e-ISSN 2581-0405

ajarcde Asian Journal of Applied Research for Community Development and Empowerment

Journal home page: http://ajarcde-safe-network.org ISSN 2581-0405

Fermentation Characteristics and Sensory Evaluation of Durian Yoghurt as a Synbiotic with Skim Milk and Sugar Formulations

Taufikkilah Romadhon[1], Aswita Emmawati[1*], Marwati[1], Yuliani[1], Rini Rahmawati[1], Martati[1],*

[1] *Agricultural Product Technology, Faculty of Agriculture, Mulawarman University. Indonesia*

ARTICLE INFO

Article History:
Received: 15 June 2025
Final Revision: 07 July 2025
Accepted: 09 July 2025
Online Publication: 13 July 2025

KEYWORDS

Prebiotic, probiotic, symbiotic, Durio zibethinus, tropical fruit

CORRESPONDING AUTHOR

*E-mail: aswita_emmawati@faperta.unmul.ac.id

A B S T R A C T

Synbiotic products are a combination of probiotics and prebiotics in food that work synergistically to enhance the survival of beneficial microbes and provide greater health benefits. Durian contains simple sugars, dietary fiber, and oligosaccharides that probiotics can utilize as a nutrient source for their growth. This study aims to evaluate the potential of durian (*Durio zibethinus*) as a prebiotic ingredient in the formulation of synbiotic yoghurt by observing its effects on fermentation characteristics, including microbiological, chemical, and sensory properties, when combined with different concentrations of skim milk and sugar (0%, 5%, and 10%). Total bacteria, lactic acid bacteria (LAB), and titratable acidity increased, while the pH value of the product decreased during the fermentation process. The addition of skim milk and sugar influenced the sensory profile of the product, with the best treatment observed in skim milk and sugar 5% (P8), based on hedonic scores for aroma, texture, and taste of the yoghurt after 24 hours of fermentation.

Contribution to Sustainable Development Goals (SDGs):
SDG 2: Zero Hunger
SDG 3: Good Health and Well-being
SDG 9: Industry, Innovation, and Infrastructure
SDG 12: Responsible Consumption and Production
SDG 13: Climate Action

1. INTRODUCTION

1.1. *Research Background*

The Ministry of Health of the Republic of Indonesia [1] reported that diarrhea accounted for 2.47% of deaths across all age groups, with enteric pathogen infections being the primary cause of diarrheal cases. Antibiotics are commonly used to prevent infections, however, their use has resulted in the emergence of antibiotic-resistant bacterial strains [2], [3]. This situation reinforces the urgency of research in this field to explore alternative approaches through the utilization of probiotics and prebiotics in the form of synbiotic products, which are beneficial in reducing the risk of intestinal infections and avoiding antibiotic resistance [4], [5].

Probiotics have been proven effective in maintaining digestive tract health. Probiotics are defined as live microorganisms that, when consumed in sufficient quantities, can provide health benefits to the host, such as restoring microbial balance in the gut, enhancing the immune system, and inhibiting the growth of pathogenic bacteria in the digestive tract [6]. With these capabilities, probiotics are expected to help reduce the incidence of diarrhea, which remains a major health problem, particularly in Indonesia.

Durian (*Durio zibethinus*) is a tropical fruit that grows abundantly in the Kalimantan region. It contains simple sugars, dietary fiber, and oligosaccharides that can be utilized by microbes or probiotics as a nutrient source for their growth [7], [8], [9]. This potential makes durian a promising prebiotic ingredient for the development of functional foods such as synbiotic products. Synbiotic products are a combination of probiotics and prebiotics in a food matrix that work synergistically to improve the survival of beneficial microbes and provide greater health benefits [10]. Synbiotic products can be developed through fermentation processes in milk-based products such as yoghurt, which is considered an ideal matrix due to its wide acceptance among consumers and its established market. Currently, the development of synbiotic yoghurt is also intensively pursued to enhance flavor and consumer acceptance [11], [12], [13]. Therefore, it is highly feasible to develop fruit-based synbiotic products or fruit yoghurts fermented with probiotic bacteria and containing oligosaccharides from tropical fruits of Kalimantan that can act as prebiotics.

1.2. Research Objective

This study aims to evaluate the potential of durian as a prebiotic ingredient in the formulation of synbiotic yoghurt, by observing its effect on fermentation characteristics, such as microbial, chemical, and sensory acceptance, when combined with different concentrations of skim milk and sugar.

