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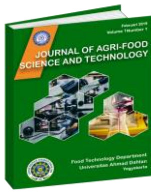

An Analysis of the Causes of Damage to Nata de Coco in the Fermentation Process

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ABSTRACT

Acetobacter xylininum greatly contributes to the fermentation process of nata de coco. It converts glucose in coconut water into cellulose slabs. The slabs turn into clear white and solid in form, called nata. This analysis is aimed to identify types and causes of damage to nata de coco in the fermentation process. Observation of the criteria of raw materials, cooking process, the making of an *Acetobacter xylinum* starter, pouring the medium into the stray, and the harvesting process of nata slabs was carried out in the fermentation process. Data collected were analyzed, and research problems were solved using the Fishbone diagram. Several methods applied in data collection were observation, interview, hands-on practice, documentation, and literature study. The results demonstrated some types of damage to nata slabs in the fermentation process, e.g., fungal contamination and defective, watery, and fibrous nata.

1. INTRODUCTION

The fermentation process in food processing refers to the processing process deploying controlled microorganic activities to enhance food durability, yield a product with characteristics of typical flavor and aroma, and produce quality food. The process can wear on using glucose as an energy source (Prabowo, 2011).

Fermentation is a chemical change process in an organic subtract through the activity of enzymes yielded by microorganisms (Suprihatin, 2010). Several common fermentation products are tempeh, cheese, kefir, and yogurt. Additionally, nata de coco is also considered one of the popular fermentation products. Nata is a gel-like fermented food product chewy in texture, white in color, and floating in acid sugary liquid. It is a food product yielded by the bacterial activities of *Acetobacter xylinum* (Herdi, 2013).

Acetobacter xylinum contributes to the fermentation process of nata de coco. It produces enzymes which can convert glucose in coconut water into cellulose slabs. The slabs turn into clear white and solid in form, called nata (Rahayu and Eli, 2014). The incubation period is one of the factors determining the end product of nata de coco. In the period, *Acetobacter xylinum* also plays a noteworthy role. Some factors averting the making of nata de coco to succeed are associated with the starter or culture of *Acetobacter xylinum*, such as an unhygienic bottle used to make the starter. In addition, the hygiene of trays used in the making of nata de coco affects the end product of nata, and employees' meticulousness in the fermentation process also contributes to the successful making of nata de coco (Sutanto and Rahayuni, 2013).

Different incubation periods yield different nata harvesting. The making of nata de coco may result adversely on grounds of unhygienic production areas, equipment, and human resources. Besides, manual cleaning methods of nata trays and glass bottles can also hamper the making of nata. Accordingly, this examination focuses on the causes of damage which may appear during the production of nata de coco, especially in the fermentation process.

2. LOCATION AND METHODS

2.1 Location

This practical work was carried out on Kretek Banguntapan Bantul Yogyakarta from March 29th-April 22nd, 2021.

2.2 Materials

The raw material used in the production of nata de coco was coconut water we collected from farmers. Some additional materials were ammonium sulfate (ZA), vinegar acid, and liquid sugar.

2.3 Research Methods

Data collection techniques were observation, interview, and documentation The observation of damages to nata de coco was conducted in the process of nata harvesting, and the analysis to find solutions to the damage was also made. The analysis method used was using a control chart.

3. RESULTS AND DISCUSSION

3.1. Cooking Raw Materials

The first step in the making of nata de coco was cooking the raw material. Cooking constituted a process by which we processed raw food materials into food materials set up for further processing. Cooking demanded temperature adjustment to make the food materials easy to mix (Minantyo, 2011). This cooking process was aimed to eradicate contaminants which might harm the quality of coconut water and optimize the process of mixing additional materials, e.g., sugar, ammonium sulfate (ZA), and vinegar acid, making them perfectly mixed (Sudiara, 2001). The next step was making a starter of *Acetobacter xylinum* and making a medium. The medium was made using the same materials as that used to make a starter of *Acetobacter xylinum*, i.e., coconut water, ammonium sulphate (ZA), liquid sugar, and vinegar acid. All materials were cooked and poured into a clean tray and covered with paper tied with rubber. The starter of *Acetobacter xylinum* was poured a day after the medium was poured into a tray. The method was vital to ensure that the medium was adequately cool and as such, did not harm the starter. The medium was then stored for 9-12 days at room temperature (27-

30℃). The storage period started from the *Acetobacter xylinum* was poured into the tray medium. Harvesting was performed after 9-12-day fermentation.

