross cleaning. Excess water should be removed following pre-rinsing to avoid dilution of the detergent in the following step.
Detergent Application	The purpose of the detergent is to remove the layers of proteins, greases and other food deposits that remain on surfaces. Detergents are not designed to remove large pieces of food

	deposits or thick layers of fat. It is in these layers that bacteria can survive and grow and make the use of a disinfectant pointless. Foam should be conducted carefully and methodically and there should be a check to ensure that all surfaces have been covered. Detergents should be made up and used according to the suppliers instructions and appropriate time should be allowed for the detergent to work.
Post Rinsing	The purpose of post rinsing is to remove the remaining food deposits. Care should be taken to minimise the amount of splash and aerosol formed which may re-contaminate surfaces. After post rinsing the surface should be free of all visible deposits, layers of soiling and residues of detergent. Any residues of detergent may neutralise the action of any subsequent disinfectant. Any pools or accumulations of water should be removed following post rinse.
Disinfection	Disinfection should only be carried out on a visually clean, well rinsed surface, with minimal amounts of water. Direct food contact surfaces should be disin-fected at least daily with other surfaces disinfected on a regular basis. Disinfect-ants should be used safely according to the supplier's instructions.
Terminal Rinsing	Most disinfectants are safe to leave on non-food contact surfaces without final rinsing. In some sections of the food industry there is a requirement to rinse food contact surfaces with water after disinfection. The standard of the water is important to ensure that the disinfected surface is not re-contaminated.

- **Topic 4:** Validation of cleaning procedure

Once a cleaning procedure has been established it is essential that it is validated. This means answering the question is ***the procedure as documented capable of controlling the identified hazards?*** This may include bacterial pathogens or allergens. The method of validating a cleaning procedure is as follows:

- Document the cleaning procedure as it actually exists. At this point you are not concerned with whether it meets specific requirements. This should be done on the job and in conjunction with those who perform the cleaning.
- Identify the general and specific hazards of concern, e.g. pathogens, allergens, etc.
- Identify the monitoring program, e.g. visual, ATP, chemical testing, etc. This will include the standard to be achieved and specific sampling points based on an assessment of risk.
- Conduct the cleaning program as documented a number of times and follow up with the monitoring checks.
- Confirm that the procedure as documented is capable of meeting the monitoring criteria.
- If the procedure is not capable, modify the cleaning method or correct the issue.
- Repeat the above process until the documented cleaning procedure is confirmed as capable of meeting the standard (verified) and approve the procedure.
- Conduct training of employees against the procedure and implement the monitoring pro-gram.
- Retain full records of the above data and process including your conclusions.
- **Topic 5:** Checking the cleanliness of the work place

  - ✓ **Visual Inspection (Best Verification Method) Surface appearance**: visible debris, soil build-up, color of equipment surface (white films, stains, etc.), biological growth (i.e., mold) and odor
  - ✓ **ATP testing**: Adenosine Triphosphate is the enzyme that carries chemical energy around living cells. The presence of ATP on a surface indicates that there’s life, and in a food processing environment “life” also means potentially dangerous microorganisms. With this type of tests, first a sanitized surface is swabbed. The sample is then activated with an enzyme called luciferase (the one that makes

fireflies glow in the dark). The amount of light that is produced by the reaction (measured with a portable device) will be a direct indication of the amount of ATP. The effectiveness of ATP testing is also its limit, meaning that it will be ineffective with nonliving cells, such as yeast extract.

- ✓ **Riboflavin testing**: Riboflavin (known as vitamin B_2) is a quick, effective and food-grade way to uncover them. Before cleaning, the whole surface or at least the difficult to clean part of the surface is sprayed with a riboflavin and dye solution, which becomes fluorescent under UV light. After the cleaning is done, the operator will check with a UV lamp if any areas remained untouched.
- ✓ Others:
  - Aerobic plate count
  - SWAB Method
  - Surface contact technique
  - Indicator and dye reduction test
  - Petrifilms plate
  - Endotoxin detection

