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COLLEGE OF ENGINEERING AND TECHNOLOGY (CoET)

DEPARTMENT OF CHEMICAL AND MINING ENGINEERING (CME)

CHEMICAL AND PROCESS ENGINEERING

PRACTICAL TRAINING (PT1) REPORT, 2015/16

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ABSTRACT

This report is organized into two main parts. Part one contains the weekly summary reports for the eight weeks of training and the second part is the main report. The main report has three important chapters.

The first chapter describes the details of the company including introduction and its historical background. The second chapter describes the process of wine making which is divided into three parts: the upstream processes, fermentation process and downstream processes.

The second chapter also includes major utilities and waste management. The third chapter describes major equipment, “the destemmer-crusher”, its maintenance, conclusion and recommendations.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION ABOUT THE COMPANY

1.1 Background

ALKO VINTAGES COMPANY LIMITED is a Tanzanian company located in Dodoma, Central Business Park. It deals currently with wine making and is one of the best wine making companies in Tanzania. The company is owned by a Tanzanian business man, Mr. Archard Kato who is the founder, technical and managing director.

ALKO VINTAGES COMPANY LIMITED started its operations officially in 2002. Since then it has been operating and growing under the leadership of Mr. Archard Kato. Till today, there are seven wine type made by the company.

- DOMPO.

  A fortified fine wine, of superior quality with brick
- IMAGE

  An elegant dry wine which borrowed its name from Image Hill overlooking Dodoma Capital City
- ST.MARRY

  A white sweet wine
- ALTAR WINE

  A sacramental Wine specially produced for the church market
- DOMPER

  A 5 liters bag-in-box sweet white wine
- BULK WINE

  A drinkable quality wine usually produced exclusively for distillation by Tanzania Distilleries Ltd to produce VALUER Brandy.
- FOR –U

  A sweet rose wine variety that is made by the company

1.2 Vision

To become a leader in Oenology, Distillers and Fruit Processing industry in the production of top quality wines, brandy, fruity juice and allied products.

1.3 Mission

To process grapes and other fruits into top quality wine, brandy, juice and allied products and market them in East Africa and around the globe. To forge partnership with grape growers to enhance grape production thus supporting the Tanzanians Agriculture first's policies and initiatives.

1.4 Core Values

The company's activities are guided by the following set of core values:

- Quality Consciousness
- Competitiveness
- Conduct business within ethical and honest ways
- Corporate Social Responsibility (CSR)

1.5 Market

The company's market is in Tanzania where it has become prominent almost throughout the country. The main regions with high intake are Dar es Salaam, Arusha, Mwanza and Dodoma. With the present storage capacity of 460,000liters, the products are still in high demand so the company is in the expansion process of extra 800,000litres

The production of quality wine and use of technical knowledge and advanced technology in wine making is what makes the company outstanding.

The main competitors in Tanzania include

(i) CETAWICO
(ii) TAVICO
(iii) Bihawana Mission
(iv) Hombolo Mission
(v) Veyula Mission
(vi) Viticulture Training (RTC)