The next step was harvesting nata slabs. Delayed harvesting would likely bring on the growth of fungi causing damages to nata products. And yet, too early harvesting would engender nata with a rough texture, watery, and perishable. Membrane peeling was undertaken after harvesting. This step was aimed to polish the appearance of nata, making it clean, lint-free, and odorless. The following step was the slitting process, allowing an easy cutting process, by which nata were cut into cube-shape at a standardized size defined by the company. Nata which had been cut should undergo the magnetic trap stage, which was necessary to remove metal particles which might be generated in the previous processes. Sorting was the next process, by which nata with an unstandardized size and entrained small dirt were dispensed. The final processes were pressing, by which water content of nata de coco produced was tipped, and packaging to allow easy distribution of nata de coco to work partners.

Raw materials used in the making of nata de coco were coconut water, ammonium sulfate (ZA), vinegar, and liquid sugar. Based on the interview, coconut water, as the fermentation medium in the making of nata de coco, should be extracted from a coconut at an appropriate age (neither too young nor too old). The coconut should be fleshy and have the expected glucose level, allowing bacteria to grow well, and hence, nata de coco could be produced. A coconut at that age was better than the young one as the latter did not contain minerals and nutrition as much as that entailed by *Acetobacter xylinum* to grow (Sihmawati et al., 2014). However, coconut water contains some nutrition only, and as such, other nutrition needed should be added. Additionally, nutrition in the medium could inhibit the growth of *Acetobacter xylinum* (Alwi et al., 2011). Additional nutrition materials were ammonium sulfate (ZA), liquid sugar, and vinegar acid.

The raw material of coconut water was boiled for an hour and another 10-15 minutes to let the additional materials, i.e., ammonium sulfate (ZA), liquid sugar, and vinegar acid dissolve and perfectly incorporate. Vinegar acid, in the making of nata de coco, acted as the regulator of the acidity of the medium yielding nata and the inhibitor of fungal contamination in the fermentation process. Ammonium sulfate (ZA) served as the source of nitrogen or nutrition which boosted the growth and activity of *Acetobacter xylinum* generated by the addition of ammonium sulfate (Alwi et al., 2011). Besides, liquid sugar contributed to the transformation of *Acetobacter xylinum* into nata in the fermentation process. Disaccharides (sucrose), as the carbohydrate source, were used by *Acetobacter xylinum* as the source of energy and nutrition to grow (Wardhana et al., 2016). Nutrition factors determined the property of some products, one of which was nata de coco. The result and composition of cellulose formed were affected by additional raw materials, i.e., ammonium sulfate (ZA), vinegar acid, and liquid sugar. An adequate concentration of carbon sources in the medium which produced nata could stimulate *Acetobacter xylinum* in synthesizing cellulose and yielding quality nata (Kornmann et al., 2003).

3.2. Making a Starter of *Acetobacter Xylinum*

The process of making a starter of *Acetobacter xylinum* was initiated by boiling coconut water and additional raw materials, i.e., ammonium sulfate (ZA), vinegar acid, and liquid sugar. Coconut water was boiled for an hour to eradicate contaminants which might harm its quality. Boiling wore on for 10-15 minutes to let additional raw materials, i.e., ammonium sulfate (ZA), vinegar acid, and liquid sugar dissolve and perfectly mix. The boiled material was poured into a cleaned bottle and stored in a clean and closed room for four-five days at room temperature to avoid sunray exposure and dirt contamination. Figure 1 exhibits the criteria of a quality starter of *Acetobacter xylinum*, i.e., having white blobs and being chewy in texture. A quality starter was reusable in another bacterial culture or could be added to the tray medium used in the making of nata de coco.

Acetobacter xylinum, which was a short bar in shape, was gram-negative bacteria. It could polymerize glucose to cellulose (Pambayun, 2002). *Acetobacter xylinum* was aerobic bacteria and lived in an acidic environment with a pH of max. 4-4.5 (Majesty, 2015). Factors determining the growth of *Acetobacter xylinum* were fermentation temperature, acidity (pH) of the medium, carbon source, and nitrogen source (Sutanto, 2013). *Acetobacter xylinum* could grow and develop into nata owing to water content, protein, fat, carbohydrate, ash, and several other minerals within the substrate as its nutrition. That being so, ammonium sulfate (ZA) and liquid sugar acted as nutrition sources which encouraged the growth of the bacteria. Vinegar acid played a role as the regulator of the acidity of the medium which yielded nata de coco. The pH of the medium should be at a range of 3.4-4.5, allowing the bacteria to grow well. A starter was of paramount importance in the making of nata. The absence of the bacteria would disallow nata slabs to form.

