PREPARATION OF WINE USING RED BANANAS, *MUSA SAPIENTUM* AND CAVENDISH BANANA AND DETERMINING ITS PHYSIOCHEMICAL CHARACTERISTICS

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Abstract

Banana is a sweet fruit with firm and creamy flesh is available throughout the year. It consists mainly of sugars and fibres which make it a source of immediate and slightly prolonged energy. Fermentation of three different species of bananas was carried out for 28 days and its physiochemical characteristics like sensory evaluation, pH, reducing sugar content, alcohol content, titrable acidity, TSS and TDS were observed after every 7 days. Yeast used was *Saccharomyces cerevisiae*. The pH of the systems decreased over a period of 28 days so did the concentration of reducing sugars and suspended solids. The titrable acidity also reduced. The alcohol content increased up to 10% after the fermentation. This study showed that wine can be prepared from banana.

Keywords: Red bananas, *Musa sapient*, Cavendish banana, Fermentation, *S. cerevisiae*, physico-chemical parameters.

1. Introduction

The art of wine making has been around since as early as 7000 BC. Over the years the process spread throughout the world. (Cuber, 2000). The earliest winery was found in Armenia around 41000BC. Vintners used their feet to crush grapes and collect their juice in a vat where it would ferment. The process for wine making is still very much the same but nowadays it is more precise and done at a very large scale with better technology. Wine is an alcoholic beverage produced by yeast fermentation of ripe grapes or any other fruit with a good proportion of sugar. Wine can be fermented with yeast that occurs naturally in grape which is the main organism responsible for alcoholic fermentation which belongs to the genus Saccharomyces. Although many genera and species of yeast are found in must, *Saccharomyces cerevisiae* is the main yeast strain that is commonly reported to be alcoholic fermentation. Wine represents a safe and healthy beverage; it also provides calories and vitamins. Wine as a beverage assumes a vital place in human life, including in spiritual, economic, and societal contexts (Ezemba, 2022). Grapes are usually preferred because of the natural chemical balance of the grape juice which aid in their fermentation process without the addition of sugars, acids, enzymes, or other nutrients. However, fruits such as banana, cucumber, pineapple etc. can also be used in wine production (Ogodo et al., 2015). Production of home-made wine has been practiced with various fruits such as apples, pears, strawberrys, cherries, plum, banana, pineapple, etc. The dry yeast which converts the sugar in the fruit juices into alcohol and organic acids have been used in homes to produce the wine (Ogodo et al., 2015). Wine is preserved by chemical or by physical means. The chemicals which have been used include Bisulphites, diethyl percarbonate and sorbic acid. Physical means include pasteurization and membrane filtration (Okafor et al., 2007). Although, the most common wine preservatives are sulphur dioxide, sodium bisulphate and sodium metabisulphite (Svens et al., 2008). Banana is one of the most important food crops of the world which is consume extensively throughout the tropics because of its availability throughout the year (Holmaseet et al., 1990). Banana juice can also be used for wine production; however, banana juice is turbid, grey in colour, very viscous, tends to settle during storage and, therefore must be clarified prior to commercialization. The turbidity and viscosity of banana wine are caused mainly by the polysaccharides in banana juice such as pectin and starch and therefore make the clarification process harder. Pectinase and amylases can also be used to improve the quality of banana wine (Ezemba, 2022). There are more than 1000 kinds of bananas contained in about 30 subgroups, with the two broad divisions being dessert bananas and cooking bananas (Fig. 1).
Ref: [https://www.onlyfoods.net/types-of-bananas.html](https://www.onlyfoods.net/types-of-bananas.html)

Fig 1: Types of bananas (onlyfoods.net)

*Musa sapientum* (gold finger) banana was developed in 1988 by scientists in Honduras. It is a unique hybrid dessert variety possessing pest resistance properties. It is initially green and gradually changes to yellow upon ripening. The banana has a sweet taste, with flavours of apple evident. When green it cooked and even made into chips and when ripe it is eaten raw and widely used in desserts its property in Australian market is increasing rapidly. However, it is yet to make a mark in Europe and North America (onlyfoods.net).

