COMPARISON OF NATA QUALITY FROM CASSAVA PEELS (*Manihot esculenta*), LADYFINGER BANANAS PEELS (*Musa acuminata* Colla), AND DURIAN PEELS *(Durio zibethinus*)

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Abstract : Agricultural waste is composed of carbohydrates which can be be used as a growth medium for bacteria *Acetobacter xylinum* to produce fermented products in the form of nata. Producing nata from fruit waste such as Cassava peels (*Manihot esculenta*), Ladyfinger bananas peels (*Musa acuminata* Colla) and Durian peels (*Durio zibethinus*) is one of the efforts to reduce environmental pollution. This study aims to compare the quality of nata from Cassava peels (endodermis), Ladyfinger bananas peels (endodermis) and durian peels (endodermis) based on the gel thickness, nata yield and organoleptic test. From the results of the study concluded that Durian peels and Ladyfinger bananas peels could be used as an essential ingredient in making nata. *Nata de durio* is the best nata product in terms of thickness, nata yield and organoleptic tests. Meanwhile Cassava peels cannot be used as raw material for making nata.
Keywords : *Acetobacter xylinum*, Cassava (*Manihot esculenta*), Ladyfinger bananas (*Musa acuminata* Colla), Durian (*Durio zibethinus*)

Abstrak : Limbah pertanian terdiri dari karbohidrat, yang dapat digunakan sebagai media pertumbuhan bagi bakteri *Acetobacter xylinum* untuk menghasilkan produk fermentasi dalam bentuk nata. Memproduksi nata dari limbah buah seperti kulit ubi kayu (*Manihot esculenta*), kulit pisang Ladyfinger (*Musa acuminata* Colla), dan kulit Durian (*Durio zibethinus*) adalah salah satu upaya untuk mengurangi pencemaran lingkungan. Penelitian ini bertujuan untuk membandingkan kualitas nata dari kulit ubi kayu (endodermis), kulit pisang emas (endodermis), dan kulit durian (endodermis) berdasarkan ketebalan gel, rendemen nata, dan uji organoleptik. Hasil penelitian menyimpulkan bahwa kulit Durian dan kulit pisang emas dapat digunakan sebagai bahan penting dalam membuat nata. Nata de durio adalah produk nata terbaik dari segi ketebalan, rendeman, dan uji organoleptik, sedangkan kulit ubi kayu tidak dapat digunakan sebagai bahan baku pembuatan nata.
Kata kunci : *Acetobacter xylinum*, Ubi kayu (*Manihot esculenta*), Pisang emas (*Musa acuminata Colla*), Durian (*Durio zibethinus*)

Introduction

Indonesia is known as one of the megadiversity countries (Rizal et al., 2013) because it has high biodiversity in the world (Iskandar, 2017), some of them is agricultural resources in the form of fruits such as Cassava (*Manihot esculenta*), Ladyfinger bananas (*Musa acuminata* Colla), and Durian (Durio zibethinus). Indonesian Ministry of Agriculture stated that the production of cassava in Indonesia in 2019 was 19,341,233 million tons (Kementan, 2020), Based on 2019 data from the Indonesian Central Statistical Bureau (Statistics, 2019) bananas was 7,264,383 million ton, durian was 1,142,102 million tons (Statistics, 2019). A large amount of production from these three commodities causes a lot of waste formed.

They are still considered as waste that is just thrown away by most people. The amount of waste in a long time will damage and pollute the environment so that it will disrupt the balance of the ecosystem in it (Shinta, 2019), efforts need to be made to reduce environmental problems, one way is by making nata derived from fruit waste, besides that the public also likes nata products (Merr et al., 2019). This is correlated with research conducted by Phisalapong which stated that In Asian countries, the majority of nata de coco production is still largely done on a household scale (Phisalaphong et al., 2016), it indicates that the high public taste in nata shown by a large amount of production even though it was still on a household scale.

The fruit peel waste is a large amount of waste material. The nutritional elements contained in it can be used as a basic ingredient in making nata. Making nata is one way that can be done to overcome the problem of household waste with the help of the bacterium *Acetobacter xylinum* (Matura et al., 2013). The component of nata is bacterial cellulose because *Acetobacter xylinum* metabolizes sugar in the medium and is added to cellulose which has unique properties as a nanofiber (Toda, 2016).