Learning Unit 2 Prepare materials and equipment

LO 2.1 Selection of materials and equipment

- **Topic 1**: Materials and equipment used in wine making

Equipment, tools and utensils	The use of equipment
Alcohol meter	It is used to determine the alcohol content in a beverage
Titratable acidity apparatus	It is used in titration
Filler	It is used for filling bottle
Bottle washing system	Automatic Bottle Washer, cleans & fresh water rinses each rack of bottles
Electronic balance	It is used to weigh fruits and other ingredients
Mechanic balance	It is used to weigh fruits and other ingredients
Fermentation tank	It is used for fermentation or aging wine
Saucepan	It is used to cook and mixing juice
wooden spoon for stirring	It is a stick made in wood used to mix juice

Sieves	It is used to separate particles based on their size.
Pasteurizer	A pasteurizer is a device which pasteurizes, treating a food product to kill disease-causing organisms such as bacteria.
Thermometer	It is used to measure temperature of juice especially during heating and Cooling
Refractometer	It is used to determine the sugar content in a liquid
PH meter	A pH meter is an electronic device used for measuring the pH (acidity or alkalinity) of a liquid
Bottles	Are used for packaging juice
labeling machine	It is used to put labels on packaging materials
Labels	It is a piece of paper which shows characteristics of a product it represents. It contains information like name of the product, name of the company and its address, list of ingredients normally in descending order and some claims if any
Refrigerator	A refrigerator lowers and maintains a temperature a few degrees above the freezing point of water. Optimum temperature range for perishable food storage is 3 to 5 °C (37 to 41 °F) lowers the reproduction rate of bacteria, so the refrigerator reduces the rate of spoilage.

Fig.Refractometer

Fig. PH Meter

Fig.Fermentation Tanks

LO 2.2 Use of equipment and tools

- **Topic 1:** Standard Operating Procedures

By definition, SOPs are a set of instructions for how to carry out routine tasks. If you would train a new employee on a given task, there should be an SOP for it. Even if you are the only one doing the work, it is important and worthwhile to write it out and have record of how to do what it is you need to do. A well-written SOPs answers these questions: *WHO* should carry out the task? *WHAT* materials are needed to complete the work? *WHERE* should the activity take place? *WHEN* will the task be performed? *HOW* does the employee complete the task? Safety is also key here. SOPs describe all known or potential job hazards and how to mitigate risk to complete things in a safe manner.

- **Topic 2:** Maintenance and adjustment

Before starting using equipment, verification should be done which consists on checking whether the equipment are working properly. If any default is there you have to correct if before or ask lab supervisor to help you. Any damage of equipment should be reported immediately to the supervisor and any accident should be reported immediately as well.

- **Topic 3:** Safety and precautions of equipment

All equipment and tools should be brought and arranged according to when they will be required during processing. They have to be handled with care in order to avoid contamination and breakage. Always read the instructions from the manufacturer before using any equipment. Remember to wear personal protective cloths.

Learning Unit 3: Processing the crude juice into wine

LO 3.1 –Add ingredients

- **Topic 1:** Water

Water is the major ingredient in all beverages (above 90%) and it should have good quality as drinking water. Drinking water should be essentially free of disease-causing microbes and other substances which can be harmful to the consumer.

In general**,** Water for beverages needs to be free from oxygen, as the presence of dissolved (oxygen) causes the drink degradation (color and flavor) by constituent's oxidation, and limits the product shelf life.

Water for use in soft drinks should ideally be soft or medium soft.

- **Topic 2:** Must or crude juice

Must is the juice of freshly pressed fruits, prior to fermentation into wine. Must contain various quantities of pulp, skins, stems, and seeds. Must is the most essential part of your wine

- **Topic 3:** Yeast

Yeast is a minute living organism which brings about the fermentation, and if the fermentation is to be successful the yeast must be given ideal conditions in which to work. Those conditions are found in a sugary, slightly acid solution such as a fruit juice, when certain other yeast nutrients are present and when the temperature is favorable 65° to 75° F, (18-24° C.).

Yeast metabolizes the sugars extracted from grains and fruits, which produces alcohol and carbon dioxide, and thereby turns wort into beer and fruits into wine respectively. In addition to fermenting the beer and wine, yeasts influence the character and flavor. The dominant types of yeast used in fermenting alcoholic beverages are the Saccharomyces species. For example, to make beer the yeast (S. cerevisiae) and lager yeast (S. uvarum) are used. Whilst in wine (Saccharomyces cerevisiae varellipsoideus (CFTRI 101 (wine yeast)) and (Saccharomyces cerevisiae) may be used.

