

CHEMICAL AND SENSORY CHARACTERISTIC OF SORGHUM (*Sorghum bicolor*) TAPAI WITH TRADITIONAL PACKAGING

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ABSTRACT

Tapai is one of the traditional food from Java island. Nowadays, traditional food is being ignored by people. Conserving traditional foods are needed. Processing into a variety of foods that has good nutrition can make traditional food exist. Sorghum (*Sorghum bicolor*) is a good source of carbohydrates, fibers, phenolic compounds, and antioxidant. However, it has not been fully utilized. Bitter taste, sandy texture and unpleasant aroma in sorghum cause people do not like it. Therefore, this study aimed to develop tapai from sorghum. This study will focus on the evaluation of starch content, pH, acidity content, sugar content and sensory evaluation tapai made from varieties of sorghum and types of natural packaging. The method used in this study was the experimental method using a completely randomized factorial design consisting of two factors, variable of sorghum (white, red and brown sorghum) and types of natural packaging (banana leaf, pandanus leaf, and guava leaf) with two replications. Duncan's multiple range tests were performed with a 5% significance for statistical analysis. Results revealed that the highest starch content was 27,4% in tapai from brown sorghum with banana leaf packaging. Regarding sugar content, tapai from brown sorghum with banana leaf packaging had the highest result. Whereas, based on sensory evaluation, tapai from white sorghum with banana leaf packaging was the most favored by panelists.

Keywords: sorghum, tapai, traditional food, packaging

INTRODUCTION

Lately, the popularity of traditional foods has increased. The rise in food start-up events is one that can create variations of traditional food preparations. According to Guerrero (2010), traditional food is a food product that is often consumed by a group of people or served in certain celebrations and times, passed down from generation to generation, made with hereditary recipes, and has certain characteristics that are different from other regional culinary delights.

Tapai is a traditional food that is popular in the Southeast Asian region, not least in Indonesia (Law, et al. 2018). Tapai is produced from the fermentation process of carbohydrate with the help of yeast (Berlian, et al., 2016).

Tapai as one of the fermented foods has a distinctive taste. Sweetness, acid, and aromas that arise are the result of the breakdown of carbohydrate components into glucose, organic acids, and alcohol by the activity of yeast during fermentation (Barus and Wijaya, 2011). In Indonesia, there are at least some well-known types of tapai namely white sticky tapai, black sticky tapai, cassava tapai (Peuyeum) and Kuningan tapai.

In general, the tapai is made with banana leaf packaging. However, in West Java, Kuningan regency, tapai is packed with guava leaves. The two types of tapai have a distinct aroma. Different types of packaging are thought to cause the tastes of the two tapai to be different. According to Svensson (2004),

volatile and non-volatile compounds in packaging can migrate from packaging to products. This is also supported by the statement of Hernandez and Gavara (1999) that during packaged food, the mass transfer can occur from and to packaging such as water vapor migration, aroma absorption by packaging and absorption of packaging odor by food.

Sorghum (*Sorghum bicolor* L.) is a cereal plant of the Poaceae family that grows in tropical and subtropical regions in the southeastern Pacific and Australia. By the Javanese people, this plant is better known as cantel. The results showed that sorghum can be processed into various products such as rice, tempeh, white bread, cookies and noodles (Suarni, 2016). However, it is still rare to find processed sorghum products that are circulating in the community. The bitterness and taste of sandy texture cause sorghum less in demand by the people (Berlian, 2016) (Schober et al, 2007). Whereas sorghum has the potential as a functional food because it has been shown to have antioxidant activity and contains polyphenols and tannins (Jeon et al, 2017). Therefore, sorghum has the potency to be processed into a very large variety of products.