1.6 Organisation Structure

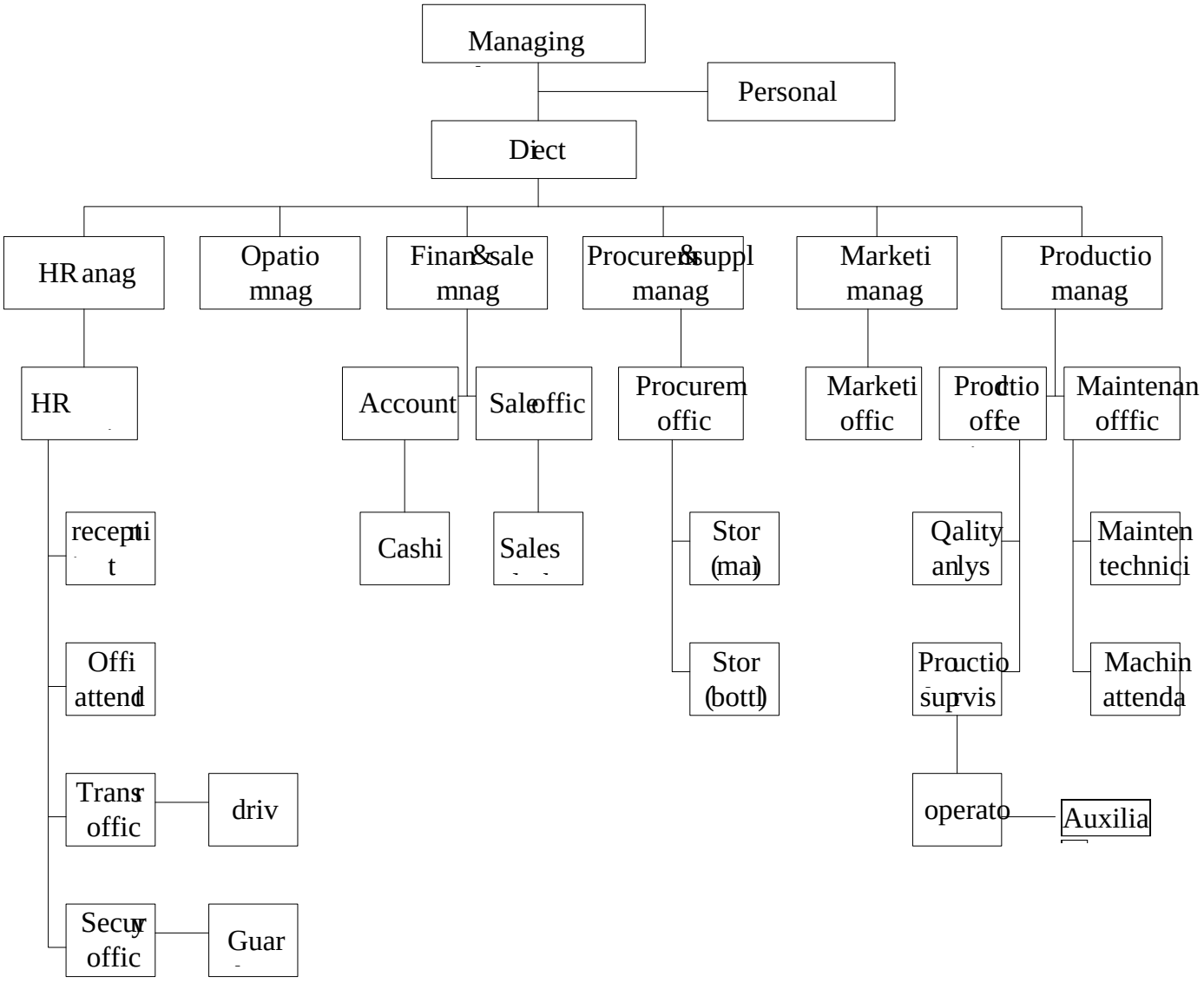

Figure 1: Organisation Structure of ALKO VINTAGES COMPANY LIMITED

1.7 Raw Materials

The main raw material used by ALKO VINTAGES COMPANY LIMITED is grape fruit. It is the type of fruit grown in the central part of Tanzania, Dodoma. The condition in Dodoma allows growth of grapes due to the drought nature of the soil. The planting of grapes started in 1953 in Kondoa district in Dodoma region by Italian priests. In 1967, an experimental vineyard was established at Isanga Prison in Dodoma. The successful results engineered the spread of the crop in a number of villages and institutions in Dodoma urban and rural districts .Domestic production of wine on a commercial scale was started in 1969 by the Dodoma Wine Company Ltd, a

subsidiary of The National Milling Corporation(a public parastatal organization).It then produced 31,800litres of red wine.

The harvest is done twice a year because of good climatic conditions. Wine making begins in the vineyard. The better the quality of grapes, the higher the quality of the resulting wine. Therefore vineyards have to be given great care for good wine to be produced.

ALKO VINTAGES acquire grapes from different parts of Dodoma. The main farmers supplying grapes to this company are mainly from Hombolo, Bihawana, Mpunguzi, Veyula and Chinangali. There are two main types of grapes

- Red grapes

  Used mostly for red wine making. This type is required in large quantity since red wine is the most prominent in the region. Many farmers grow this type of grape.
- White grapes

  Used for white wine making. They are grown in small quantity since white wines have got no large market compared to red ones.

2.0 WINE MAKING PROCESS

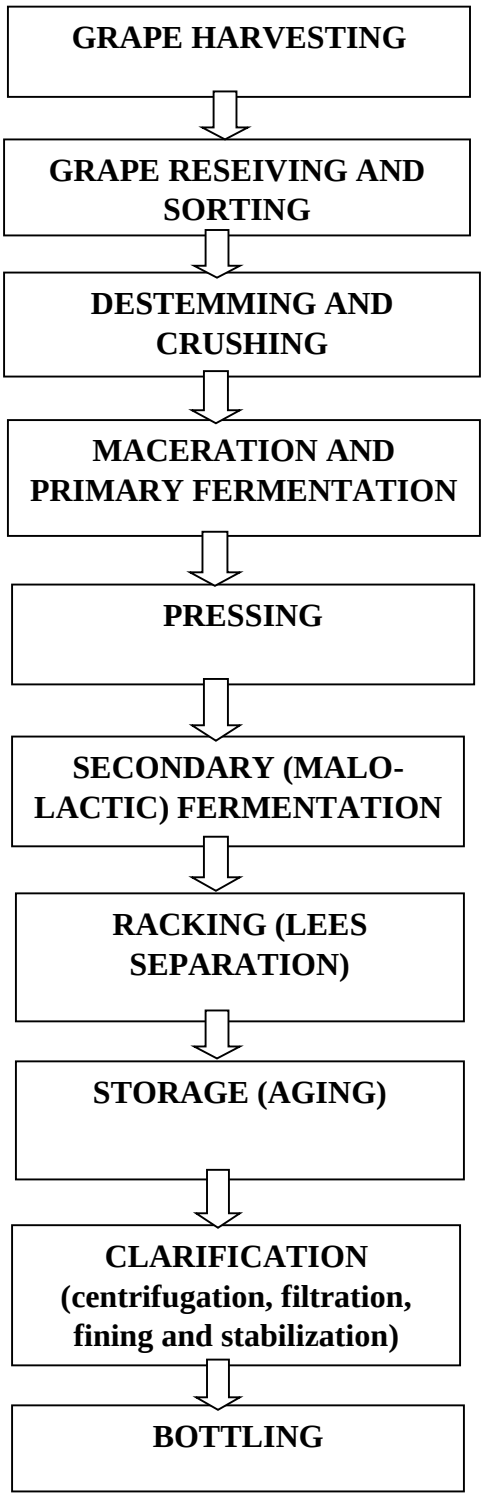

Figure 2: Block Diagram for Red Winemaking

The process of winemaking is divided into three sub-processes:

1) Upstream processes

2) Fermentation
3) Downstream processes

2.1 Upstream Processes

Include all processes taking place prior to fermentation. These processes are grape harvesting, receiving, destemming and crushing

2.1.1 Harvesting

Grapes are ripe and ready to harvest when they are rich in color, juicy, full-flavored, easily crushed but not shriveled, and plump. They should be tightly attached to the stems. There are many grape farmers in Dodoma including those in Mpunguzi, Chinangali and Hombolo. ALKO VINTAGES buys grapes from these farmers but before, the grape samples are taken to the laboratory for sugar content measurement, which should be at least 90□ Oechsle (22□Brix).

