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The Effect of Addition Purple Sweet Potato Extract (*Ipomea batatas* L.) and Storage at 4°C on the Antioxidant and Antibacterial Activities of Yogurt

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ABSTRACT
Yogurt is one of the fermented dairy products produced by lactic acid bacteria from milk, which contains beneficial nutritional components for human health. The innovation of yogurt production with the addition of probiotic cultures and food ingredients containing bioactive compounds can enhance its quality. This research aims to investigate the effect of adding purple sweet potato extract and storage treatment at 4℃ on yogurt's antioxidant and antibacterial activities. Four treatments were conducted in yogurt production, namely without adding purple sweet potato extract and adding 5%, 10%, and 15% (v/v) extract. All treatments were fermented using *Lactobacillus bulgaricus*, *Streptococcus thermophilus*, and *Lactobacillus plantarum* S1K2T1 as starter cultures. Subsequently, the yogurt was stored at 4℃ for 6 days, and chemical parameters, antioxidant, and antibacterial activities were examined. The highest result was observed in the treatment with 15% addition, showing a total antioxidant activity of 70.98% and an IC50 value of 13.96 ppm, which is equivalent to 2.06 times that of 200 ppm ascorbic acid. The six days storage affected antioxidant activity, but it was not significantly different. The antibacterial test showed indications of inhibition against *Staphylococcus aureus* ATCC 25923, *Salmonella typhi* NCTC 786, and *Escherichia coli* ATCC 25922, although the effect was very weak.

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1. INTRODUCTION

Cow's milk is a food ingredient that is high in macronutrients, minerals, vitamins, and other important bioactive compounds so it is widely consumed by the world community to improve health (Cimmino et al., 2023). However, cow's milk has a relatively short shelf life because it is easily damaged and can even become a source of disease for humans if it is not processed using the correct and less hygienic method (Navyanti et al., 2015). Efforts that can be made to extend the shelf life of milk are by processing either pasteurization (Setyawardani et al., 2021) or by fermentation using lactic acid bacteria into yogurt products (Sun et al., 2023).

Fermentation technology by Lactic Acid Bacteria (LAB) has been widely used to extend the shelf life of food products because it has been shown to have antifungal and antibacterial activity which acts as a bio-preservative agent (Dopazo et al., 2023). Apart from being a bio-preservative agent, fermentation by LAB in milk will also increase the nutritional value which has a beneficial impact on human health (Sun et al., 2023). Lactic acid bacteria can convert the carbohydrate, protein, and fat components in cow's milk into simpler forms so that they can be easily digested by the body. Protein conversion will produce bioactive peptides in the form of casein and whey protein which can act as antioxidants because they can stabilize and stop radical chain reactions (Rahmawati et al., 2016).

The development of the times and the emergence of a healthy lifestyle among the people encourage the development of yogurt product manufacture to present products with better functional properties. The addition of probiotics is one of the innovations that have been made. *Lactobacillus plantarum* is a probiotic that can increase lactic acid production during the milk fermentation process and is able to produce antimicrobial bacteriocins which can act as antibacterials. *Lactobacillus plantarum* is also able to survive in acidic intestinal conditions and is even able to reduce pathogenic bacteria that cause diarrhea (Nugrahani et al., 2020). In addition to innovation through the addition of probiotic starter, the addition of food ingredients that have bioactive content can also be done to obtain yogurt with a more delicious taste and can increase the nutritional value which is good for human health. Purple sweet potato has great potential to be rich in anthocyanins, which are bioactive compounds that function as antioxidants, antibacterial and anti-cancer (Ramadhani et al., 2018).

This study focused on the potential of purple sweet potato in increasing antioxidant activity in yogurt products. This is based on several previous studies which have proven the ability of purple sweet potato to increase antioxidant activity and improve the quality of yogurt. In addition, the starter *L. plantarum* S1K2T1 was added as a probiotic to increase lactic acid production during the fermentation process and provide an antibacterial effect (Amarantini et al., 2020).