Desirable characteristics of good yeast used in Wine making:

- ✓ Effective conversion of the fruit sugar to alcohol
- ✓ Sulfur dioxide tolerance
- ✓ Rapid initiation of fermentation(48hrs)
- ✓ Ability to cause even fermentation
- ✓ Ability to ferment at low temperature;
- ✓ Ability to ferment to dryness (alcoholic tolerance)
- ✓ Production of a desirable aroma and flavors
- ✓ Low foaming
- ✓ For sensory quality of the wine
- ✓ Relatively high glycerol production
- ✓ Production of a relatively low amount of higher alcohol

- **Topic 4:** Sugar and honey

❖ **SUGAR**

Sugar is the main substrate for fermentation of fruits juice into alcohol; although, other food nutrients such as protein and fats can be broken down by some microorganism in some cases where sugar is limited, but as long as sugar is present yeast cells will continue the process of fermentation until other factors that affect the growth of yeast become unfavorable. Sugars are the most common substrate of fermentation to produce ethanol, lactic acid, hydrogen and carbon dioxide. Although sugar is an important substrate of fermentation, higher sugar concentration inhibits the growth of micro-organisms. However, yeasts are fairly tolerant of high concentrations of sugar and grow well in solutions containing 40% sugar. Higher sugar content has been reported to prolong the fermentation time with less alcoholic production

❖ **Honey**

The sugars in honey are 95% fermentable, typically consisting of 38% fructose, 30% glucose, 8% various disaccharides and 3% unfermentable dextrin. Honey contains wild yeasts and bacteria, but its low water content usually around 16% keeps these microorganisms dormant. Honey also contains amylase enzyme, which can break down larger sugars and starches into fermentable sugars like maltose and sucrose.

- **Topic 5:** Bentonite

Clay mineral used for clarification

- **Topic 6:** Sorghum flour

Sorghum flour: it helps as nourishment of yeast and improves aroma and flavor in wine

- **Topic 7:** Juice extraction

Juice separation techniques depend on the type of fruit and its content compounds. Precious natural substances of fruit/vegetables need to be preserved (vitamins, minerals, essential oils, colors, flavors). **Citrus** can be processed for juice from pulp and essential oil from peels as by-product. Some fruits are only marched (apples), others must be peeled (orange), some contain seeds (papaya), others not (pineapple).

Stages of juice processing	What is done
1. Inspection	Remove rotten, foreign materials (leaves, stems, stones,..)
1. Washing	In wash tank, with clean potable water, to remove surface contaminants (pesticide, soil, dirt, insect…)
1. Sorting/grading	On a sorting table, get fruit with similar color, maturity. The color, flavor and taste of final product depend on the status of the fruit
1. Pulping	Depending on the fruit, peel (orange) to remove skin, core (papaya) to remove seeds, chop (pineapple) to facilitate juice extraction.
1. Extraction of juice	Pressing to remove juice, filtration or centrifugation and decantation to clarify the juice. Pectinase, cellulose and hemicellulose are also relevant enzymes in degrading cell walls and maximizing juice extraction.
1. heating/cooling	Temperature and time of heat treatment (decontamination) depend on the fruit/vegetable, original types and microbial load, but also, depending on the destination of the final product.
1. Filling/sealing/labeling	In opaque packaging material to protect light sensible contents such as Beta carotene and vitamins

Fig. Juice extraction machine

- **Topic 8:** Brix measurement and adjustment

A refractometer measures TSS as °Brix in 0.1% graduations. There are hand-held refractometers as well as digital battery/mains-operated models available. All models apply similar principles. However, the manufacturers' instructions must always be followed.

Some refractometers automatically compensate for changes in temperature, whereas others may be calibrated to read accurately at a fixed temperature (usually 20°C). To obtain accurate readings at temperatures other than 20°C it is necessary to refer to the International Temperature Correction factor.

When the brix of the juice did not reach the desired level, sugar is added until the brix reaches the required amount of sugar. When brix is too high then dilution is done in order to reduce sugar content.