Previous research has been carried out on tapai such as the physical and chemical characteristics of onggok tapai (Fahmi, N. and Nurrahman, 2011), sensory characteristics of purple yam tapai with different yeast doses (Handayani, 2013), and the influence of cassava types and fermentation time of cassava tapai (Dirayati, 2017). The results showed that the type of starch source, fermentation time and yeast concentration resulted in the characteristics of the tape with different flavors (Handayani, 2013, Dirayati, 2017). However, research has never been done about the use of sorghum as the main ingredient in making tape. Therefore, our research was conducted on sorghum tape. Besides, the study also carried out an analysis of the effect of the use of traditional packaging of banana leaves, guava leaves and pandanus leaves on the chemical characteristics produced.

MATERIALS AND METHODS

Material

The main ingredient was white, red, and brown sorghum obtained from the Organic

Shop Florensia, Surabaya. Commercial yeast tapai, banana leaves, guava leaves, and pandanus leaves were obtained from the Sopyonyono market, Surabaya. Chemicals such as aquades, Na bisulfite, KI, Na₂CO₃.10H₂O, Na₂CO₃, phenolphthalein indicator (PP), obtained from Bratachem stores, NaOH, HCl, H₂SO₄ obtained from Merck.

Methods

Sorghum tapai production

300 grams of each white, red, and brown sorghum were cleaned and then soaked in water for 12 hours with the ratio of sorghum and water (w/v) 1:5. Furthermore, sorghum was cooked in a pressure cooker at 100°C for 20 minutes, then cooking was continued in a steamer for 15 minutes, then cooled at room temperature, then weighed.

One percent of yeast tapai was mixed sorghum (w/w). (Berlian, 2016). The fermentation was conducted in banana leaves, guava leaves, and pandanus leaves packaging. Fermentation was carried out for 48 hours at 30°C in an incubator. The fermented tapai was analyzed for the starch content, total sugar, total acid, pH, sensory evaluation (preference test).

Starch Content

Sample Preparation

0.1 gram sample was weighed in a 250 mL Erlenmeyer, 50 mL of aqua dest was added, and 5 mL of 25% HCl, then heated at 100°C for 3 hours. After being cooled, the suspension was neutralized with 25% NaOH to pH 7. Transfer quantitatively in a 100 mL flask, then adjust until the mark sign with distillate water. This solution is then filtered with filter paper.

Sample analysis

A total of 25 mL of filtrate plus 25 mL of Luff Schoorl solution in Erlenmeyer (25 mL of Luff Schoorl solution with 25 ml of distilled water) were prepared. Erlenmeyer was connected to the return cooler, then bring to a boil. Boiling the solution was maintained for 10 minutes. Subsequently quickly cooled and added 15 mL 20% KI and carefully added 25 mL 25% H₂SO₄. Then closed and placed in a dark place for 30 minutes. The released iodine was titrated with 0.1 N Na₂S₂O₃ solution using a starch indicator of 2-3 mL. To clarify the color change at the end of the titration, it

was advisable to provide starch when the titration was almost over.

Calculation of Starch Content

Starch content obtained by calculating the difference between standard treatment and sample titration, reducing sugar levels after inversion (after being hydrolyzed with 25% HCl) in ingredients can be searched using the inverse sugar difference table before inverse multiplied by 0.9.

$$\text{Starch content (\%)} = \frac{\text{mg glucose} \times \text{FP} \times 0,9}{\text{mg starch sample}} \times 100\%$$

Note:

mg glucose = number in table of *Luff Schoorl*, based on the mL difference of titration

FP = mL filtrated of titrate

Analysis of the Total Sugar Anthrone Method (Morris, 1948)

20 grams of tapai was put into the beaker glass, then 20 mL of water was added. The tapai then crushed by *waring blender* until all the sugar was extracted, and the tapai crumb was transferred to another glass cup quantitatively and then heated to a 100 ° C water bath for 30 minutes. After cooling, the sample was filtered using Whatman filter paper No. 2. The sample was then added 1.5-2.5 mL of saturated acetate Pb solution, then filtered again. 50 mL of the filtrate then added 2.5 grams of dry Na-oxalate.

