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Effect of Ragi Concentration on the Physical and Chemical Characteristics of Kepok Banana Tape (*Musa paradisiaca L.*)

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Abstract: Banana tape is one of the innovations in processing bananas into new processed products that can be enjoyed by the community, which is almost the same as making tape in general. The purpose of this study was to determine the right variation of ragi concentration on the physical and chemical characteristics of kepok banana tape. This type of research is experimental with the Completely Randomized Design (RAL) method with variations in ragi concentration, namely 0.5 grams, 1 gram, 1.5 grams, 2 grams and 2.5 grams with a fermetation time of 3 days. The parameters of this study include physical analysis (taste, flavor, color and texture) and chemical analysis (glucose, alcohol and pH). The results showed that ragi concentration of 0.5 gram produced the best organoleptic test of taste 3.75, aroma 3.4, color 3.6 and texture 3.45. Chemical tests showed that a ragi concentration of 1.5 grams produced the best results in glucose levels of 7.9%, alcohol 1.24% and pH 4.41. This study has the potential to be used as a contextual chemistry learning medium, particularly in understanding fermentation processes, pH changes, and biochemical transformations in everyday food products.

Keywords: Fermentation; Kepok banana; Ragi concentration; Tape

Introduction

Bananas are a horticultural commodity that is the fourth most important global agriculture after rice, wheat and corn (Sirrappa, 2021). As many as 56.4% of the total bananas in the world are produced by Asia and 50% come from Indonesia. According to data from the (Mentri Pertanian Republik Indonesia, 2024) banana production from 2023 to 2024 will increase by around 481.800 tons, while banana production in the Central Sulawesi region will reach 230.468 tons in 2023 (Badan Pusat Statistik Provinsi Sulawesi Tengah, 2023). However, the amount of banana production in Indonesia is not in line with the level of public consumption, according to data from the (Kementerian Pertanian Republik Indonesia, 2022)it is estimated that the average consumption from 2023 to 2024 will increase by 0.063 kg/capita/year. The amount of abundant banana production and the amount of public consumption is still relatively low, this can cause an increase in waste from bananas. In addition, piang also has a low selling price in the market, so innovation is needed in banana processing to produce new processed products that can increase its economic value (Triana et al., 2023).

Banana tape is one of the innovations in processing bananas into new processed products that can be consumed by the public. One of the bananas that can be used in making tape is the kepok banana. This is based on the fairly high carbohydrate content of kepok bananas, which is 31.04 per 100 grams (Ruhdiana & Sandi, 2023) when compared to ambon bananas which are only 24.72 per 100 grams (Wulandari et al., 2018) with a starch content in kepok bananas of 27.70% (Ruhdiana & Sandi, 2023). The manufacture of banana tape uses the principle of fermentation containing fermentative microorganisms (Nurjannah &

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Nurhikmah, 2020). The condition of tape fermentation is that the raw materials used must contain high starch (Utami, 2017). The starch found in bananas will be used by microbes as a substrate (Muhiddin et al., 2023). Microorganisms contained in the ragi tape will play an active role in the fermentation process, so the concentration of ragi used must be observed. Therefore, research was carried out to determine the right ragi concentration against physical and chemical characteristics so that good quality banana tape and selling value were obtained.

The physical parameters in this study include taste, aroma, color and texture while chemical parameters include glucose, alcohol and pH. This study aims to determine the appropriate ragi concentration variation on the physical and chemical characteristics of the kepok banana tape.

Method

Tools and Materials

The tools used in this study include stove, boiler, strainer, knife, closed container, spoon, open container, digital scale, *blender*, funnel, droppipette, measuring pipette, suction rubber, measuring cup, beaker, beaker, beaker, erlenmeyer, pH meter, 1 set of titration device, electric bath, *thermometer*, test tube, test tube rack, *water bath*, cuvette, UV-Vis spectrophotometer.

The materials used in this study include banana kepok, ragi tape, banana leaves, aquades, filter paper, aluminum foil, *phenolphthalene*, NaOH 0.1 N, *Anthrone reagent*, pH 4 buffer solution, pH 7 buffer solution, Pb-acetate, Na-oxalate, 80% alcohol, $CaCO_3$ solids.

Making Kepok Banana Tape

A total of 500 grams of kepok bananas are washed and steamed with the skin for approximately 30 minutes. Next, it is drained and cooled to room temperature, then peeled and cut into small pieces to facilitate the fermentation process. After that, it is fermented with a ragi concentration of 0.5, 1.0, 1.5, 2.0 and 2.5 grams for 72 hours or 3 days.

