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**Experimental Plan Assessment**

**Laboratory Course** : CHE3110L

**Experiment Title** : Wine Making

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**Teacher's Name** : Dr. Camila Flor Y. Lobarbio

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Criteria	Grade
<i>Preparation &amp; Planning for Experiment (x 0.50)</i>	
<i>Ability to Answer Questions (x 0.50)</i>	
<b>Grade</b>	

**Assessed and Graded By:** \_\_\_\_\_  
 (Signature over printed name)

**Date and Time** \_\_\_\_\_



## Experiment Plan

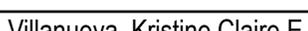
(Form CHE 3110L-2)

Prepared and submitted by:



  
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Experiment: **Wine Making**

### Objectives of the Experiment

1. Prepare a process flowsheet for the production of wine, complete with details in process conditions and stream specification;
2. Monitor overall and component mass and energy flows during the lab-scale implementation of the product manufacture;
3. Calculate component yields in every process step and for the entire process; and
4. Identify critical steps in the process based on laboratory data and the entire experience of generating the product.

### Methodological Framework

#### Objective 1:

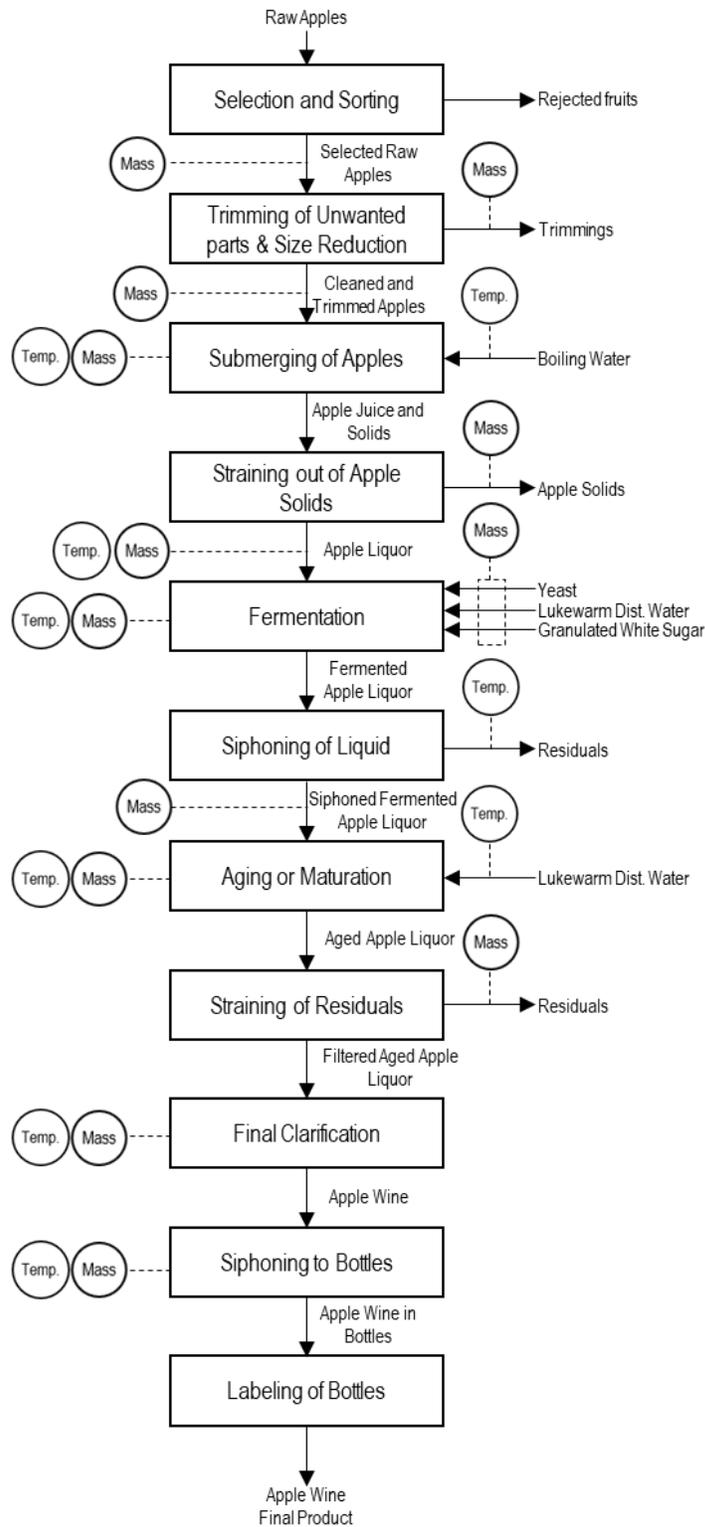
To prepare the process flowsheet of the production of wine, the following are to be done:

