Original Research Article

ANTIBACTERIAL ACTIVITY OF SYNBIOTIC YOGHURT PEEL EXTRACT OF RED DRAGON FRUIT (*Hylocereus polyrhizus*) EVAPORATION WITH HONEY

ABSTRACT

Synbiotic yogurt is a combination of probiotics and prebiotics. Red dragon fruit peel extract contains 10.79% pectin, which can be used as a prebiotic. Red dragon fruit peel synbiotic yogurt produces an unpleasant aftertaste. The addition of honey can improve the functional properties of dragon fruit peel synbiotic yogurt. Yogurt with the addition of prebiotics can increased the functional properties of probiotic yogurt and increase the viability of bacteria the digestive tract. The purpose of this study was to determine the antibacterial activity of synbiotic yogurt with evaporated red dragon fruit peel extract and honey. This research was conducted at the Laboratory of Animal Products Technology, Faculty of Animal Husbandry, Universitas Brawijaya. The research material is white rats (*Rattus norvegicus*) male aged 3 months with a weight of 150-180 g (adapted for 7 days with basal feed), probiotic yoghurt, synbiotic yoghurt with addition of red dragon fruit peel extract (*Hylocereus polyrhizus*) 20% made from 10% skim milk and yoghurt starter containing *Lactobacillus bulgaricus* and *Streptococcus thermophilus* (1:1), and the addition of 2% honey to synbiotic. Animals were given probiotic yogurt (P0), 20% red dragon fruit peel extract synbiotic yogurt (P1), and 20% red dragon fruit peel extract synbiotic yogurt with 2% honey sweetener (P2). The duration of experimenting is 1 month. The experimental animal is then dissected and excrement in the ileum part is taken for testing. The data obtained were analyzed using descriptive qualitative. The results showed that P0 did decrease coliform and *Enterococcus spp* but increase total bacteria, mold and yeast, and *Escherichia coli. The a*ddition of evaporated red dragon fruit peel extract in synbiotic yogurt (P1) did decrease total bacteria, coliform, and *Enterococcus spp* but increase in mold and yeast and *Escherichia coli.* The addition of honey (P2) did decrease total decrease, mold and yeast, and *Enterococcus spp* but increase *Escherichia coli. The addition of honey to the synbiotic yogurt of red dragon fruit peel extract can affect the total number of bacteria, mold and yeast, coliform, Escherichia coli, and Enterococcus spp.*

Keywords: symbiotic yoghurt, red dragon fruit peel, honey, antibacterial activity, Escherichia coli, Enterococus spp.

1. INTRODUCTION

Yogurt is a product obtained from the fermentation of milk using the bacteria *Lactobacillus bulgaricus* and Streptococcus thermophilous and or other appropriate lactic acid bacteria, with or without the addition of other foodstuffs and permitted food additives. Probiotics used in fermented milk such as yogurt are *Lactobacillus bulgaricus* and *Streptococcus thermophilus* because they have a synbiotic relationship [1]. Yogurt with the addition of prebiotics can increased the functional properties of probiotic yogurt and increase the viability of bacteria in the digestive tract [2]. The

addition of prebiotics to probiotic yogurt is called synbiotic yogurt [3]. One of the ingredients that can be a prebiotic ingredient is the peel of the red dragon fruit (*Hylocereus polyrhizus*).

The peel of the red dragon fruit becomes waste even though the content contained in the peel of the red dragon fruit can be used as a prebiotic and increase the functional value of yogurt. The peel content of the red dragon fruit (*Hylocereus polyrhizus*) contains higher fiber and betacyanin when compared to the peel of the white dragon fruit (Hylocereus undatus). The peel of the red dragon fruit has 46.7% fiber, 10.79% pectin, 150.46/100g betacyanin, alkaloid compounds, steroids, saponins, and tannins [4]. The addition of red dragon fruit peel extract also affects the taste of the yogurt. Making synbiotic yogurt with red dragon fruit peel extract produces an aftertaste that consumers don't like very much [5].

The addition of natural sweeteners such as honey is an attempt to increase the sweetness of yogurt. The addition of honey to yoghurt can improves the quality and nutritional value of yoghurt and improves organoleptic properties [6]. The content contained in honey is 41% fructose, 35% glucose, and 1.9% sucrose [7]. Honey can improve the growth of Lactic Acid Bacteria (BAL) in making yogurt because of the oligosaccharides that can be used as source energy of for prebiotics [8]. The addition of honey up to 3% can improve the quality of yoghurt without having a detrimental effect on the characteristics of Lactic Acid Bacteria (BAL) and the characteristics of yoghurt [9].

Yogurt as a functional food has many benefits because the content of probiotics and prebiotics becomes synbiotic such as preventing the growth of pathogenic bacteria in digestion. Enterococcus spp and Escherichia coli bacteria can cause digestive disorders such as poisoning and diarrhea [10]. An increase in the growth of coliform microbes and a decrease in the number of non-pathogenic bacteria attached to intestinal villi will result in the formation of mucin compounds so that there is damage to the epithelial cells and intestinal villi [11]. Synbiotic products are expected to increase the viability of probiotics and ward off pathogenic bacteria that cause indigestion.

