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Characteristics of Vinegar from Black Sticky Rice *Tapai* with Different Cooking Methods

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A B S T R A C T

This study aims to (i) determine differences in the cooking method of steaming and cooking method of boiling on the characteristics of vinegar from black sticky rice tapai, (ii) to determine the antioxidant and anthocyanin activity of vinegar from black sticky rice tapai using the steaming method and cooking method of boiling, (iii), to determine the cooking technique that produces the best product based on organoleptic testing and also to find out the results of consumer acceptance tests on vinegar from the best black sticky rice tapai with commercial products. The treatment in this study was the black sticky rice cooking technique by steaming and boiling. The data obtained were analyzed using paired t-test. The results showed that the use of the steaming method and the boiling method had a significant effect ($P<0.05$) on several characteristics of the vinegar produced from black sticky rice tapai, such as acetic acid content, alcohol content, sugar content, anthocyanin content, pH, and antioxidant activity. The total anthocyanins produced in vinegar from black sticky rice tapai using the steaming method were 20.22% and 20.14% for the boiling method, and the antioxidant activity of vinegar from black sticky rice tapai using the steaming method was 92.52% and 92.11% for the boiling method. Based on the organoleptic test, the best product obtained from the highest average preference of panelists for vinegar from black sticky rice tapai was the boiling method with parameters of color, aroma, and taste. Furthermore, in the consumer acceptance test, vinegar from black sticky rice tapai had a higher average preference value compared to commercial products with each parameter, such as color (4.04), aroma (3.92), and taste (3.88).

1. INTRODUCTION

1.1. Research Background

Black sticky rice has advantages over other glutinous rice in the form of high bioactive content, especially total anthocyanins [1]. Anthocyanin is one of the main compounds found in black sticky rice, which has various health benefits. Various studies show the health benefits of anthocyanins, such as antioxidant activity, cardiovascular protection, neuroprotection, increased vision, antidiabetic, anti-obesity, anti-inflammatory effects, cancer prevention and protection, and antimicrobial activity [2].

Vinegar, or vinegar, is one of the most commonly used spices. Vinegar can be made from a variety of ingredients that contain sugar. Black sticky rice processed into t*apai* can be further processed into vinegar. Tapai from black sticky rice that meets the requirements is fermented with Acetobacter aceti starter to produce vinegar [3]. Processing black sticky rice into vinegar is thought to increase the anthocyanin stability of black sticky rice due to the possibility of acylation between anthocyanin and acetic acid in vinegar.

Black sticky rice is cooked first when making vinegar from black sticky rice. Cooking aims to get soft glutinous rice to make it easier for microbes to obtain nutrients for their growth [4]. This cooking is a process of gelatinization of starch. When starch is heated with water above the gelatinization temperature, the starch granules will swell and break [5]. These broken starch granules cause black sticky rice to become soft. People still use traditional methods such as boiling for cooking black sticky rice because it is more practical and less expensive. Therefore, the boiling method and other similar methods, such as steaming is expected to help the community process black sticky rice into products that have more value, such as vinegar.

1.2. Research Objective

The objective of this study is (i) to determine differences in the cooking method of steaming and cooking method of boiling on the characteristics of vinegar from black sticky rice tapai, (ii) to determine the antioxidant and anthocyanin activity of vinegar from black sticky rice tapai using the steaming method and cooking method of boiling, (iii), to determine the cooking technique that produces the best product based on organoleptic testing and also to find out the results of consumer acceptance tests on vinegar from the best black sticky rice tapai with commercial products.

2. MATERIALS AND METHODS

2.1. Materials and Instrumentals

The main material in this study was black sticky rice obtained from a market in Padang City, Indonesia. In addition, other materials such as yeast were also purchased at the market in the city of Padang, and Acetobacter aceti culture was obtained from Gajah Mada University.