2. RESEARCH METHOD

The study used an experimental method by carrying out three main stages, specifically the preparation of purple sweet potato samples and *Lactobacillus bulgariccus* FNCC 0040, *Streptococcus thermophilus* FNCC 0041, and *L. plantarum* S1K2T1 isolates for making yogurt starter, followed by making yogurt without additions and adding 5%, 10%, and 15% purple sweet potato extract and ending with measuring antioxidant and antibacterial activity in yogurt. *Lactobacillus bulgariccus* FNCC 0040, and *S. thermophilus* FNCC 0041 were obtained from the Laboratory of Food and Nutrition Inter-University Center UGM Yogyakarta. While the isolate of *L. plantarum* S1K2T1 was obtained from the results of previous research (Amarantini et al., 2020), a collection of the Research Laboratory of the Faculty of Biotechnology, Universitas Kristen Duta Wacana Yogyakarta. The concentrated purple sweet potato sample obtained from Mirota Campus supermarket in Yogyakarta was washed and mashed using a blender by adding 300 ml of water for every 100 grams of sweet potato. Before use, purple sweet potato extract was pasteurized at 60°C for 15 minutes (Utami et al., 2020). LAB isolates for starter were recultured on MRS broth media and then incubated at 37°C for 24 hours. Before being used as a starter, LAB isolates were confirmed by growing on selective media MRSA + CaCO3 (Amarantini et al., 2020), gram staining, and observing morphological forms (Hamidah et al., 2019).

Starter preparation and yoghurt fermentation process were designed by modifying the results of previous studies (Ramadhani et al., 2018; Devangga et al., 2018). All isolates whose purity had been confirmed were re-cultured in MRS broth for 24 hours until a white precipitate formed. Cell mass was collected by centrifugation at 5000rpm for 5 minutes to separate the cell mass from the medium. The cell mass obtained was then washed with normal saline solution (0.85% NaCl) three times. Next, the starter was made by inoculating the entire cell mass into a mixture of 90% commercial cow's milk, 5% sucrose, and 5% skim milk and then incubating at 40°C for 24 hours. Yogurt was made using commercial cow's milk added with 5% sucrose (w/v), 5% skim milk (w/v), and made four variations of adding purple sweet potato extract, namely the addition of 0%, 5%, 10%, and 15% (v/v) and the addition of 10% starter then fermented at 40°C for 24 hours. Furthermore, the yogurt was stored for up to six days at 4 °C, and measurements were made of the pH value and total acid as well as taking the acid extract crude every 2 days.

Furthermore, tamarind crude extract is used for the analysis of antioxidant and antibacterial activity. Antioxidant analysis was carried out using the DPPH damping method. A 50 ppm DPPH solution was prepared by dissolving 5 mg of DPPH with 100 ml of methanol. Each sample was made up to 1000, 750, 500, and 250ppm. 2 ml of DPPH 0.1 mM 50 ppm was added to every 2 ml of sample (1:1) then stored in a dark room for 30 minutes and analyzed using UV-Vis spectrophotometry at a wavelength of 517 nm (Af'idah et al., 2019). Antibacterial analysis was carried out by the paper disc diffusion method. Paper discs with a diameter of 6 mm were then dripped with 50µl of sample and waited for it to dry and placed on MHA containing a suspension of pathogenic bacteria. The plates were incubated at 37°C for 24 hours after which the inhibition zone was measured and calculated (Amarantini et al., 2020).

3. RESULT AND DISCUSSION

The pH value and total lactic acid are two extract content. The total lactic acid produced in yogurt without the addition of purple sweet potato extract was only 0.56% while yogurt with the addition of 5%, 10%, and 15% extract had total lactic acid of 0.72%, 0.74%, and 0.78 %. Purple sweet potato is known to have a fairly high content of oligosaccharides. Oligosaccharides can function as prebiotics or nutrient sources that LAB can use to grow and develop during the fermentation process.

The increase in total lactic acid levels is the result of the activity of breaking down sugar by lactic acid bacteria. Oligosaccharides from purple sweet potatoes and lactose from available milk substrates will be converted into glucose and galactose then converted into lactic acid (Rizky et al., 2015). Apart from the effect of adding purple sweet potato extract, the lactic acid content was also affected by the addition of the probiotic *L. plantarum* S1K2T1 which can produce lactic acid during the fermentation process. The total lactic acid in yogurt made with *L. bulgaricus* and *S. thermophillus* starter with the addition of probiotic *L. plantarum* S1K2T1 produced a lower possible because, during the fermentation process, LAB only obtains nutrients from commercial cow's milk, skim milk, and sucrose to grow and develop. Because the amount of sugar is less, the amount of substrate that can be amount of total lactic acid when compared to yogurt with the addition of purple sweet potato extract. This is converted into lactic acid is also less. Overall, the total lactic acid produced from the 4 treatments for making yogurt is still by the quality standards of the Indonesian National Standard (SNI), which is between 0.5% -2.0% (Mawarni et al., 2015).

