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Development of Functional Beverages Based on Sorghum (Sorghum bicolor) Sap Through Controlled Fermentation

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Abstract: The use of sorghum is currently limited to its basic potential, particularly the sorghum grain, which is used as a food ingredient. Sorghum stalks, which produce sap, are typically used as animal feed because they have no economic value. Sorghum is commonly consumed in the form of porridge, bread, chips, and drinks. However, so far, sorghum stalks have only been used for animal feed. Sorghum sap derived from sorghum stalks can be used to make wine, as its composition is higher than sugarcane sap. Wine is made through a fermentation process with the help of Saccharomyces cerevisiae. This study aims to determine the alcohol and glucose levels, organoleptic properties, and polyphenol levels. This study used a Completely Randomized Design (CRD). In this study, the fixed variables used were the glucose content of raw materials, the type of yeast, and pH, while the variable that changed was the % volume of the starter. The experiment was carried out by preparing sorghum sap, then the sorghum sap was poured into an Erlenmeyer flask with nutrients, and added starter (5%, 6%, 7%, 8%, 9%, 10%), operating 21 days and pH 4.3 then analysis of alcohol content and glucose content. The results showed that at % volume of starter 10% and fermentation time 21 days gave the highest alcohol content of 19.5%, glucose content 5.8 brix and total polyphenols 0.3449 mg/mL.

Keywords: Alcohol; Fermentation; Polyphenols; Sorghum; Sorghum sap; Sugar content

Introduction

East Nusa Tenggara, a sorghum-producing region, spans 14 regencies, including Malaka Regency, the largest sorghum cultivation area in West Malaka District. Sorghum utilization is currently limited to its basic potential, particularly the grain, which is used as a food ingredient (Suarni & Herman Subagio, 2013). Sorghum stalks that produce sap are usually used as animal feed because they do not have any economic value (Rahmi et al., 2020). Sorghum is usually consumed in the form of porridge, bread, chips, drinks (Nge & Ballo, 2022).

Sorghum is a sugar-producing commodity that has a short harvest period, namely 2-4 months. When squeezed, sorghum stems produce sap that tastes sweet. One stalk of sorghum can produce 70% sap (Nurdyastuti, 2010). Sorghum sap contains a high glucose content because the quality of sorghum sap is higher than that of sugarcane sap. Andrzejewski in Mujiharto, (2016) stated that the sugar content in sorghum sap (16.8°Brix, total sugar 142 g/L) is not much different and even tends to be higher than that of sugar cane sap (15.7°Brix, total sugar 131 g/L).The use of sorghum as a functional drink has not been widely practiced.

Nira Sorghum can be used as a raw material for making functional beverages, namely wine, because the glucose content in sorghum sap is higher than that of sugarcane sap. The glucose content of sorghum sap contains 61.84% total sugar and also contains bagasse, the residue from pressing the stalks in the form of cellulose, a polysaccharide that is hydrolyzed into, monosaccharides such as glucose which are then converted into alcohol (Noerhartarti & Rahayuningsih, 2013). Wine is an alcoholic beverage produced through a fermentation process. Wine has health benefits when consumed in moderation, including reducing the risk of heart disease (Malingkas et al., 2021), Alzheimer's, preventing cancer, strengthening the immune system

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(Haseeb et al., 2017) and effective in preventing coronary heart disease (Nge et al., 2015)

Fermentation is a technique that can be used to modify the physicochemical and sensory characteristics of a product. One such product is wine. The compounds generally found in wine are ethyl alcohol, esters, amino acids, sugars, and polyphenols (Nge et al., 2016). This nutrition increases because during fermentation there is a release of amino acids and nutrients from the yeast (Swami et al., 2014). The polyphenol content in wine contributes to color and flavor and can act as a natural preservative, allowing it to last longer when stored for extended periods (Nge & Ballo, 2022). The important polyphenol in wine is resveratrol because it has antioxidant properties that can provide health benefits (Colica et al., 2018). Polyphenols are found in abundance in the seeds and skin of fruit. If the seeds and skin are not removed during processing, the product will have higher phenolic compounds (Nge & Ballo, 2019). The amount of polyphenol compounds in wine can vary due to differences in fruit varieties, climate, and degree of fruit ripeness (Arranz et al., 2012).