The equipment used in this study were glassware, spectrophotometer, shaker, vortex, electric rice cooker, pH meter, Hunter Lab, oven, aluminum cup, refractometer, centrifuge, EDTA tube.

2.2. Methods and Procedures

This study used an exploratory method consisting of 2 treatments and 3 replications.
Treatment A: cooking black sticky rice with the steaming method.
Treatment B: cooking black sticky rice with the boiling method.

2.3. The Process of Making Vinegar

2.3.1. Cooking black sticky rice

The process of cooking black sticky rice was carried out using 2 methods or treatments, namely:

a. Black sticky rice as much as 600 grams was soaked for 12 hours, then cooked by boiling and drained. After that, proceed to the stage of making tapai and making vinegar.
b. Black sticky rice as much as 600 grams was soaked for 12 hours, then cooked by steaming and drained. After that, proceed to the stage of making tapai and making vinegar.

2.3.2. Making Black Sticky Rice Tapai [3]

Black sticky rice tapai was made using black sticky rice in the previous stage, added 6% yeast and fermented for 72 hours under anaerobic conditions.

2.3.3. Making Vinegar from Black sticky rice Tapai [3]

Vinegar from black sticky rice tapai was made from black sticky rice obtained from the previous stage by adding 30% water andAcetobacter aceti as much as 6%. Then fermented for 20 days under aerobic conditions.

2.4. Analysis

2.4.1. Alcohol Content Analysis (Modification of Specific Gravity Method) [6]

Twenty-five milliliters of the sample was added to 100 ml of distilled water and placed in a distilled flask. The mixture is distilled so that the distillate is exactly 25 ml. The pycnometer, whose weight is known is then filled with the resulting distillate and weighed at a specific temperature, for example 28 0C. The weight of the distillate can be calculated from the weight of the picnometer containing the sample minus the weight of the empty picnometer, for example the weight of the distillate = A g. The contents are replaced with distilled water, at the same temperature it is weighed to obtain the weight of distilled water, for example = B g. So that the SG is: Specific Gravity = A (g) B (g) = for example, 0.991 Then find the temperature and convert the ethanol content using the conversion table for the specific gravity of the ethanol content (v/v).

2.4.2. Refractometer Method Sugar Level [7]

The prism of the refractometer is cleaned with lens paper or tissue. Samples were taken with a dropper pipette, then placed on the surface of the prism and slowly closed. The brix value can be determined by looking at the dark and light boundaries. The brix value indicates the total sugar content in the solution.

2.4.3. Total Anthocyanin with pH-differential method [8]

Anthocyanin concentrations were measured in 2 buffer solutions, namely potassium chloride buffer solution (0.025 M) pH 1 and sodium acetate buffer solution (0.4 M) pH 4.5. The absorbance of the two pH treatments was measured with a spectrophotometer at a wavelength of 515 nm and 700 nm. The absorbance value is calculated by the formula:

$$A = [(A515 - A700)]pH\ 1 - (A515 - A700)pH\ 4.5]$$

The anthocyanin concentration was calculated as cyanidin-3-glycoside using a molar extinction coefficient of 29600 L/cm and a molecular weight of 448.8.

$$\text{Anthocyanin concentration (mg/L)} = A \times BM \times FP \times 1000 Ɛ \times l$$

Where A is the absorbance, BM is the molecular weight (448.8), FP is the dilution factor, and Ɛ is the extinction coefficient (29600 L/cm), l is the length of the cuvette (cm).