2.1.2 Grape receiving

Grapes are received by means of loaded trucks at ALKO VINTAGES ready for crushing. They come in crates which are estimated to be 20Kg each. It is also estimated that 1.5Kg gives 1 Litre of juice.

2.1.3 Destemming and Crushing

Destemming is the process of separating stems from the grapes. Depending on the winemaking procedure, this process may be undertaken before crushing with the purpose of lowering the development of tannins and vegetal flavors in the resulting wine. The same apply here at ALKO VINTAGES. Crushing is the process when gently squeezing the berries and breaking the skins to start liberating the contents of the berries. The process is carried out by equipment called Destemmer-Crusher (see chapter 3). The stems separated from grapes are discharged at one outlet of the machine and the grapes enter the crusher.

Additives and Analysis During Crushing:

- **SO_2 addition**

SO_2 is added to the must in form of potassium metabisulphite (PMBS) which contain 57.6% SO_2.

The purpose of SO_2 in winemaking is to:-

- Prevent enzymatic oxidation by inhibiting the enzyme polyphenoloxidase (*tyrosinase*), this is its most effective role as an antioxidant.

- Prevent microbial activity. It is effective against bacteria and non-*Saccharomyces* yeast.

Analysis of Free and Total SO_2:

- Apparatus:
    1. 50ml Burette (Dr. Schilling)
    2. 50ml Pipette
    3. 10ml Pipette
    4. 20ml Pipette
    5. 250ml Erlenmeyer flask
- Reagents:
    1. 1N Sodium hydroxide (NaOH)
    2. 4N Sulphuric acid (H_2SO_4)
    3. N/64 Potassium iodate (KI/KIO_3)
    4. IOTECT IODINE INDICATOR
- Method:

I: Free SO_2

(a) Pipette 50ml of wine sample in 250ml Erlenmeyer flask.
(b) Add 10ml 4N H_2SO_4.
(c) Add small amount of Iodine indicator.
(d) Titrate against N/64 KI/KIO_3 until blue colour appears.
(e) Tabulate reading on burette.

II: Total SO_2

(a) Pipette 50ml of wine sample into Erlenmeyer flask.
(b) Add 20ml 1N NaOH.
(c) Wait for 15 minutes.
(d) Add 10ml of 4N H_2SO_4.
(e) Add small amount of Iodine indicator.
(f) Titrate against N/64 KI/KIO_3 until colour change to blue.
(g) Tabulate reading on Burette.

Calculation:

Titre value (ml) X 10 = x mg/L

1mg/L = 1 ppm

SO2 addition calculation:

SO2 is added using the following formula

$$\frac{(gallons\ of\ wine)\ X\ (3.785)\ X\ (ppm\ of\ addition)}{(1000)\ X\ (0.576)} = \text{grams of PMB}$$

- 3.785 is the conversion from gallons to litres
- 1000 converts mg/L (ppm) to g/L
- 0.576 is the % of SO2 in PMBS

- **Enzyme addition**

Enzymes are added prior to fermentation to clarify juice and improve yield. The major types are pectinase, hemicellulases and glucanases. They act by breaking down the structural components of grape pulp.

- **Sugar Content Analysis**

Soon after crushing, the must sample is taken to the laboratory for sugar analysis. This is done using a hydrometer or a refractometer. A hydrometer works by measuring the density of the liquid you are testing compared to water at a certain temperature. Temperature affects density, so it is important to have a sample close to your hydrometer's calibration temperature. When using refractrometer, make sure the glass lens is clean and dry, and reads 0 □Brix when testing with plain water. The amount of sugar needed at this stage, ranges 22□-25□ Brix.

2.2 Fermentation Process

Includes Maceration (for red wine), Primary (alcoholic) fermentation, pressing and malolactic fermentation.

2.2.1 Maceration

Maceration is the process of soaking crushed grapes, seeds and stems in a wine must to extract colour and aroma compounds as well as tannins. It is the lack of maceration that makes white wines so light in colour and nearly tannin free.

Types of Maceration

There are three most common types of maceration:-

a) **Extended maceration:**

This takes place during primary fermentation. The process begins as soon as the grapes skins have been ruptured. At this time the juice is released from inside the grape skins as well as the stems. To end maceration, the skins, seeds and stems are removed from the must. ALKO VINTAGES uses this type, where the must is introduced into two maceration tanks of capacity 80 HL (8,000 Litres) each.

b) **Carbonic maceration:**

This is characterized by the fermentation of whole grape clusters. The grapes are not destemmed, nor are the skins ruptured in any way. The clusters are put into a special fermentation vat that has been filled with carbon dioxide.

c) **Cold soak maceration:**

This is the pre-fermentation maceration and gets its name due to the practice of chilling the must below 55 F (12.8C) to inhibit yeast fermentation. At these temperatures extraction will move somewhat slowly giving a lot of control over how much you extract. Once the optimal extraction has been reached the grape solids and stems should be removed and the must brought back to a higher temperature so fermentation can begin.