Glucose Analysis

Glucose levels were determined using the Anthrone method (Nuryanti et al., 2024). The results obtained will then be analyzed using the equation:

$$\% \text{ glucose content} = \frac{FP \times Concentration\ (x)\ 100\% \times V\ filtrate}{sample\ weight\ (mg)} \quad (1)$$

Alcohol Analysis

Alcohol content was determined using the acid-base titration method (Berlian et al., 2016). The results obtained will then be analyzed using the equation:

$$\text{Alcohol content } (\%) = \frac{a \times M \times Mr\ C_2H_5OH \times FP}{sample\ weight \times 100} \quad (2)$$

Information:
a: Average titration yield (mL)
FP: Dilution factor
M: Molaritas NaOH (0,1 N)
Mr: Massa relativ C_2H_5OH = 46

pH Content

pH determination of kepok banana tape was carried out using a pH meter which was carried out three times of each sample of kepok banana tape (Aryana, 2018).

Organoleptics

The organoleptic testing of kepok banana tape was carried out by 20 panelists from the Chemistry Education Study Program, Tadulako University. The score range from 1-5 from very good to very dislike with the parameters tested include taste, aroma, color and texture.

Result and Discussion

Making Kepok Banana Tape

Figure 1 showing the results of the fermentation of pisag kepok tape using banana leaf wrappers. The use of banana leaves is based on the presence of polyphenols contained in banana leaves which can play a maximum role in the fermentation process and can inhibit the growth of bacteria that can inhibit the fermentation process (Mutmainah & Qomariyah, 2021). The results obtained showed that the kepok banana tape produced a pale yellow color, with a distinctive flavor of the tape and produced a small amount of water vapor which was a by-product of the fermentation process.

Ragi tape result 0.5 gram Ragi tape result 1 gram Ragi tape result 1.5 gram Ragi tape result 2 gram Ragi tape result 2.5 gram

Figure 1. Banana kepok tape

Glucose Analysis

Fermentation is a food processing process to produce new processed products that have distinctive characteristics by utilizing the help of microbes (Azara & Saidi, 2020). The results of the glucose level analysis of banana kepok tape can be seen in Table 1.

Table 1. Results of Glucose Levels on Kepok Banana Tape

Sample	Ragi Concentration	Glucosa Content
Banana kepok tape	0.5 gram	5.6 %
Banana kepok tape	1 gram	7.8 %
Banana kepok tape	1.5 gram	7.9 %
Banana kepok tape	2 gram	7.4 %
Banana kepok tape	2.5 gram	6.0 %

Table 1, it shows that the glucose level of banana tape kepok has increased and then decreased again, where the highest glucose level was obtained at a ragi concentration of 1.5 grams and the lowest concentration was obtained at a concentration of 0.5 grams.

The decrease in glucose levels that occurs can occur due to the microbial activity contained in the ragi tape which will break down starch into glucose molecules and be further converted into alcohol and other organic acids (Dewi, 2018). According to Ninsix, (2013) the more ragi concentration is added, the more microbes will be present in the fermentation process. This can result in a decrease in glucose levels in banana tape kepok. *Saccharomyces cerevisiae* is a microbe found in the ragi tape, will use the starch in the kepok banana as a source of nutrients which will then be converted into alcohol so that the amount of glucose contained in the kepok banana tape will be reduced (Aryana, 2018). The reaction of starch to glucose can be seen in Figure 2.

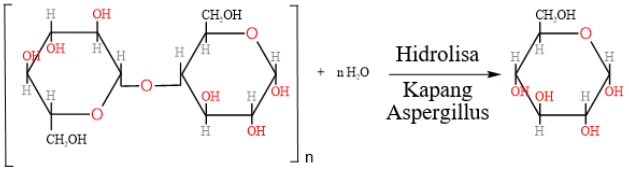

Figure 2. Reaction of starch to glucose

Alcohol Analysis

Alcohol is the result of overhauling glucose with the help of *the enzyme zymase*, determining the alcohol content of banana tape using the acid-base titration method. The results of determining the alcohol content of banana kepok tape can be seen in Table 2.

Table 2 showed that the higher the ragi concentration in the fermentation process of kepok banana tape could cause the alcohol content of kepok banana tape to increase. The higher the level of ragi given, the higher the alcohol content produced.

Table 2. Results of Alcohol Content of Banana Kepok Tape

Sample	Ragi Concentration	Alcohol Content
Banana kepok tape	0.5 gram	0.83%
Banana kepok tape	1 gram	1.15%
Banana kepok tape	1.5 gram	1.24%
Banana kepok tape	2 gram	1.47%
Banana kepok tape	2.5 gram	1.70%

The increase in alcohol content occurs due to the administration of different ragi concentrations. This is due to the increased activity of microorganisms contained in the fermentation process. According to Widiyaningrum, (2009) the high and low alcohol content in a tape product will be very closely related to the number of microorganises found in banana tape kepok. From the difference in the concentration of ragi, this will affect the growth of microorganisms during the fermentation process, which will result in the hydrolysis of starch into alcohol faster than a smaller concentration. The reshuffle of starch into alcohol is assisted by the enzyme *amylase* and the promotion of alcohol into organic acids is assisted by *the enzyme zimase* and converted to organic acids (ethanol) by the enzyme *alcoholase* which causes the sour taste (Dewi, 2018). The reaction of glucose conversion to alcohol and acid can be seen in Figure 3.