3.3. Making the Medium

This was the process of pouring into the tray, where nata slabs were formed. In making the medium, we used the same raw materials as that used to make a starter of *Acetobacterium xylinum*, i.e., coconut water, ammonium sulfate (ZA), vinegar acid, and liquid sugar. After boiled, the raw materials were poured into a tray covered using paper tied using rubber. The tray should be covered with paper to hinder sun rays which could inhibit nata formation and prevent dirt, sand, metal, and the like to contaminate. The tray medium was left cool for a day to in order not to harm the starter.

3.4. Pouring the Starter of *Acetobacter Xylinum*

The starter was poured one day after the medium was poured into the tray. The one-day interval was of utmost importance, ensuring that the medium was adequately cool and thereby safe for the starter. *Acetobacter xylinum* played a pivotal role in the making of nata de coco. It converted glucose contained by coconut water into cellulose slabs. Cellulose slabs turned into clear white in color and solid in texture, the name of which was nata (Rahayu and Eli, 2014)

The addition of the starter of *Acetobacter xylinium* at a different concentration might influence the thickness of nata during fermentation. One 50-ml bottle of the starter for *Acetobacter xylinium* could be poured into ten tray media.

3.5. Harvesting Nata Slabs

Table 1 indicates the post-boiling results of harvested nata slabs after 9-12 fermentation. A delayed harvest would likely induce the growth of fungi damaging nata products. Nevertheless, too early harvests would produce a rough nata texture and watery and perishable nata. A tray had a loading capacity of the raw materials of 2 L. Damaged or unstandardized nata slabs from the fermentation process were put into a sack and weighed Analysis and problem-solving was carried out to prevent more nata damages.

The process of harvesting nata slabs, building on our observation, fulfilled the company standards which referred to SNI (Indonesia National Standard) of 1996 concerning the characteristics of nata, i.e., aroma, flavor, color, normal texture, and fiber content. One of the factors determining the characteristics of nata was the fermentation period.

Table 1. Post-boiling Results of Harvested Nata.

Date of Cooking	Total Boiled Materials (Liter)	Post-boiling Results	Estimated Date of Harvesting	Total Nata Harvested (kg)	Criteria
12/3/21	3000	1568	23/3/21	2140	Fulfilled
13/3/21	3000	1610	24/3/21	2180	Fulfilled
16/3/21	3000	1528	26/3/21	2090	Fulfilled
17/3/21	3000	1616	30/3/21	1980	Fulfilled
23/3/21	3000	1536	2/4/21	2120	Fulfilled
29/3/21	3000	1560	9/4/21	2090	Fulfilled
30/3/21	3000	1624	12/4/21	2030	Fulfilled
31/3/21	3000	3170	13/4/21	4480	Fulfilled
5/4/21	5000	3176	16/4/21	4085	Fulfilled
9/4/21	5000	2648	20/4/21	3530	Fulfilled

Table 2. Quality Standards of Nata Products in Packaging (SNI 01 – 4317 – 1996)

Characteristics	Description
Aroma	Odorless/normal
Flavor	Flavorless/normal
Color	White
Texture	Chewy

Source: SNI, 1996

3.6. Damage to Nata de Coco in the Fermentation Process

Figure 1 points out a damaged nata slab because of fungal contaminants, resulted by an unhygienic tray, facility, and infrastructure in the making of the media, leaving contaminants, such as dirt, sand, metal, and others. Tools used should be ensured for their hygiene to avert the transfer of contaminants, e.g., dirt, metal, sand, and so forth, which might cause damage or annoy the production process through contaminated tools (PPM dan PL, 2004).

Figure 1 Damage to Nata de Coco as a Result of Fungal Contaminant

Figure 2 Damage to Nata de Coco in Light of Damaged Paper

Figure 2 presents a damaged nata slab by virtue of paper damage due to workers pouring the media carelessly and covering the tray with paper in such a way that the paper was perforated and torn. This hindered sunray exposure and fungal contaminants, e.g., dirt, sand, metal, and so on to compromise the fermentation process of nata.