Standard glucose solution series of 0.2, 0.4, 0.6, 0.8, and 1.0 mL were prepared into the test tube then diluted up to the total volume was 1.0 mL. 1 ml of distilled water was prepared as a blank solution. Then, 5 mL of each Anthrone reagent was added to each standard glucose solution and blank, then vortexed and heated on a 100 ° C water bath for 12 minutes. the absorbance samples were measured with a UV-Vis spectrophotometer at a wavelength of 630 nm, then a plot of data was made between glucose levels and absorbance on a standard curve.

Samples were analyzed by inserting 5 mL of filtrate tapai into a 100 ml measuring flask, then diluted to the mark with distilled water. 1 mL of the sample was put into a closed test tube, then 5 ml of Anthrone reagent was added quickly, then vortexed and heated on a 100 ° C water bath for 12 minutes. After

cooling, the absorbance samples were measured by a UV-Vis spectrophotometer at a wavelength of 630 nm.

Total acid content

Total acid content based on acid levels equivalent to lactic acid levels (Harjiyanti, 2013). Samples were crushed then filtered. 10 mL of filtrate was added with phenolphthalein indicator then titrated with 0.1 N NaOH until finished.

$$\text{Acid Content} = \frac{V1 \times N \times B}{V2 \times 1000} \times 100\%$$

Note :

V1 = volume of NaOH (mL)

V2 = volume of sample (mL)

N = normality of NaOH (0,1N)

B = molecular weight of lactic acid (90)

pH measurements

10 g of the sample were crushed then added 10 mL (1:1) of aquades. The solution was measured by the pH using a pH meter.

Sensory Evaluation (hedonic test)

Sensory evaluation was referred to Sarlina et al (2017). Determination of the tapai favored by the panelists of each treatment, organoleptic assessments were carried out on the quality of the product which included color, aroma, and texture. This test was based on giving panelists a score on quality in terms of color, flavor, aroma, and texture. The number of panelists was 30 people. Rating scores given based on organoleptic assessment criteria were 5 (very like), 4 (likes), 3 (quite likes), 2 (fewer likes) and 1 (dislikes).

Data Analysis

The data obtained were analyzed with ANOVA (Analysis of Variance) with a confidence level of 5%. If there are significant differences then proceed with the Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Starch content

Test of starch content in white, red, and brown sorghum fermented with banana leaves, guava leaves, and pandanus leaves are presented in Figure 1. The results (Figure 1) showed that each sorghum produces a different level of starch after the fermentation process. Sorghum and package significantly influenced starch content ($p \leq 0.05$). The highest of starch content was found in brown sorghum tapai package

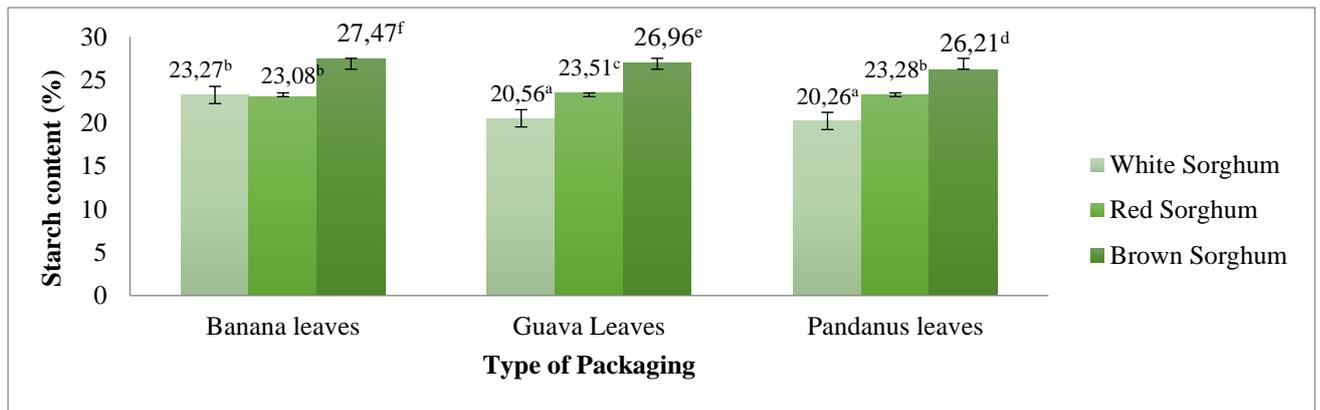


Figure 1. The relationship between the treatment of sorghum type and type of packaging on the starch content (%) of the sorghum tapii