2. MATERIALS AND METHODS

The material used in this study include skim milk, durian fruit puree, sugar, and yoghurt starter culture biokul plain (*Streptococcus thermophilus, Lactobacillus bulgaricus, Lactobacillus acidophilus* and *Bifidobacterium*) Nutrient Agar (NA), Mann Rogosa and Shpe Agar (MRSA), Dichloran Rose Bengal Chlorampenicol (DRBC) NaCl, Aquadest, buffer solution, Phenolphthalein, NaOH, ethanol, H_2SO_4 and $Na_2S_2O_3$. The equipment used includes a blender, jars, analytical balance, thermometer, incubator, autoclave, Bunsen burner, micropipette, test tubes, petri dishes, colony counter, pH meter, burette, indicator paper, volumetric flask, vacuum pump, Erlenmeyer flasks, and filter paper.

2.1. Processing of Yoghurt

Durian pulp is made by adding water with a ratio of 1: 3. Skim milk and sugar are added at 10% per volume of durian pulp. The addition of skim milk and sugar is done to induce the growth of lactic acid bacteria. The mixture of durian pulp, skim milk and sugar is heated at 100°C for 5 minutes. Then the mixture of fruit pulp is left to warm enough. The starter culture was inoculated at 5% per volume of fruit pulp and homogenized. Fermentation is carried out at room temperature for 24 hours (0, 6, 12 and 24 hours). The sample is taken and analysed to determine the number of bacteria, lactic acid bacteria, pH, and total titrated acid.

Determination of the number of bacteria and lactic acid bacteria is done by referring to the Bacteriological Analytical Manual (BAM) [14]. Determination of pH is carried out by pH meters, and total titrated acid is carried out by acid-base titration using 0.1N NaOH.

2.2. Profile sensory

The sensory evaluation of durian yoghurt was initially conducted by 25 panelist using a 1-5 hedonic scale to assess aroma, taste, and texture preferences. Based on hedonic results, the three most preferred samples, along with the control sample (without added milk and sugar), were further evaluated by trained panelists. From the original 25 participants, 10 individuals were selected and trained as panelists after undergoing a reliability test to assess their ability to identify and describe the sensory attributes of yoghurt consistently. Their reliability was validated through a series of triangle tests, which measured their capacity to distinguish fundamental sensory characteristic

2.3. Experimental design

This study employed a Completely Randomized Design (CRD) with two factors. The first factor was the percentage of skim milk with three levels: S1 = 0%, S2 = 5%, S3 = 10%. The second factor was the percentage of sugar, with three levels: G1 = 0%, G2 = 5%, G3 = 10%. The treatments were combined to from 9 treatment combinations (table 1). The parameters to be analysed include microbiological, chemical, and sensory characteristics, such as the number of bacteria, lactic acid bacteria, pH, total titrated acid, and sensory profile at 0, 6, 12, 18, and 24 hours.

Table 1. The formulation of milk skim and sugar

Sugar (%) / Milk skim (%)	0	5	10
0	P0	P1	P2
5	P3	P4	P5
10	P6	P7	P8

3. RESULT AND DISCUSSION

3.1. Microbiology Characteristics

The microbiological characteristics, specifically the total bacteria and lactic acid bacteria (LAB) during the fermentation process up to 24 hours with the addition of skim milk and sugar, are presented in Figures 1 and 2. The total bacteria and LAB increased throughout the fermentation process. Although the addition of skim milk and sugar supported bacterial growth, it did not have a statistically significant effect. The concentrations of skim milk and sugar used (P8) were not sufficient to produce a significant impact on the growth of total bacteria and LAB in the product. This is evident from the fermentation treatment without skim milk and sugar addition (P0), which still showed optimal microbial growth. The sugar and polysaccharides contained in agricultural products can serve as primary energy sources for bacterial metabolism [15], [16], [17]. Durian has been reported to contain 15–42 g of carbohydrates and 2–3 g of fiber per 100 g of pulp, depending on the variety [7], [8], [9]. This phenomenon also indicates that durian can function as a good prebiotic for probiotics even without the addition of skim milk and sugar.

The 24 hours fermentation process resulted in a lactic acid bacteria (LAB) count of up to 10^7 CFU/mL, which meets the minimum probiotic content required in a fermented product, as stated in the Indonesian National Standard 2009 [18]. At this concentration, probiotics can provide significant health benefits, particularly for the human digestive system. Probiotics inhibit the growth of pathogenic microorganisms through several mechanisms, such as reducing their ability to adhere to and colonize the intestinal mucosa, producing bioactive metabolites, and lowering the pH in the colon to create an unfavorable environment for pathogens. Additionally, probiotics contribute to

 https://doi.org/10.29165/ajarcde.v9i2.724

electrolyte absorption, toxin neutralization, and enhancement of the body's immune response [19], [20], [21], [22].