The fermentation process can affect the concentration of resveratrol in wine, with wines with longer maturation periods having higher resveratrol values. Maturation in wine can increase the sugar, acid, and polyphenol content (Markoski et al., 2016). The purpose of this study was to determine the alcohol content, glucose content, organoleptic and polyphenol content of wine made from sorghum sap through a controlled fermentation process.

Method

The time and place of this research were carried out in December 2024 at the Biology Laboratory of Artha Wacana Christian University, Kupang, and polyphenol testing was carried out at the Politani Kupang Laboratory.

Tools and materials

The tools used in this research are refractometer, plastic basin, Erlenmeyer flask, 150 ml measuring cup, sieve, stainless steel spoon, funnel, bottles (glass and plastic), catter, plastic hose, glue stick, stationery, and camera. Material used in this study is Sorghum stalks were obtained from Umalor village, West Malaka sub-district, Malaka Regencyyeastand several reagents for analysis. The main set of tools used in this research are hoses and fermented bottles.

Research methods

This study used a Completely Randomized Design (CRD). The fixed variables were the glucose content of the raw materials, the type of yeast, and the pH, while the variable was the percentage volume of the starter.

Research Design Stages

1. *Observation Stage*

The observation phase was conducted directly at the research site to determine the conditions at the site. This was done by interviewing local residents regarding sorghum production in Umalor Village, West Malaka District, Malaka Regency. Surveys were also conducted at several plantations to observe the development of sorghum cultivation.

2. *Preparation of Tools and Materials*

Prepare the tools and materials used in this research.

3. *Sampling*

The research sample (sorghum stalks) was obtained in Umalor Village, West Malaka District, Malaka Regency.

4. *Sorghum Sap Extraction*

Before the pressing process, the sorghum stalks are first cleaned. Once all the leaves on the sorghum stalks are clean, the stalks are separated from the outermost layer of skin and then cut into bite-sized pieces.±15 cm. The cut stems are then pounded, then squeezed with a cloth (bathis) to separate the sap from the dregs of the sorghum stalks. The sap from the squeezed sorghum stalks is then filtered using a cloth to remove any impurities. The initial sugar content is then measured.

5. *Making a starter*

Next, the starter is made, namely sorghum sap is poured into an Erlenmeyer flask and yeast (S. Cerevisiae) is added according to the concentration of 5%, 6%, 7%, 8%, 9%, 10%.

6. *Sorghum Wine Making*

The process of separating the sap and raffinate (the raffinate in question is the dregs of the sorghum stalks) is carried out by filtering using a filter cloth. A total of 600 ml of sap extracted from the sorghum stalks is then pasteurized at a boiling temperature of 800 C while stirring, then cooled, separated into six containers according to the starter concentration.5%, 6%, 7%, 8%, 9%, 10%.

7. *Fermentation Process*

For the fermentation process, sorghum sap /The prepared substrate solution is put into the fermenter bottle,then enterThe starter was fermented according to the variables (5%, 6%, 7%, 8%, 9%, and

10%) for 21 days. After that, glucose, alcohol, and polyphenol levels were analyzed, and organoleptic tests were performed.

Observed Parameters

1. Alcohol Content Test

Alcohol content testing was conducted at the UKAW Biology Laboratory. The alcohol content testing procedure was performed using a refractometer. A wine sample was dripped onto the refractometer prism, then the prism was closed, ensuring the liquid was evenly distributed without air bubbles. Then, the scale on the refractometer lens was observed.

2. Glucose Level Test

Glucose levels are determined using a refractometer. Place 2-3 drops of wine on the refractometer prism, carefully close the prism, ensuring the liquid is evenly distributed without air bubbles. Then, observe the scale on the refractometer lens. The Brix value will be displayed on the refractometer lens.

3. Organoleptic Test (Color, Taste, Aroma)

Organoleptic testing was conducted to determine the quality of sorghum wine using 20 semi-trained panelists to assess the quality of sorghum wine. The sorghum wine quality assessment was conducted by giving each selected panelist an assessment form covering parameters such as taste, aroma, and color of the sorghum wine. Each panelist was asked to write down their level of preference for the sample presented by giving a score based on a numerical scale (1-4) on the organoleptic test sheet. The data analysis used was quantitative descriptive analysis by analyzing alcohol content, glucose content, and organoleptic tests of sorghum wine.

Result and Discussion

Alcohol Content Test

Based on research resultswhich was conducted at the Biology Laboratory of Artha Wacana Christian University, Kupang.Measuring alcohol content using a refractometer for starter volume variationsthen the alcohol content value is obtained as follows, namely in Figure 1.