Maceration management:

The following are important things to monitor while carrying out maceration:-

- **Tannins**

The main sources of tannins in wine are grape skins, seeds, stems and oak. The amount of tannins extracted is controlled by manipulating maceration temperature, duration and the amount of stems

included. If tannins are over extracted, you can try to fine them out but you may end up having to age the wine much longer than you originally attended.

- **Temperature management**

When maceration takes place during fermentation, temperature management becomes a critical part of the winemaking process. The yeast produce carbon dioxide during fermentation which make the skins, seeds and stems float to the top forming the "cap". Since fermentation is exothermic which means heat is given off. To release the heat pumping over is applied where the "cap" is punched down forcing the solids back down into the must.

2.2.2 Primary (Alcoholic) Fermentation

The process of fermentation in winemaking turns grape juice into an alcoholic beverage. During fermentation, yeast transform sugars present in the juice into ethanol and carbon dioxide (as a byproduct) as per equation below:

$$C_6H_{12}O_6 + \xrightarrow{yeast} 2C_2H_5OH + 2CO_2 + Energy$$

In winemaking, there are distinctions made between ambient yeasts which are naturally present in wine cellars, vineyards and on the grapes themselves and cultured yeasts which are specifically isolated and inoculated for use in winemaking.

ALKO VINTAGES use cultured yeast called *Saccharomyces cereviciae* (also known as "sugar yeast"). Primary fermentation is more vigorous portion of the fermentation process during which time approximately 70% of the total amount of alcohol is produced. It usually takes 3-7 days to complete. The yield of ethanol is affected by such factors as temperature, extent of agitation, sugar concentration, acidity, and strain of yeast activity. The lower the temperature the higher the alcohol yield due to a more complete fermentation (better sugar utilisation) and less loss of alcohol contained with CO_2. To determine when fermentation is nearly finished, specific gravity is monitored. When the specific gravity falls to 1.000, the wine is nearly ready. For precise monitoring, Fehling reaction is used.

The reaction is as follows:

$$RCHO(aq) + 2Cu^{2+}(aq) + 4OH^{-}(aq) \rightarrow RCOOH(aq) + Cu_2O(s) + 2H_2O(l)$$

The colour of the resulting solution indicates the amount of sugar left. A large amount of sugar results in complete loss of the blue copper (II) ions leaving the red copper (I) oxide. ***Table 1: Products of Alcoholic Fermentations***

Product	Theoretical %w/w	Industrial fermentation %w/w	Wine yeast %w/w
Ethanol	51.1	48.4	47.86
Carbon dioxide	48.9	46.5	47.02
Acetaldehyde	-	0.08	0.01
Acetic acid	-	0.25	0.35
Glycerol	-	3.6	2.99
Lactic acid	-	0.2	0.20
Succinic acid	-	0.7	0.045
Higher alcohols	-	0.33	0.10
Yeast mass (dry weight)	-	1.2	0.55

Fermentation Management:

- **Yeast addition**

To prepare yeast, add 150ml of water to a clean glass and bring to a temperature of 38□C water, gentle mixing may be required to ensure all the yeast is properly wetted. Leave for 10 minutes to allow the yeast to re-hydrate; make sure the must is at a temperature of at least 20□C (best between 20□C and 25□C). The amount of water needed for the hydration depends on the quantity of yeast being used, which is determined by the initial sugar concentration of the must. In ganeral, for fermentations with initial Brix levels up to 24.5□, 1 gram of yeast per gallon of the must is sufficient.

- **Diammonium phosphate (DAP)**

DAP is added to juice (or must) to supplement natural levels of Yeast Assimilable Nitrogen (YAN). It is added at the beginning or middle of fermentation. Addition of DAP can stimulate yeast growth

and fermentation activity and helps to prevent the formation of H_2S. Addition rates vary from 25-200 mg/L.

- **Temperature control**

Temperature has a direct influence on the wine quality because wine yeast creates different compounds at various temperatures. Cooler temperature fermentations preserve more aromatic esters and create lean, forcused wine but often with reduced mouthfeel. Warmer temperature fermentations give greater complexity and mouthfeel, but at the loss of the original clarity of the fruit. The warmer a fermentation gets, the higher the amount of H_2S will be produced. For white wines, the temperature can be adjusted to obtain a uniform Brix reduction of 1-2□ per day; roughly corresponding to a temperature of 12-16□C. For red wines, a reduction of 2-4□ Brix per day is achieved at temperatures between 18-24□C.

- **CO_2 management**

CO_2 is no stranger to winemakers: It floods the cellar during fermentation, serves as a blanketing layer in tanks to keep oxygen at bay and makes sparkling wines sparkle but in still wines, at subbubble level, it does not get much respect. It is colourless and odourless, but potentially lethal, as it is poisonous and displaces the air that contains the oxygen that we need. Good ventilation is very important; as precautions such as never entering a closed tank without measuring for oxygen level.

Large wineries should have alarms to indicate low oxygen levels.

2.2.3 Pressing

Pressing in winemaking means applying pressure to grapes or pomace in order to separate juice or wine from grapes and grape skins. The juice obtained from crushing process is called “free run juice” and that obtained from pressing, “pressed juice” which is 15-30% of total juice volume from the grapes.

The role of pressing

The role of pressing is to recover the juice (or wine) associated with the pulp and skin sections of the grapes that are not readily released by natural draining.