Fig. How to use a refractometer

- **Topic 9:** Use of Pearson square for brix adjustment

Consider adjusting sugar to 15-22˚ Brix (9-12˚ Baume) by adding table sugar (or diluting juice with water) as necessary

Adjust acidity to taste, ideally pH between 3.2 – 3.6 (some fruits may be higher, pH>4.0 to be avoided)

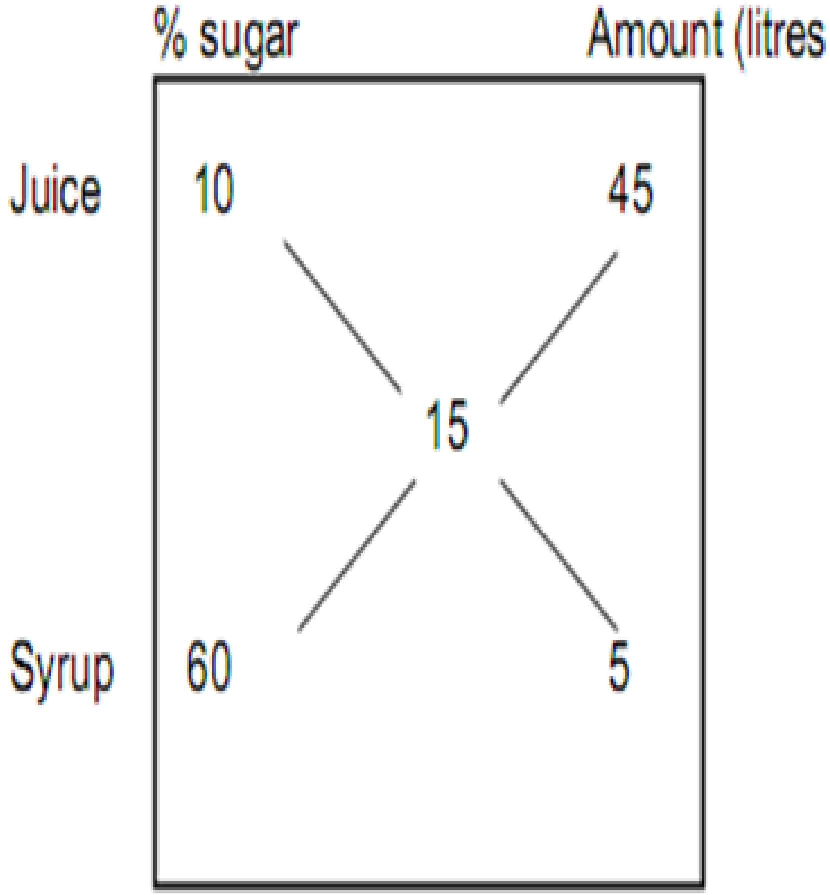
Use Pearson square for calculation of quantities

to mix:

- % sugar in juice and syrup on left side
- % sugar of the final product in middle
- Substrate the smaller from the larger amount diagonally to find the amounts (liters) to mix for getting to the defined concentration of sugar in the final product.

Example:

If the brix of juice is 10^o and 15^o is required, in this case to adjust the brix to the required one it needs to add syrup with high sugar concentration.



45l of juice will be mixed to 5l of syrup

LO 3.2 Pasteurize the juice

Thermal processing is the most widely used technology for pasteurization of fruit juices and beverages. Juice pasteurization is based on reduction of the most resistant microorganisms of public health significance. The process could be accomplished by different time-temperature combinations.

- **Topic 1:** Low temperature long time method (LTLT)

Fruit juice has been traditionally pasteurized by batch heating at 63-65°C for relatively long time 30 minutes. This method has been replaced by high temperature short time treatment due to the undesirable quality changes during this process.

- **Topic 2:** High temperature short time (HTST)

HTST treatment could minimize those undesirable quality changes made by batch heating due to the much less duration of heat treatment. Currently, HTST pasteurization is the most commonly used method for heat treatment of fruit juice. For example, orange juice is processed by HTST at 90 to 95°C for 15 to 30 seconds. And apple juice is treated by HTST at 77 to 88°C for 25 to 30 seconds.

LO 3.3 Fermentation of the juice

- **Topic 1:** What is fermentation?