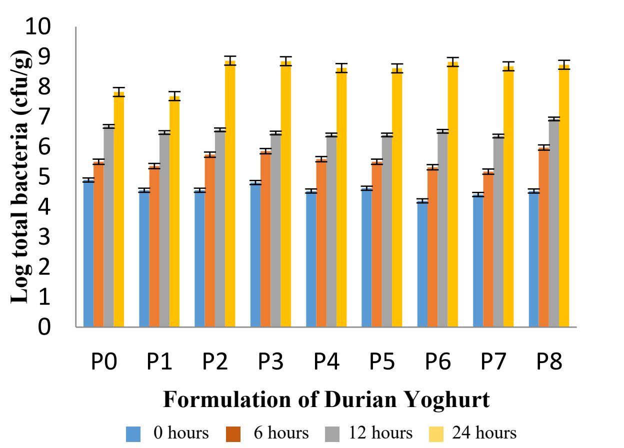

Figure 1. Total bacterial development during durian yoghurt fermentation

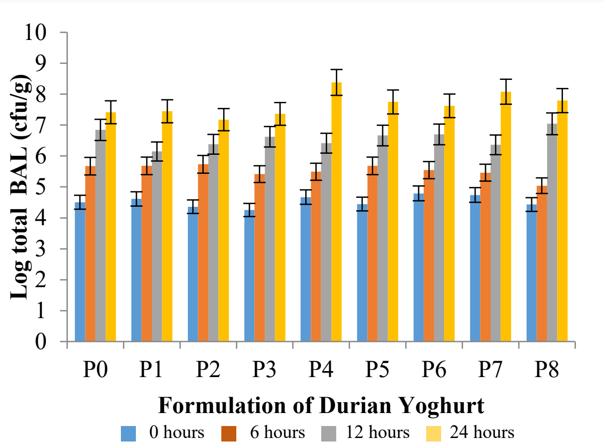

Figure 2. Total lactic acid bacteria development during durian yoghurt fermentation

3.2. *Chemical Characteristics*

The pH value of durian yoghurt consistently decreased during the fermentation process, from an initial range of 6.3–6.5 to 4.0–4.3 at the 24 hour (Figure 3). The addition of skim milk and sugar did not show a significant effect on the product's pH value. The decrease in pH was due to the production of secondary metabolites, particularly lactic acid, by microorganisms, which indicates a successful fermentation process and active probiotic function in the product [23], [24].

The pH reduction observed in the control treatment (P0) suggests that the natural carbohydrates and oligosaccharides in the fruit were sufficient to support the growth of lactic acid bacteria (LAB) and acid production, which are essential characteristics of fermented products [25], [26]. The resulting pH range of 4.0–4.3 is considered ideal for ensuring microbial stability and desirable sensory quality, as it falls within the yoghurt pH standard specified by the Indonesian National Standard [18].

The titratable acidity of the product increased throughout the fermentation process. The highest increase was recorded at 12 hours of fermentation, followed by a fluctuation at 18 hours, and then a further increase by the end of fermentation (Figure 4). This upward trend occurred consistently across all yoghurt treatments (P0-P8). These results confirm that the natural carbohydrate and oligosaccharide content in durian is sufficient to optimally support the growth of lactic acid bacteria (LAB). The obtained acidity values were relatively higher than those specified by the SNI, which ranges from 0.5–2.0% [18]. The findings also differ from the study by Kirtiyani [11], which reported a maximum titratable acidity of 0.8% in banana yoghurt with 10% sugar and 5% skim milk. Similarly, Arifani [12] reported a titratable acidity of 1.17% in dragon fruit yoghurt with the addition of 9% skim milk. The higher acidity levels observed in the present study are presumably due to the high content of natural sugars and polysaccharides in durian fruit.