Types of Pressses

There are two types of presses, namely batch and continuous presses

a) Batch presses

Batch presses operate in cycle in which they are filled, rotated, and sometimes held at, pressured, depressurized, and emptied. The filling time is determined by the capacity of the must pulp or conveyors and size of the press. The pressure is generally increased to a maximum pressure of 4 to 6 atm (bars) in stages over a period of between 1 and 2 hours. There are several types of batch presses including basket presses, moving head presses, bladder presses and membrane presses. Most batch presses (excluding basket presses) are rotated while the pressure is being applied so that a regular-shaped cake is developed. Although older and smaller models were often manually operated, most of these presses today have extensive programming capability and the pressures and hoding times of the press cycles can be programmed.

b) Continous presses

The benefit of continuous presses is the "continuous" sequence that allows large volumes of grapes to be pressed within minimum labour involvement. Instead of pressing separate batches that need to be emptied and refilled, continuous press typically have an input area and some mechanism (such as an auger screw or belt) that transfers the grapes through the pressings with an output area for the discarded cake. ALKO VINTAGES uses this kind of press, in which the pressing machine can be operated either manually or automatic. After being pressed which takes up to 6 hours, the juice is conveyed by a screw conveyor and pumped to the malo-lactic fermentation tanks.

2.2.4 Secondary (Malo-lactic) Fermentation

Malo-lactic fermentation is the conversion of the grape acid malate to lactate conducted by members of the lactic acid bacteria.

Malate is a dicarboxylic acid, meaning that it contains two carboxyl groups. Lactate has single carboxyl group and is monocarboxylic. Therefore the conversion of malate to lactate is a decarboxylation producing one molecule of CO2 for every molecule of lactate.

Effects of malolactic fermentation:

- **Deacidification**

This may not be desired in wines already low in acidity, but this conversion may occur whether desired or not if conditions support the growth of malolactic bacteria. The fixation of hydrogen ions on lactate can reduce the titratable acidity (TA) by 0.01 to 0.03g/L. The pH is also increased by as much as 0.3 units. This is very important because if a wine is low in pH (below 3.5) the metabolic activity of bacteria can raise the pH to a level supporting the growth of more species.

- **Bacterial stability**

This means that the growth of other organisms is inhibited. It is due to the consumption of nutrients so that the conditions are not permissive for other microbes, but it may also be a consequence of the production of bacteriocins, compounds that are toxic to members of other species.

Another important consideration is the timing of malolactic fermentation. If it occurs prior to bottling it prevents microbial growth in the bottle.

- **Flavor changes**

There are several important flavor changes that occur in wine that has undergone a malolactic fermentation in addition to deacidification. Flavor changes associated with malolactic fermentation are production of acetic acid, diacetyl, acetoin, 2,3 Butantediol, ethyl lactate, diethyl succinate, acrolein, and other compounds.

How to tell if malo-lactic fermentation is completed?

- Malolactic fermentation is maintained at 18□C and pH□3.4.
- The whole fermentation can take place from 1 to 3 months before finished.
- It is completed when the malic acid value □0.3g/L.

2.3 Downstream Processes

Includes racking, aging, blending, clarification and bottling.

2.3.1 Racking (Lees separation)

Alexis Lichine's Encyclopedia of Wines and Spirits defines racking (sometimes called soutirage) as "siphoning wine or beer off the lees (in the case of wine) or trub (in case of beer), into a new, clean barrel or other vessel. Racking allows clarification and aids in stabilisation. Wine that is allowed to age on the lees often develops "off-tastes". The process is repeated when the casks are

moved to the second-year cellar. Racking was developed in the Bordeaux region of France in the 19th century at a time when there was no electricity to power pumps.

When To Rack?

The first racking:

The first racking should normally be done around 5 to 7 days into the fermentation. This is an optimum time to rack a must for several reasons:-

(i) Putting fermentation under protection of an air-lock. The reason an air-lock is needed at this point is because this is when fermentation will dramatically slow down. When the wine yeast becomes less active, the must is no longer able to sufficiently protect itself from the continuous, long-term threats posed by outside contaminants.

(ii) Because 70-80% of the sediment will have already occurred. It will take much longer for atleast 30% to show up. So racking the wine on the 5th to 7th day is a good idea from a timing standpoint an optimum time to get the bulk of the sediment out of way.

(iii)To remove any pulp that may be present. Leaving the pulp in the must for a longer period of time could result in a wine that is too harsh tasting; and any shorter period of time in a wine that has less body and character than you may prefer.

The second racking:

This should be done when fermentation activity is complete. It could be up to 4 or 5 weeks after the first racking depending on how fast your fermentation has come along. Once the racking has been done, the wine air-lock should be put on right back because the must will now need more time to become completely clear.

The third racking:

The third and quite often the last racking, should be done after the wine has completely cleared up. Again this is an opportune time to get the sediment away from the wine. It only makes sense to rack the wine away from the sediment as soon as all of it has occurred.

2.3.2 Aging

The aging of wine is potentially able to improve the quality of wine. This distinguishes wine from most other consumable goods. While wine is perishable and capable of deteriorating, complex

chemical reactions involving a wine's sugars, acids and phenolic compounds (such as tannins) can alter the aroma, colour, mouthfeel and taste of the wine in a way that may be more pleasing to the taster. The ability of a wine to age is influenced by many factors including grape variety, vintage, viticultural practices, wine region and winemaking style. At ALKO VINTAGES, aging is done in stainless steel tanks for 6 months.

