

Application of optimized *Streptococcus thermophilus* and *Lactobacillus bulgaricus* on coconut milk in the production of niyoghurt

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Abstract. This research aimed to optimize the growth of commercial yogurt starter cultures (*Streptococcus thermophilus* and *Lactobacillus bulgaricus*) on coconut milk before they were applied in the production of coconut yogurt, which is known as niyogurt or cocogurt. The research consists of three steps. Firstly, both microbes were grown on 100% cow's milk and were analyzed for pH and total lactic acid bacteria (LAB) to examine the length of fermentation time. Secondly, both microbes were gradually grown on cow's milk and coconut milk media, with samples ranging in combinations of the two kinds of milk from 100% milk to 100% coconut milk. Finally, the optimized starter cultures were then applied to niyogurt production. The results showed that the pH of the starter cultures obtained in 100% milk after 48 hours of fermentation was 4.41 ± 0.04 for *Streptococcus thermophilus* and 4.44 ± 0.03 for *Lactobacillus bulgaricus*. Meanwhile, the total lactic acid bacteria counts were 8.62 ± 3.03 log cfu/ml for *Streptococcus thermophilus* and 9.55 ± 2.22 log cfu/ml for *Lactobacillus bulgaricus*. These results showed that both commercial starter cultures need long periods to reach the targeted pH and total lactic acid bacteria (LAB) suggesting that enrichment was needed before commercial starter cultures were used. Furthermore, after analyzing six samples of growth on different ratios of milk and coconut milk, it was seen that both starters could grow optimally on 100% coconut milk. The total LAB after 24 hours of fermentation was 11.07 log cfu/ml with pH 4.05. Based on chemical and microbiological analyses, the characteristics of niyogurt have met Indonesia's Standard for food consumption (SNI 2981:2009). The niyogurt consisted of 3.15% protein content, 8.3% fat content, 0.83% total acid, 0.76% mineral content, and 11.48 log cfu/ml total LAB.

Keywords: coconut milk, niyogurt, pH, starter cultures, total LAB

INTRODUCTION

Fresh cow's milk is widely used as the main raw material for making yogurt. Unfortunately, 67% of milk consumed in Indonesia (1.5 billion) is still imported [1]. The amount of milk production in Aceh in 2019 decreased by 0.01 tons from 53.55 tons in 2018 [2], which means that the sustainability of processed milk production in Aceh might decrease if the production of raw materials decreased.

In addition, for low-income people, the price of fresh cow's milk is still relatively expensive. The high price of fresh cow's milk in Aceh Province (IDR 33,000 - 35,000 per litre) has resulted in the production of processed milk and

the variety of its products in the province being underdeveloped because the price of the product has become more expensive. Based on estimated figures from the Ministry of Agriculture of the Republic of Indonesia in 2020, Aceh produced 62,917 tons of coconuts and is ranked as the 16th largest coconut producer in Indonesia. However, the number of processed products that use coconut milk as an ingredient is still relatively low. Cow's milk and coconut milk share various characteristics and properties which would allow coconut milk to be processed using the same methods as cow's milk. Coconut milk contains sucrose, fructose, and glucose, which can be fermented by *Streptococcus thermophilus* and *Lactobacillus bulgaricus* which create organic acid compounds [3]. Therefore, coconut milk has the potential to be used as the main ingredient for making yogurt. Yogurt made from coconut milk is known as cocogurt or niyogurt [4].

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Niyogurt products are often consumed by vegans, which are people who eat foods that do not include any animal products or byproducts (including milk) [5]. Based on 2021 statistics, 79 million people, or about 1% of the world's population, are vegans. In Indonesia, based on data on the number of vegetarians registered with the Indonesia Vegetarian Society (IVS) in 2020, around 160,000 people were identified as vegetarians [6]. In addition to being vegan and vegetarian, the consumption of niyogurt products can also improve the immune system because of their probiotic benefits [3] so it is highly recommended for consumption, especially during the Covid-19 pandemic.