Cavendish bananas accounted for 47% of global banana production between 1998 and 2000, and the vast majority of bananas entering international trade (en.m.wikipedia.org). The fruits of the Cavendish bananas are eaten raw, used in baking, fruit salads, etc. The outer skin is partially green when bananas are sold in food markets, and turns yellow when the fruit ripens. As it ripens the starch is converted to sugars turning the fruit sweet. When it reaches its final stage, brown/black "sugar spots" develop. When overripe, the skin turns black and the flesh becomes mushy (en.m.wikipedia.org).

Red bananas are a subgroup of bananas from Southeast Asia with red skin. They’re soft and have a sweet flavour when ripe. Red bananas provide many essential nutrients and may benefit your immune system, heart health, and digestion. Like yellow bananas, red bananas provide essential nutrients. They’re particularly rich in potassium, vitamin C, and vitamin B6 and contain a fair amount of fibre (Mishra and Tadepalli, 2020).

Fig 2: Cavendish banana  
Fig 3: Musa Sapient  
Fig 4: Red bananas

### 2. Materials and Methodology

#### 2.1 Preparation of must:

**Materials:** Glass bottles with lid, wooden spoon, yeast (baker's yeast *S. Cerevisiae*), Potassium Metabisulphite, weighing balance

3 different species of banana: *Cavendish Banana, Musa sapientum* banana, *red banana*

**Methodology:**

A dozen of bananas of each of the three species were taken ground using a grinder without addition of water. Three 1 litre glass bottles filled with 700ml of water were autoclaved at 121°C for 15 min. They were allowed to cool down. 300ml of this banana paste was added to each of the bottles and stirred to make the must (Tamrakar et al., 2019).

#### 2.2 Fermentation

The fermentation process is the critical operation in the making of wine. In the primary stage, the contents of the bottles were mixed twice daily and aerated. Later the mixing was discontinued to aid fermentation (Mishra and Tadepalli, 2020).

#### 2.3 Determination of physiochemical characteristics of wine

Various tests were performed to keep check on the quality of wine. The tests were performed at every 7-day interval i.e., 0th day, 7th day, 14th day and 21st day (Tamraker et al., 2019).
2.3.1 Sensory evaluation
The wines produced were compared for colour, flavour, taste, clarity, and overall acceptability. (Ogodo et.al., 2015).

2.3.2 Determination of pH value
Material: pH paper
Method: pH of the wine was checked using pH paper. 10ml of the juice was measured into a sterile beaker and checked for any changes in the pH.

2.3.3 Determination of Reducing sugar
Materials: DNSA reagent, test tubes, pipette, test tube stand, colorimeter, distilled water, water bath, glucose solution (100mg/ml) for standard.
Method: The quantitative estimation of reducing sugar of the juice was determined using DNSA method (Twumasi, 1999). 10 test tubes were taken and glucose solution was added in each test tube according to following table.

<table>
<thead>
<tr>
<th>Glucose solution</th>
<th>Distilled water</th>
<th>DNA (ml)</th>
</tr>
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<tbody>
<tr>
<td>0.1</td>
<td>0.9</td>
<td>1</td>
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<tr>
<td>0.2</td>
<td>0.8</td>
<td>1</td>
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<td>0.3</td>
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<td>0.4</td>
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<td>0.5</td>
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<td>0.6</td>
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3 more test tubes were taken and various wine samples(1ml) were added to them and the reducing sugar content were checked at 540nm in colorimeter. Standard graph was plotted and the unknown concentration of reducing sugar in wine samples were determined using the standard graph.

2.3.4 Determination of alcohol content
Materials: Ethanol, distilled water, test tubes, colorimeter.
Methodology: CAN assay method was used for determination of alcohol content of the wine. Standard graph was prepared using various concentrations (2%, 4%, 6%, 8%, and 10%) of ethanol. the absorbance was taken at 420nm using colorimeter.

3 more test tubes were taken and various wine samples (1ml) were added to them and the alcohol content were checked at 420nm. Using the standard graph, the alcohol % was determined. (Twumasi, 1999).

2.3.5 Total titrable acidity
Materials: Burette 25ml, burette stand, 3 conical flask/beaker, 0.1 M NaOH, phenolphthalein indicator.
Methodology: 1ml sample was taken into the flasks. 5mL distilled water was added and 2-3 drops of phenolphthalein indicator was added.0.1 M NaOH was used to titrate it. The titration was stopped at the appearance of faint, but definite pink colour. The titre was taken. This served as the final titre. The titratable acidity was calculated with reference to tartaric acid. (Ezemba, 2022)

2.3.6 Total suspended solids
Materials: Filter paper, weighing balance, hot air oven, desiccator
Methodology: A pre-weighed filter paper was used to filter the wine sample. The filter paper and filter cake were dried using hot air oven at 105°C for 1 hr. The paper was then placed in desiccator and cooled down. Then the filter paper was weighed again and the total suspended solids were calculated. (Mishra and Tadepalli, 2020).