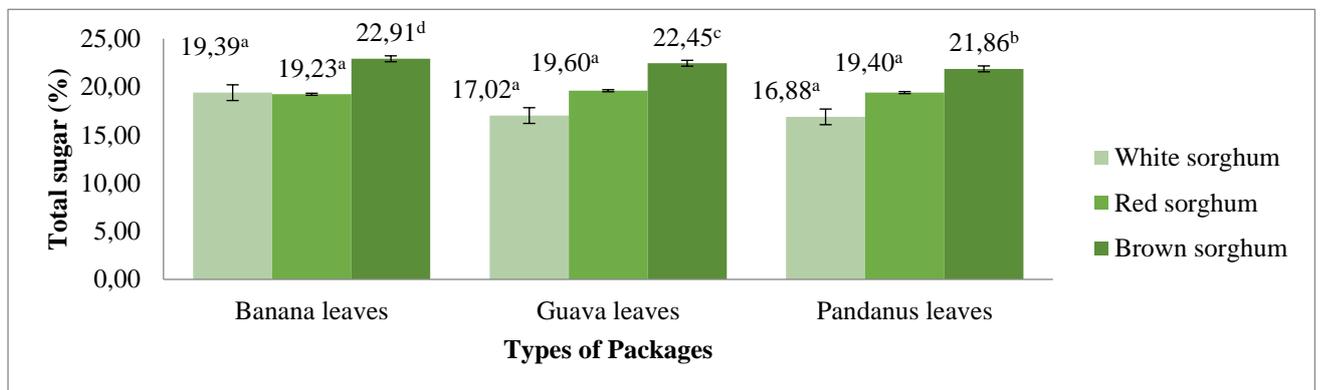


Figure 2. The relationship between the treatment of sorghum type and type of packaging on the total sugar (%) of the sorghum tapii

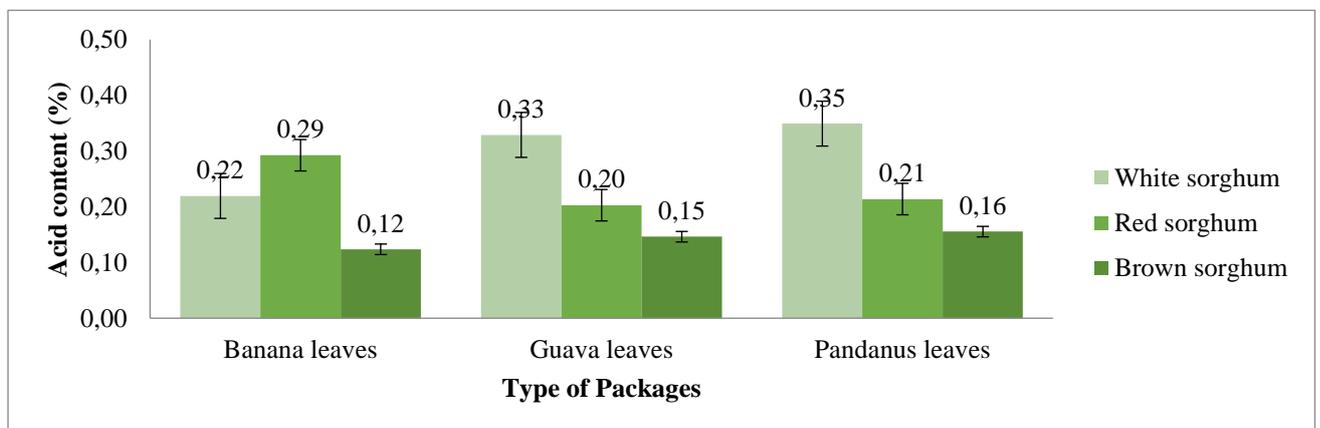


Figure 3. The relationship between the treatment of sorghum type and type of packaging on the total acid (%) of the sorghum tapii

with banana leaves (27,47%), whereas the lowest was white sorghum tapii package with pandanus leaves (20,26%).