Several studies on the manufacture of niyogurt have been carried out previously [7,8]. However, the yogurt produced in these studies displayed a more liquid texture than yogurt normally is and the resulting pH has not reached SNI food consumption standards (pH of 3.7–4.0). Good quality niyogurt can be made if the bacterial culture used has grown optimally on coconut milk media. Therefore, *Streptococcus thermophilus* and *Lactobacillus bulgaricus* used in this study were gradually optimized on milk media, a mixture of milk and coconut milk to coconut milk media. Later, these two bacteria were used as starter cultures for making the niyogurt.

METHODOLOGY

Preliminary research

The purpose of the preliminary study was to determine the fermentation time required by *Streptococcus thermophilus* and *Lactobacillus bulgaricus* bacteria to reach pH 4.2–4.4 and 3.5–3.8 on milk media. Milk was pasteurized using a water bath at a temperature of 80°C for 30 minutes, calculated when the temperature was reached. The starter culture breeding process took place at a temperature of 43°C in an incubator. The pH value was analyzed for each culture produced and the time required was recorded.

Starter cultures preparation

In this step, the starter cultures were grown on various mixtures of cow's milk and coconut milk media with different percentages of each. This research was conducted using a factorial Randomized Block Design (RBD) consisting of 2 factors. The first factor is the ratio of the percentage of cow's milk and coconut milk (K), of which there were 6 different ratios (100% cow's milk and 0% coconut milk; 80%:20%; 60%:40%; 40%:60%; 20%:80%; 0%:100%). The second factor is the starter bacteria (S), of

which there were 2 types (*Streptococcus thermophilus* and *Lactobacillus bulgaricus*). Each starter bacteria was tested on each ratio of milks, meaning that there were 24 experimental units.

Milk and coconut milk were put into a container and pasteurized using a water bath at 70°C for 30 minutes. The coconut milk was extracted from grated coconut meat and water in a ratio of 1:2 (w/v). The heating temperature was lowered to 45°C by immersing the container in ice water. Then, 150 mL of the pasteurized milk and coconut milk mixture was put into a plastic container and mixed with 2% of each starter. Fermentation was carried out in an incubator at a temperature of 43°C and the required incubation time was adjusted if the pH had reached 4.2–4.4 and 3.5–3.8 [9].

Application of starter cultures in the production of niyoghurt

Coconut milk (500 ml) was put into a container, then skim milk and sugar were added according to the calculation results of non-fat solid standardization [10]. The coconut milk was pasteurized at a temperature of 85°C for 30 minutes using a water bath. The pasteurized coconut milk was cooled by immersing it in ice water until the temperature reached 45°C. The coconut milk was put in 150 ml plastic containers and 2% starter LAB (*Streptococcus thermophilus* and *Lactobacillus bulgaricus* in a 1:1 ratio) was added [9]. Incubation was carried out for 24 hours at 43°C in an incubator.

Analysis of samples

Coconut milk was analyzed chemically (water, mineral, protein, and fat contents). The fat content follows the standards from the SNI 01-3141-1998 procedure, while another proximate analysis follows AOAC [11]. The starter cultures were analyzed for pH and total LAB. The niyoghurt was analyzed for microbiological (total LAB [12]), chemical (water, mineral, protein, and fat content as well as total acid [13]), and physical (viscosity [14]) characteristics.

Analysis of data

The data from the second step of this study, in which the cultures were grown on various combinations of cow's milk and coconut milk, were analyzed using Analysis of Variance (ANOVA). If the results obtained had a significant difference between treatments, then further tests were carried out using Duncan's test (DMRT). Data from the results of the first

and third stages of the research are presented with standard deviation (SD).