Table 1. The Effect of the Addition of Purple Sweet Potato Extract and Storage at 4°C on Total Lactic Acid

Treatment	**Total of lactic acid (%) based on the storage time (days)**				**Mean ± SD**
	0	**2**	**4**	**6**	
P1	0.56	0.55	0.49	0.48	0.52 ± 0.04
P2	0.72	0.72	0.59	0.59	0.65 ± 0.07
P3	0.74	0.72	0.57	0.57	0.64 ± 0.1
P4	0.78	0.71	0.6	0.59	0.53 ± 0.3

Information:
P1: Yogurt without the addition of purple sweet potato extract
P2: Yogurt with the addition of 5% purple jalapeno extract
P3: Yogurt with the addition of 10% purple jalapeno extract
P4: Yogurt with the addition of 15% purple jalapeno extract

Table. 2 Effect of the Addition of Purple Sweet Potato Extract and Storage at 4°C on the pH value of yogurt

Treatment	**pH Value of yogurt based on the storage time (days)**				**Mean ± SD**
	0	**2**	**4**	**6**	
P1	4.50	4, 61	4, 66	4, 68	4.61 ± 0.07
P2	4, 37	4.45	4,4 9	4,4 5	4.46 ± 0.07
P3	4, 30	4,4 1	4.48	4,4 5	4,42 ± 0.09
P4	4, 24	4, 36	4, 41	4,44	4.36 ± 0.09

Information:
P1: Yogurt without the addition of purple sweet potato extract
P2: Yogurt with the addition of 5% purple jalapeno extract
P3: Yogurt with the addition of 10% purple jalapeno extract
P4: Yogurt with the addition of 15% purple jalapeno extract

Increasing or decreasing the pH value is closely related to the total lactic acid produced during the fermentation process. The total lactic acid produced will be excreted out of the cells and will eventually accumulate causing a decrease in the pH value and an increase in the acidity of the product (Ramadhani et al., 2018). It can be seen in Table 2 that the pH value decreases with increasing concentration of purple sweet potato extract in the product. The pH value of yogurt without the addition of extract was 4.50 while yogurt with the addition of 15% extract had a value of 4.24. When compared with a good pH standard according to SNI 2009, the pH value is still classified as a good pH value because it is still in the range of 3.8-4.5. The statistical results showed a sig value ($P < 0.05$) so it could be concluded that the addition of purple sweet potato extract had a significant effect on decreasing the pH value of yogurt. A good pH value indicates a process of lactic acid production by lactic acid bacteria during the fermentation process which affects the decrease in pH value (Oktavia et al., 2015).

An antioxidant activity test on yogurt samples was carried out using the DDPH method. DPPH is a synthetic radical that, when reacted with compounds containing antioxidants, will carry out a hydrogen atom donor mechanism, causing the DPPH color to decay from purple to yellow. Table 3 showed that the antioxidant activity of the yogurt sample increased as the concentration of the extract added increased. The highest yield was in yogurt with the addition of 15% sweet potato extract which was 70.98% and the lowest was in yogurt without the addition of purple sweet potato extract which was 49.35%. The antioxidant activity of yogurt without the addition of purple sweet potato extract was not much different from the antioxidant activity of yogurt with the addition of 5% purple sweet potato extract. These results indicate that during the fermentation process, a proteolytic mechanism occurs by lactic acid bacteria on the cow's milk substrate break down proteins into short peptides that have antioxidant activity because they can stabilize and stop the radical chain reaction in DDPH (Muthia et al., 2017).