Effects of Aging on Wine:

As red wines ages, the harsh tannins of its youth gradually give way to a shofter mouthfeel. An inky dark colour will eventually lose its depth of colour and begins to appear orange at the edges, and then later eventually turning brown. These colour changes occur due to the complex chemical reactions of the phenolic compounds of the wine. In processes that begin during fermentation and continue after bottling, these compounds bind together and aggregate. Eventually these particles reach a certain size where they are too large to stay suspended in the solution and precipitate out. The presence of visible sediment in a bottle will usually indicate a mature wine. The resulting wine, with this loss of tannins and pigment, will have a paler colour, taste softer and less astringent. The sediment, while harmless, can have an unpleasant taste and is often separated from the wine by decanting. During the aging process, the perception of a wine's acidity may change even though the total measurable amount of acidity is more or less constant throughout a wine's life. This is due to esterification of the acids, combining with alcohols in complex array to form esters.

2.3.3 Blending

Diffrerent batches of wine can be mixed before bottling in order to achieve the desired taste. The winemaker can correct perceived inadequacies by mixing wines from different grapes and batches that were produced under different conditions. For example ALKO VINTAGES blends South Africa red wine with their red wine to get a better tasting wine. These adjustments can be as simple as adjusting acid or tannin levels, to as complex as blending different varieties or vintages to achieve a consistent taste.

Reasons for blending

(i) To help the winery keep a consistent product from bottle to bottle.
Blending among the various storage vessels of a particular vintage cancels out any variation created that year from a number of sources, such as differences that exist from more than

one vineyard, differences that develop from one fermentation container to the next, different tannin levels between barrels, etc.

(ii) To keep the non-varietals consistent from one year to the next. This is little more involved than blending across a particular vintage.

The first requires a limited amount of skill and is most routine in nature from a general wine making standpoint, whereas the later requires one's ability to taste and blend their way to creation that matches what was produced the year before.

How blending is done:

Knowing the measurable profiles of the wines to be potentially blended is the starting point for any blending challenge. By knowing as many measurable features as possible, you can then begin to determine some blending parameters.

The Pearson Square is a visual math tool that can help in determining blending ratios of two wines to achieve an quantifiable outcome.

Example: Blending two wines with two different acid levels, one being 0.55% the other 1.10% , we can use the Pearson Square to determine the ratio needed. Say we want acid level to be 0.70%.

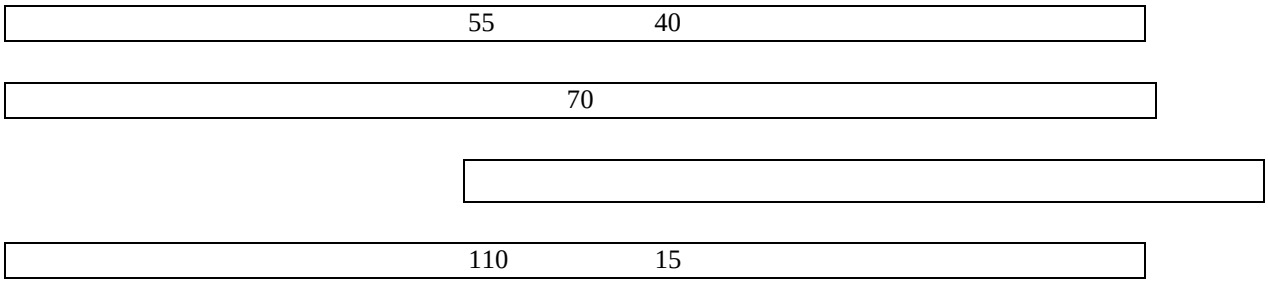

Figure 3: The Pearson Square

Explanation:

The top left conner and the bottom left conner represent the acid level of the two wines to be blended. The centre number is the acid level we want to achieve. The two numbers on the right are numbers that you calculate. The 15 is simply the difference between 55 and 70, and 40 is the difference between 110 and 70. The 15 and 40 now represents the blending ratio of the wines.

2.3.4 Clarification

The process, natural or induced, whereby 'unwanted' suspended particles are removed from a wine and it subsequently becomes 'clear'. The best example of natural clarification is the sedimentation of yeast cells at the end of the alcoholic fermentation.

Induced clarifications which are carried out at ALKO VINTAGES includes centrifugation, fining, filtration and stabilization.

a) Centrifugation

Centrifuges work by speedind up the sedimentation of particles. In a centrifuge, the acceration due to gravity in sedimentation is replaced by the centrifugal force generated by the spin of the centrifuge. To ensure efficiency in clarifying the wine, centrifuges can work at very high speed. The ALKO VINTAGES' centrifuge works at the speed of 14,000 rpm and it is self decanting (automatic extraction of lees).

Principle of operation

The centrifuge operates under the principle of centrifugal force created by a rotating shaft at the center of the centrifuge. Alko Vintages operates with the centrifuge of 14000rpm capacity. At this seed, the wine being supplied from the inlet pipe to the center of the machine is thrown to the sides by centrifugal force. The walls of the centrifuge are perforated to allow only liquid wine to pass while the bacteria and dirt remain on the wall. The juice is then pumped to another vessel or directly to the filter for further clarification.

Figure 4: ALKO VINTAGES' Centrifuge **The role of centrifugation:**

(i) Rapid clarification of the musts.

(ii) Removal of yeasts during fermentation to slow down the alcoholic fermentation.

(iii)Post-fermentation clarification, removing yeasts, particularly for stopped fermentations.

(iv) Immediate clarification of fined wines.

Fining and fining agents

- **Fining**

This is the addition of a substance or mixture of substances to the wine, inorder to clarify, stabilize or modify its organoleptic qualities, which is subsequently removed.