From Figure 1, the greater the % volume of the starter, the greater the alcohol content obtained obtained obtained.With maximum alcohol content achieved at starter concentrations of 9% and 10% with a total alcohol content of 19%. Starter concentration plays an important role in fermentation because it determines the amount of yeast available to convert glucose into alcohol. At 5% starters, the alcohol content produced is 17%, 6% starters produce an alcohol content of 17.5%, 7% starters produce an alcohol content of 18%, 8% starters produce an alcohol content of 18.5%, 9% starters produce an alcohol content of 19%. However, at a starter concentration of 10%, the alcohol content remains at 19%. This shows that increasing the starter concentration above 9% no longer significantly increases the alcohol content because the excess amount of yeast is no longer effective because the availability of sugar as a substrate is starting to be limited.

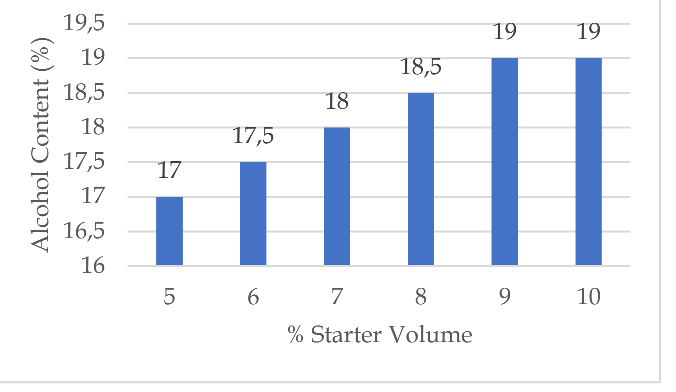

Figure 1. Results of alcohol content of sorghum sap wine

Optimal alcohol content increases up to a 9% starter concentration. At this concentration, yeast activity is at an efficient level, with sufficient yeast numbers to consume sugars without inter-yeast competition. At a 10% starter concentration, even with a higher yeast count, the yeast's ability to produce alcohol does not increase because the available sugars are depleted or fermentation conditions become less than optimal.

Based on research Puspita, (2009), this is because the % starter volume is affected by the lag phase, namely the larger the starter, the shorter the lag phase, so that it quickly reaches exponential growth, namely the yeast grows perfectly and is able to adapt well, so that glucose can be converted optimally and the product begins to form. The function of making a starter is to reduce the lag phase, so that the fermentation time is faster and the ethanol content produced is also greater.

The image above also shows that the optimum point is when the starter volume is increased by 9% with an alcohol content of 19%. When the starter volume is increased by 10%, the alcohol content remains the same, namely 19%. This shows that increasing the starter concentration above 9% no longer increases the alcohol content significantly because the excess amount of yeast is no longer effective because the availability of sugar as a substrate is starting to be limited.

According to Puspita, (2009), the amount of yeast used must be precise because if the yeast used to convert glucose to alcohol is small, the yeast's ability to ferment will be reduced. Likewise, if yeast is used excessively, it will inhibit the fermentation process, resulting in a lag phase (slow growth). In addition, biomass increases. This biomass increase is possible because the fermentation bottle is not tightly closed, allowing air to enter the bottle and causes biomass growth, which results in a decrease in alcohol content. Fermentation must be anaerobic so that biomass does not increase but converts glucose to ethanol. This decrease can also be caused by the conversion of alcohol into other compounds (acid compounds).

Glucose Level Test

The results of glucose level testing using a refractometer showed a difference in glucose levels detected after fermentation. Measurement of glucose levels (brix) can be seenin Figure 2.

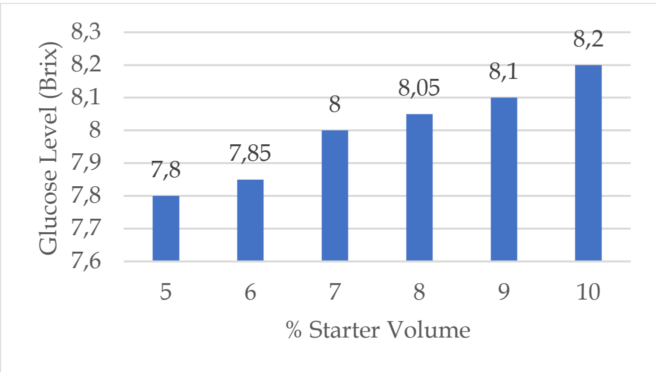

Figure 2. Glucose Level (Brix)