According to Boudries *et al*, (2014), the starch content of white sorghum was $66.81 \pm 0.27\%$ and red sorghum $65 \pm 0.11\%$. Starch was used by yeast as the main ingredients of fermentation. Therefore, starch content decrease after the fermentation process. The fermentation process converted starch into

alcohol and organic acids. This was appropriate with Berlian (2016), the cassava fermentation process causes starch levels to decrease after the fermentation process. Microbes in tapii play a role in the fermentation process by remodeling glucose into alcohol. Yeast generally consists of populations of genera *Aspergillus*, *Saccharomyces*, *Candida*, *Hansenulla*, and *Acetobacter* bacteria (Oktaviana, *et. al* 2015).

Total Sugar

The total sugar profile presented in Figure 2. Both sorghum and packaging were significantly influenced total sugar after the fermentation process ($p \leq 0.05$). The highest total sugar was brown sorghum tape in banana leaf packaging (22.9%), while the lowest total sugar was the white sorghum tapi in pandanus leaves. Utami and Noviyanti (2010) stated that in making tapi the hydrolysis stage was represented by the boiling stage. In the process of hydrolysis occurs the addition of water molecules in the breakdown of starch. So, the higher the starch content, the more water is absorbed by the hydrolysis process.

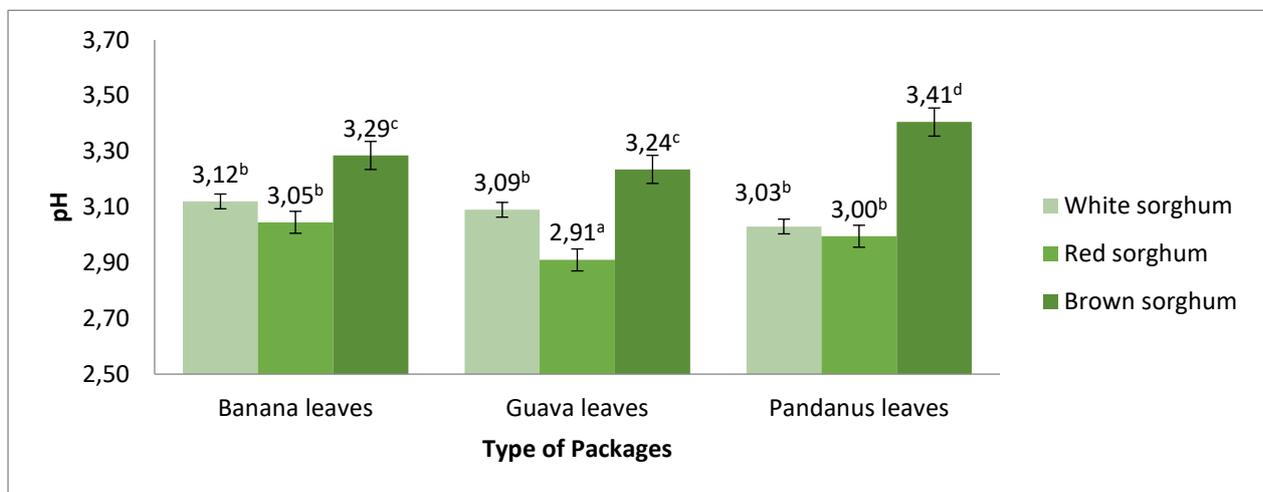


Figure 4. The relationship between the treatment of sorghum type and type of packaging on the pH of the sorghum tapi

In addition to the production of glucose during fermentation, stachyose (a tetrasaccharide containing glucose, fructose, and two galactose units) is also produced during the hydrolysis of starch. Other oligosaccharides such as maltoheptaose, maltohexaose, maltopentaose (highest sugar monomer), maltotetraose and isomaltotriose (lowest sugar monomer) may be produced too (Azmi and Mel, 2014). The result was similar to that reported by Asnawi *et al*, (2013), who found the value of 18-21% for cassava tapi.