Table 3. Antioxidant Activity (% inhibition of DPPH) Yogurt During Storage Period

Storage Period	% Inhibition of DPPH			
	P1	P2	P3	P4
0	49.35	54,67	62,2	70.98
2	53,56	55,78	60,7	70,26
4	52.01	61,6	60,2	70.01
6	57,18	61,14	60,2	69,54
Mean ± SD	52.02±3.27	58.29±3.58	60.82±0.94	70.14±0.51

Information:
P1: Yogurt without the addition of purple sweet potato extract
P2: Yogurt with the addition of 5% purple jalapeno extract
P3: Yogurt with the addition of 10% purple jalapeno extract
P4: Yogurt with the addition of 15% purple jalapeno extract

Based on statistical tests, data were obtained ($P<0.05$) so that it can be said that increasing the concentration of purple sweet potato extract had a significant effect on increasing the antioxidant activity of yogurt. Devangga et al., (2018) stated that yogurt with the addition of purple sweet potato flour by 1 -3% can increase antioxidant activity by 2.4 to 4.9 times compared to yogurt without the addition of purple sweet potato flour. The addition of 3% purple sweet potato flour in yoghurt fermentation is known to increase antioxidant activity by 20.62%, while yoghurt without purple sweet potato flour only has an antioxidant content of 4.21%. The average antioxidant activity of purple sweet potato in fresh condition ranges from 23.28% - 82.07% depending on the variety (Farida et al., 2022). Thus, the addition of purple sweet potato extract of 5% -15% can increase antioxidant activity in yogurt products.

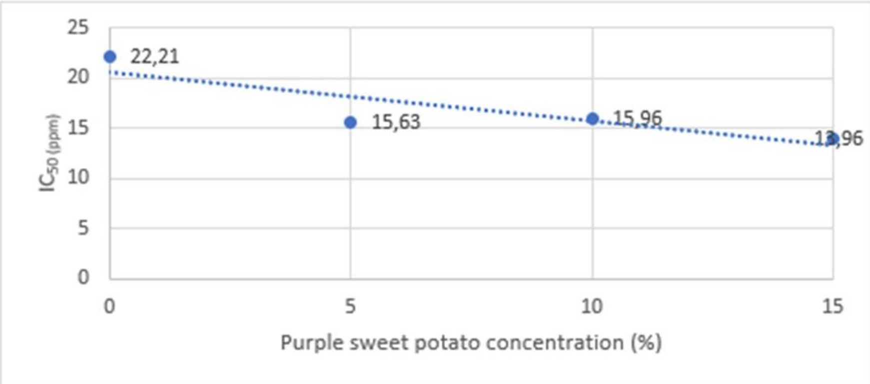

Figure 1. The effect of adding purple sweet potato extract to the IC_{50} value of Yogurt

Calculation of the IC_{50} value was carried out to determine the effective concentration of the sample in absorbing 50% of DPPH. Based on the results of calculating the IC_{50} value presented in Figure 1, it can be seen that the antioxidant properties of the four samples belong to very strong antioxidants because the IC_{50} value is <50 ppm (Trisantini, et al., 2016). The lowest sample concentration that was able to reduce 50% of free radicals was yogurt with the addition of 15% purple sweet potato extract with an IC_{50} value of 13.96 ppm.

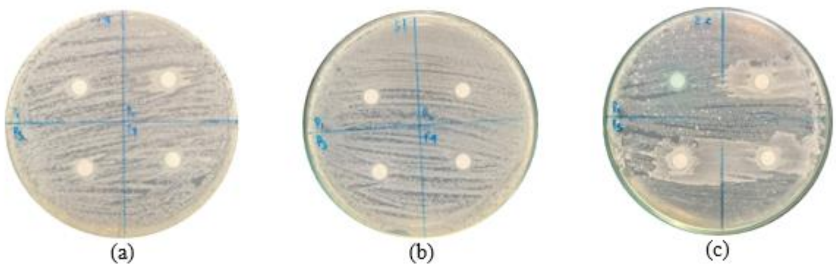

Figure 2. Yogurt Antibacterial Activity against (a) *Staphylococcus aureus* ATCC 25923, (b) *Salmonella typhi* NCTC 786, (c) *Escherichia coli* ATCC 25922.

