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The process of making nata de salacca from honey salak fruit (*Salacca edulis* Reinw) with the application of biotechnology techniques-article review

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ABSTRACT

Salak is typical Indonesian fruit commonly found in tropical countries. This fruit can fill global fruit market via exports to various countries. One of the varieties is "salak madu" ("honey salak"), whose scientific name is (*Salacca edulis* Reinw), which has higher economic value than "salak pondoh super". Some of the characteristics of honey salak are thick flesh, high water content, and sweet taste. Due to its high water content, honey salak rots quickly, resulting in useless waste and causing unfavorable smell. As such, utilization of overripe salak fruit (ripe close to rotten) can be done with implementation of biotechnological approach using *Acetobacter xylinum* to make nata. This study is aimed at utilizing overripe honey salak (ripe close to rotten) by processing it into Nata de salaca and identifying the factors affecting the production of Nata de salaca. The study used systematic review method by reviewing and examining previously published journal articles. The results of this study suggest that overripe salak can be utilized to make Nata de Salaca with the help of *Acetobacter xylinum*. Based on ratio of salak substrate to water, a good Nata has the ratio of 1 : 4. 1. Whereas, based on the factor of sprout extract additive material, it is 3%. Dan Whereas based on optimum duration of fermentation, it is 10 minutes.

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1. Introduction

One of commodities originating from Indonesia is honey salak (*Salacca edulis* Reinw). Honey salak has several health benefits such as improving appetite, giving good effect on eyes, and having potential to prevent cancers. Whereas, some of its advantages are sweet taste like honey, crunchy and soft texture. In addition, honey salak has higher economic value than "salak pondoh". Its price may reach up, meanwhile, its distribution is limited. This is due to its thin skin with large scales, resulting in dry and wrinkled skin caused by evaporation and making it difficult to peel. Drying of honey salak skin causes its quality to decrease quickly (Darmawati, et. al., 2020; Annisaurrohmah, et.al., 2014).

The flesh of honey salak (*Salacca edulis* Reinw) changes its color rapidly. Post-harvest color change is triggered by enzymatic reactions. Such change in color may decrease quality, nutrition, and selling value. Honey salak which experiences color change would rot rapidly due to high

content of ethylene. The rapid decay rotting of honey salak during harvesting season would result in accumulation the produce and over-ripeness of the fruits which cause them not worth selling, ending with the dumping of fruits and may result in becoming fruit waste. Waste can be processed according to its type, i.e. solid, liquid, and gas. Frequently, such wastes are still dumped directly to the environment so that they cause new problems. Some of the effects caused by waste are bad smell and pollution which disrupt comfortable life of community (Azhari & Wiryanto, 2015). Processing waste into nata has promising prospect in the future. Waste of local fruits can be obtained without cost. As such, application of biotechnology by utilizing microbes is required to change them into Nata de Salacca (Pratiwi, et. al., 2015).

Nata is food which is low in sugar and high in fibre. As such, this food is recommended for people with diabetes and cancers, besides having health benefits (Gresinta, et. al., 2019). The making of nata commonly utilize fruits as raw materials such as tomato, salacca, pineapple, coconut, banana, and many more. Nate made of salak as raw material is called Nata de Salacca (Pratiwi, et. al., 2015). Nata de Salacca is rarely introduced to public. Nata de Salacca is nata made through fermentation by *Acetobacter xylinum* with salak fruit as raw material. The salak fruits to be utilized are the ones in overripe condition. The production of Nata de Salacca should put into consideration the ratio of salak substance to the water, since this factor is highly influential to the product. Pratiwi, et. al., (2015) suggested that the production of nata should take into account organoleptic factors of smell, color, and texture. If these factors are ignored, Nata de Salacca will become less interesting to consumers.

2. Method

The study applied article review, i.e. data collection and data processing using literature review. This was done in several steps, i.e. article search, article selection, synthesis, and report writing. Data were analyzed using descriptive analysis technique of qualitative approach where the data collected from the review were described or explained according to the subject studied. The criteria to be included in this study were articles published in the last 10 years, articles on production of Nata de Salacca, utilization of *Acetobacter xylinum*, duration of fermentation, effect of material addition, and effect of ratio of salak concentrate to water. Whereas, the criteria excluded from this study were articles published in less than the last 10 years, articles od starter variation and effect of starter concentration.

3. Findings and Discussion

According to Christie and Lestari (2020), salak fruit contains high nutrition and is beneficial to metabolism of *Acetobacter xylinum* so that nata can be formed. According to Asri (2017), qualities of nata in terms of nutrient content, organoleptics, and product appearance are basically affected by the raw materials.

This study discusses several factors affecting production of Nata de Salacca such as, among others, duration of fermentation, addition of materials, and ratio of fruit concentration to water (Table 1). This is supported by Putri et. al (2021) suggesting that factors affecting production of Nata de Salacca among others are duration of fermentation, addition of materials, use of sterile equipments, etc.