RESULTS AND DISCUSSION

pH Optimization of Niyoghurt Culture Growth

The pH value of the starter culture of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* in 100% cow's milk ranged from 4.41 to 5.57, as seen in Table 1. According to [15], the optimal condition for the growth of *Streptococcus thermophilus* is at pH 6.5 and will stop growing at pH 4.2–4.4. Meanwhile, the optimum condition for the growth of *Lactobacillus bulgaricus* is at pH 5.5 and will stop at pH 3.5–3.8. As seen in the data in Table 1, the starter cultures of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* required a longer fermentation time to lower the pH value. The pH of the starter cultures obtained in 100% milk after 48 hours of fermentation was 4.41 ± 0.04 for *Streptococcus thermophilus* and 4.44 ± 0.03 for *Lactobacillus bulgaricus*. It was suspected that the starter culture used had been stored for a long time, causing a decrease in growth activity in the starter culture and the ability of the starter to produce acidic products. Therefore, in the starter cultures preparation, the fermentation time used was 48 hours. Each starter culture produced yogurt with a slightly runny texture, creamy color, sour taste, and a distinctive odor. As seen in Table 1, the pH value of the starter culture obtained ranged from 4.01 to 5.74. From Figure 1, the pH value was lower, at 4.04, in the experiment with the mixture of 20% coconut milk. In the mixture with 40% coconut milk, the pH showed a value of 4.62, higher than the previous mixture. However, with the use of 60%, 80%, and 100% coconut milk, there was a decrease again with the average pH value obtained almost the same, respectively 4.23,

4.01, and 4.05. This is presumably because the starter culture requires time to adapt to the growth medium.

The main components of carbohydrates in coconut milk are sucrose and starch while the natural substrate for LAB is lactose [16]. To break down sucrose into fructose and glucose, LAB growth adaptation is needed to produce sucrose enzymes that can break down sucrose. According to the results of research by [17] in the manufacture of fermented coconut milk using *Lactobacillus reuteri* as a starter there was process hydrolysis of the sucrose content in coconut milk by the lactic acid bacteria (LAB) starter after the fermentation process for 48 hours. The total sucrose content in coconut milk was 4.3–4.4 g/L, after fermentation it reached final values of 0.7 and 0.8 g/L. In accordance with the statement of [18], LAB requires adaptation time and energy to produce enzymes that can break down polysaccharides into monosaccharides such as glucose. The glucose formed will be used in lactic acid fermentation. According to [19], in early growth, LAB uses energy sources from monosaccharides until all monosaccharides are used up, then enzymes are synthesized to break down polysaccharides that will be used in the next growth phase.

As seen in Figure 1, the DMRT_{0.05} further test results showed that the starter culture of *Lactobacillus bulgaricus* produced a lower pH value than the starter culture of *Streptococcus thermophilus*. This indicates that the starter culture of *Lactobacillus bulgaricus* is more active in producing lactic acid. According to [18], *Lactobacillus bulgaricus* will be more active at low pH so the amount of lactic acid produced will be higher. The level of lactic acid is influenced by the ability of LAB to form lactic acid which is determined by the type of starter, the number of starters used, and the state of the fermentation environment.

Table 1. pH value in starter cultures of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* in 100% milk

Fermentation Time	pH Values	
	<i>Streptococcus thermophilus</i> (ST)	<i>Lactobacillus bulgaricus</i> (LB)
16 hours	5.5 ± 0.01	5.57 ± 0.1
19 hours	5.53 ± 0.04	5.53 ± 0.08
24 hours	5.32 ± 0.04	5.28 ± 0.08
36 hours	4.57 ± 0.03	4.62 ± 0.04
48 hours	4.41 ± 0.04	4.44 ± 0.03

*Values (Mean±standard deviation, three replicates).

