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The Flour Source's Role as a Fermentation Substrate Influences the Physical Attributes of Nata de Coco

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ABSTRACT

The production of coconut water in Indonesia is very abundant, but there are problems with its utilization. Discarding unused coconut water often results in an unpleasant odor, as fermentation produces acetic acid pollution. Coconut water has an economic value and is rich in nutrients. One product that can be made from coconut water is nata via fermentation. Making nata requires a source of carbon that can be obtained from flour and is influenced by its type. Thus, this study aims to examine the effect of adding different types of flour as a source of carbon for fermentation in making nata de coco. We use corn, tapioca, rice, and modified cassava flour (mocaf), along with granulated sugar as a sample control. The resulting nata de coco is analyzed for its physical characteristics, including yield, moisture content, and nata thickness. The results showed that nata made using carbon sources from rice flour produced the greatest yield (69.55%), as well as the highest thickness (3.958 mm). Nata, derived from rice flour, also has the highest moisture content (>85%). The study's results indicate that the selection of flour as a carbon source during nata de coco production significantly impacts its yield, thickness, and moisture content.

Keywords: rice flour, tapioca flour, nata de coco, carbon source

1. INTRODUCTION

Indonesia produces quite abundant coconut water, but its utilization is still lacking. Unused coconut water is often neglected and not utilized, and it has an unpleasant odor that comes from acetic acid due to the fermentation process. However, coconut water has a high economic value and is rich in nutrients. One of the processed products made from coconut water is nata, which is very popular among people as a favorite food[1], [2].

Nata is an organic food product resulting from the fermentation of coconut water by *Acetobacter xylinum* and has a high fiber content [3]. Nata products are considered a source of fiber because they are high in cellulose, cholesterol-free, and low in fat [4]. Apart from that, nata has also been proven to be effective in controlling body weight and protecting against diseases such as diverticulosis, colon cancer, and anal cancer[4], [5].

The process of making nata from fermenting coconut water not only increases food variety but also increases the nutritional value of the coconut water used. As demand for food increases every day, there is a need to provide sustainable and diverse food to meet people's daily needs. Processing coconut water can also help increase the diversification of coconut products. Old coconut water is considered waste and is generally thrown into the environment, but this can be prevented and used as raw material for a fermented product called nata. Products made from fermented coconut water in the form of nata are in demand because they have been proven to have many health benefits[1], [4].

Nata can be categorized as a low-calorie food that consists mostly of water and cellulose and is generally often used as desserts, fruit cocktails, and ice cream [6]. Currently, nata can not only be made from coconut water but various media can be used for its development, as long as sufficient carbon and nitrogen sources are available, as well as other growth requirements such as pH and temperature[1], [7], [8].

Acetobacter xylinum bacteria plays an important role in nata production through cellulose synthesis. However, the use of these bacteria can be prevented by having *Acetobacter spp*. Sugar can also be converted into cellulose during the fermentation process. Various starters are used to increase machete production and achieve the desired product characteristics. Therefore, changes in the way starter is used aim to optimize nata production and produce products with the desired properties. *Acetobacter xylinum* is a nata-producing bacteria. In its growth and reproduction, the microbe *Acetobacter xylinum* needs a source of nutrition derived from carbon, nitrogen, and other minerals[1], [2], [8], [9]. Besides that, controlling the fermentation process is very important to get the best nata product. Coconut water contains several necessary nutrients, so it is necessary to compensate for the lack of these nutrients. Carbohydrates such as flour can be added as a carbon source. Flour provides carbon sources for bacteria, for instance, corn, tapioca, rice, and modified cassava flour (mocaf)[2]. Mocaf is fermented based on cassava flour to enhance the physical properties of flour [10]–[12]. However, the source of flour affects the fermentation of nata de coco. Thus, the objective of this research is to investigate the effect of different flour added to nata de coco fermentation. The physical properties of nata including the yield of nata, moisture content, and thickness of nata are investigated.

2. MATERIALS AND METHODS

2.1 Materials

In this experimental study, nata fermentation consisting of 200 ml of coconut water and 25 ml of *Acetobacter xylinum* was placed in a plastic pan as a fermentation container. In this research, various types of flour were used as a carbon source, including corn flour, tapioca, rice, and mocaf. Apart from that, sucrose is also used in the same amount at 10 grams. $CO(NH2)_2$ as a nitrogen source and around 10 ml of vinegar to adjust the pH to 4.5.