The antibacterial activity test of the acid extract crude of yogurt samples aims to determine the ability of yogurt extract to inhibit the growth of pathogenic bacteria represented by *S. aureus* ATCC 25923, *S. typhi* NCTC 786, and *E. coli* ATCC 25922. These three bacteria are used as indicators for testing antibacterial activity because they belong to a group of bacteria that can cause disease and are transmitted through food (*foodborne diseases*). Based on Figure 2. It can be seen that the yogurt from the four treatments indicates the ability to carry out an inhibitory reaction against the growth of *S. aureus* ATCC 25923, *S. typhi* NCTC 786, and *E. coli* ATCC 25922 bacteria even though it was very small. Inhibition response with a weak category was also found in purple sweet potato peel extract at a concentration of 1000 ppm, which was only able to inhibit *Propionibacterium acnes* isolates with an inhibition zone diameter value of 10.3 ± 0.03 mm (Paramita et al., 2016). Therefore, further research is still needed to confirm the content of compounds in purple sweet potato that have antibacterial potential.

4. CONCLUSION

The addition of purple sweet potato extract has a significant effect on increasing the antioxidant activity of cow's milk yogurt. The highest antioxidant activity was in yogurt with the addition of 15% purple sweet potato extract with a total antioxidant of 70.98% with an effective sample concentration in inhibiting 50% DPPH 50ppm of 13.96 ppm which is equivalent to 2.06 times ascorbic acid. Whereas antibacterial test of the four treatments showed indications of inhibition against *S. aureus* ATCC 25923, *S. typhi* NCTC 786, and *E. coli* ATCC 25922 bacteria although very small. Yoghurt products with the addition of purple sweet potato extract can be applied and consumed as a health drink with sufficient vitamin C content.

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6. REFERENCES

Af'idah, F., & Trimulyono, G. (2019). Uji aktivitas antioksidan dan kadar asam laktat yoghurt tempe kedelai (Glycine max) dan yoghurt tempe kacang hijau (Vigna radiata). *Lentera Bio*, 8(1), 17-24.

Amarantini, C., Budiarso, T. Y., Antika, Y. E., & Prakasita, V. C. (2020). Characterisation of *Lactobacillus plantarum* isolated from pickled cucumber, and its antagonist effect on pathogenic bacteria. *International Food Research Journal*, 27(5), 805-813.

Cimmino, F., Catapano, A., Villano, I., Di Maio, G., Petrella, L., Traina, G., & Cavaliere, G. (2023). Invited review: Human, cow, and donkey milk comparison: Focus on metabolic effects. *Journal of Dairy Science*. 106:3072–3085. DOI: https://doi.org/10.3168/jds.2022-22465.

Devangga, F., Bambang D., & Nurwantoro. (2018). Optimasi Persentase Penggunaan Tepung Ubi Jalar Ungu (Ipomoea batatas L. Poir) pada Yoghurt Berdasarkan Parameter Aktivitas Antioksidan, Derajat Keasaman, Viskositas dan Mutu Hedonik. *Jurnal Teknologi Pangan*, 3(1): 183-190.

Dopazo, V., Illueca, F., Luz, C., Musto, L., Moreno, A., Calpe, J., & Meca, G. (2023). Evaluation of shelf life and technological properties of bread elaborated with lactic acid bacteria fermented whey as a bio preservation ingredient. *LWT-Food Science and Technology*, 114427. DOI: https://doi.org/10.1016/j.lwt.2023.114427.

Farida, S., Niniek, D.K., Nunuk, H., Gettik, A., & Purwanti. (2022). Karakteristik Kimia dan Aktifitas Antioksidan Tepung Ubi Jalar Ungu Varietas Antin 2 dan Varietas Antin 3. *Jurnal Green House*, 1(1): 07-18.

Hamidah, M. N., Rianingsih, L., & Romadhon, R. (2019). Aktivitas antibakteri isolat bakteri asam laktat dari peda dengan jenis ikan berbeda terhadap *E. coli* dan *S. aureus*. *Jurnal Ilmu dan Teknologi Perikanan*, 1(2), 11-21. DOI: https://doi.org/10.14710/jitpi.2019.6742.

Mawarni, A. N., & Fithriyah, N. H. (2015). Pengaruh konsentrasi starter terhadap kadar asam laktat dalam pembuatan fruitghurt dari kulit buah semangka. *Prosiding Semnastek*. 2407 – 1846. DOI: https://jurnal.umj.ac.id/index.php/semnastek/article/view/445.

Muthia, K. N. S., Sarjono, P. R., & Aminin, A. L. (2017). Aktivitas antioksidan dan antibakteri produk fermentasi susu kedelai dan whey tahu menggunakan bakteri asam laktat komersial. *Jurnal Kimia Sains dan Aplikasi*, 20(1), 9-12.