Figure 3 Nata Damage in Light of Starter Quality

Figure 3 shows a damaged nata on account of the quality of a starter for Acetobacter xylinum and sun ray exposure. The starter was not ready yet by age. This was commonly on grounds of the placement of the tray media, which was put on the top shelf near the outdoor wall, causing sun rays to expose and confound the fermentation process. The making process of nata de coco was determined by several factors. The growth of Acetobacter xylinum as the requisite bacteria in the fermentation process of coconut water was determined by oxygen, pH, temperature, and nutrition. These factors should be concerned in order to acquire quality nata de coco. Additionally, rigorousness and tool hygiene were also salient in the making of nata de coco. The latter greatly relied on tool sanitation and the correct use of materials.

Figure 4 Nata Damage Owing to Incubation

Figure 4 showcases damage to a nata slab as a result of improper media incubation or storage, yielding a poor formation process of nata because of unprepared media for nata harvesting. Fermentation duration determined the formation process of nata (Wahono, 2016). The longer the fermentation period, the more hardened or chewier the nata texture. Within a proper range of periods, *Acetobacter xylinum* could convert glucose into cellulose fibers which were called nata. Moreover, a short fermentation period would likely create a rough nata texture by virtue of poor nata formation by *Acetobacter xylinum.*

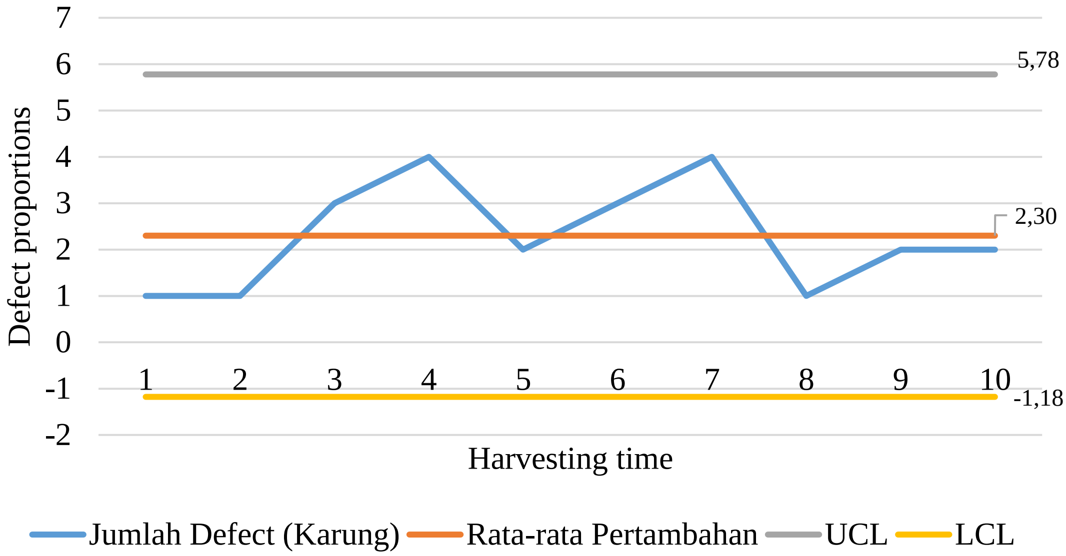

Figure 5. Control Chart of Defective Nata de Coco Products in the Fermentation Process

Figure 5 shows off the control chart of damaged nata de coco in the fermentation process. The highest number of sacks of defective nata de coco was four, elicited after a ten-time harvesting process of nata slabs (one sack = 25 kg). Figure 5 demonstrates that damage coming to the fore in the fermentation process was still normal or controllable, and accordingly, did not go beyond the top threshold, i.e., 5.78. As such, to hinder more damage, some improvements should be made in the fermentation process of nata de coco, as regards either the handling of raw materials, hygiene of tools, facilities, and infrastructures, quality of a starter of *Acetobacter xylinum*, and quality of human resources.

4. CONCLUSIONS

This research disentangles types of damage to nata de coco in the fermentation process, i.e., fungal contaminants, fibrous and watery nata, and defective nata. Besides, the causes of damage to nata de coco in the fermentation process were the factors of the quality of a starter for *Acetobacter xylinum*, raw materials, careless human resources, facilities and infrastructures, temperature, and environment.

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