2.2 Fermentation of nata de coco

At the start of the experiment, the first step was to boil 200 mL of coconut water. Then, a carbon source consisting of 10 grams of flour (corn, tapioca, rice, and mocaf) and 1 gram of $CO(NH_2)_2$ were added as a nitrogen source. The mixture was then stirred thoroughly. Next, 10 ml of acetic acid was added to the mixture to adjust the pH value around 4.5. The mixture was then placed on a sterile pan, covered with newspaper, and tied with a rubber band so that it was tightly covered. A starter of *Acetobacter xylinum* bacteria was added to the culture broth. The fermentation process takes place for 10 days in a dry place at ambient temperature[2], [13].

2.3 Analysis of the nata de coco

The parameters observed in the nata de coco analysis included yield, thickness of nata, and moisture content [2], [8], [9]. Nata yield is calculated as the wet weight of nata de coco produced in the cultivation container per volume of coconut water used for fermentation. The thickness of the nata layer is measured with a caliper on all four sides. The moisture content test was carried out using the AOAC method [14]. The nata pieces measure 1 x 1 cm and weigh them in a pan. Then, the nata is placed in the oven at 105 °C for 6 hours. The dried nata samples were then weighed, and the moisture content was calculated based on the water content determined from the average of the three samples.

2.3 Analysis of data

All the data was collected in triplicate. The one-way ANOVA and post-hoc Duncan's test were used to evaluate and compare, respectively, the effects of the source of flour on the physical character of nata de coco including yield, thickness, and moisture content. IBM SPSS Statistics version 16.0 (IBM, United States) designated the significance level $p < 0.05$.

3. RESULTS AND DISCUSSION

3.1 Yield of nata de coco

Based on experiments on making nata de coco with various source of flour as a carbon source in fermentation of 200 ml of coconut water, the results can be seen in **Figure 1**, where nata made using rice flour produced the greatest yield. Several factors can influence why nata made with rice flour has the greatest yield or production results compared to using other types of flour. Several factors could potentially influence this outcome including carbohydrate content: Rice flour has a fairly high carbohydrate content. This carbohydrate is a source of energy for the *Acetobacter xylinum* bacteria in the fermentation process of making nata. The availability of sufficient carbohydrates in rice flour can support bacterial growth and better cellulose production [4].

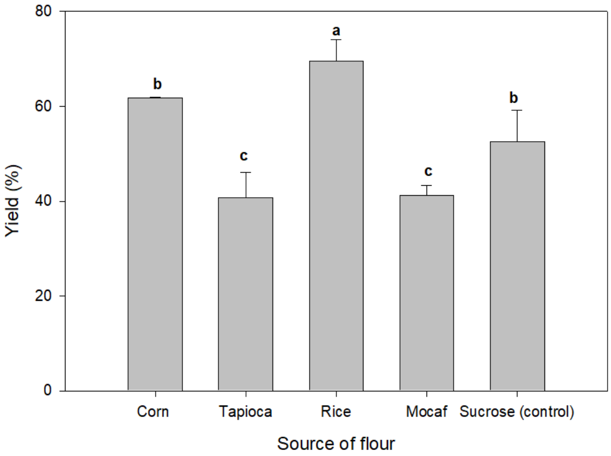

Figure 1. Effect of Source of flour as a carbon source on the yield of nata de coco. Different alphabets on each bar represented statistically different values, with p ≤ 0.05.

The other explanation is that rice flour contains more amylose, which is a type of starch with a linear structure [15]. *Acetobacter xylinum* can more easily break down amylose into glucose, a carbon source for cellulose production, thanks to the linear structure of amylose. This can increase the yield or production of nata. Other nutritional composition: of rice flour also contains other nutrients such as protein, fat, fiber, and vitamin B complex, which can provide additional nutrition for bacterial growth and better nata production [16].

However, keep in mind that the aforementioned factors are general, and other variables such as fermentation conditions, temperature, fermentation time, and the amount of starter used will determine specific results. Therefore, it is important to pay attention to all these variables and factors when making nata with rice flour or other types of flour.