From Figure 2, the results of glucose level testing after 21 days of fermentation, the glucose levels detected were as follows in the 5% starter: glucose level 7.8%, in the 6% starter glucose level 7.85%, starter 7% glucose level 8.0%, starter 8% glucose level 8.05%, starter 9% glucose level 8.1%, starter 10% glucose level 8.2%. The initial sugar content of 15% decreased during fermentation. However, the results showed that the higher the starter concentration, the glucose level increased. The relatively high glucose level (7.8%–8.2%) after fermentation indicates that not all of the sugar in the sorghum sap was converted into alcohol. This is because the high initial sugar content of 15% exceeded the yeast's capacity to convert all sugar to alcohol within 21 days. The results of this study indicate that the higher the starter concentration, the glucose level increased. This could occur due to competition between yeasts that reduces fermentation efficiency or due to the accumulation of alcohol that inhibits yeast activity. In this study Lie et al., (2024) said that a fermentation duration of 21 days may not be sufficient to optimize sugar conversion at higher starter concentrations.

At low starter concentrations of 5%–6%, residual glucose levels were lower, at 7.8%–7.85%, indicating that fermentation activity was more efficient at these concentrations. However, at higher starter concentrations of 7%–10%, glucose levels gradually increased to 8.2%. This indicates that at high starter concentrations, even though more yeast was available, fermentation efficiency decreased. This is because competition between yeast at high starter concentrations can lead to competition between yeast for nutrients, thus decreasing fermentation efficiency. Increasing alcohol levels at high starter concentrations can also inhibit yeast activity, so that sugar is not fully converted. The relatively high initial sugar content contributes to high glucose levels. Some sugar is not fermented because yeast has a certain capacity to consume sugar, and residual sugar will remain in solution if this capacity is exceeded.

The alcohol produced from fermentation can reach levels that inhibit yeast activity, stopping the fermentation process before all the sugars are converted. Based on previous fermentation results, the alcohol content produced increased by 19% up to a starter concentration of 9% but did not increase further at 10%. Detected glucose levels were also higher at starter concentrations of 9%-10%, indicating that fermentation was not running optimally at these concentrations. This is because higher starter concentrations can increase the initial fermentation rate, but at certain concentrations, can cause imbalance or inefficiency in fermentation. Based on research Yumas & Rosniati, (2014), a fermentation duration of 21 days is sufficient for low starter concentrations, but not sufficient to optimize fermentation at high starter concentrations.

Polyphenol Content

The polyphenol content in sorghum sap wine was measured using the Folin-Ciocalteu reagent method, which is based on the reducing power of phenolic hydroxyl groups and is very nonspecific but can detect all types of phenols with varying sensitivity. This oxidation-reduction reaction occurs under alkaline conditions and reduces the phosphotungstate-phosphomolybdate complex with the reagent to a blue color. This method does not differentiate between types of phenolic components. The higher the number of phenolic hydroxyl groups, the greater the concentration of the phenolic component detected. Gallic acid is used as a standard in measuring polyphenol levels. Gallic acid is an organic acid with the chemical name 3,4,5-trihydroxybenzoic acid ($C_6H2(OH)3CO2H$). The standard curve of gallic acid produced has a linear equation $y=0.0637x-0.1019$. The structure of gallic acid can be seen in Figure 3.

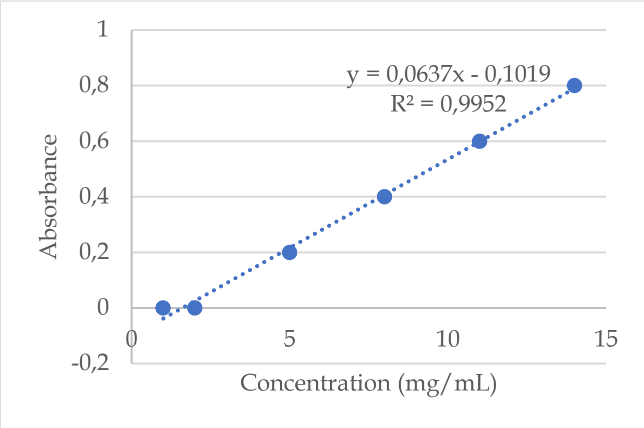

Figure 3. Gallic Acid Standard Curve

Polyphenols are bioactive compounds that act as antioxidants and contribute to the aroma, flavor, and color stability of wine. In this study, the polyphenol content of sorghum sap wine was measured using a spectrophotometer after a 21-day fermentation process with varying yeast starter concentrations (5%, 6%, 7%, 8%, 9%, and 10%). The polyphenol content data can be seen in Figure 4.