2.3.7 Total dissolved solids
Materials: Crucible, weighing balance
Methodology: The weight of the crucible was measured using weighing balance. The sample was filtered and the filtrate with the crucible was kept in oven for 1 hour at 105°C. it was allowed to cool down in the desiccator and the weight was taken using weighing balance. (Mishra and Tadepalli, 2020).

3. Result and Discussion
3.1 Visible changes in wine: The colour of the wine for Red and Cavendish bananas changed from brown to pale yellow and that for musa sapient was white throughout the fermentation. In the beginning of the fermentation, the mixture was opaque. As the fermentation proceeded, the solids settled at the bottom of the bottle and frothing was seen at the top (Fig. 5,6).

Fig. 5: Visible changes in wine over the course of fermentation
3.2 Determination of physiochemical characteristics of wine.

3.2.1 Determination of pH: Throughout the period of fermentation, pH of the must was within the acidic range. The pH of the fermenting wine as shown in the graph indicate a gradual decrease in the pH as the fermentation time increased. At day 0 the pH of Red banana was 6, of Musa sapient and Cavendish banana was 5 which decreased to 3.5 at day 28 (Graph 1).

3.2.2 Determination of Reducing sugar: The reducing sugar of the wine decreased as day progressed. This states that the sugar is being reduced to alcohol and CO₂ by yeast cells. The absorption of the DNSA reagent is lowered as the days increased. The absorption range differed with the different species of banana. The decrease in the reducing sugar indicates the use of sugar for fermentation resulting in production of alcohol. The result was found similar to Twumasi, 1999. This is being shown in the graph below (Graph 2).
3.2.3 Determination of alcohol content: The initial alcohol content was between 1.4% to 2% for all the three banana varieties which increased to 9.4% on 28th day for Red bananas, 11.5% for Cavendish bananas and 9.4% for Musa sapient respectively. This result is found to conform to that of Ezemba 2022 who observed gradual increase in the alcohol content in the fermentation of plantain (Graph 3).

3.2.4 Total titrable acidity: The titrable acidity of wine in terms of tartaric acid was calculated and it was observed that the tartaric acid content in the wine decreases as the fermentation progress. Tartaric acid reduces the pH and provide tartness. Tartaric acid plays a key role in the stability of wine and influence the taste, colour and odour of final product. A high tartaric acid content in final bottled wine is indicative of the wine being unstable (Randox food diagnostics) (Graph 4).
Graph 4: Changes in total titrable acidity over a period of 28 days

3.2.5 Total suspended solids (TSS): The initial TSS were in the range of 0.2g/mL to 1g/mL for all the three banana species which dropped down to 0.2g/ml for red bananas, 0.1g/mL for Cavendish bananas and 0.2g/mL for Musa sapient at the end of fermentation. This could be because the yeast degraded the larger particles and used them up for their growth and fermentation (Graph 5).

Graph 5: Changes in the concentration of total suspended solids

3.2.6 Total dissolved solids (TDS): The TDS of the wine also decrease as the fermentation period increases. For Red bananas and Cavendish bananas it was 50g/ml which decreased to 3.9g/ml and 1.2g/ml respectively, for Musa sapient it was recorded 13.8g/ml on 0th day to 1.9g/ml at the end. This could be attributed to the efficiency of the yeast in fermentation. It also implies that consumers are not exposed to the risk of taking in too much solid into the body (Graph 6) (Ogodo, 2015).

Graph 6: Changes in Total dissolved solids over a period of time

Conclusion:
All the objectives of the paper were successfully achieved. It has a lot of nutritional benefits and is available throughout the year. It is a fruit which gets ripe within few days and have high chances of getting contaminated by microbes therefore the ripe bananas can be used in winemaking and hence a lot of bananas can be saved from going waste. The average alcohol content of all three bananas was 10%. Wine was produced successfully and has high chances of banana to produce a palatable wine and compete in the market.

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