Fermentation: is metabolic process in which an organism converts carbohydrate, such as sugar into alcohol and an CO_2

The chemical equation below summarizes the fermentation of sucrose, whose chemical formula is C12H22O11. One mole of sucrose is converted into four moles of ethanol and four moles of carbon dioxide:

$C_{12}H_{22}O_{11} + H_2O$ + invertase $2C_6H_{12}O_6$

$C_6H_{12}O_6$ + Zymase $\rightarrow 2C_2H_5OH + 2CO_2 + 2ATP$

- **Topic 2:** Yeast preparation and addition

The viability of the yeast is the single most important factor to a successful fermentation critical parameter are:

- ✓ Correct culture preparation
- ✓ Avoid temperature and/or mechanical shock (no vigorous mixing)
- ✓ Ensuring that nutrient levels are adequate
- ✓ Always prepare a yeast culture (starter) – never add dry yeast to must/juice

Preparation of culture:

- Hydrate yeast at 35°C in 10x volume of water
- Stir very gently to wet yeast grains and leave to settle
- Add a little juice or sugar solution within 10-15 minutes (juice must be within 5˚C of culture temp)
- Continue to add juice at regular intervals once yeast is active (note: fermentation will generate heat)
- Build culture up to 5% of final ferment volume
- Temperature difference between culture and juice <5°C before adding culture to bulk of juice/must
- Pour culture gently into top of must/juice in one motion
- Don’t mix or **stir the culture into the must,** it will gradually expand and mix into the must as yeast growth occurs

- **Topic 3:** Primary fermentation

Primary fermentation is a stage of **fermentation** in the **winemaking** process. At the beginning of this stage, yeast - either naturally occurring or added by the winemaker - converts the sugars in the **wine** to alcohol. ... **Primary fermentation** is followed by the longer, secondary **fermentation**. The firstly is the aerobic ("with air") fermentation, is comparatively vigorous but may last only between 4 and 7 days, with at least 70% of all of the activity of fermentation performed during this period. There is a great deal of foaming during this period of rapid fermentation. During this time the fermentation vessel is usually opened to the air, because yeast cells need air to grow and multiply. This is the most active and productive phase of fermentation. In fact up to 70% of the total amount of alcohol is produced during this stage which only lasts about three to five days. After that we move into secondary fermentation.

The yeasts perform best within an optimum temperature range of 20o C to 30o C.

- **Topic 4:** Secondary fermentation

The wine is then settle down to the secondary, anaerobic ("without air") ferment. The secondary fermentation should be at about 16^0C, and the finished wine should be stored at $10\text{-}13^0$C. The second stage or secondary fermentation is a slower fermentation process than primary. The sugars have almost all been consumed and the yeast is having trouble finding its food source. Over the two weeks, the remaining 30% of the alcohol is converted.

During the secondary fermentation it is wise to employ a device called a fermentation trap, or air lock, which both cuts off the air supply to the yeast and protects wine from bacterial infection. As the fermentation precedes so the alcohol content increases, until finally it reaches a concentration which is such as to inhibit the yeast, preventing any further activity. Any sugar still left in the wine then remains only as a sweetening agent.

When this process is complete, the wine is separated from the sediment and transferred to an aging tank. As the aging process continues, more sedimentation occurs, and the wine is often transferred across a series of tanks during aging.

- **Topic 5:** Factors affecting alcoholic fermentation

During fermentation, there are a lot of factors that affect process which require adequate attention and must therefore be taken into consideration to improve the quality of the wine that will be produced.

1. Yeast strains

Selection of the starter cultures of yeast (*saccharomyces cerevisiae*) to be used in the production of wine is very important and must be carried out or done with all accuracy required. Pure cultures of wine yeasts (*saccharomyces cerivisiae*) in the form of packaged dry yeast or tube agar culture is now available for wine maker.

2. pH and Acids

pH is a measure of the acidity or basicity of a solution. pH is one of the most important factors that affect quality of pineapple juice and hence the wine

The pH of the must is very important in the fermentation process but little attention has been paid to the effect of fixed organic acids on the alcohol fermentation of the must. The juices have a pH of 3-4 due to tartaric acids, malic acids and small amount of citric acids. If the pH of the must is lower than 3, fermentation is somehow reduced; yeasts however, are not quite sensitive to the amount of fixed organic acids present in normal must. These acids appear to inhibit the growth of many undesirable bacteria in the finished wine. The fatty acids that have inhibitory effects are fortunately very negligible in normal fermentation. Acidity in Wine has the role on **Taste & Color**

Yeasts can grow in a pH range of 4 to 4.5 and moulds can grow from pH 2 to 8.5. The major roles of pH with respect to quality of wine are: Perception of acidity and its impact on fruit flavor, acid taste and sugar/acid balance of wines.