- Research on the procedures of wine homebrewing and its ingredient proportions
- Determine the key process steps
- Determine the underlying reactions
- Identify process conditions such as temperature during fermentation and storage environment
- Establish the flow of inputs and outputs of the different processes such as materials and products

- Present the overall process as a flow diagram specifying on the process and stream conditions

**Objective 2:**

To monitor the component mass and energy flows, recordings of the mass and temperatures from each process step throughout the manufacturing will be made. This is represented as a process flow diagram below:



**Objective 3:**

To calculate the component yield of each process step and for the entire process, an information flow diagram is provided:

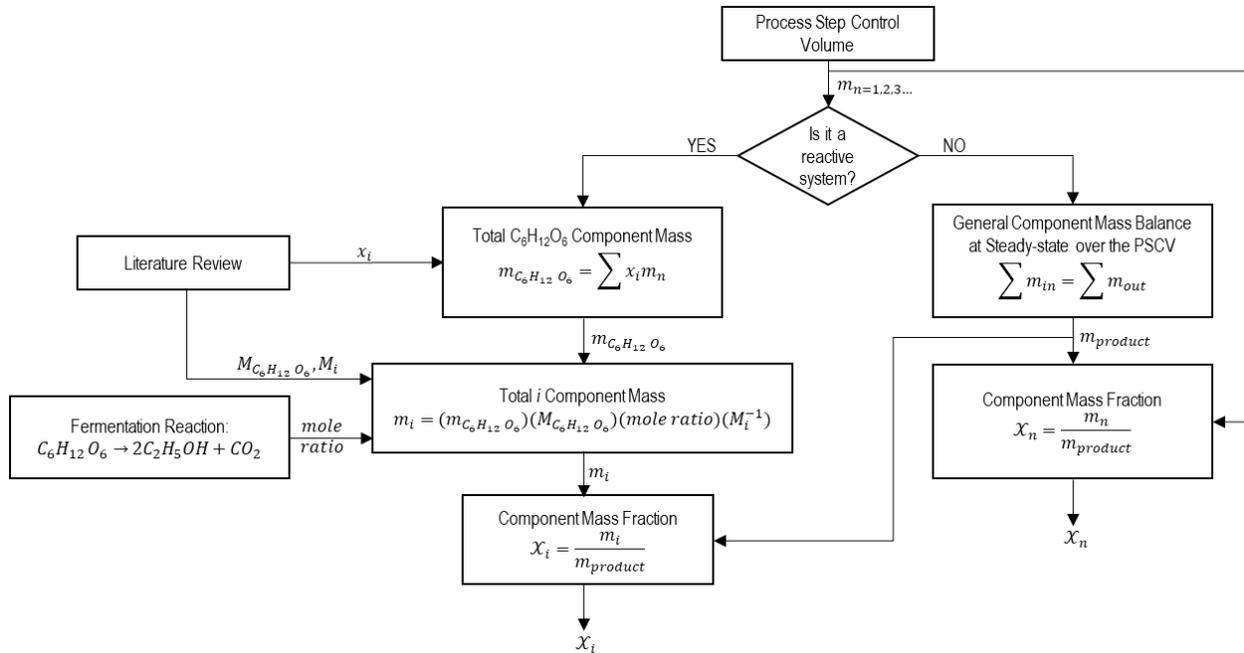


Table of Symbols			
	Mass of stream $n$	$M_{C_6H_{12}O_6}$	Molar mass of glucose
$m_{C_6H_{12}O_6}$	Mass of glucose	$M_i$	Molar mass of component $i$
$m_i$	Mass of component $i$	$X_i$	Mass ratio of component $i$
$m_{product}$	Mass of product stream	$X_n$	Mass ratio of stream $n$
$x_i$	Mass fraction of component $i$		

**Objective 4:**

Critical Steps based on laboratory data and potential eventualities:

- Apple Selection -The quality of selected apples may affect wine quality; thus, only fresh apples are selected for optimum output. The quantity of apples in terms of mass is determined in order to obtain the optimum value of juice to be extracted for fermentation even after some preparation.
- Chopping -This process removes the inessential parts of the apple, the stem, and the seeds, and sets the actual amount of fruit in terms of mass to be used for juice extraction.
- Fermentation –The conditions to which the fermentation vessel is exposed, such as temperature, may affect the rate of conversion of the sugars into ethanol and carbon dioxide; too much exposure to oxygen causes the wine to oxidize, creating sharp, nutty flavors that is caused by the reactions that convert ethanol to acetaldehyde.