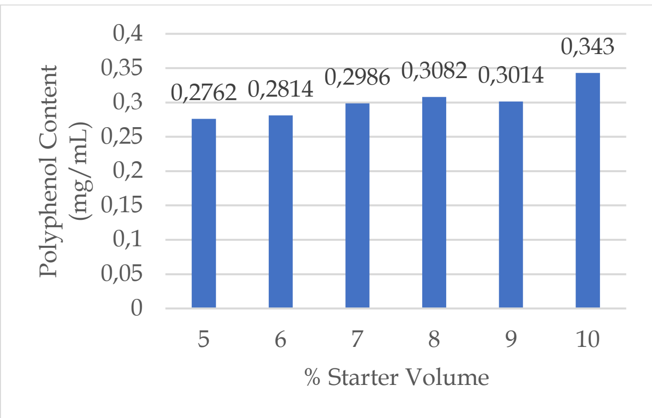

Figure 4. Polyphenol Content

Based on Figure 4, it can be seen that polyphenol levels increase with increasing starter concentration, especially from 5% to 10% starter volume. The results of polyphenol level testing show differences in the polyphenol concentration produced in each starter volume variation, namely 5% starter polyphenol content of 0.2762 mg/mL, 6% starter polyphenol content of 0.2814 mg/mL, 7% starter polyphenol content of 0.2986 mg/mL, 8% starter polyphenol content of 0.3082 mg/mL, 9% starter polyphenol content of 0.3014 mg/mL, 10% starter polyphenol content of 0.3430 mg/mL. This increase in polyphenol levels is thought to be due to the yeast releasing enzymes during the fermentation process that can break down complex compounds into simple phenolic compounds. The fermentation process can increase polyphenol extraction from the substrate. Higher yeast starter increases the activity of microorganisms that contribute to the release of phenolic compounds (Rahmi et al., 2020).

At starter concentrations of 5% to 8%, polyphenol levels increased gradually, from 0.2762 mg/mL to 0.3082 mg/mL. This indicates that the presence of sufficient yeast activity can increase the release of polyphenol compounds through fermentation. At a starter concentration of 9%, polyphenol levels decreased slightly to 0.3014 mg/mL. This decrease may be caused by competition between yeast concentrations, resulting in less than optimal release of phenolic compounds. Alcohol accumulation and changes in fermentation conditions (such as pH) at high starter concentrations can trigger the degradation of certain polyphenols.

At a starter concentration of 10%, polyphenol levels increased to 0.3430 mg/mL. This indicates that at this concentration, the yeast has optimal ability to break down complex compounds and increase polyphenol levels, despite inter-yeast competition. Rahmadi, (2019) stated that starter concentration affects the activity of microorganisms, which play a role in the release and synthesis of polyphenols. High starter tends to produce higher levels of polyphenols. This is in line with Ramadhany & Dera, (2022) stated that during 21 days of fermentation, polyphenol release occurs gradually. However, if fermentation is prolonged, polyphenols can degrade. Changes in pH during fermentation can affect polyphenol stability, with certain conditions leading to degradation of these compounds.

The highest polyphenol content (0.3430 mg/mL) in the 10% starter indicates that a high starter concentration can provide optimal results under certain conditions. This may be due to the high starter producing more enzymes that contribute to polyphenol release. With a higher yeast count, fermentation can break down complex compounds into simpler polyphenols. However, increasing the starter also risks inter-yeast competition and less stable fermentation conditions, as seen in the 9% starter, where polyphenol levels decreased.

Organoleptic Test

Organoleptic Testis a test of a product based on taste. In assessing food ingredients, the properties that determine whether a product is acceptable or not are sensory properties.includes taste, aroma and color. Based on the results of organoleptic tests from 22 semi-trained panelists to provide answers regarding sorghum sap wine with a rating scale of 1-4, namely (1) really dislike (2) dislike (3) like and (4) really like.