- **Fining agents**

These are the substances added to wine to clarify it and improve its organoleptic qualities.

Fining agents can be grouped according to their general nature:-

a) Earths: bentonite, kaolin
b) Proteins: gelatin, isinglass, caseins, pasteurized milk, albumens, yeasts
c) Polysaccharides: alginates, gum arabic
d) Carbons
e) Synthetic polymers: PVPP, nylon
f) Silica gel (silicon dioxide)
g) Tannins
h) Others: including metal chelators, blue fining, and enzymes

How fining agents work?

Most of the suspended solids in the must or wine have an electrical charge. Some have positive charge while others have a negative charge. Many fining agents also have a positive or negative electrical charge.

When fining agents are added to the must or wine, they will attract and bind like a magnet to particles of opposite electrical charge, then become heavy and sink to the bottom of the wine as sediment, leaving the wine clearer.

The other way that some fining agents work is through absorption. The agent may have no electrical charge at all, but has “sponge-like” qualities allowing it to bind with elements in the wine, and settle at the bottom.

b) Filtration

This is passing wine or must through a media in order to strain out the particles suspended in it. It is purely physical process and involves the separation of liquid (wine) from any sediment deposits or suspended particles. The size of the paricles to be removed determines which of the many filtration systems and grades is required.

At ALKO VINTAGES, there three types of filtration which are carried out in wine clarification;

(i) Coarse (depth) filtration

In depth filtration, often done after fermentation, the wine is pushed through a thick layer of pads made from cellulose fibers, diatomaceous earth or perlite.

(ii) Fine (surface) filtration

In surface filtration the wine passes through a thin membrane. The pore size of these types of filter is relatively smaller, compared to course filters.

(iii)Sterile filtration

The finest surface filtration, microfiltration, can sterilize the wine by trapping all yeast and, optionally, bacteria, and so is often done immediately prior to bottling. An absolute rated filter of 0.45 μm is generally considered to result in a microbial stable wine.

Alko Vintages company limited uses Plate and frame filters operating with different sizes of filter membranes as mentioned above. The choice of the membrane depends on the level of filtration needed. Most of the times, sterile filtration is preferred.

Mode of operation

Every frame is fixed with two filters one on each side. There is one stream of wine that supplies wine to every filter. Then wine goes cross one filter and gets collected to the one channel that leads outside the filter. All the suspended dirt remains on each side of the filter materials. Filters are changed when their time of use is over. At this moment they normally obtain too much filter cake to pass the wine, thus offer great resistance to the pump.

Figure 5: ALKO VINTAGES' Plate-and-Frame Filter

c) Stabilization

This is a set of procedures used to ensure that the wine stays clear and does not spoil. Initially, stability tests are undertaken for substances that might come out of solution and demage the appearance of the wine, such as proteins and tartrates. If any of the tests suggests "instability", then the winemaker intervenes by, for example, removing the protein by bentonite fining or chilling the wine to initiate tartrate crystallisation.

2.3.5 Bottling

The bottling section is an independent unit of the industry. It comprises of the following sections:-

Bottling line

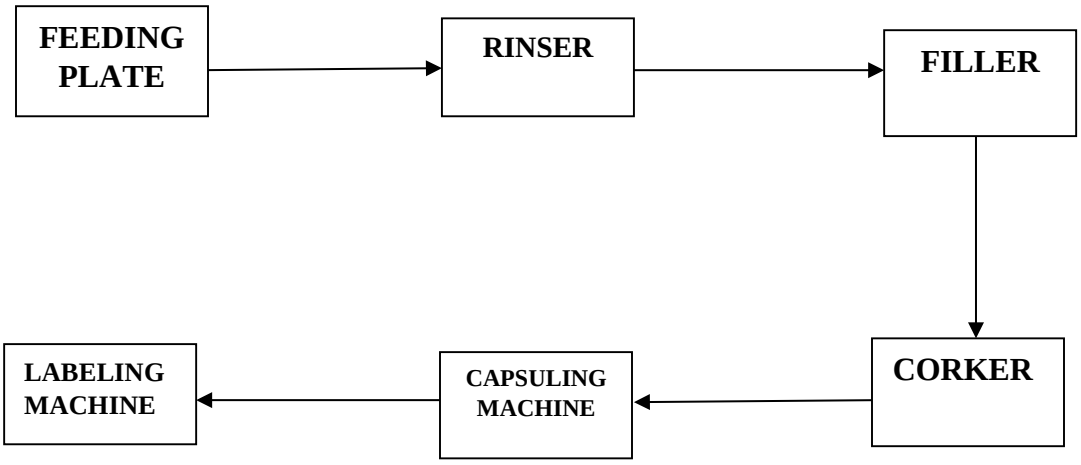

Figure 6: Block Diagram Showing Bottling Line Machines Arrangement

- **The bottle feed plate**

  This part is a circular plate which moves in a slow circular motion. Bottles are arranged on the plate which when rotating it feeds them on the moving belt conveyor that leads to the rinsing machine.

- **The bottle rinsing machine**

  At the rinsing machine a bottle is picked by the neck and turned upside down against the nozzle that sprays water in it to rinse. Each bottle completes a circle of washing and is delivered on the conveyor on the other side of the machine taking it directly to the filler.

- **The filler**

  A bottle is caught by the neck and raised by pneumatic system against the nozzle which fills to the required level as the bottle moves around the filler machine to the other side. Each bottle here is filled with 750ml of wine.