2.4.4. Antioxidant activity with DPPH [9]

The mixed solution containing 1.5 ml of DPPH solution (4.73 mg of DPPH in 100 ml of ethanol) and 300 µm of sample extract was homogenized and incubated for 40 minutes in the dark at room temperature. The absorbance was read at 515 nm against the control (100%) using a spectrophotometer. The percentage of radical scavenging ability is calculated using the following formula.

$$\text{Scavenging ability (\%)} = \text{Absorbance control-Absorbance sampleAbsorbance control} \times 100$$

2.4.5. pH measurement [7]

The pH meter is calibrated with a buffer solution that matches the pH of the sample. The sample temperature is measured, the pH meter temperature regulator is set at the measured temperature. The pH meter is turned on and allowed to stabilize (15-30 minutes). The electrodes were rinsed with aliquots of sample or distilled water. The electrode is immersed in the sample solution; the pH meter is set. The electrode is left immersed for a while until a stable reading is obtained.

2.4.6. Acetic Acid Content [10]

A 10 mL vinegar sample from the fermented product was taken and put into a 100 mL volumetric flask. then distilled water is added until it reaches the boundary mark then homogenized. The filtrate is taken as much as 10 mL, then put into the Erlenmeyer and added 2-3 drops of PP indicator. After that, it was titrated using 0.1 N NaOH solution until a pink color was formed. Scale readings can be taken from the first time the pink color is formed until a few moments later. The total acetic acid content can be calculated using the formula from Ref. [6], namely:

Total acetic acid = $VNaOH$ × $NNaOH$ × M_r acetic acid × volume of sample× 1000 × 100%

Informations:
V NaOH = Volume of NaOH used up for titration (mL)
N NaOH = Concentration of NaOH (0.1 N) M_r = Relative mass of CH_3COOH (60.05 g/mol

2.4.7. Organoleptic Test [11]

Organoleptic testing was carried out on the resulting product. This organoleptic test included a preference test for the color, aroma, taste of vinegar for each treatment and was carried out by 25 panelists. The test is presented by serving vinegar (vinegar) which has been added with honey and then diluted with 3 dilutions. The test used is a preference test using a numerical scale: dislike very much (1), like (2) usual (3), like (4) and really like (5). More details can be seen in the organoleptic test form in Appendix 6.

The organoleptic test stages in this study were:

a. 5 ml of each sample into the test glass.
b. Each sample is coded randomly with 3 digits.
c. Then an assessment of appearance, taste and aroma was carried out.
d. Panelists must put a mark (√) on the table provided.
e. The test was carried out in a separate room with 25 panelists.
f. The test numbers are listed on the organoleptic test form.

2.4.8. Consumer Acceptance Test

The acceptance test uses the method from research conducted by Ref. [11] modified. The best vinegar obtained is then compared with one vinegar on the market. Vinegar from black sticky rice tapai and market products are subjected to a preference test. This test was conducted on 25 people in general. Parameters tested consisted of color, aroma, and taste. General public correspondents provided ratings for color, aroma, and taste parameters. Public correspondents made observations by seeing the color, smelling the aroma, and tasting the vinegar. The scale used for the assessment is: really dislike (1), like (2) normal (3), like (4) and like very much (5).

3. RESULT AND DISCUSSION

3.1. Analysis of the alcohol content of black sticky rice tapai

It is very important to know the alcohol content of black sticky rice tapai, because knowing the alcohol level of black sticky rice can indicate the formation of vinegar or not. The following results of the alcohol content in vinegar from black sticky rice tapai can be seen in Table 1.

Table 1. The alcohol content of vinegar from black sticky rice tapai.

Treatment	Mean of Alcohol Content ± SD	P-Value
Steaming	8.1567^a ± 0.0152	0.00
Boiling	9.8567^b ± 0.0153	

Note: The numbers in the column followed by lowercase letters are not the same, significantly different according to the Paired sample T-test at the 5% level of significance or if the P-Value <0.05 then H_0 rejected, H_1 accepted and vice versa.

The black sticky rice tapai alcohol content obtained was 8.16% for steaming and 9.86% for boiling. The values obtained were analyzed by paired sample test with a significant level of 5% which was obtained P<0.05. The results of the alcohol content obtained are in accordance with SNI [12], the maximum percentage of alcohol content that is allowed in food and beverage ingredients is between 8-20%.