- Liquid Siphoning –Loss of fermented juice during siphoning in a spillage may affect the total amount of product to be gained. Quality may be affected as some agitated residuals may join in the siphon stream along with the siphoned liquid.

- Aging – Heat effects may hasten wine deterioration. Moreover, exposure to oxygen may increase the chances of converting the wine to cider due to oxidation.
- Residual Straining and Final Clarification – Spent yeast are to be fully removed from the wine before bottling, to prevent yeast-related wine faults such as the presence of flavors that are undesirable, as well as yeast films.
- Bottling – Improperly sanitized bottles can hasten spoilage of final product. Inadequate bottle volume may lead to some portion of the wine to be discarded.

### Materials, Measuring Apparatus & Equipment

Material	Quantity
Apples	8 lbs
Granulated White Sugar	2 lbs
Distilled Water	5L
Yeast	1 tsp.
Tap Water	10L

Apparatus	Size	Quantity
Metal Pot	At least 3 liters	1
Measuring cup/s ( <i>sic</i> )		1-2
Measuring spoon/s ( <i>sic</i> )		1-2
Jar (Fermentation Vessel)	At least 1 gallon	2
Wooden Spatula		1
Cloth	1 meter	1
Rubber band	Standard size	20
Strainer		1
Plastic Funnel		
Vinyl tubing	5 feet	1
Cheese cloth	1 meter	1
Knife		1
Chopping board		1

Equipment	Specifications
Stove Top	Gas/Butane-powered ( <i>sic</i> )
Weighing Scale	Max. Weight capacity at 30 kgs

### Task Plan

Time	Task	Person Responsible
Day 1	<b>Preparation</b>	
	Measure about 2 liters of distilled water and bring to a boil.	Talandron
	Check apples for bruises and broken skin. See if there are any signs of pests breaking into the fruit.	
	Rinse apples with running water, removing excess dirt.	
	Wipe apples with a clean cloth, removing excess water.	Amaba
	Cut apples into small pieces and remove the seeds and stem.	