Navyanti, F., & Adriyani, R. (2015). Hygiene sanitation, physical qualities and bacterial in fresh cow's milk of x milk company in Surabaya. *Jurnal Kesehatan Lingkungan Unair*, 8(1), 36-47. DOI: https://doi.org/10.20473/jkl.v8i1.2015.36-47.

Nugrahani, G., Apridamayanti, P., & Sari, R. (2020). Aktivitas antibakteri yogurt hasil fermentasi *Lactobacillus plantarum* terhadap bakteri *Escherichia coli* dan *Staphylococcus aureus*. *Jurnal Cerebellum*, *6*(2), 55-58. DOI:10.26418/jc.v6i2.45306.

Oktavia, H. M., Kusumawati, N., & Kuswardhani, I. (2015). Pengaruh lama penyimpanan selama distribusi dan pemasaran terhadap viabilitas bakteri asam laktat dan tingkat keasaman pada yogurt murbei hitam (Morus nigra L.). *Jurnal Teknologi Pangan dan Gizi (Journal of Food Technology and Nutrition)*, 14(1), 22-30. DOI: 10.33508/jtpg.v14i1.1514.

Paramita, N.L.P.V., Rasmita, L.D., Putri, I G.A.A.R.C., Utami, N.P.P., Budiningrum, N.W., Suastini, I G.A.N., Wintari, L.K.S., Yustiantara, P.S., & Wirasuta, I M.A.G. (2016). Perbandingan Aktivitas Antibakteri Ekstrak kaya antosianin dari Kulit Ubi Jalar Ungu (Ipomoea batatas L.) dan Kulit Buah Anggur Hitam (Vitis Vinifera L.) terhadap Isolat Bakteri *Propionibacterium acnes*. *Jurnal Farmasi Udayana*, 5(2): 53-57.

Rahmawati, I. S., & Suntornsuk, W. (2016). Effects of Fermentation and Storage on Bioactive Activities in Milks and Yoghurts. *Procedia Chemistry*. 18: 53– 62. https://doi.org/10.1016/j.proche.2016.01.010

Ramadhani, T. B., Nurwanto., & Antonius, H. (2018). Karakteristik yoghurt dengan penambahan tepung ubi jalar ungu. *Jurnal Teknologi Pangan*. 2 (2): 183-190. DOI: https://doi.org/10.14710/jtp.2018.21631.

Rizky, A. M., & Zubaidah, E. (2015). Pengaruh penambahan tepung ubi ungu jepang (ipomea batatas) terhadap sifat fisik, kimia, dan organoleptic kefir ubi ungu. *Jurnal Pangan dan Agroindustri*. 3 (4): 1393-1404. DOI: https://jpa.ub.ac.id/index.php/jpa/article/view/262.

Setyawardani, E., Rahardjo, A. H. D., & Setyawardani, T. (2021). Pengaruh Jenis Susu Terhadap Sineresis, Water Holding Capacity, Dan Viskositas. *Jurnal of Animal Science and Technology*. 3(3), 242-251.

Sun, Y., Guo, S., Wu, T., Yang, Y., Shen, T., Ma, X., & Zhang, H. (2023). *Bifidobacterium adolescentis* B8589- and *Lacticaseibacillus paracasei* PC-01-co-fermented milk has more γ-aminobutyric acid and short-chain fatty acids than *Lacticaseibacillus paracasei* PC-01-fermented milk. *LWT-Food Science and Technology* 179, 114645. DOI: https://doi.org/10.1016/j.lwt.2023.114645.

Tristantini, D., Ismawati, A., Pradana, B. T., & Jonathan, J. G. (2016). *Pengujian aktivitas antioksidan menggunakan metode DPPH pada daun tanjung (Mimusops elengi L)*. Paper presented at Seminar Nasional Teknik Kimia Kejuangan 2016, Yogyakarta, Indonesia.

Utami, M. M. D., Pantaya, D., Subagja, H., Ningsih, N., & Dewi, A. C. (2020). Teknologi pengolahan yoghurt sebagai diversifikasi produk susu kambing pada kelompok ternak Desa Wonoasri Kecamatan Tempurejo Kabupaten Jember. *PRIMA J. Community Empower. Serv*, 4(1), 30.