The alcohol content with the boiling method was higher than the alcohol content in the boiling method. This is due to the formation of black sticky rice tapai, which is the change of glucose to alcohol. This alcohol increases affected by the glucose content in black sticky rice. The black sticky rice glucose comes from the raw materials used. To obtain glucose from raw materials, it begins with the cooking process. The cooking process using the boiling method produces softer raw materials (gelatinization) compared to steaming. The boiling process for products that use starch aims to make the starch undergo a gelatinization process, so that the starch granules expand and the protein is denatured [13]

3.2. Analysis of vinegar from black sticky rice tapai

3.2.1. Acetic Acid Content

The acetic acid content is an important test because the acetic acid content indicates whether the product is vinegar or not. The following results of acetic acid levels in vinegar from black sticky rice tapai can be seen in Table 2.

Table 2. Total acetic acid of vinegar from black sticky rice tapai.

Treatment	Mean of Acetic Acid Content (%) ± SD	P-Value
Steaming	7.6700^a ± 0.14731	0.029
Boiling	8.2033^b ± 0.01528	

Note: The numbers in the column followed by lowercase letters are not the same, significantly different according to the Paired sample T-test at the 5% level of significance or if the P-Value <0.05 then H0 rejected, H1 accepted and vice versa.

Table 2 shows that the acetic acid contents obtained are different for each cooking method used. The results obtained were carried out by the T test, namely the paired sample test with a significant level of 5% which obtained P <0.05 so that it can be concluded that H0 was rejected, which means that the treatment used (different cooking methods) has a significant effect on the acetic acid content produced.

In the table above we can see, where the acetic acid content of vinegar from black sticky rice tapai with the steaming method is 7.67% and the acetic acid level of vinegar from black sticky rice tapai with the boiling method is 8.20%. The acetic acid content obtained in this study complies with SNI [14] concerning the quality requirements for fermented vinegar, namely the limit on the amount of acetic acid content is at least 4%.

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The acetic acid content is largely determined by the alcohol content at the processing stage to become black sticky rice tapai, and alcohol is formed from the sugar content of the raw material, and the raw material can be broken down into glucose, namely by the cooking process of the boiling method and the cooking method of steaming. This is following Adam and Moss [15] which stated that the sugar content strongly influenced the ethanol content produced in the first stage of fermentation in the raw material. This means that the higher the sugar content in the raw material, the more ethanol produced as a substrate for fermentation into acetic acid.

3.2.2. Sugar Content

Sugar content is an important test to do, in this study the sugar content was obtained using refractophotometry. Refractometer is a tool used to measure the level or concentration of a dissolved substance. The following results of the sugar content in vinegar from black sticky rice tapai can be seen in Table 3.

Table 3. Sugar content of vinegar from black sticky rice tapai

Treatment	**Mean of Sugar Content (%) ± SD**	***P-Value***
Steaming	3.9300^a ± 0.02646	0.015
Boiling	4.1267^b ± 0.02517	

Note: The numbers in the column followed by lowercase letters are not the same, significantly different according to the Paired sample T-test at the 5% level of significance or if the P-Value <0.05 then H0 rejected, H1 accepted and vice versa.

In Table 3, it can be seen that the sugar content obtained is different for each cooking method used. The results obtained were carried out by the T test, namely the paired sample test with a significant level of 5% which obtained P <0.05 or had a significant effect on the resulting sugar content. The results obtained showed that the sugar content of vinegar from black sticky rice tapai using the steaming method was 3.93% and the sugar content of vinegar from black sticky rice tapai using the boiling method was 4.13%.

The sugar content obtained in this vinegar was the result of the sugar content not being transformed into alcohol. During fermentation, yeast will break down sugar (sucrose) into glucose and fructose, and glucose is used by yeast to produce ethanol and CO_2. Acetic acid bacteria completely oxidize ethanol to acetic acid and also incompletely oxidize glucose to gluconic acid. The remaining sugar indicates the presence of sugar not utilized by yeast for the formation of ethanol and *Acetobacter acetii* prefers ethanol as a carbon source for the formation of acetic acid.