Acidity and Taste: Taken as a group, the acids in wine are just as important as the alcohol. Acids have a profound impact on sense perception, particularly taste. They not only have a refreshing taste, but also play an integral role in reducing the perception of "sweetness." Acidity and Color: The acidity of a wine is critical in maintaining the color in red wines. As acidity decreases, the anthocyanins lose their color and may even turn blue. In addition, oxidation is inversely related to acidity. The less acidic, the higher the degree of oxidation a wine will undergo. Acidity and Microbial Stability: In addition to these important roles, high acidity has anti-microbial benefits. Since most bacteria cannot grow in acidic conditions, maintaining acidity is an important defense strategy that winemakers employ to retard spoilage.

3. Temperature

Temperature control is vital in the production of fine table wines as: High temperatures encourage the loss of alcohol and aroma and flavour compounds due to volatilization. If the temperature goes above 30 -35ºC, the yeast becomes sluggish and fermentation may stop. Low temperatures will lead to a poor extraction of colour and tannins in red wines and can also cause sluggish fermentations and the production of high levels of ethyl acetate. Fermentations tend to overheat as the alcoholic fermentation generates a lot of heat.

4. Yield of alcohol

The yield of the alcohol varies with **the yeast strain, composition of must, fermentation temperature, amount of mixing via stirring and the design of the fermenter particularly the surface area to volume ratio.**

5. Carbon Source

The sugar in the must is mainly 15-25% fructose and glucose. These are excellent carbon source for yeast growth, sugar content of the must above 25% solid retards fermentation due to osmotic effects. Yeast can also grow on the variety of other carbon source especially aerobically. Carbon dioxide content of 7.2 atmosphere (pressure) essentially stops yeast growth and a higher CO_2 pressure up to 30 atm is necessary to prevent alcoholic fermentation.

LO 3.4. Filtration of wine

- **Topic 1:** Clarification of wine

During wine clarification Bentonite (clay mineral used for clarification) is added

- ✓ 0.25gm/L dose in wine
- ✓ Make up as 5% slurry in water
- ✓ Make up day before use to allow swelling of particles
- ✓ Add to wine after SO2 addition
- ✓ Rack clear wine 2 days after SO2/bentonite addition

- **Topic 2:** Stabilization of wine

Wines containing residual sugar can be stabilized by:

- ✓ removing the yeast with a sterile filter
- ✓ adding potassium Sorbate just before the wine is bottled,
- ✓ killing the yeast with high alcohol content and
- ✓ killing the yeast by pasteurization.

LO 3.5. Packaging and storage

Right before bottling a small amount of sulfite is added to help preserve the wine and prevent further fermentation. Bottles are sealed using a cork, the air in the head space is removed immediately before inserting the cork

Fig. The cork

Fig. Cork opener

Bottles should be stored upright for about 3 days and then at an angle or on their side in order to keep the cork wet

If the cork is not kept wet, it can introduce air through the tiny holes which can introduce oxidation/bacteria into the wine

Also the percent humidity can affect the performance of the cork

About 60% humidity it desired

Some wineries are switching to screw caps or synthetic corks in order to avoid this effect.

Also bottles should be kept out of direct sunlight

- As a precaution some wines affected by sunlight are bottled in colored glass
- Sunlight exposure causes oxidation and the breakdown of wine

The optimal storage temperature for wines is about 55°F

REFERENCES

1. Jancis Robinson, The Oxford Companion to Wine, 3rd Edition, Oxford University Press, USA; 3rd edition (October 1, 2006)
2. David Bird, Understanding Wine Technology, 3rd Edition, Wine Appreciation Guild; Revised and Updated 3rd Edition edition (April 29, 2011)
3. Yair Margalit, Concepts in Wine Technology: Small Winery Operations, 3rd Edition, Wine Appreciation Guild; 3rd edition edition (September 3, 2012)
4. James Halliday; Hugh Johnson, The Art and Science of Wine, Firefly Books; Revised and updated edition (February 16, 2007)