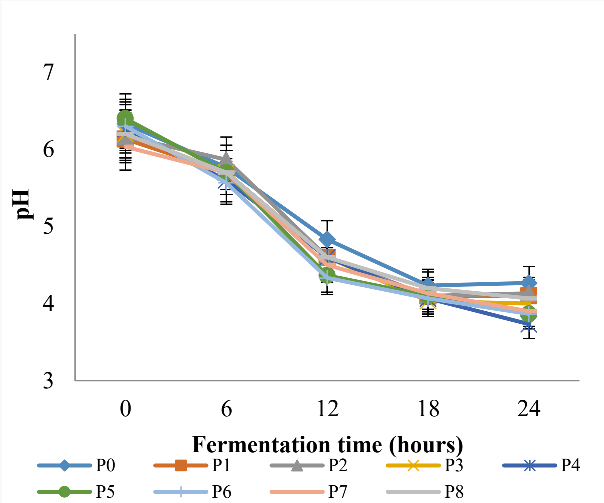

Figure 3. Changes in pH of durian yoghurt during fermentation

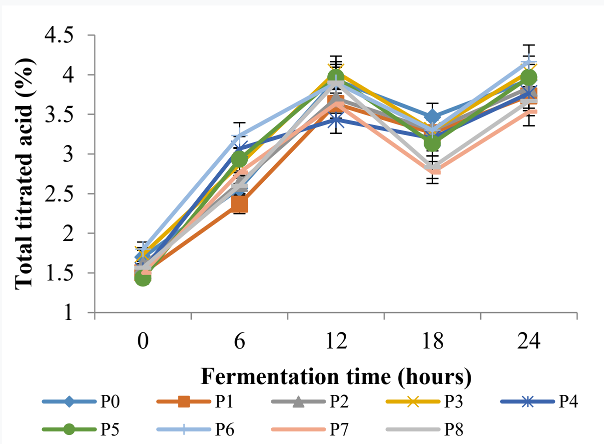

Figure 4. Total Acid Changes of Durian Yogurt During Fermentation

3.3. *Profil sensory*

The hedonic test involving 25 panellists indicated that the durian yoghurt product was generally well accepted, with scores ranging from "slightly liked" to "liked" for aroma, taste and texture attributes (Table 2). In the hedonic evaluation, the addition of skim milk and sugar showed a significant influence on the sensory profile of the product. This was evident in treatment P8, which received the highest scores (3.7–4.0, categorized as "liked"), while treatment P0 recorded the lowest scores (2.9–3.2, categorized as "neutral"). The use of durian without any additional ingredients failed to produce the sensory qualities desired by the panelists.

Other treatments, such as P3 and P7, also achieved scores close to those of P8, indicating that the addition of skim milk and sugar had a positive effect on the sensory characteristics of durian yoghurt. These results are consistent with previous studies which reported that sugar addition enhances hedonic scores or consumer acceptance of red dragon fruit yoghurt [13], [27], [28]. The addition of sugar can suppress excessive sourness in yoghurt products and enhance aroma due to its effect on volatile compounds. At the same time, the use of skim milk can improve the thickness and consistency of the product, as it contains proteins and solids that make it smoother and provide a pleasant mouthfeel sensation.

Table 2. Panellist preferences on taste, aroma and texture of Durian Yoghurt based on 1-5 hedonic scale

Treatments	Hedonic scale		
	Aroma	Taste	Texture
P0	3.2±1.05c	3.2±1.09a	2.9±1.01c
P1	3.7±0.83c	3.7±0.91ab	3.3±0.73ab
P2	3.4±0.81c	3.4±0.85a	3.2±1.06ab
P3	3.9±0.14c	3.2±0.71a	3.5±0.85ab
P4	3.4±0.85c	3.6±1.13a	2.3±0.97ab
P5	3.5±0.93c	3.5±1.16ab	3.2±0.80ab
P6	3.2±0.71c	3.0±0.92a	3.5±0.88ab
P7	3.9±0.93cd	3.8±1.03ab	3.9±0.64ab
P8	4.0±1.04d	4.0±0.99b	3.7±0.99ab

4. CONCLUSION

Durian yogurt fermentation caused changes in microbiology, pH and total acid during fermentation. Microorganisms increased, total acid increased, and pH decreased to 18 hours, stabilising at 24 hours. Durian yoghurt received good preference from panellists, particularly in terms of aroma, taste, and texture. The level of preference increases with increasing milk and added sugar. The most preferred product is P8, which is enhanced with 10% milk and 10% sugar, and is evaluated using hedonic scales for taste, aroma, and texture.

REFERENCE

[1] Kemenkes, "PROFIL KESEHATAN INDONESIA TAHUN 2020," Jakarta, 2021.