3.2.3. Anthocyanin Content

In the determination of anthocyanin content, namely by using a pH differential. Anthocyanins are a subclass of water-soluble flavonoids responsible for the red, purple and blue colors in fruits, vegetables, cereals, flowers. So that anthocyanin can be a natural food coloring, besides that, anthocyanin is also believed to be an antioxidant. The following results of anthocyanin levels in vinegar from black sticky rice tapai can be seen in Table 4.

The anthocyanin content of vinegar from black sticky rice tapai obtained was 20.22 mg/100 mL for steaming and 20.14 mg/100mL for boiling. The values obtained were analyzed by paired sample test with a significant level of 5% which obtained P <0.05 so that it can be concluded that the cooking method used had a significant effect. The results of the anthocyanin levels of vinegar from black sticky rice tapai obtained were almost close to those obtained with an anthocyanin content of 21.83% [16].

Table 4. Anthocyanin content of vinegar from black sticky rice tapai.

Treatment	**Mean of Anthocyanin Content (%) ± SD**	***P-Value***
Steaming	20.2233^a ± 0.0115	0.002
Boiling	20.1400^b ± 0.0100	

Note: The numbers in the column followed by lowercase letters are not the same, significantly different according to the Paired sample T-test at the 5% level of significance or if the P-Value <0.05 then H0 rejected, H1 accepted and vice versa.

Anthocyanin vinegar from black sticky rice tapai obtained had a higher content by steaming than by boiling. Based on Ref. [17] anthocyanins were damaged a lot when boiled compared to steaming. This is because in the boiling method, the material is submerged in boiling water with a temperature of 100ºC, so that most of the anthocyanin compounds dissolve in water and are damaged by heat during the boiling process. Heating results in the loss of several nutrients, especially those that are labile such as ascorbic acid, anthocyanin and beta-carotene [18].

3.2.4. Alcohol Content

The alcohol content is the test that must be determined on vinegar. The purpose of knowing the alcohol content in vinegar is to see the results of the remaining alcohol residue after undergoing two stages of fermentation. The following results of the alcohol content in vinegar from black sticky rice tapai is seen in Table 5.

Table 5. Vinegar alcohol content value of black sticky rice tapai.

Treatment	**Mean of Alcohol Content (%) ± SD**	***P-Value***
Steaming	0.0567^a ± 0.00577	0.00
Boiling	0.9333^b ± 0.00577	

Note: The numbers in the column followed by lowercase letters are not the same, significantly different according to the Paired sample T-test at the 5% level of significance or if the P-Value <0.05 then H0 rejected, H1 accepted and vice versa.

The alcohol content of vinegar from black sticky rice tapai obtained was 0.06% for steaming and 0.93% for boiling. The values obtained were analyzed by paired sample test with a significant level of 5% which was obtained P<0.05 (different cooking methods had a significant effect).

The alcohol content obtained is following SNI where, regarding the quality requirements of fermented vinegar, the limit on the amount of residual alcohol is a maximum of 10% [14]. The results of the residual alcohol content obtained in this study decreased, where the results of the alcohol content at the time of making black sticky rice tapai experienced an increase in the amount of alcohol content. This is because it has been broken down into acetic acid. Haumasse [19] states that the decrease in alcohol content occurs because when the fermentation occurs, the alcohol content which has been oxidized by Acetobacter acetii will produce acetic acid and H_2O.

3.2.5. *Antioxidant Activity*

Antioxidant activity is a compound that is able to inhibit the oxidation process, in this study the measurement of antioxidant activity was obtained by the DPPH method. The following results of the antioxidant activity of vinegar from black sticky rice tapai is seen in Table 6.