Table 1. Effect of concentration of salak substrate (*Salacca edulis* Reinw) and water dose

Extract	Dose	Result	
		Weight	Thickness
Sprout Extract	1 %	381,6	0,53
	2 %	434,3	0,53
	3 %	438,6	0,57

Study by Silitonga, et. al. (2019) suggested that ratio of 1:2 resulted in dark or brownish color, thickness of 0,6 cm and weight of 452,6 gram. Dark color in this concentration was caused by weight and thickness of nata. Thicker nata would result in darker color. In addition, duration of fermentation would affect color. Longer fermentation would result in darker color. Whereas,

thickness of nata was affected by formation of cellulose tissue. Formation of cellulose tissue was affected by *Acetobacter xylinum* (Putriana & Aminah, 2013). In the ratio of 1 : 4, the resulted nata had clear color, thinner and more flat texture compared to the others. The thickness was 0,6 cm and weight was 437,3 gram. Whereas, the ratio of 1: 6 resulted in white color, thickness of 0,36 cm and weight of 329,6 gram. According to Silitonga, et. al. (2019) nata which was worth using was the one with white color, with the ratio of 1 : 4. Meanwhile, Putriana and Aminah (2013) suggested that the one worthed for nata making was the one with milky white color. It can be seen from the table that the one with milky white color is the substrate to water ratio of 1 : 6.

Table 2. Effect of sprout extract addition (Silitonga, et. al., 2019)

Extract	Dose	Result	
		Weight	Thickness
Sprout extract	1 %	381,6	0,53
	2 %	434,3	0,53
	3 %	438,6	0,57

Table 2 indicated that thicker nata would result in heavier nata (Arifiani, et. al., 2015). In addition, higher concentration of sprout extract would result in thicker nata. Increase in nata thickness is related to availability of nutrients in the fermentation media. Wehereas, quality of nata is affected by growth of *Acetobacter xylinum*. *Acetobacter xylinum* requires sufficient nitrogen to enhance growth, both from organic and anorganic sources (Silitonga, et. al. 2019). Besides that, addition of sprout extract is aimed to improve color and viscocity of nata, as well as to make it more economical (Wahyuni, 2019). The study by Alfarisi, et. al., (2021) suggested that the use of green bean sprout extract resulted in thicker nata due to its high content of cellulose and water. Study by Putranto and Taofik, (2017) suggested that higher concentration of sprout extract would result in less fibres and hence leading to less production.

3.1. Role of *Acetobacter xylinum* bacteria in the Fermentation Process

Acetobacter xylinum is gram negative bacteria, aerobic, and has the ability to perform extracellular synthesis of cellulose. According to Melliawati and Djohan, (2013) *Acetobacter xylinum* was utilized as inoculum to produce relatively large number of cellulose fibres. The application of *Acetobacter xylinum* also played role in giving white color and shiny and smooth surface. This is due to its ability to form cellulose perfectly (Putri, et. al., 2021). Microfibril tissues of cellulose can form in the process of extracellular bacteria fermentation.

Acetobacter xylinum bacteria play roles in production of Nata de Salacca, since the transform nutrients which later would be easier to be absorbed by the body. In addition, application of microbes would affect the flavour of the product. *Acetobacter xylinum* bacteria perform its job by transforming nata-formation components from glucose to cellulose. Carbohydrate in salak serves as the nutrient for the metabolism of *Acetobacter xylinum*. Quality of nata is also affected by duration of fermentation (Lusi, et. al., 2017). Result of nata fermentation can be seen from its physical and chemical characteristics, consisting of pH level, sugar level, and density. Nata produced using *Acetobacter xylinum* shows pH of around 5,79-6,41. According to Rustaman, (2011) when colonies of microorganisms produce acetic acids, gluconic acids, and lactic acids, then there would be decrease in pH, accumulation of gluconic acids, and decrease in sugar concentration.

3.2. Process of Nata Formation

A number of cells of *Acetobacter xylinum* absorb glucose and then unite it with fatty acid. Tissues in the cells are precursors which use enzymes to polymerize glucose becoming cellulose outside the cells of *Acetobacter xylinum*. Within pH range of 3,5-7,5, they would turn into. After that, a thin layer in nata (pellicle) is visible on the surface of the medium and then comes the clarifying process underneath upon 24 hours of incubation. Presence of bacteria inside is indicated by appearance of smooth transparent tissue on the surface. *Acetobacter xylinum* would produce carbon dioxide slowly which would cause floating of nata so that nata is pushed to the surface. Enzymes of *Acetobacter xylinum* would form bacterial polysaccharide which originates from precursors consisting of a number of sugar components such as, among others, manose, glucose, and ribose. Uridine diphosphate glucose (UDPG) is a precursor in the formation of cellulose in *Acetobacter xylinum* bacteria (Rizal, et. al., 2013).

3.3. Effect of Duration of Fermentation on Production of Nata de Salacca

Effect of duration of fermentation on the production of Nata de Salacca and examination of its organoleptics are presented in Table 3 (Salelatu & Rumahlatu, 2016).