Color Aspect

Organoleptic testing is a method of evaluating product quality based on sensory assessment by panelists. In this study, the color aspect of sorghum sap wine was assessed by panelists to determine their level of preference for the color produced after 21 days of fermentation with varying starter concentrations (5%, 6%, 7%, 8%, 9%, and 10%). The results of the organoleptic test for preference in the color aspect of sorghum sap wine can be seen in Table 1.

Table 1. Organoleptic results of the color aspect of sorghum sap wine

Color Aspect	%Starter Volume					
	P1	P2	P3	P4	P5	P6
Very Dislike	1	0	0	0	0	0
Do not like	0	4	18	0	6	0
Like	54	57	21	24	42	42
Really like	12	4	24	56	20	32
Total	67	65	64	80	68	74

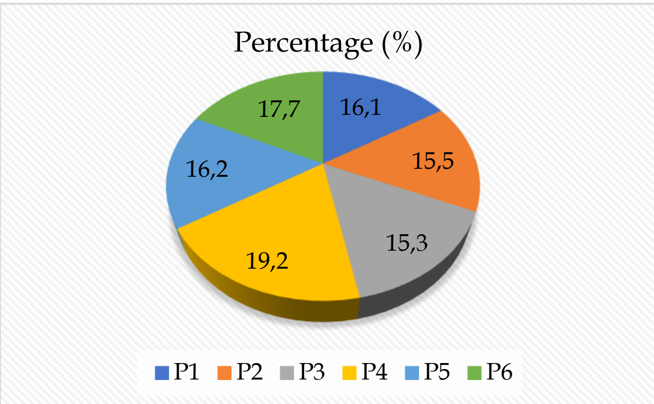

Figure 5. Percentage of Panelists' Preference for the Color of Sorghum Palm Wine

Based on Figure 5, the organoleptic test results show the percentage of panelists' preference for the color of sorghum sap wine as follows: Starter 5% (P1): 16.1%, Starter 6% (P2): 15.5%, Starter 7% (P3): 15.3%, Starter 8% (P4): 19.2%, Starter 9% (P5): 16.2%, Starter 10% (P6): 17.7%. Wine color is influenced by various factors during fermentation, including starter concentration. Starter (yeast) contributes to the formation of certain chemical compounds that affect color, such as polyphenols, natural pigments, or Maillard reactions during the fermentation process. In sorghum sap wine, different starter concentrations produce different levels of color, which affects the panelists' perception of the beauty and visual appeal of the wine.

The highest preference level was found in the 8% starter (P4), where the 8% starter produced the highest color preference level of 19.2%, indicating that this concentration provided the most attractive color or matched the panelists' preferences. The wine color in the 8% starter was clearer, more stable, or had a balanced color intensity, making it more aesthetically pleasing.

The lowest preference levels were at 6% (P2) and 7% (P3) starter volumes, namely 15.5% and 15.3%. This could be caused by the color being too pale, less attractive, so it does not match the panelists' preferences. The 10% starter (P6) provided a preferred color, but not optimal. The highest starter concentration of 8% (P4) produced a preference level of 19.2%. This shows that at 8% concentration, the wine color is clear, and not thick. Starter volumes of 9% (P5) and 5% (P1) had similar preference levels. The 9% starter produced a preference level of 16.2%, while the starter's 5% produced 16.1%. Although the starter concentrations were different, both had almost the same results. This shows that the wine color at these two concentrations had an intensity close to the panelists' preferences but was not optimal. Based on research(Rahmi et al., 2020)Pigments such as anthocyanins, flavonoids, or tannins found in sorghum sap can change during fermentation, influenced by the starter concentration. Optimal starter concentration produces a more stable and attractive color. Fermentation for 21 days influences the formation of color compounds. During this time, natural pigments may have undergone oxidation or transformations that differ with each starter concentration. Temperature, pH, and microbial activity also influence wine color. Too little or too much starter can affect chemical reactions related to color stability and intensity. Wine color is also influenced by product clarity. A more optimal starter can result in more efficient fermentation, thereby reducing particles that cause cloudiness.

Aroma Aspect

The organoleptic aroma test aims to assess panelists' preference for the aroma produced by sorghum sap wine. Aroma is a crucial parameter in determining wine quality because it reflects the volatile compounds produced during fermentation, such as esters, alcohols, and other compounds that contribute to the aroma's characteristics. The results of the organoleptic test of preferences for the aroma aspect of sorghum sap wine can be seen in Table 2.