3.2 The thickness of nata de coco

Variations in carbon sources also affect the thickness of the nata produced. It can be seen in **Figure 2** that the one with the highest level of thickness is nata, which is made from the carbon source of rice flour. This is because rice flour has a high amylose content, which can provide a good carbon source for *Acetobacter xylinum* bacteria during the nata fermentation process. The abundant carbohydrate content in rice flour can support bacterial growth and cellulose production, which in turn can produce nata de coco with a higher thickness. Corn flour is also a carbon source commonly used in making nata de coco. Even though corn flour contains amylose, the high fiber content in corn flour can affect the texture characteristics of the resulting nata[17].

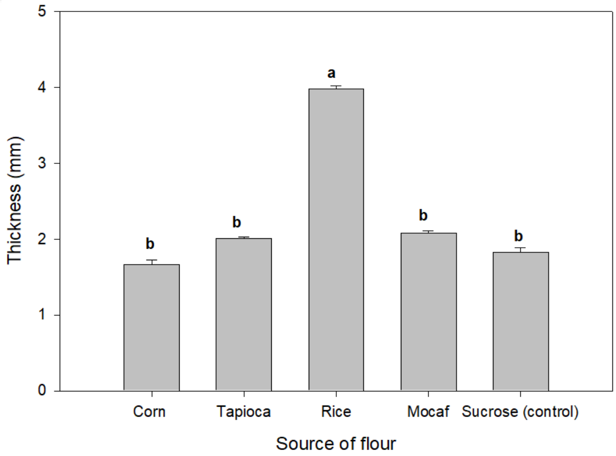

Figure 2. Effect of Source of flour as a carbon source on the thickness of nata de coco. Different alphabets on each bar represented statistically different values, with p ≤ 0.05.

3.3 The moisture content of nata de coco

The moisture content of nata de coco from different of flour sources is shown in **Figure 3**. Figure 3 reveals that All the sample showed the same in moisture content. The standard nata has a water content of >85% [4]. This moisture content indicates that nata de coco using a carbon source from a variety of flour has a higher level of moisture content. Although the carbon source used in making nata de coco can influence product characteristics, its effect on the moisture content of nata de coco may not be directly significant (p>0.05). Other factors, such as storage conditions and the processing of nata de coco itself, also influence the moisture content in nata de coco[18].

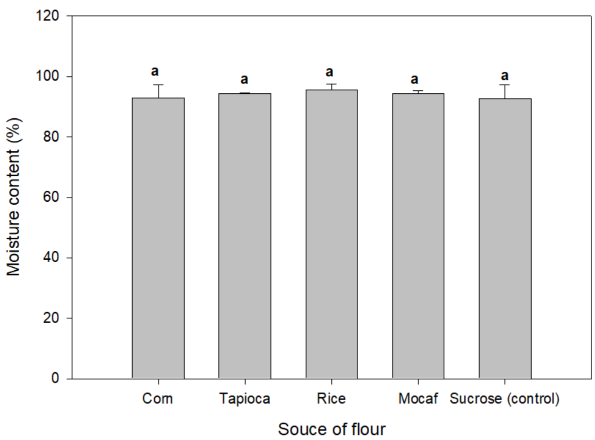

Figure 2. Effect of Source of flour as a carbon source on the moisture content of nata de coco. Different alphabets on each bar represented statistically different values, with p ≤ 0.05.

4. CONCLUSION

The research concludes that the choice of carbon source from flour significantly influences the yield, and thickness of nata de coco. The carbon source of rice flour achieved the highest results in terms of yield, thickness, and moisture content parameters. The results of nata using rice flour obtained a yield value of 69.55%, a thickness of 3.958 mm, and a moisture content of 95.52%.

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CONFLICT OF INTEREST

No potential conflict of interest was reported by the author(s).

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Arjunaatha Tyaga Naryamajati: conceptualization, investigation, writing—original draft preparation
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Dewangga Priyo Sasmito: investigation, data curation
Vishal Chherti: validation, writing-review editing
Alwani Hamad: conceptualization, methodology, writing—review and editing, supervision

All authors have read and agreed to the published version of the manuscript.

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