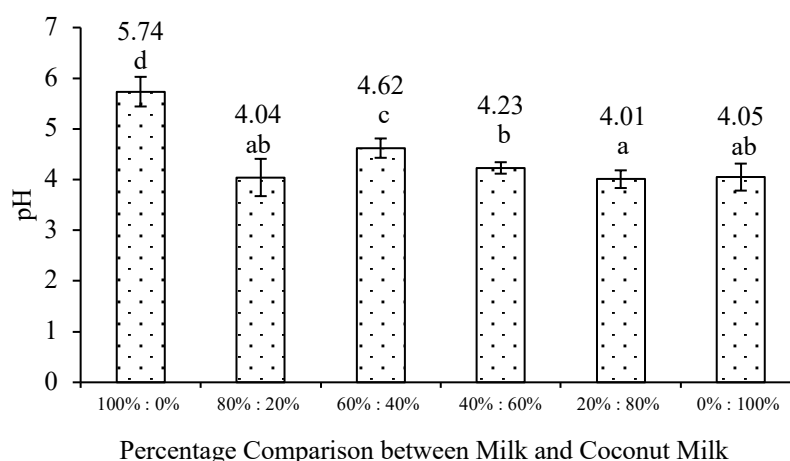


Figure 1. The effect of the ratio of the percentage of milk: coconut milk on the pH of the starter culture. The value followed by the same letter indicates a non-significant difference (coefficient of variation = 2.09%)

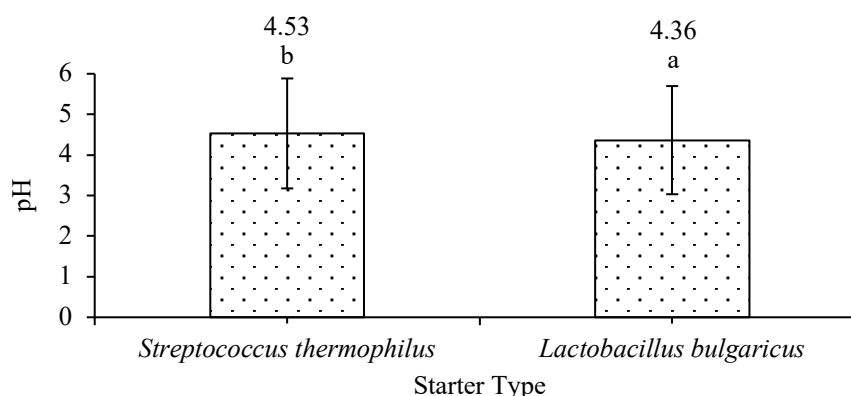


Figure 2. Effect of starter type on the pH value of starter culture. The value followed by the same letter shows a non-significant difference (coefficient of variation = 2.09%)

In the manufacture of starter cultures in this study, there were differences in the heating temperature and fermentation time used. In Figure 1, the percentage ratio of 100% milk:0% coconut milk and 80% milk:20% coconut milk uses a heating temperature of 70°C and a fermentation time of 48 hours. While the percentage ratio of 60% milk:40% coconut milk to 0% milk:100% coconut milk uses a heating temperature of 85°C and a fermentation time of 24 hours. The difference in heating temperature and fermentation time is caused by damage to the starter culture during the manufacturing process due to microbial contamination. This was presumably due to differences in conditions and the percentage of coconut milk used. Each starter culture produced has a liquid texture, a sweet and slightly sour taste, and a distinctive smell of coconut milk.

According to the research results of [20] in the process of heating coconut milk using the short-

term temperature method to increase to 95°C there are microbes of 4.39 cfu/ml which indicated that there are bacteria that are resistant to the short-term temperature method. The population of bacteria in coconut milk has a higher resistance to heat than the population of yeasts and molds so the higher the heating temperature used, the less the population of yeasts, molds, and bacteria found in coconut milk. Therefore, the use of a temperature of 85°C for 30 minutes in this study was more effective in reducing the number of microorganisms contained in coconut milk. Each starter culture produced has a liquid texture, a sweet and slightly sour taste, and a distinctive smell of coconut milk. Furthermore, the starter obtained was applied in the production of nyoghurt to see the quality characteristics produced in nyoghurt.

Table 2. Total LAB in 100% milk

LAB	Total LAB (log cfu/ml)
<i>Streptococcus thermophilus</i> (S1)	8.62 ± 3.03
<i>Lactobacillus bulgaricus</i> (S2)	9.55 ± 2.22

*Values (Mean±standard deviation, two replicates).