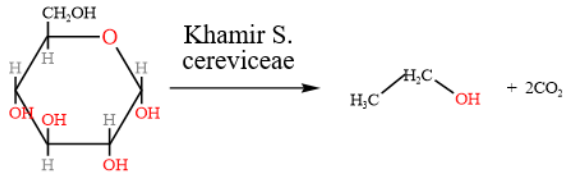

Figure 3. Reaction of glucose into alcohol and organic acids

pH Content

The pH value is one of the parameters used to indicate the acidity level of a processed product (Yuliantoro et al., 2023). The results of measuring the pH of the kepok banana tape can be seen in Table 3.

Table 3. pH Measurement Results

Concentration Variations Ragi (gram)	pH Treatment			Average
	1	2	3	
0.5	4.50	4.50	4.50	4.50
1.0	4.47	4.47	4.47	4.47
1.5	4.41	4.41	4.41	4.41
2.0	4.37	4.37	4.37	4.37
2.5	4.25	4.25	4.25	4.25

Table 3 shows that the higher the ragi concentration in the fermentation process of banana kepok tape, the more acidic the average pH obtained will be. According to Yuliantoro et al., (2023) tape ragi generally consists of mold, ragi and bacteria. The higher the concentration of

ragi tape used, the greater the amount of mold, ragi and bacteria contained in the tape which results in the more amount of starch that is hydrolyzed into glucose, alcohol, acetic acid and other acids so that the pH value of the kepok banana tape will be acidic. In addition, acetic acid bacteria such as *Acetobacter* can also oxidize alcohol and starch into acetic acid. In addition to acetic acid being formed, pyruvic acid and lactic acid can also be formed. Pyrrhic acid is an intermediate product that is formed during the hydrolysis process of glucose into alcohol. Pyruvic acid can also be converted into alcohol and lactic acid with the help of the bacterium *Pedicoccus pentosaseus* (Buckle et al., 1985).

Determination of Organoleprick Hedonic Scale Sensory Test Taste Preferences

Results of organoleptic analysis of the taste of kepok banana tape showed that the higher the concentration of ragi used in the fermentation process, the lower the average organoleptic value of banana tape flavor obtained. This can be seen in Figure 4.

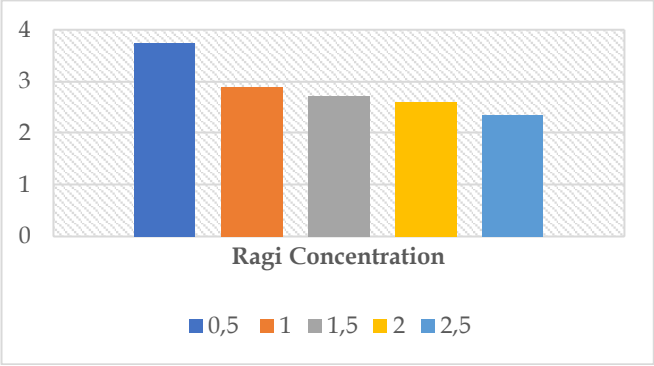

Figure 4. Organoleptic taste test of kepok banana tape

The decrease in the average organoleptic value of the taste of tape banana kepok obtained can be caused by the concentration of ragi used during the fermentation process which can affect the levels of glucose, alcohol and acid produced. The higher the concentration of ragi used, the more ragi, mold and bacteria will remodel the starch into glucose and then further remodel it into alcohol so that the resulting banana tape taste will be less sweet and produce a stronger sour taste (Unika & Astuti, 2015).

Fondness for Scents

The results of organoleptic analysis of the aroma tape of kepok bananas show that the higher the concentration of ragi used in the fermentation process, the average organoleptic value of the aroma of banana tape obtained will decrease. This can be seen in Figure 5.

The distinctive aroma produced by the tape of bananas is caused by microorganisms found in ragi, namely Mucorchlamidosporus and Endomycopsis fibuliger which will break down the starch in bananas into dextrin and simple glucose compounds then Sacchromyces cerevisiae will remodel simple glucose into alcohol. The alcohol will then be oxidized into organic acids, the resulting acids will carry out an esterification process to produce ester compounds which are the components that form the characteristic aroma of tape which has volatile properties (Unika & Astuti, 2015).