- **Stoppering machine**

  It releases one cork at a time and stoppers the bottle then releases it on the conveyor line to be taken to the finishing line.

The whole bottling line is sequenced and controlled by one control panel. Thus in case of any malfunction, the control system indicates clearly what part of the system malfunctions. The bottling capacity (or rate) of the line at this winery is 1250 bottles/hour.

Finishing line

It contains the capsuling machine, labeling machine and packaging machine. First the capsule covering the bottle mouth and then the label on the sides of the bottle is placed. Then the bottle is conveyed by a belt to the packaging place.

2.4 Major Utilities

There are three major utilities to be discussed:-

a) Water

Water is one of the most important utilities in the winery. ALKO VINTAGES gets its water from Dodoma Urban Water Supply and Sewerage Authority (DUWASA) which is used for different purposes.

Uses of Water:

- **Cooling purposes:** maceration and fermentation tanks to maintain the desired temperatures.
- **Cleaning purposes:** equipments such as plate and frame filters, centrifuge machine, pressing machine, destemmer-crusher, maceration, fermentation and storage tanks, bottling machines; and overall cleaning of the winery.

b) Compressed air

Air is compressed by a compressor up to 16 bars in accordance to the need. Many of ALKO VINTAGES' bottling and finishing equipments use compressed air in their operations. Such equipments are rinser, filler, corker and capsuling machines.

c) Electricity

Electric power at ALKO VINTAGES is mainly from two sources:

- Tanzania Electric Supply Company (TANESCO)
- A standby generator which can produce up to 400V

The power obtained from these sources is used for operating machines such as electric motors for pumping purposes, motors for driving belt conveyors, automatic temperature control system, centrifuge machine, destemmer-crusher, pressing machine and packaging machine.

3.0 MAJOR EQUIPMENT

The major equipment chosen from the winery was Destemmer-Crusher.

3.1 Equipment Description

The ALKO VINTAGES' destemmer-crusher is manufactured by SIPREM INTERNATIONAL 'Italian technology for quality wines!' and has the following specifications:-

- Series of manufacture: ALFA16
- Serial No: C13012D09
- Year of manufacture: 2013
- Weight: 280Kg
- Capacity: 12-15 Tons/Hr
- Voltage: 380V ~
- Frequency: 50Hz
- Material: stainless steel

3.2 Construction

The equipment is composed of:

1) A loading hopper
2) A perforated drum
3) A beater bar
4) The crusher unit
5) Crushing rollers

3.3 Mode of Operation

The loading hopper receives the grapes and conveys them to the grape separating and destemming unit. A perforated drum installed inside this unit contains a revolving beater bar. The drum rotates in the same direction as the beater bar, but at lower speed so that the grapes can be gently and smoothly separated from the stalks.

The destemmed grapes then pass through the holes in the drum into the crusher unit below, which comprises two star-shaped rollers made of non-toxic rubber (see figure. 4), the crushed grape product is then conveyed through collection tanks or by means of pumps to the next processing stage.

All metal components are made of stainless steel to ensure a long working life and corrosion resistance, and to provide a surface suitable for contact with foodstuffs.

3.4 Function of Destemmer-Crusher

The Destemmer crusher is used to first separate stems from the grapes and then crushing. The clusters are broken apart as the grape berries are torn from the stems. The berries fall through the cage and are then crushed by rollers before falling into the must pan of the crusher.

The advantages of this sequence are thought to be that some whole berries can be left and that the stems are not in contact with the must, thus preventing extraction of undesirable stemmy components.

3.5 Reason for Maintenance

Maintenance is very important for the equipment since it is under stresses during operation which may cause:-

- Wearing of machine parts due to friction.
- Vibrations of machine parts which come from gears and belts which are out of alignment.

3.6 Sequence in Fault Diagnosis

For scheduled maintenance, the equipment is diagnosed yearly. When the equipment is to be checked and maintained, ALKO VINTAGES' bring an expert with experience in winemaking equipments from abroad.

3.7 Sequence in Shutdown and Checkups

For unscheduled maintenance, and mainly small maintenances, the company uses normal technicians from the country who are paid at hand.

There are checkups (or maintenance) done at the start of working circle and others at the end as the table below indicates:

Table 2: Order of Checkups During Normal Functioning Conditions

TYPE OF OPERATION	FREQUENCY	
	START OF WORKING CIRCLE	END OF WORKING CIRCLE
Safety devices control	X	
Button efficiency control	X	
Clean the machine		X
Check electrical cables	X	X
Crankcase and container control	X	
Transmission belt adjustment	YEARLY	
Joint and soldering control	YEARLY	

3.8 Repairing

No repairing has been done to this equipment. The equipment has only two years since it was bought. This is one of the reason why there is no replacement of machine parts, but another reason is proper operations on the equipment.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The winemaking process requires high technology in order to produce high quality wine. Though ALKO VINTAGES CO. LTD is still a small company, its technology is highly advanced which is the reason for being an outstanding vintage in Tanzania.

On studying the company's machines and equipments, it was found that most of equipment manuals are in Italian language which the workers are not familiar with, hence difficult to read them and maintain the equipments.

4.2 Recommendations

The following recommendations are made according to the drawn conclusions:

- Due to the fact that the maintenance manuals of company's equipments are in Italian language, the company should translate them into a more understandable language to the workers for easy understanding of machines' operations.
- Since the company is now on expansion of its production and storage capacity, instead of depending on abroad technicians for maintenance, the company should train our technicians in the country and employ them under contracts. This will decrease the huge amount of money spent by the company on paying abroad technicians yearly.

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