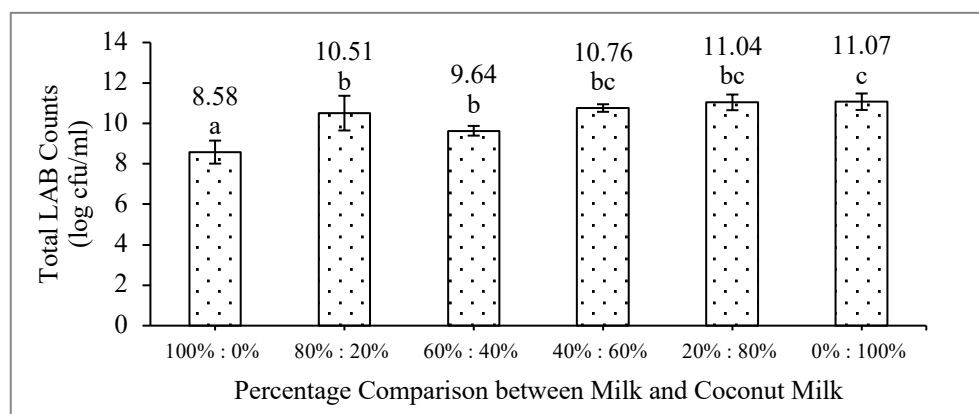


Figure 3. The effect of the ratio of the percentage of milk: coconut milk on total LAB Niyoghurt. The value followed by the same letter shows a non-significant difference (coefficient of variation = 5.01%)

Total Lactic Acid Bacteria (LAB)

The results of a preliminary study on total LAB in 100% milk can be seen in Table 2. Based on Table 2, the *Lactobacillus bulgaricus* had more colonies than *Streptococcus thermophilus*. This shows that *Lactobacillus bulgaricus* had a higher growth activity. Also, the number of cultures produced by both *Streptococcus thermophilus* and *Lactobacillus bulgaricus* (Table 2) has met the requirements as a starter in making yogurt. According to [21], in making yogurt, a starter culture is needed with a number of LAB colonies of 10^6 – 10^{10} cfu/ml.

Based on Figure 3, the total LAB obtained ranged from 8.58 to 11.07 log cfu/ml. Total LAB was lower in the percentage ratio of 60% milk:40% coconut milk. It is suspected that LAB has not been able to optimally utilize the components contained in its growth media. At a ratio of 60% milk:40% coconut milk, the lactose content of milk begins to decrease, thereby reducing the growth of LAB. LAB uses lactose as a carbon source and its metabolism product is lactic acid so the total amount of LAB during the fermentation process also changes. This is by the statement [22] that posits that during the fermentation process, lactose is converted by LAB into lactic acid meaning that the more lactose content is used to produce lactic acid, the more LAB activity will be.

Niyoghurt Characteristics

The chemical and microbiological characteristics of the niyoghurt produced were compared with previous studies and SNI 2981:2009 (Table 3). However, the results of the chemical analysis of niyoghurt (fat and protein content) in this study were slightly different from the niyoghurt produced in previous studies. The average fat content of the yogurt produced is higher than the results of previous studies. This is presumably because the LAB used has not been able to break down fat in niyoghurt.

According to [23], the acidic atmosphere in yogurt can affect the activity of fat-breaking enzymes, namely lipase. The higher the yogurt acid produced, the lower the activity of the fat-breaking enzyme from lipase. According to [24], if the activity of lipolytic enzymes decreases in an acidic environment, then the changes in fat composition that occur will be low. This is supported by [25] which states that pH is one of the factors that can affect the structure and activity of the lipase enzyme.