Nata is a food product derived from the fermentation process. Requirements for making nata in general, namely the basic ingredients used must have a high glucose (carbohydrate) content. Without the presence of glucose (carbohydrates) nata cannot be formed. Cassava peels (*Manihot esculenta*) in terms of nutrient content turned out to have a fairly high carbohydrate content, namely in 100 grams of carbohydrate-containing as much as 50 grams (Rahmawati, 2010), Ladyfinger bananas peels (*Musa acuminata* Colla) in 100 grams of carbohydrate-containing as much as 18,50 grams (Harlis et al., 2015) and Durian peels (*Durio zibethinus*) in 100 grams of material containing 57,85 grams of carbohydrates (Matura et al., 2013), the peels of these fruits can be used as a basic ingredient in the process of making nata. Based on the description above, a research was carried out on comparing the quality of nata from Cassava peels (*Manihot esculenta*), Ladyfinger bananas peels (*Musa acuminata* Colla) and

Durian peels (*Durio zibethinus*) based on gel thickness, nata yield and organoleptic test. An effort not only to utilize waste but also to explore the candidate for new kind of nata.

Research Methods

This research measures the quality of nata based on gel thickness, the yield of nata and organoleptic test. *Nata de coco* as control, it produces from coconut water, *Nata de Cassava* produce from cassava peels, *Nata de banana* produce from Ladyfinger bananas peels, and *Nata de durio* produce from Durian peels. The culture of bacteria *Acetobacter xylinum* which is the starter of nata comes from Hasanuddin University Makassar.

Making *nata de coco*

600 ml of boiled coconut water into the pan for 3 minutes (in a boiling state), then added 60 grams of sugar, 12 ml bean sprout solution and 30 ml acetic acid and pH measurements were taken. Then removed and put in 200 ml jam bottles each, allowed to cool. 20 ml *Acetabocter xylinum* is added to each bottle and then closed and stored for 14 days at room temperature (27ºC).

Making *nata de cassava*

The peels of cassava are peeled by taking the inner skin (endodermis) then washed and soaked for 2 hours. Furthermore, cassava peels weighed 200 grams, put in a blender and added 600 ml of distilled water, then blended until smooth and filtered to separate the solution with pulp after that the solution was cooked and 60 grams of added sugar added, 12 ml bean sprouts and acetic acid solution as much as 30 ml is added when boiling, allowed to continue boiling while stirring ± 3 minutes then measuring the pH. Then removed and put in a 200 ml jam jar each, allowed to cool. 20 ml *Acetabocter xylinum* is added to each bottle and then closed and stored for 14 days at room temperature (27ºC).

Making *nata de banana*

The inside of a Ladyfinger bananas peels (endodermis) is scraped off using a spoon, weighed 300 grams and put in a blender while adding 600 ml of distilled water, blended until smooth and then filtered to separate the solution with pulp. The solution is cooked and 60 grams of sugar are added, 12 ml of bean sprout solution and 30 ml of acetic acid are added when boiling, allowed to continue boiling while stirring ± 3 minutes and then measuring the pH. Then removed and put in 200 ml jam bottles each, allowed to cool. 20 ml *Acetabocter xylinum* is added to each bottle and then closed and stored for 14 days at room temperature (27ºC).

Making *nata de durio*

The white inner skin (endodermis) is taken and washed from Durian peels, then weighed 300 grams, put in a blender and 600 ml of distilled water added. Blend until smooth and then filtered to separate the solution with pulp. The solution is cooked and 60 grams of sugar are added, 12 ml of bean sprout solution and 30 ml of acetic acid are added when boiling, allowed to continue boiling while stirring ± 3 minutes and then measuring the pH. Then removed and put in 200 ml jam bottles each, allowed to cool. 20 ml *Acetabocter xylinum* is added to each bottle and then closed and stored for 14 days at room temperature (27ºC).

Organoleptic tests

Organoleptic tests include color, texture, taste, and smell. This test is based on the hedonic scale that is used 1 = dislike, 2 = quite like, 3 = somewhat like, 4 = like, 5 = really like.

Results and Discussion

Gel Thickness

Gel thickness is determined based on measurements using callipers.

Table 1. Gel thickness on each nata

Sample	Thickness (mm)
K0 (*Nata de coco*)	15.2 ±1.5[a]
K1 (*Nata de cassava*)	0 ±0[d]
K2 (*Nata de banana*)	3.9 ±0.3[c]
K3 (*Nata de durio*)	5.7 ±0.5[b]

Nata is defined as biomass consisting mostly of cellulose, agar-shaped and white in color. This biomass results from the growth of *Acetobacter xylinum* on an acidic and sugar-containing liquid surface. The availability of sugar which is a source of energy for microbes that can produce acetic acid together with the formation of cellulose that wraps bacterial cells (Toda, 2016). Nitrogen is also very instrumental in the growth of *Acetobacter xylinum*. The nitrogen source used in this study was a solution of mung bean sprouts as a substitute for urea (Budhiono et al., 1999). This research used pure *Acetobacter xylinum* which was obtained from bacterial rejuvenation twice.