	Discard trimmings.	
	Weigh final yield of apples. Record.	
	Clean out two fermentation vessels using soap and running water. Rinse and pat dry with a clean, lint-free cloth.	Talandron
	Weigh both fermentation vessels. Record.	
	<b>Juice Extraction</b>	
	Place chopped apples in a previously sanitized fermentation vessel.	Talandron
	Fill vessel with boiling water, enough to submerge the apples. Stir slightly with a wooden ladle.	
	Take the initial temperature reading with a thermometer. Let the mixture rest for a few minutes and take temperature readings as it cools by 5-minute interval	Amaba
	Weigh entire vessel. Record.	
	Once the temperature is constant, cover vessel with a clean cloth, secured with a rubber band or strap.	
Day 2-4	Leave contents in the vessel for the next 3 days, stirring 2-3 times per day.	
	Check the temperature of the mixture prior to straining. Record.	
	Strain out apple solids from the apple liquor, transferring the liquor to another vessel.	Talandron
	Weigh the strained solids. Record.	
	Weigh the vessel with the liquor in it. Record.	
	Discard the apple solids.	
	Clean the used vessel with soap and water. Pat dry and store.	
	<b>Fermentation</b>	
Day 5	Measure at least 150 mL of distilled water, heat up to 36.5-40.5°C. Check the temperature. Record.	Amaba
	Top up the apple liquor with lukewarm distilled water, until it reaches a gallon.	Talandron
	Add 2 lbs. of granulated white sugar until all of the sugar is dissolved.	
	Prepare 1 tsp of wine yeast depending on the package instructions.	
	Add the prepared wine yeast into the mixture and stir gently. Cover vessel with a new cloth and secure with a tie.	Amaba
	Weigh the final mixture and take a temperature reading. Record.	
	Read off the initial specific gravity of the mixture using a hydrometer. Record.	
Day 6-19	Let the mixture ferment for two weeks, stirring contents 2-3 times per day.	Talandron
	<b>Aging or Maturation</b>	
Day 20	Transfer the liquid to another vessel by siphoning. Avoid disturbing the solids that have settled.	
	Weigh the residuals. Record.	Amaba
	Weigh the siphoned liquid. Record.	
	Discard the residuals properly, wash the used vessel.	

	If the mixture is less than a gallon, top it up with distilled water, stir slightly then cover with layers of cloth, secured with a tie.	Talandron
	Weigh the final mixture. Record.	
Day 21-51	Store the vessel in a cool dark spot and allow it to remain undisturbed for at least a month.	
Day 52	<b>Final Clarification</b>	
	Weigh the mixture in the vessel. Check its temperature prior to clarification.	Amaba
	Weigh the cheesecloth and strainer before straining.	
	Strain the wine through a cheesecloth and sterilized strainer into another sterilized vessel.	Talandron
	Weigh the cheesecloth and strainer again to account for the weight of the filtered solids and the absorbed liquid.	
	Weigh the used vessel. Record.	
Weigh the mixture before storing.		
Day 53-67	Store again for at least 2 weeks.	
Day 68	<b>Bottling and Labeling</b>	
	Weigh again, prior to siphoning.	Talandron
	Sterilize wine bottles using hot water.	
	Weigh bottles prior to filling.	Amaba
	Transfer the strained wine into the sterilized wine bottles by siphon using sterilized plastic tubing.	
	Check the temperature inside the bottles before sealing. Record.	
	Take a reading for the final specific gravity of the mixture. Record.	
	Finally, seal the wine bottle with a cork and label them accordingly.	
Day 69-70	<b>Post-Lab Analytics</b>	
	Determine the pH of the wine using a pH meter.	Villanueva
	Determine the specific gravity of the product using a hydrometer.	Yu
	Determine alcohol content of final apple wine product	

### Sample Calculation

#### Mass Balance Calculations

##### Process 1: Preparation

$$m_{\text{apples}} = 3.6 \text{ kg}$$

$$x_{\text{solids}} = 0.6 \quad m_{\text{solids}} = 2.16 \text{ kg}$$

$$x_{\text{juice}} = 0.4 \quad m_{\text{juice}} = 1.44 \text{ kg}$$

$$m_{\text{H}_2\text{O}} = 2 \text{ kg}$$

$$x_{\text{H}_2\text{O}} = 1$$

$$m_{\text{mix-1}} = m_{\text{apples}} + m_{\text{H}_2\text{O}} = 5.6 \text{ kg}$$