The protein content of coconut milk in this study was 3.85% which was slightly higher than the protein in fresh cow's milk, which was 3.5% [26]. According to [27], in addition to globulins and albumins, coconut milk also contains prolamins and glutenins. The decrease in protein content of niyoghurt is due to the protein breakdown by LAB. Following the statement of

Table 3. Percentage of the chemical, physical, and microbiological composition of coconut milk, yogurt, and niyogurt

Analysis	Component	Coconut Milk	Niyogurt	Yogurt (SNI)	Yunita et.al [7]*	Yunita et.al [9]**	Yunita et.al [31] ***
Chemical	Water (%)	77.50	77.11 ± 0.27	-	81.37	80.28	74.45
	Protein (%)	3.85	3.15 ± 0.056	min 2.7	11.93	11.53	3.91
	Fat (%)	8.50	8.3 ± 0.1	min 3.0	1.13	1.1	1.19
	Mineral (%)	0.25	0.76 ± 0.26	max 1.0	-	-	0.75
	Total acid (%)	-	0.83 ± 0.13	0.5-2.0	0.91	0.08	-
Physical	Viscosity (cp)	-	224.57 ± 13.32	-	-	4433	-
Microbiological	Total LAB (log cfu/ml)	-	11.48 ± 0.01	min. 7	-	9	-

*) Niyogurt with different ST: LB ratios and storage times

**) Niyogurt with different types of stabilizers

***) Niyogurt with the use of spices

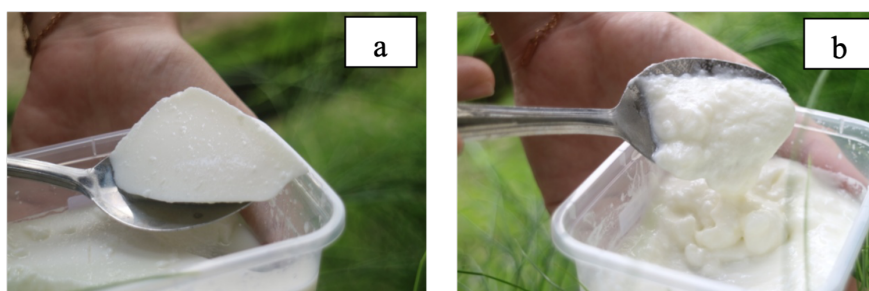


Figure 4. Niyogurt produced in this study: before stirring (a) and after stirring (b)

[28] that the decrease in protein in yogurt is due to the catabolic activity of LAB which breaks down protein into peptides.

Additionally, the viscosity of the resulting niyogurt was different from previous studies (Table 3). This is due to the addition of a stabilizer (xanthan gum). According to [29], yogurt viscosity should show a characteristic of resistance to flow which provides strength to withstand the relative motion. Rohman and Maharani [30] stated that apart from the ingredients, the manufacturing process also affects the viscosity of yogurt.

Based on SNI 2981:2009, the quality requirements of yogurt are having a thick and solid appearance, having a distinctive yogurt aroma, having a typical sour taste, and a homogeneous consistency. The yogurt produced has a sour and slightly sweet taste, a distinctive smell of coconut milk yogurt, a dense and thick texture, and is cream-colored. The appearance of the resulting niyogurt can be seen in Figure 4.

CONCLUSION

Optimization of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* isolates on various milk and coconut milk media affected pH, growth of LAB starter culture, and quality characteristics of the yogurt produced. The ratio of the percentage of milk and coconut milk on affects the pH of the starter culture; the higher the concentration of coconut milk, the lower the resulting pH value, ranging from 4.01 to 5.74. *Lactobacillus bulgaricus* culture produced a lower pH (4.36) than the starter *Streptococcus thermophilus* (4.53). A comparison of the percentage of milk and coconut milk affected the total growth of LAB in the starter culture. The higher the proportion of coconut milk, the total LAB increased, ranging from 8.58 to 11.07 log cfu/ml. The chemical and microbiological characteristics of the produced niyogurt complied with SNI.