Yeast has a role in the formation of reducing the sugar by hydrolyzing starch to sucrose (maltose) then convert to monosaccharide (glucose and fructose), then convert to alcohol, organic acid and the other compounds (Nuraida dan Owens 2014).

Total Acid

Total acid indicates the acidity of a product. In this study, the highest acid content was found in white sorghum tapi with pandanus leaves packaging (0.35%), while the lowest acid content was found in brown sorghum tapi with banana leaves packaging (0.12%). The acids formed were the result of changes from sugars that were converted into alcohol and subsequently undergo changes to organic acids such as lactic acid and acetic acid.

According to Dirayati (2017), the cassava tapi fermentation process begins with the conversion of starch in cassava by the amylase enzyme released by microbes into maltose. Maltose can be converted into glucose by the enzyme maltase. Glucose by the enzyme zymase is converted into alcohol. Furthermore,

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alcohol can be converted to acetic acid, pyruvic acid, and lactic acid by the enzyme alcoholase. The formation of acetic acid, pyruvic acid and lactic acid due to the presence of *Acetobacter* bacteria that are often present in yeast.

Organic acids from alcohols form aromatic esters so that the tape has a distinctive taste. Also, yeast especially *Saccharomyces cerevisiae* can grow at pH 3,5-6,5 well (Oktaviana, 2015).

Prakoso and Santoso in Novianti and Sulandri (2014) in their research stated that the fermentation process in making breadfruit

tapai converted native breadfruit to the soft texture, sour taste, have a sweet aroma and color changes. The sweet taste on the tapai occurred due to the change of carbohydrates into glucose as a simpler carbohydrate, while the sour taste because of the acid in the fermentation process, so fermentation process will increase alcohol levels and total acid content (Fahmi and Nurrahman, 2011).

This is according to the research of Buckle *et al.* (1987) that pyruvic acid is a product formed in the hydrolysis of glucose into ethanol. Pyruvic acid can be converted into ethanol and lactic acid.

Table 1. Organoleptic test

Treatment		Parameter		
Sorghum type	Packaging type	Taste	Aroma	Texture
White sorghum	Banana leaves	2,6 ^{fg}	4,64 ^a	4,32 ^a
	Guava leaves	2,36 ^{gh}	3,76 ^a	4,16 ^a
	Pandanus leaves	2,72 ^{de}	4,24 ^a	4,08 ^a
Red sorghum	Banana leaves	3,08 ^{ab}	4,12 ^a	3,6 ^{ab}
	Guava leaves	2,96 ^{bc}	3,6 ^{bc}	3,24 ^b
	Pandanus leaves	3,16 ^a	3,64 ^{ab}	3,28 ^b
Brown sorghum	Banana leaves	2,68 ^f	3,2 ^{cd}	2,72 ^{ab}
	Guava leaves	2,76 ^{cd}	2,92 ^d	2,72 ^{ab}
	Pandanus leaves	2,32 ^h	2,76 ^d	2,36 ^c

Note: Different letters in the same column indicate significantly different.

pH value

The pH profile presented in Figure 4. Both sorghum and packaging were significantly influenced pH value ($p \leq 0.05$). The highest pH was brown sorghum tape in pandanus leaves (3,405), while the lowest pH was the red sorghum tapai in guava leaves. The result was lower than that reported by Asnawi *et al.*, (2013), who found the pH value of 5,1 for cassava tapai. The formation of organic acids causes the pH of sorghum tapai to decrease (Sujaya *et al.*, 2001).