$$x_{\text{H}_2\text{O}} = 0.36 \quad m_{\text{H}_2\text{O}} = 2.00 \text{ kg}$$

$$x_{\text{solids}} = 0.38 \quad m_{\text{solids}} = 2.16 \text{ kg}$$

$$x_{\text{juice}} = 0.26 \quad m_{\text{juice}} = 1.44 \text{ kg}$$



### Process 2: Extraction (Removal of Apple Solids)

$$m_{\text{mix-1}} = 5.6 \text{ kg}$$

$$x_{\text{H}_2\text{O}} = 0.36 \quad m_{\text{H}_2\text{O}} = 2.00 \text{ kg}$$

$$x_{\text{solids}} = 0.38 \quad m_{\text{solids}} = 2.16 \text{ kg}$$

$$x_{\text{juice}} = 0.26 \quad m_{\text{juice}} = 1.44 \text{ kg}$$

$$m_{\text{mix-2}} = m_{\text{feed}} - m_{\text{solids}} = 3.44 \text{ kg}$$

$$x_{\text{juice}} = 0.42 \quad m_{\text{juice}} = 1.44 \text{ kg}$$

$$x_{\text{H}_2\text{O}} = 0.58 \quad m_{\text{H}_2\text{O}} = 2.00 \text{ kg}$$

### Process 3: Fermentation (Addition of Refined Sugar and Yeast)

$$m_{\text{mix-2}} = 3.44 \text{ kg}$$

$$x_{\text{juice}} = 0.42 \quad m_{\text{juice}} = 1.44 \text{ kg} \quad \% \text{ fruit sugar in juice} = 10\%$$

$$x_{\text{H}_2\text{O}} = 0.58 \quad m_{\text{H}_2\text{O}} = 2.00 \text{ kg}$$

$$m_{\text{fruitsugar}} = x_{\text{fruitsugar}} m_{\text{juice}} = 0.144$$

$$m_{\text{refinedsugar}} = 0.9 \text{ kg}$$

$$m_{\text{total sugars}} = m_{\text{refinedsugar}} + m_{\text{sugar/juice}} = 1.044$$

$$m_{\text{H}_2\text{O-TopUp}} = 0.1 \text{ kg}$$

$$m_{\text{yeast}} = 2.83 \text{ g} = 2.83 \times 10^{-3} \text{ kg}$$

$$m_{\text{mix-3}} = m_{\text{mix-2}} + m_{\text{refinedsugar}} + m_{\text{H}_2\text{O-TopUp}} + m_{\text{yeast}} = 4.44 \text{ kg}$$

$$x_{\text{tot. sugars}} = 0.24 \quad m_{\text{tot. sugars}} = 1.04 \text{ kg}$$

$$x_{\text{liq.mix.}} = 0.76 \quad m_{\text{liq.mix.}} = 3.30 \text{ kg}$$

### Process 4: Aging or Maturation (Conversion of Glucose to Ethanol and Carbon Dioxide)



$$m_{\text{total sugars}} = 1.04 \text{ kg}$$

$$\text{MW}_{\text{glucose}} = 180 \text{ g / mol}$$

$$\text{mol}_{\text{glucose}} = m_{\text{sugar}} (1000 \text{ g/kg}) (1 / \text{MW}_{\text{glucose}}) = 5.8 \text{ moles}$$

$$\text{mol}_{\text{CO}_2} = (\text{mol}_{\text{glucose}}) (2 \text{ mol}_{\text{CO}_2} / 1 \text{ mol}_{\text{glucose}}) = 11.6 \text{ moles (assume 100\% conversion and no yeast growth)}$$

$$\text{MW}_{\text{CO}_2} = 44.01 \text{ g / mol}$$

$$m_{\text{CO}_2} = \text{mol}_{\text{CO}_2} (\text{MW}_{\text{CO}_2}) = 510.516 \text{ g} = 0.51 \text{ kg}$$