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REFERENCE

- [1] Nurminabari, I.S.; Sumartini; Arifin, D. P. 2018. Kajian penambahan skim dan santan terhadap karakteristik yoghurt dari whey. *J. Pasundan. Food. Techno.* **5**(1): 54–62.
- [2] Badan Pusat Statistik. Produksi Susu Segar menurut Provinsi, 2009-2019. Retrieved on March 19, 2021 from: <https://www.bps.go.id/dynamictable/2015/12/22%2000:00:00/1083/produksi-susu-segar-menurut-provinsi-2009-2017.html>.
- [3] Riana, E.; Hendrawan, Y.; Hawa, L. C. 2018. Analisis kualitas yoghurt santan dengan penambahan ekstrak buah tropis pada variasi suhu inkubasi. *J. Keteknikan Pertanian Tropis dan Biosistem* **6**(3): 251-260.
- [4] Destiana, I. D.; Aprilia, D.; Hermalia, S. 2021. Karakteristik mutu kimia dan biologi cocogurt dengan perbedaan konsentrasi pektin dan pisang sebagai prebiotik alami. *J. Edufortech.* **6**(2): 135-138.
- [5] Turner, D. R.; Sinclair, W. H.; Knez, W. L. 2014. Nutritional adequacy of vegetarian and omnivore dietary intakes. *J. Nutr. Health. Sci.* **1**(2): 201.
- [6] Indonesia Vegetarian Society. 2020. Definisi vegan. Retrieved on December 12, 2021, from: <https://www.ivsvsi.org/organisasi>.
- [7] Yunita, D.; Rohaya, S.; Husna, N.; Maulina, I. 2011. Pembuatan niyoghurt dengan perbedaan perbandingan *Streptococcus thermophilus* dan *Lactobacillus bulgaricus* serta perubahan mutunya selama penyimpanan. *J. Tekno. Pertanian* **12**(2): 83–90.
- [8] Sarah; Indarti, E.; Yunita, D. 2021. Pengujian starter yoghurt (*Streptococcus thermophilus* dan *Lactobacillus bulgaricus*) serta ekstrak jambang (*Syzygium cumini* L.) pada kasus niyoghurt jambang yang telah rusak. *J. Ilmiah Mahasiswa Pertanian* **6**(1): 37-43.
- [9] Yunita, D.; Dary, R.; Rohaya, S. 2017a. Penambahan rempah-rempah (Cengkeh dan kayu manis) dalam pembuatan yoghurt berbahan baku santan kelapa (Niyoghurt). Seminar Nasional Perhimpunan Ahli Teknologi Pangan Indonesia (PATPI); Bandar Lampung; p. 221-226.
- [10] Mariska, D. 2018. Pembuatan Keju Oles (*Spread Cheese*) Berbahan Baku Santan Kelapa. *Skripsi*. Jurusan Teknologi Hasil Pertanian Fakultas Pertanian Universitas Syiah Kuala, Banda Aceh.
- [11] AOAC. 2005. *Official Methods of Analysis of The Association of Analytical Chemists* (Washington D.C.)
- [12] Nurgrahadi, N. N.; Puspawati; Sugitha, I. M. 2020. Pengaruh perlakuan 3 jenis bakteri asam laktat dan kombinasinya terhadap karakteristik keju kedelai. *J. Ilmu dan Tekno. Pangan* **9**(4): 412–425.
- [13] Stachelska, M. A.; Foligni, R. 2018. Development of a time-effective and highly specific quantitative real-time polymerase chain reaction assay for the identification of *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus* in artisanal raw cow's milk cheese. *Acta Veterinaria Brno. J.* **87**(3): 301–308.
- [14] Wibawanti, J. M. W.; Rinawidiastuti. 2018. Sifat fisik dan organoleptik yogurt drink susu kambing dengan penambahan ekstrak kulit manggis (*Garcinia mangostana* L.). *J. Ilmu dan Tekno. Hasil Ternak* **13**(1): 27- 37.
- [15] Hendarto, D. R.; Handayani, A. P.; Esterelita, E.; Handoko, Y. G. 2019. Mekanisme biokimiawi dan optimalisasi *Lactobacillus bulgaricus* dan *Streptococcus thermophilus* dalam pengolahan yoghurt yang berkualitas. *J Sains Dasar* **8**(1): 13-19.
- [16] Cahya, F.; Susanto, W. H. 2014. Pengaruh pohon pasca sadap dan kematangan buah kelapa terhadap sifat fisik, kimia organoleptik pasta santan. *J Pangan dan Agroindustri* **2**(4): 249-258.
- [17] Mauro, C. S. I.; Garcia, S. 2019. Coconut milk beverage fermented by *Lactobacillus reuteri*: optimization process and stability during refrigerated storage. *J. Food. Sci. Technol.* **56**(2): 854-864.
- [18] Machmud, N. A.; Retnowati, Y.; Uno, W. D. 2013. Aktivitas *lactobacillus bulgaricus* pada fermentasi susu jagung