Table 3. Effect of duration of fermentation on the production of Nata de Salacca

No	Duration of Fermentation (days)	Results			
		Color	Texture	Taste	Aroma
1	10	Brownish White	Highly Chewy	Plain	Rather sour aroma
2	14	Dark Brownish White	Chewy	Rather sour bitter	Sour aroma

A number of aspects of effects of duration of fermentation on the taste of nata de salacca found in research journals are as follows:

1) Color Aspect

Duration of fermentation of nata de salacca causes formation of fibre threads resulting in brownish white color of the nata. Based on Table 3, 14 days fermentation resulted in darker color compared to 10 days fermentation. Presence of brown color was caused by enzymatic and non-enzymatic reactions. Enzymatic brownish reaction was caused by oxidation catalyzed by phenol oxidase or polyphenol oxidase. Whereas, non-enzymatic brownish reaction consist of three types, i.e. maillard reaction, caramelization, and vitamin C oxidation. Maillard reaction is formation of melanoidin caused by two reactions between reductive sugar and amino group. Caramelization happens when sugar is heated to certain boiling point and results in specific aroma. Whereas, browning by vitamin C oxidation is included in reductor compound, which also serves as precursor to the formation of non-enzymatic brown color (Salelatu & Rumahlatu, 2016). Characteristic of good nata is white in color (Putri, et. al. (2021) and Putriana dan Aminah (2013)). As such, concluded from Table 3, the suitable color for consumption is color from 10 day fermentation.

2) Texture Aspect

Texture is defined as something that can be seen and felt (with fingers) on a surface (Wariyah, 2012). Based on Table 3, the 10 day fermentation shows chewy (elastic) texture which meets the criteria. As such, the texture of the nata is considered as good nata. Characteristics of good nata texture according to Putriana dan Aminah, (2013) are chewy (elastic) and not hard. This is because during fermentation of cellulose by *Acetobacter xylinum,* the bacteria are in their exponential stage. In this stage they grow rapidly. In addition, the longer duration of fermentation would result in less weight of nata. This happens because bacteria would die due to decrease in nutrient availability. Such condition increases competition among the bacteria for survival.

3) Taste Aspect

Taste aspect involves tongue sense. Existing taste may be affected by a number of factors such as, among others, chemical compounds, temperature, concentration, and interaction with other tastes (Rembulan, 2019). Salak contains tanin which causes it to taste sour and bitter. Fibres in nata would absorb water which would affect the texture of nata to become gel. Based on study using organoleptic tests, long duration of fermentation resulted in less favorable texture since the pores between celluloses were filled with water available in the media. Formation of bond between nitrogen and polysaccharide can increase number of fibres which may affect the taste of nata. Such bond is caused by the lack of nitrogen in the media (Salelatu & Rumahlatu, 2016).

4) Aspek Aroma

Ester (compound which produce aroma of fruit) is volatile. The process by which aroma is produced varies among different fruits. Aroma would increase in fruits close to climacteric ageà. According to Table 3, the 10 day fermentation produces aroma typical of salak which suits the criteria, i.e. sour aroma. This suits the characteristics of good nata. According to Putriana and Aminah, (2013), good nata is characterized with non-sour aroma. Sour aroma is produced from *Acetobacter xylinum* bacteria (Wahyuni & Jumiati, 2019). Aroma of nata is caused by tannin content. When tannin is solved in water it will form colloid and will have sour and bitter aroma.

Aroma of nata de salacca consists of two types, i.e. the one derived from the raw material and the one produced from fermentation process.

3.4. Effect of addition of Zwavelzur Ammoniak (ZA) on Nata de Salacca

Zwavelzur ammoniak (ZA) is a source of nitrogen originating from non-natural material such as ammonium sulphate or urea. Addition of ZA to nata de salacca would not ne harmful to health as long as it does not exceed maximum limit of 0,5% of the whole materials, and the ZA is of food grade quality. However, currently there have been a number of studies to change chemical ZA with natural materials such as sprout extract, water remaining from boiling of peanuts, and liquid waste of tofu (Yanti, et. al., 2020).

According to Putri, et. al., (2021), ZA would give effect on the thickness of formed cellulose. The addition of more urea would result in more cellulose in layers. Addition of urea would result in greater yield compared to the one without urea, This means that *Acetobacter xylinum* requires source of nitrogen for the biosynthesis of cellulose. However, the ZA nitrogen exceeding 0,5% of the whole material is not good since it would decrease the yield of cellulose (Yanti, et. al., 2020).

4. Conclusion

Salak (*Salacca edulis* Reinw) which is overripe can be utilized to produce Nata de Salacca which is rich in fibres. A good nata according to the ratio of salak substrate to water is 1 : 4, since this would be attractive in terms of organoleptics and worth consuming. Whereas based on the factor of addition of sprout extract, the level is 3%, since the texture would be more chewy. And based on the optimum duration of fermentation, it is 10 minutes. Based on reviews made, it is recommended to continue with studies on nutrients contained in nata de salacca.

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