The thickness of the cellulose tissue as a result of the fermentation process increases with the increasing amount of sugar added to the fermentation medium (Nugroho & Aji, 2015). This indicates that the availability of sufficient nutrients in the growing medium causes the bacteria to be able to metabolize and reproduce high enough, so that the production of metabolism is even more (Kotatha & Rungrodnimitchai, 2018). Cellulose monomers resulting from the secretion of *Acetobacter xylinum* continue to bind to one another to form layers that continue to thicken along with the ongoing metabolism of *Acetobacter xylinum* (Alberto et al., 2019). The more the secretion of *Acetobacter xylinum*, the thicker the cellulose produced from the fermentation process (Toda, 2016). Table 1 shows the measurement results of the thickness of *Nata de durio* is 0,57 cm and thickness of nata de banana is 0,39 cm, it indicates that the content of nutrients found in durian peels can meet the needs of macronutrients and micronutrients for the bacterium *Acetobacter xylinum* to grow and develop. If the activity of the bacterium *Acetobacter xylinum* increases, the nata produced is also thicker and heavier (Toda, 2016), this research shows that the difference in phytonutrient content and nutrient balance in the medium influences the growth of *Acetobacter xylinum* bacterial cells, it correlated with (Alberto et al., 2019). The thickness of *nata de banana* is lower than that of *nata de durio* which is 0,39 cm, and this is due to the lower carbohydrate content of Ladyfinger bananas peels (18,5%) (Harlis et al., 2015) compared to Durian peels (57,85%) (Matura et al., 2013). The more carbohydrate content in the ingredients used the thicker nata produced (Matura et al., 2013). Cassava peels have carbohydrate content (50%)(Rahmawati, 2010), but in this study, nata could not be formed because this was due to the HCN content contained in cassava peels. Hydrogen cyanide is a weak acid found in many plants such as nuts and tubers. Proper processing of cassava can reduce HCN levels found in the peels of cassava (Hutami & Harijono, 2014).

Soaking treatment with the addition of table salt or NaCl is one way to reduce levels of cyanide acid. One of its properties, NaCl is able to dissolve cyanide acid. Besides the nature of cyanide acid that is easy to react with NaCl in the immersion process. Sodium chloride when reacting with cyanide acid will form sodium cyanide and hydrochloric acid, so that CN molecules that are bound with Na + will also be wasted with immersion water which will be very influential in reducing HCN levels in cassava (Hutami & Harijono, 2014). According to (Arisman, 2017) the optimum concentration of sodium chloride in bitter cassava tubers which is 8% with a decrease in cyanide acid levels of 80.90%. HCN is an acid that dissolves easily in water. Based on Arisman (2008) and Cipollone et al. (2008) in (Sari & Astili, 2018) stated that in the skin of cassava there are HCN compounds that can be reduced by processing such as drying, bleaching, and boiling. Cassava naturally contains the enzyme rhodanese which can detoxify HCN by forming thiocyanate. However, this natural detoxification cannot effectively eliminate HCN (Arisman, 2017). Rhodanase enzyme will catalyze the transfer of sulfur from thiosulfate compounds to cyanide which will form a thiocyanate compound that is not toxic, Cipollone et al. (2008) in (Sari & Astili, 2018). While in this study immersion was only done for 2 hours, and no boiling was done so that HCN did not come out of the cassava peels and caused the formation of *nata de cassava*. Another thing that causes the formation of *nata de cassava* is that the selection of raw materials, Cassava (*Manihot esculenta*) used in making *nata de cassava* must be intact without injury because the amount of cyanide will increase on the skin of cassava if a wound occurs on the tuber or deliberately cut tubers by farmers (Siboro R, 2016). In this study not all Cassava were used intact, some of the cassava used were injured so that it became the cause of the *nata de cassava* failure. Another factor that causes the formation of *nata de cassava* is the concentration of the bean sprout solution which is used very small which is in this study only used the concentration of bean sprout solution as much as 2% in 600 ml. While in the research of Setyaningtyas (Setyangingtyas, 2014) nata de cassava can be formed where the concentration of bean sprout extract is best used is at a concentration of 50% with a thickness of 4.13 mm, so it is suspected that the source of nitrogen used is not enough for food *Acetobacter xylinum*.

Nata Yield

The yield of nata obtained is determined based on the ratio between the weight of nata with the volume of fermentation media.

Table 2. The yield of nata calculation results

Nata	Yield (% w/v)
Nata de coco	21,22%
Nata de cassava	-
Nata de banana	7,55%
Nata de durio	10,83%

Nata Yield is determined based on the ratio between the weight of nata with the volume of fermentation media. From the yield results, the yield of *nata de durio* obtained before washing was 10.83% and *nata de banana* 7.55% lower compared to the yield obtained in the research of Rossi (Rossi, 2008) which ranged from 21.93% to 47.22 %. The results of the analysis of variance in Table 2 show the real difference from each treatment.