- (*Zea mays*) dengan penambahan sukrosa dan laktosa. *J. Sainstek* 7(2): 1-10.
- [19] Erdiandini, I.; Sunarti, T. C.; Meryandini, A. 2015. Seleksi bakteri asam laktat dan pemanfaatannya sebagai starter kering menggunakan matriks tapioka asam. *J. Sumberdaya Hayati* 1(1): 26-33.
- [20] Szparaga, A.; Tabor, S.; Kocira, S.; Czerwinska, E.; Kubon, M.; Plociennik, B.; Findura, P. 2019. Survivability of probiotic bacteria in model systems of non-fermented and fermented coconut and hemp milks. *J. Sustainability* 11(21): 6093.
- [21] Mandei, J. H. 2015. Utilization of blondo as a starter in processing of yoghurt. *B Palma* 16(1): 66-76.
- [22] Oktaviana, A. Y.; Suherman, D.; Sulistyowati, E. 2015. Pengaruh ragi tape terhadap pH, bakteri asam laktat dan laktosa yogurt. *J. Sain. Pet. Indo.* 10(1): 22-31.
- [23] Bayu, M. K.; Rizqiati, H.; Nurwantoro, N. 2017. Analisis total padatan terlarut, keasaman, kadar lemak, dan tingkat viskositas pada kefir optima dengan lama fermentasi yang berbeda. *J. Teknologi Pangan* 1(2): 33-38.
- [24] Thohari, I.; Amertaningtyas, D.; Purwadi, P.; Jaya, F. 2014. Pengaruh pati ganyong (*Cannaedulis*, ker) modifikasi terhadap kualitas kefir. *J. Ilmu-Ilmu Peternakan (Indonesian Journal of Animal Science)* 24(1): 77-81.
- [25] Septiani, S. 2019. Karakterisasi lipase termostabil (isolat AI96) berdasarkan parameter temperatur dan pH pada industri makanan. *J. Lantanida* 7(1): 49-63.
- [26] Putri, E. 2016. Kualitas protein susu sapi segar berdasarkan waktu penyimpanan. *J. Chempublish* 1(2): 14-20.
- [27] Edem, V. E.; Elijah, A. I. 2016. Optimization of coconut (*Cocos nucifera*) milk extraction using response surface methodology. *Int. J. Nutr. Food Sci.* 5(6): 384-394.
- [28] Khoiriyah, L. K.; Fatchiyah, F. 2013. Karakter biokimia dan profil protein yogurt kambing PE difermentasi bakteri asam laktat (BAL). *J. Exp. Life Sci.* 3(1): 1-6.
- [29] Evadewi, F. D.; Tjahjani, C. M. P. 2021. Viskositas, keasaman, warna dan sifat organoleptik yoghurt susu kambing yang diperkaya dengan ekstrak beras hitam. *J. ilmiah Univ Batanghari Jambi* 21(2): 837-841.
- [30] Rohman, E.; Maharani, S. 2020. Peranan warna, viskositas, dan sineresis terhadap produk yoghurt. *J. Edufortech.* 5(2): 1-11.
- [31] Yunita, D.; Melia, W.; Dary, R.; Rohaya, S. 2017. Penggunaan karagenan dan gum xanthan sebagai bahan penstabil dalam pembuatan niyoghurt. Prosiding Semhas Teknologi Hasil Pertanian; Banda Aceh; p. 18-22.