[2] L. Poirel *et al.*, " Antimicrobial Resistance in Escherichia coli ," *Microbiol Spectr*, vol. 6, no. 4, Jul. 2018, doi: 10.1128/microbiolspec.arba-0026-2017.

[3] H. Talukder, S. A. Roky, K. Debnath, B. Sharma, J. Ahmed, and S. Roy, "Prevalence and Antimicrobial Resistance Profile of Salmonella Isolated from Human, Animal and Environment Samples in South Asia: A 10-Year Meta-analysis," Dec. 01, 2023, *Springer Science and Business Media B.V.* doi: 10.1007/s44197-023-00160-x.

[4] C. E. Rauch, A. S. Mika, A. J. McCubbin, Z. Huschtscha, and R. J. S. Costa, "Effect of prebiotics, probiotics, and synbiotics on gastrointestinal outcomes in healthy adults and active adults at rest and in response to exercise—A systematic literature review," *Front Nutr*, pp. 1–48, 2022.

[5] B. R. Shah, B. Li, H. Al Sabbah, W. Xu, and J. Mráz, "Effects of prebiotic dietary fibers and probiotics on human health: With special focus on recent advancement in their encapsulated formulations," Aug. 01, 2020, *Elsevier Ltd*. doi: 10.1016/j.tifs.2020.06.010.

[6] F. Guarner Chair, S. G. Aamir Khan James Garisch Rami Eliakim Alfred Gangl, and A. Thomson Justus Krabshuis, "World Gastroenterology Organisation Global Guidelines," 2011.

[7] G. Khaksar, S. Kasemcholathan, and S. Sirikantaramas, "Durian (Durio zibethinus L.): Nutritional Composition, Pharmacological Implications, Value-Added Products, and Omics-Based Investigations," Apr. 01, 2024, *Multidisciplinary Digital Publishing Institute (MDPI)*. doi: 10.3390/horticulturae10040342.

[8] M. Belgis, C. Hanny Wijaya, A. Apriyantono, and B. Kusbiantoro, "Physicochemical differences and sensory profiling of six lai (Durio kutejensis) and four durian (Durio zibethinus) cultivars indigenous Indonesia," 2016. [Online]. Available: https://www.researchgate.net/publication/305409583

[9] Rusmiati, S. G. Sari, and K. R. Amalia, "Analisis Kandungan Proksimat Daging Buah dan Biji Tiga Varietas Durian (Durio zibethinus Murr.) yang Berasal dari Tempat Tumbuh yang Berdekatan," *Bioscientiae*, vol. 18, no. 1, pp. 1–11, 2021.

[10] K. S. Swanson *et al.*, "The International Scientific Association for Probiotics and Prebiotics (ISAPP) consensus statement on the definition and scope of synbiotics," Nov. 01, 2020, *Nature Research*. doi: 10.1038/s41575-020-0344-2.

[11] N. K. A. A. Kirtiyani, B. R. Handayani, and M. D. Ariyana, "Pengaruh Lama Fermentasi Terhadap Mutu Yoghurt Pisang Mas Bali," in *Seminar Nasional Sains dan Teknologi (SAINTEK) Mataram*, Mataram: LPPM Universitas Mataram, Jan. 2025, pp. 154–165.

[12] D. Arifani, S. R. Zulaikhah, and S. A. C. Luthfi, "Physicochemical Properties of Red Dragon fruit (Hylocereus polyrhizus L.) Yoghurt with the addition of Various Levels of skim milk," *Jurnal Ilmu dan Teknologi Peternakan*, vol. 11, no. 1, pp. 1–5, 2023.

[13] W. N. Utami, N. Suhartatik, and A. Mustofa, "Chickpea milk yoghurt (Cicer arietinum L.) with addition of red dragon fruit extract (Hylocereus polyrhizus) and variation types of sugar," *JITIPARI*, vol. 7, no. 1, pp. 89–99, 2022, [Online]. Available: http://ejurnal.unisri.ac.id/index.php/jtpr/index

[14] W. H. Andrews and T. S. Hammack, "Chapter 1. Food sampling/Preparations of Sample Homogenate," in *Bacteriological Analytical Manual*, Food and Drug Adminitration, 22AD, ch. 1.

[15] A. Emmawati, R. Rizaini, and A. Rahmadi, "Perubahan populasi bakteri asam laktat, kapang/khamir, keasaman dan respons sensoris yoghurt durian," *Journal of Tropical AgriFood*, vol. 2, no. 2, p. 79, Jul. 2021, doi: 10.35941/jtaf.2.2.2020.5131.79-89.