$$\text{mol}_{\text{EtOH}} = (\text{mol}_{\text{glucose}}) (2 \text{ mol}_{\text{EtOH}} / 1 \text{ mol}_{\text{glucose}}) = 11.6 \text{ moles (assume 100\% conversion and no yeast growth)}$$

$$\text{MW}_{\text{EtOH}} = 46.07 \text{ g / mol}$$

$$m_{\text{EtOH}} = \text{mol}_{\text{EtOH}} (\text{MW}_{\text{EtOH}}) = 534.412 \text{ g} = 0.53 \text{ kg}$$

(Assume no  $\text{CO}_2$  is left)

$$m_{\text{mix-4}} = m_{\text{mix-3}} - m_{\text{CO}_2} = 3.93 \text{ kg}$$

$$x_{\text{EtOH}} = 0.14$$

$$x_{\text{liq. mix.}} = 0.84$$

### Process 5: Clarification

$$m_{\text{mix-4}} = 3.93 \text{ kg}$$

$$m_{\text{strain}} = 0.05(m_{\text{mix-4}}) = 0.1965 \text{ kg}$$

$$m_{\text{mix-5}} = m_{\text{mix-4}} - m_{\text{strain}} = 3.73 \text{ kg (Wine)}$$

Percent Alcohol by Volume from Specific Gravity

$$\% \text{Alcohol by Volume} = (\text{Initial Gravity} - \text{Final Gravity}) \times 131.25$$

**Raw Data Sheets**

	Magnitude	Unit
<b>Preparation of Apples</b>		
Weight of Raw Apples (whole)		g
Weight of Distilled Water (2 liters)		g
Weight of Apples (Cleaned and Trimmed)		g
Weight of Dried & Sterilized Fermentation Vessel 1		g
Weight of Dried & Sterilized Fermentation Vessel 2		g
<b>Extraction of Juice</b>		
Temperatures of Mixture in Fermentation Vessel 1		°C
Weight of Dried & Sterilized Fermentation Vessel 1 with Mixture that has been cooled off		g
Temperature of Mixture in Fermentation Vessel 1 before straining		°C
Weight of Strained Solids		g
Weight of Dried & Sterilized Fermentation Vessel 2 with Strained Apple Liquor		g
<b>Fermentation</b>		
Temperature of lukewarm distilled water		°C
Weight of Granulated White Sugar		g
Weight of 1 teaspoon Yeast		g
Weight of Fermentation Vessel 2 with Final Mixture		g
Temperature of Final Mixture in the Fermentation Vessel 2 before covering		°C
Specific Gravity (Initial)		
<b>Aging or Maturation</b>		
Weight of Fermentation Vessel 2 with Residuals		g
Weight of Fermentation Vessel 1 with Siphoned Liquid		g
Weight of Fermentation Vessel 1 with Final Mixture		g
<b>Final Clarification</b>		
Weight of Fermentation Vessel 1 with Mixture before Straining		g
Temperature of Mixture in Fermentation Vessel 1 before Straining		°C
Weight of Dried & Sterilized Cheesecloth and Strainer before Straining		g
Weight of Dried & Sterilized Fermentation Vessel 2 before Straining		g
Weight of Fermentation Vessel 1 after Straining		g
Weight of Cheesecloth and Strainer after Straining		g

Weight of Fermentation Vessel 2 with the Strained Liquid		g
<b>Bottling and Labeling</b>		
Weight of Fermentation Vessel 2 with Aged Apple Wine		g
Temperature of Mixture in Fermentation Vessel 2 before Straining		°C
Weight of Dried and Sterilized Wine Bottles before Siphoning		g
Weight of Wine Bottles with Siphoned Aged Apple Wine		g
Temperature of Siphoned Aged Apple Wine in Wine Bottles		°C
<b>Post-Lab Analytics</b>		
pH level of final product wine		
Specific gravity of final product wine		
Percent Alcohol by Volume		%