Table 2. Organoleptic results of the aroma aspect of sorghum sap wine

Aroma Aspect	%Starter Volume					
	P1	P2	P3	P4	P5	P6
Very Dislike	0	0	0	0	1	0
Do not like	24	20	8	4	12	12
Like	24	33	30	24	27	30
Really like	8	4	32	48	24	24
Total	56	57	70	76	64	66

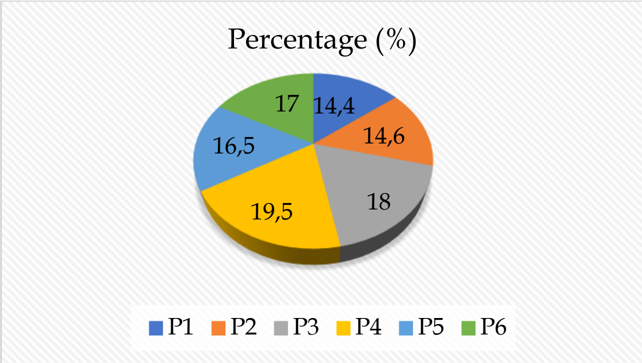

Figure 6. Percentage of Panelists' Preference for Wine Aroma

Based on diagram 6, it shows the percentage of panelists' preference level for wine aroma as follows: Starter 5% (P1): 14.4, Starter 6% (P2): 14.6%, Starter 7% (P3): 18%, Starter 8% (P4): 19.5%, Starter 9% (P5): 16.5%, Starter 10% (P6): 17%. Variations in starter concentration affect wine aroma because yeast concentration determines the speed and efficiency of sugar metabolism into volatile compounds such as alcohol, esters, and organic acids that contribute to aroma. Starter 8% (P4) has the highest preference level (19.5%), which indicates that at this concentration, the volatile compounds produced are in a balanced proportion and produce the most attractive aroma for panelists. At 5% (P1) and 6% (P2) starters, the lowest preference levels were (14.4% and 14.6%), this was due to the aroma being less strong or not complex because fermentation activity at low starter concentrations produced fewer volatile compounds.

The starters at 7% (P3), 9% (P5), and 10% (P6) had medium levels of preference, indicating that these starter concentrations produced an attractive aroma but were not as optimal as the 8% starter. The highest level of preference was found in the 8% starter (P4), at 19.5% for aroma. This indicates that this starter concentration can produce an optimal amount of volatile compounds. The aroma of the wine at this concentration has a balance between fermentation aromas and a slight alcohol aroma, which was considered ideal by the panelists. The lowest preference levels were found for starters with 5% (P1) and 6% (P2), at 14.4% and 14.6%, respectively. Suboptimal fermentation activity at low starter concentrations likely resulted in fewer volatile compounds or a less distinctive and appealing aroma.

The 10% starter (P6) was not preferred more than the 8% starter (P4) resulting in a 17% aroma preference rating, which was lower than the 8% starter. This indicates that starters with too high a concentration can produce an aroma that is too strong or unbalanced, for example, too dominant an alcohol aroma, thus reducing panelists' preference.

The starter concentration affects the amount of active yeast, which in turn impacts the production of volatile compounds during fermentation. Too little starter produces less complex aromas, while too much starter can produce excessive or unbalanced aromas (Rahmasari et al., 2022). Wine aromas come from volatile compounds such as esters, which provide fruity aromas, alcohol, which provides warm aromas, and organic acids, which provide fresh aromas. The concentration of these compounds is influenced by the metabolic activity of yeast during fermentation (Nge & Ballo, 2022). The 21-day fermentation period influences the wine's aroma characteristics. During this time, volatile compounds may have peaked at a certain starter concentration (8%), resulting in desirable aromas.

Taste Aspect

Flavor is one of the main parameters in the organoleptic testing of wine. Wine flavor is influenced by a combination of various compounds produced during fermentation, such as residual sugars, organic acids, alcohol, and other volatile compounds. The results of the organoleptic test of preferences for the taste aspect of sorghum sap wine can be seen in Table 3.