[16] Y. D. Safitri *et al.*, "Total Lactic Acid Bacteria and Total Soluble Solids in Coconut Yogurt with The Addition od Butterfly Pea Flowers During Storage Time," Semarang: Universitas Muhammadiyah Semarang, Oct. 2024.

[17] H. A. Jonathan, I. N. Fitriawati, I. I. Arief, M. S. Soenarno, and R. H. Mulyono, "Fisikokimia, Mikrobiologi dan Organoleptik Yogurt Probiotik dengan Penambahan Buah merah (Pandanus conodeous L.)," *Jurnal Ilmu Produksi dan Teknologi Hasil Peternakan*, vol. 10, no. 1, pp. 34–41, Jan. 2022, doi: 10.29244/jipthp.10.1.34-41.

[18] SNI, *Yoghurt*. Indonesia, 2009.

 https://doi.org/10.29165/ajarcde.v9i2.724

[19] S. Guo *et al.*, “Escherichia coli nissle 1917 protects intestinal barrier function by inhibiting NF-κB-mediated activation of the MLCK-P-MLC signaling pathway,” *Mediators Inflamm*, vol. 2019, 2019, doi: 10.1155/2019/5796491.

[20] A. Milajerdi *et al.*, “The effect of probiotics on inflammatory biomarkers: a meta-analysis of randomized clinical trials,” *Eur J Nutr*, vol. 59, no. 2, pp. 633–649, Mar. 2020, doi: 10.1007/s00394-019-01931-8.

[21] N. M. Maftei *et al.*, “The Potential Impact of Probiotics on Human Health: An Update on Their Health-Promoting Properties,” Feb. 01, 2024, *Multidisciplinary Digital Publishing Institute (MDPI)*. doi: 10.3390/microorganisms12020234.

[22] N. Jukic Peladic, G. Dell’Aquila, B. Carrieri, M. Maggio, A. Cherubini, and P. Orlandoni, “Potential Role of Probiotics for Inflammaging: A Narrative Review,” Aug. 24, 2021, *NLM (Medline)*. doi: 10.3390/nu13092919.

[23] F. A. Canon *et al.*, “Sifat Fisik, Kimia Dan Sensoris Yoghurt Kelapa Muda (Cocos nucifera L.) Dengan Penambahan Puree Buah Naga Merah (Hylocereus Polyhizus),” *Jurnal Teknologi Pertanian*, vol. 14, no. 2, 2023.

[24] Y. A. Manday and U. Mayasari, “Pengaruh Penambahan Madu pada Yoghurt Santan Kelapa (Cocos nucifera L.) terhadap Pertumbuhan Bakteri Asam Laktat,” *Menara Ilmu: Jurnal Penelitian dan kajian Ilmiah*, vol. 18, pp. 55–65, 2024.

[25] Rasbawati, I. I. D. Novieta, and Nurmiati, “Karakteristik Organoleptik dan Nilai pH Yoghurt dengan Penambahan Sari Buah Mengkudu (Morinda citrifolia L),” *Jurnal Ilmu Produksi dan Teknologi Hasil Peternakan*, vol. 07, no. 1, pp. 41–46, 2019.

[26] A. Frilanda, W. S. Putranto, and J. Gumilar, “Pengaruh Berbagai Konsentrasi Pulp Buah Naga Merah pada Pembuatan Set Yoghurt terhadap Total Bakteri Asam Laktat, Nilai pH, dan Total Asam,” *Jurnal Teknologi Hasil Peternakan*, vol. 3, no. 1, p. 32, Mar. 2022, doi: 10.24198/jthp.v3i1.39239.

[27] S. R. Zulaikhah, A. H. Sidhi, and L. P. Ayuningtyas, “Viskositas Dan Sifat Organoleptik Yogurt Buah Naga Merah (Hylocereus Polyrhyzus) Dengan Penambahan Gula Kelapa Kristal,” Fakultas Peternakan Universitas Jenderal Soedirman, Jun. 2022, pp. 797–803.

[28] S. Maisaro and D. Utomo, “Yoghurt sinbiotik ekstrak kulit buah naga merah (Hylocereus polyrhizus) dengan penambahan gula merah sebagai imunitas tubuh pada masa pandemi covid-19,” *Teknologi Pangan : Media Informasi dan Komunikasi Ilmiah Teknologi Pertanian*, vol. 13, no. 1, pp. 99–110, Mar. 2022, doi: 10.35891/tp.v13i1.3004.