Changes of pH in fermentation are caused by the activity of yeast cells in addition to producing ethanol as a primary metabolite also produces acids such as malic acid, tartaric acid, citric acid, lactic acid, acetic acid, butyric acid as a by-product. These acids reduce the pH of the medium (Oktaviana, *et al.*, 2015). The result was corresponding to total acid that

brown sorghum tapai has the lowest of total acid.

Organoleptic (Hedonic) Test

The hedonic test is an organoleptic sensory analysis used to determine the magnitude of the quality difference between several similar products by giving an assessment or score of certain properties of a product and to determine the level of liking of a product. This level of preference is called the hedonic scale, for example very like, like, rather like, rather dislike, dislike, very dislike and others (Stone and Joel, 2004). In this study, there were three attributes tested, namely taste, aroma, and texture.

Taste is one of the important attributes in organoleptic testing of food products. The results of the research showed that the highest value of the taste parameter was the pandanus leaf packaging in red sorghum tapai with a value of 3.16 (likes), whereas the pandanus leaf packaging in brown sorghum tapai had the

lowest value of 2.32 (somewhat dislike). The red sorghum tapai packaged with pandanus leaves has a sweet and slightly sour taste.

The taste of sorghum tapai was influenced by the results of fermentation which produces sugar, alcohol, organic acids and carbon dioxide. According to Astawan (2004), the basic principle of starchy food fermentation is the degradation of starch components into dextrans and sugars, which are then converted to alcohol or acid to produce fermented foods that have a sweet, alcoholic and slightly acidic or slightly acidic taste.

This is supported by the statement of Fahmi and Nurrahman (2011) which states that the appropriate time will produce a tape that tastes distinctive, sweet taste with a little acid and the smell of alcohol. The sweet taste due to changes in carbohydrates into glucose as a simpler carbohydrate, while the sour taste because in the fermentation process is formed acid, so the longer the ripening there will be an increase in alcohol content and total acid.

The aroma is the sensation of smell received by the sense of smell when food is put in the mouth. The aroma is very influential on the level of preference of panelists because a good aroma can improve the assessment of the organoleptic properties of a food product. Aroma tapai is caused due to their presence of volatile compounds derived from these products, such as organic acid, alcohol, glucose (Handayani, 2013). The white sorghum tapai with banana leaf packaging had the highest score of 4.65 (likes), while the lowest score was the brown sorghum tapai with pandanus leaf packaging.

The results obtained from the texture parameters showed that all samples have a soft texture. However, panelists gave different values. The white sorghum tapai with banana leaf packaging had the highest value of 4.32 (likes), while the lowest value was the brown sorghum tapai with pandanus leaf packaging which was 2.36 (somewhat dislike). White sorghum tapai generally had the highest average texture compared to red and brown sorghum tapai. Allegedly the white sorghum tapai had a soft texture. Following Hasanah et al, (2012), the fermentation process produces sugar, alcohol, acid and also causes soft texture.

White sorghum tapai with banana leaf packaging was the best treatment sample with an average value of 3.87. The tapai had a sweet, slightly acidic acid, the aroma of alcohol was not too sharp, and the texture was soft. *L. plantarum* is a group of bacteria that produce large amounts of lactic acid as the result of sugar (carbohydrate) metabolism. Lactic acid produced will reduce the pH value of the growth environment and cause a sour taste. The mixture of sour taste from lactic acid, sweetness from the result of sugar degradation, and the presence of alcohol due to the activity of yeast *S. cerevisiae* which converts sugar greatly determine the taste of tape so that it has specific characteristics (Barus and Wijaya, 2011).

CONCLUSION

Results revealed that the highest starch content was 27,4% in tapai from brown sorghum with banana leaf packaging. Regarding sugar content, tapai from brown sorghum with banana leaf packaging had the highest result. Whereas, based on sensory evaluation, tapai from white sorghum with banana leaf packaging was the most favored by panelists.

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