Table 3. Organoleptic Results taste aspect wine sap sorghum

Taste Aspect	%Starter Volume					
	P1	P2	P3	P4	P5	P6
Very Dislike	9	2	2	0	0	2
Do not like	8	22	24	0	4	4
Like	24	21	18	27	51	21
Really like	4	8	8	52	12	44
Total	45	53	52	79	67	71

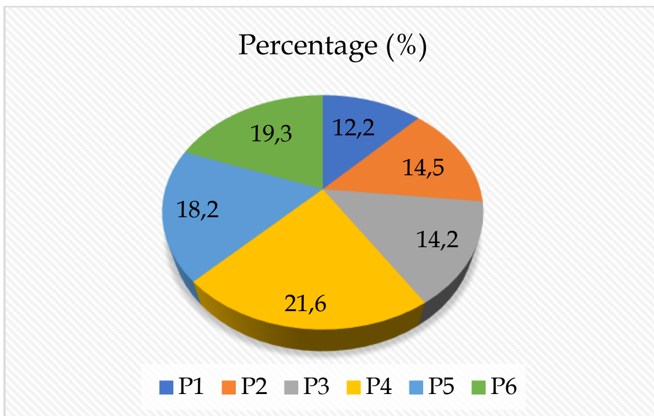

Figure 7. Percentage of Panelists' Preference for the Taste of Sorghum Palm Wine

Based on diagram 7, it shows the percentage of panelists' preference level for the taste of wine as follows: starter 5% (P1): 12.2%, Starter 6% (P2): 14.5%, Starter 7% (P3): 14.2%, Starter 8% (P4): 21.6%, Starter 9% (P5):

18.2%, Starter 10% (P6): 19.3%. The results show that the starter concentration significantly affects the taste of wine, with the highest level of panelists' preference found in starter 8% (21.6%) and the lowest in starter 5% (12.2%). This is due to different fermentation activities at each starter concentration, which impacts the resulting flavor profile, such as the balance between sweet, sour, and bitter.

The highest preference rating at 8% starter concentration (P4), at 21.6%, indicates that the wine's flavor is at its optimal point. The sweetness from residual sugar, the acidity from organic acids, and the warmth from the alcohol are likely in good balance, resulting in a flavor favored by panelists. The lowest liking level at 5% starter concentration (P1), at 12.2%, was due to suboptimal fermentation activity. Low yeast concentrations produce limited flavor compounds, resulting in a less complex or appealing wine flavor. At starter concentrations of 6% (P2) and 7% (P3), the taste preference levels were relatively low, namely 14.5% and 14.2%, indicating that increasing the starter concentration from 5% was not sufficient to produce optimal wine taste.

The highest preference level was found in the 8% starter (P4), which was 21.6%, indicating that this concentration was able to produce the most balanced flavor. This is due to the balance of residual sugar and acid; residual sugar provides sweetness, while organic acids provide a fresh and sharp taste. Furthermore, alcohol provides warmth to the wine's flavor without dominating or adding bitterness. The lowest preference level was found in the 5% starter (P1), which was 12.2%. This was due to suboptimal fermentation activity due to the low starter concentration. The flavor profile was less complex because flavor compounds such as alcohol, organic acids, and volatile esters were not produced in sufficient quantities.

A 10% starter produced a high level of favorability (19.3%) but was still lower than an 8% starter (21.6%). This indicates that too high a starter concentration can produce an unbalanced flavor. Starter concentration affects fermentation intensity, which determines the amount of residual sugar, alcohol, and organic acids in the wine. Too low a starter concentration results in a less complex flavor, while too high a starter concentration can produce a sharp or unbalanced flavor. Residual sugars contribute to the sweetness of the wine. The balance between sweetness, acidity, and bitterness is crucial for determining panelists' favorability. Volatile compounds such as esters and aldehydes influence the aroma and flavor of the wine. A complex and interesting flavor profile usually results from the combination of these volatile compounds (Pratama et al., 2018).

Conclusion

From the research results, it can be concluded that the concentration of yeast starters significantly affects the alcohol content produced, which is 19% at a starter concentration of 10%. The highest glucose content in the 10% starter is 8.2%, while the high polyphenol content indicates the potential of sorghum sap wine as a beverage that has antioxidant benefits. A starter with a concentration of 10% has an optimal polyphenol content of 0.343 mg/mL. The results of organoleptic testing showed that the starter concentration affects the level of panelists' preference for the color, aroma, and taste of sorghum sap wine. A starter concentration of 8% (P4) is the highest level of preference in all three aspects with each percentage of color (19.2%), aroma (19.5%), and taste (21.6%).

Authors' Contribution

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Conflicts of Interest

The author declares that there are no conflicts of interest in this research.

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