Table 6. Antioxidant activity of vinegar from black sticky rice tapai.

Treatment	Mean of Antioxidant Activity (%) ± SD	*P-Value*
Steaming	92.5200[a] ± 0.0100	0.008
Boiling	92.1100[b] ± 0.0529	

Note: The numbers in the column followed by lowercase letters are not the same, significantly different according to the Paired sample T-test at the 5% level of significance or if the P-Value <0.05 then H0 rejected, H1 accepted and vice versa.

The antioxidant activity value of vinegar from black sticky rice tapai obtained was 92.52% for steaming and 92.11% for boiling. The values obtained were analyzed by paired sample test with a significant level of 5% which obtained P <0.05 so that it can be concluded that H1 is accepted, which means that the treatment used (different cooking methods) has a significant effect.

The results obtained were in accordance with the results of the anthocyanin levels of vinegar from black sticky rice tapai obtained which were almost close to those obtained by Tanaka et al [16], namely with an anthocyanin content of 92.71%. The high content of the antioxidant activity of vinegar from black sticky rice was influenced by the amount of anthocyanins in the raw materials for vinegar produced.

3.2.6. pH Value

pH measurement is an important test to do, in this study pH measurements were obtained using a pH meter. The results of the pH of vinegar from black sticky rice tapai is seen in Table 7.

Table 7. pH value of vinegar from black sticky rice tapai.

Treatment	Mean of pH ± SD	*P-Value*
Steaming	3.5833[a] ± 0.0001	0.019
Boiling	3.5167[b] ± 0.0057	

Note: The numbers in the column followed by lowercase letters are not the same, significantly different according to the Paired sample T-test at the 5% level of significance or if the P-Value <0.05 then H0 rejected, H1 accepted and vice versa.

The pH value of vinegar from black sticky rice tapai obtained was 3.58 for steaming and 3.52 for boiling. The values obtained were analyzed by paired sample test with a significant level of 5% which obtained P <0.05 or had a significant effect. This decrease in pH is due to microbial activity in yeast which produces acid. According to Ref. [20], tapai yeast contains lactic acid bacteria which can convert glucose into lactic acid. The formation of lactic acid will lower the pH. The decrease in the pH value of tapai is also due to the activity of the Acetobacter aceti bacteria which converts ethanol to acetic acid in the presence of oxygen.

3.2.7. Organoleptic Test

Organoleptic test is a very important test, because this test determines the quality and consumer acceptance of our products. Testing this product using the consumer's five senses. Thus, in this case the aspects tested can be the color, taste, and aroma.

In this organoleptic test using 25 panelists to assess products with a range of numerical scales such as (5) really like, (4) like, (3) normal, (2) don't like, (1) really don't like. The results of the organoleptic test assessment in this study are shown in Table 8.

Table 8. Organoleptic test of vinegar from black sticky rice tapai

Parameter	Treatment	
	Steaming	Boiling
Color	3.80	4.04
Aroma	3.76	3.92
Taste	3.72	3.88

Color is one of the first indicators seen by the human senses. Attractive colors and in accordance with consumer desires are the main attraction in choosing a product [21]. Table 8 shows that the color of vinegar from black sticky rice tapai has a value of 3.80 (steaming) and 4.04 (boiling). This shows vinegar from black sticky rice tapai with color parameters preferred by panelists. Vinegar produced in the boiling and steaming treatment has a purplish-brown color, Vinegar from black sticky rice tapai using the boiling method has a higher preference value than the steaming method. The color of the vinegar produced is influenced by the treatment given. Vinegar from black sticky rice tapai using the boiling method produces a darker color than vinegar from black sticky rice tapai using the steaming method. This color difference is due to the anthocyanin degradation during boiling and steaming [22]. In addition, the color of vinegar is also influenced by the type of base material used [5].