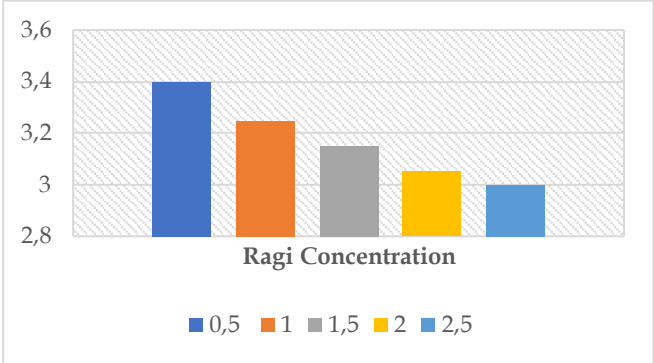

Figure 5. Organoleptic test of the aroma of kepok banana tape

Color Preference

The results of organoleptic analysis of the color of the kepok banana tape showed that the higher the concentration of ragi used in the fermentation process, the lower the average organoleptic value of the color of the banana tape obtained. This can be seen in Figure 6.

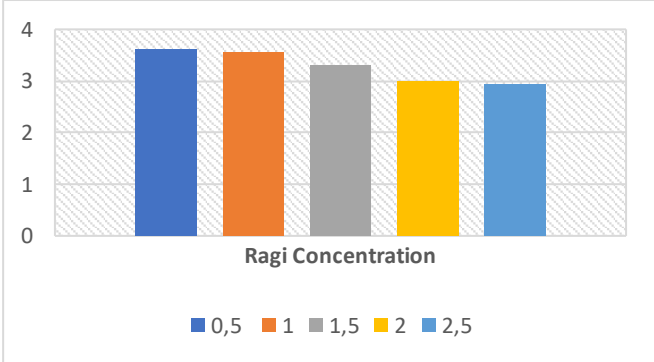

Figure 6. Organoleptic test of the color of kepok banana tape

The fermentation process can cause changes in the color or properties of ingredients due to an overhaul of the content of food ingredients. The color change in the kepok banana tape is caused by the presence of Saccharomyses cerevisiae, Candida, and Hansenula. Saccharomyses cerevisiae is a group of ragi where during the fermentation process will be carried to the surface of the tape by the help of carbon dioxide bubbles, Saccharomyses cerevisiae generally remodel glucose into alcohol and form esters in its further process. The resulting ester is a component that forms the color

change of banana tape to a less bright yellow (Buckle et al., 1985).

Fondness for Texture

The results of organoleptic analysis of the texture of the kepok banana tape showed that the higher the concentration of ragi used in the fermentation process, the lower the average organoleptic value of the banana tape texture obtained. This can be seen in Figure 7.

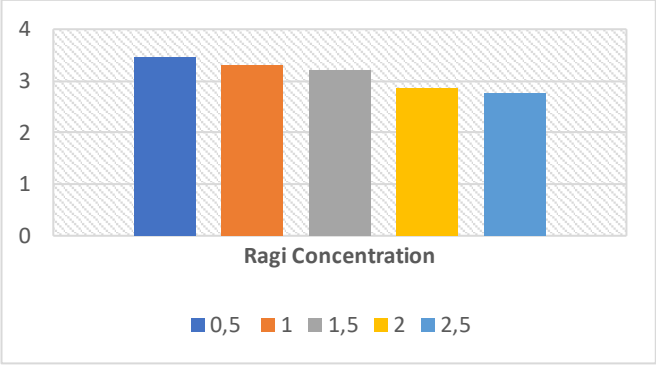

Figure 7. Organoleptic test of the texture of kepok banana tape

The decrease in the average organoleptic value of the texture of the kepok banana tape obtained can be caused by the ragi concentration and the fermentation time used where these two factors will affect the texture of the banana tape caused by the increasing moisture content. The water formed is a byproduct of the fermentation process (Aryana, 2018). During the fermentation process, there is a change in ingredients both physically and chemically. Chemical changes that occur in food during the fermentation process are not entirely caused by microorganisms contained in ragi, it is estimated that the enzymes contained in fermented pagan ingredients also play a role due to the cooking and maturation process (Buckle et al., 1985).

Conclusion

Based on the research that has been carried out, it can be concluded that: The difference in the concentration of tape ragi will have a real effect on glucose, alcohol, pH and organoleptic levels with taste, aroma, color and texture parameters. The best treatment in the organoleptic test of kepok banana tape was a ragi concentration of 0.5 grams where the total taste parameters were 3.75, total aroma was 3.4, total color was 3.6 and total texture was 3.45. The best treatment in the chemical test of kepok banana tape lies in the variation in concentration of 1.5 grams where the glucose content is obtained at 7.9%, the alcohol content is 1.24% and the pH is 4.41. This experiment has has the potential to be used as a contextual chemistry learning medium, particularly in understanding fermentation processes, pH changes, and biochemical transformations in everyday food products.

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Author Contributions

All authors contributed equally to the writing of this.

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Conflicts of Interest

All authors declare that they have no conflict of interest.

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