The highest yield of nata was produced in the treatment with Durian peels and the lowest was in the treatment of Ladyfinger bananas peels. The tendency of the amount of yield in Durian peels treatment is likely due to the type and content of carbon, nitrogen and mineral sources that are sufficiently met (Obeng et al., 2018). Macro-nutrient and micro-nutrient elements in a medium are needed to support bacterial cell growth and extra-cellular cellulose formation (Fontana et al., 2017). Utilization of carbon and nitrogen sources to a certain extent, will increase bacterial activity for growth and produce high cellulose, which in turn affects the yield (Talawar et al., 2015). The weight of cellulose produced increases with the increasing amount of nutrients added to the growing medium. The more nutrients available, the more interwoven cellulose is produced as a product of secondary metabolites (Fontana et al., 2017). The cellulose intertwining continues to bind to form a strong and compact bond, according to Warsino, the weight of cellulose produced is influenced not only by the thickness of the cellulose but also by the bond cohesiveness, the more compact the bond will increase in weight (Warsino, 2009).

Making nata using Durian peels and Ladyfinger bananas peels was declared successful while making nata from Cassava peels was declared a failure. This is because the HCN content contained in the skin of Cassava and the concentration of the bean sprout solution used is very small so it is suspected that the source of nitrogen used is not enough for the food *Acetobacter xylinum*.

Organoleptic test

Respondents in this study were 20 students, 10 people were asked to compare *nata de coco* with *nata de banana*, while 10 others were asked to compare *nata de coco* with *nata de durio*. Statistic inferential or inductive statistic is a technique of statistic which applied to observe data from the sampling unit, and conclude the result for the whole population (Sugiyono, 2008), 20 student is a sample from 40 student batch 2017 of Biology Department, Science and Technology Faculty, State Islamic University of Alauddin Makassar Indonesia. The questionnaire assessment uses a Hedonic scale (1 = dislike, 2 = quite like, 3 = somewhat like, 4 = like, 5 = really like).

Table 3. Organoleptic test results of *nata de coco* with *nata de banana*

Sample	**Total Preferred-Value**			
	color	**texture**	**taste**	**smell**
Nata de coco	40	38	42	42
Nata de banana	34	29	35	38

Table 4. Organoleptic test results of *nata de coco* with *nata de durio*

Sample	**Total Preferred-Value**			
	color	**texture**	**Taste**	**smell**
Nata de coco	47	43	46	46
Nata de durio	30	41	40	40

The color of food is very important because it can arouse appetite. The actual color of nata produced depends on the base material used, but through the boiling process, it affects the color of the nata to become clear white. To observe the color of the nata produced, a color assessment was conducted by respondents. From the respondent's assessment, it was found that respondents preferred the color of *nata de coco* compared to the color of *nata de banana* and *nata de durio*.

The texture is an appearance from outside which can be directly seen by the appraiser so that it will affect the assessment of whether or not the product is accepted. The actual texture of nata is chewy meaning that when bitten it is not soft and hardened and the nata is not left between the teeth. From the respondent’s assessment, it was found that the respondents preferred the texture of *nata de coco* compared to the texture of *nata de banana* and *nata de durio*.

The taste of nata before it is processed is acidic because it uses acetic acid after the nata is washed and soaked the acid odor disappears and in the process of boiling the nata is added sugar so that the taste becomes sweet (Fontana et al., 2017). From the respondent's assessment, it was found that the respondents liked the taste of *nata de coco* compared to the texture of *nata de banana* and *nata de durio*.

The aroma is difficult to measure so it usually causes different opinions in assessing the quality of the aroma. Differences of opinion are caused by each person having a different sense of smell, although they can distinguish odors, each person has different preferences. Respondents' assessment found that respondents liked the smell of *nata de coco* compared to the texture of *nata de banana* and *nata de durio*.

Based on the organoleptic data the color of *nata de banana* is preferred over the color of *nata de durio* while the texture, taste and aroma of *nata de durio* are preferred over the texture of *nata de banana*. While the results of organoleptic testing by comparing *nata de banana*, *nata de durio* with *nata de coco* as a control, the results show that *nata de coco* is preferred by the 20 respondents compared to *nata de banana* and *nata de durio* in terms of color, taste, aroma and texture. This is because people more often consume *nata de coco* in their daily lives while *nata de banana* and *nata de durio* are the first time consumed by respondents so that they are still adapting to variants of *nata de banana* and *nata de durio*.

Conclusions

Conclusion of this research were Ladyfinger bananas peels (*Musa acuminata* Colla) and Durian peels (*Durio zibethinus*) as part of waste can be used as basic ingredients in making nata, while Cassava peels (*Manihot esculenta*) cannot be used as a basic ingredient. The best nata was *nata de durio* with a Gel thickness 0,57 cm, nata yield 10,83% respectively, and the organoleptic test was preferred over *nata de banana*.

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