Aroma is the main parameter that determines consumer acceptance of a food product [23.]The aroma that appears in the vinegar from the black sticky rice tapai produced is still normal and is liked by the panelists with a value of 3.76 (steaming) and 3.92 (boiling). Vinegar from black sticky rice tapai made by the steaming and boiling method has a unique sour aroma of vinegar from black sticky rice tapai and is liked by the panelists, meanwhile vinegar made using the boiling method has the highest value compared to steaming, where this aroma is produced from alcohol which is broken down into acetic acid by Acetobacter aceti. The longer the fermentation, the aroma of vinegar from black sticky rice tapai will increase, because the longer the vinegar from black sticky rice tapai ferments, it will taste sour and produce a pungent aroma. Ref. [24] said that the pungent aroma of tapai comes from a fermentation process that produces alcohol and from alcohol to acetic acid.

Taste is the next parameter assessed by the human senses after color and aroma [21]. The most preferred vinegar from black sticky rice tapai with the boiling method by the panelists for the taste parameter was 3.88. Whereas vinegar from black sticky rice tapai using the steaming method has an acceptance level of 3.72. According to panelists, vinegar from black sticky rice tapai with the boiling method has a more favorable taste. Vinegar from black sticky rice tapai using the boiling method has a more distinctive sour taste compared to vinegar from black sticky rice tapai using the steaming method. According to Ref. [25], the resulting sour taste increases because the alcohol-degrading bacteria work optimally and the sugar contained therein decreases during the fermentation process. According to Ref. [26], during the fermentation process Saccharomyces cerevisiae will break down sugar into O_2 and organic acids and other components that can give a special taste.

3.2.8. Consumer Acceptance Test

The consumer acceptance test was carried out on vinegar from black sticky rice tapai which is the most preferred with

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commercial products for parameters of color, aroma, taste and taste. This consumer acceptance test was carried out with the aim of seeing whether the products obtained from the research results are acceptable in the market and compete with commercial products. The results of the consumer acceptance test are presented in Table 9.

Table 9. Consumer Acceptance Test Results for Assessment Parameters

Parameter	**Vinegar from black sticky rice tapai by boiling method**	**Commercial Vinegar (NUTRI GREAT Apple Vinegar)**
Color	4.04	3.84
Aroma	3.92	3.80
Taste	3.88	3.76

The results of the consumer acceptance test showed that the color, aroma, and taste parameters of the panelists judged that the vinegar from black sticky rice tapai had the color, aroma, and taste that the panelists liked somewhat, which can be seen from the slightly higher preference value. This is because the vinegar from black sticky rice tapai has a more attractive color which comes from the raw material used, namely black sticky rice tapai. In addition, commercial vinegar has a more sour and bitter sour taste which affects the consumer's taste assessment parameters, where the value is somewhat lower than vinegar from black sticky rice tapai. The aroma of vinegar from black sticky rice tapai has a higher preference value than commercial vinegar, because the aroma of commercial vinegar tastes a bit sour so that panelists prefer vinegar from black sticky rice tapai.

4. CONCLUSION

1. The use of the steaming method and the boiling method had a significant effect ($P<0.05$) on several characteristics of the vinegar from the black sticky rice tapai produced such as acetic acid content, alcohol content, sugar content, anthocyanin, pH, and antioxidant activity.
2. The total anthocyanin produced in vinegar from black sticky rice tapai by the steaming method was 20.22% and 20.14% for the boiling method. The antioxidant activity of vinegar from black sticky rice tapai using the steaming method is around 92.52% and 92.11% for the boiling method.
3. The best product was obtained from the highest average preference of panelists for black sticky rice tapai vinegar was the boiling method with the most preferred parameters of color, aroma and taste.
4. The results of the consumer acceptance test assessment were obtained by comparing commercial products where the vinegar yield from black sticky rice tapai using the boiling method had a higher average preference value than the commercial product with each parameter such as color (4.04), aroma (3.92), and taste (3.88).

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