Yogurt with the addition of dietary fiber from the peel extract of the red dragon fruit (*Hylocereus polyrhizus*) and the natural sweetener of honey can be studied to test its antimicrobial properties. This research needs to be followed up on the natural sweeteners used in synbiotic yogurt in terms of antibacterial activity against experimental animals.

2. MATERIAL AND METHODS

The materials for this research are white rats (*Rattus norvegicus*) male aged 3 months with a weight of 150-180 g. Trial animals to be adapted in advance for 7 days and given basal feed. Animals are in good health and do not develop diseases. Animals were given probiotic yogurt (P0), 20% red dragon fruit peel extract synbiotic yogurt (P1), and 20% red dragon fruit peel extract synbiotic yogurt with 2% honey sweetener (P2). The experimental animal is then dissected and excrement in the ileum part is taken for testing.

3. RESULTS AND DISCUSSION

3.1 Effect of treatment on the average total number of excreta bacteria in experimental animals given synbiotic yogurt.

Table 1. Average total number of excreta bacteria in experimental animals given synbiotic yogurt (Log CFU/g)

Ileum	P0		P1		P2	
	Before	After	Before	After	Before	After
TPC	10,18	10,47	10,89	10,60	10,80	10,18

Based on Table 1, the average total bacteria show the presence of antibacterial activity by synbiotic yogurt of dragon fruit peel extract with honey sweetener. In Table 1, the results of these observations show that the P0 treatment has increased and P1 and P2 have decreased. The results of the study showed that the synbiotic yogurt of dragon fruit peel extract with honey sweetener has antibacterial activity. The difference in the total number of bacteria is due to the addition of food ingredients to the yogurt. This is in accordance with Munfaat, *et al*. (2015), the addition of foodstuffs can affect the interaction between microbes in products.

The P0 treatment has increased because the lactose in milk is used by lactic acid bacteria so that it can increase the growth and activity of lactic acid bacteria. Lactic acid bacteria in yogurt digest protein and lactose to compose new cells and influence the growth rate of lactic acid bacteria [13]. *Lactobacillus bulgaricus* and *Streptococcus thermophilous* are a

combination of bacteria that coexist and benefit living things found in the intestines. Probiotic yogurt can improve and improve the balance of microflora in the intestinal tract [14].

The result of the P1 treatment decreased because the addition of red dragon fruit peel extract can increase the growth and activity of lactic acid bacteria. This increase in activity exceeds yogurt without addition because the red dragon fruit peel extract has dietary fiber which is prebiotic. The dietary fiber content contained in the peel of the red dragon fruit is around 46.7% [4]. This prebiotic can increase the activity and growth of lactic acid bacteria. In addition, red dragon fruit peel extract also has antibacterial content that is a flavonoid. Flavonoids can reduce total bacteria. Flavonoids can damage the cell walls of bacteria, resulting in bacterial death. The anthocyanins and betacyanins in the dragon fruit peel extract that give it color also have antibacterial properties. Betacyanin gives a purplish-red color to the peel of the red dragon fruit and has antimicrobial and antifungal characteristics [15]. The hydrophilic properties of betacyanin can inhibit growth rather than bacteria by damaging cell membranes or inhibiting protein synthesis [16]. Damage to cell membranes causes loss of internal and external pH of cells so that they are out of balance and cause death [17].

The P2 treatment also decreased more when compared to the control and P1. The addition of honey can increase the activity and part the growth of lactic acid bacteria. Lactic acid bacteria could convert carbohydrates such as the lactose in milk and fructose in honey sweeteners into lactic acid. The content contained in honey is 41% fructose, 35% glucose, and 1.9% sucrose (Yurliasni, *et al*., 2019). This is match with Zakaria's research (2008)[18], the addition of sugar up to 15% tends to increase lactic acid levels in synbiotic yogurt through a fermentation process carried out by lactic acid bacteria against carbohydrates, lactose, and fructose. Fructose in large quantities can inhibit the growth of bacteria. This is in accordance with Watanabe's (2000)[19], research which shows fructose has higher antibacterial properties compared to glucose and sucrose. Other ingredients such as flavonoids in honey also have antibacterial properties. Phenol compounds and phenolic compounds derivatives can also cause protein denaturation contained in the cell wall that it can damage the arrangement and change the permeability mechanism of microsomes, lysosomes, and cell walls [12]. Flavonoids also cause lysis so that aggregation occurs in the bacterial membrane which results in a reduction in nutrient uptake [20].

3.2 Effect of treatment on average total mold and excreta yeast in experimental animals given synbiotic yogurt.

Table 2. Average value of total amount of mold and yeast in excreta of experimental animals given synbiotic yogurt (Log CFU/g)

Ileum	P0		P1		P2	
	Before	After	Before	After	Before	After
Mold and Yeast	8,66	8,92	8,57	8,94	8,48	8.18

Based on Table 2, the average total mold and yeast showed that the P0 and P1 treatments had increased. This can happen in the process of feeding experimental animals. According to Auchtung (2018) [21], the formation of mold and yeast colonization in the intestines and feces is due to the transition from consumed foodstuffs and oral cavities to the digestive system of experimental animals. Mold and yeast can grow in the ileum due to additional nutrients from the food consumed [22]. Some foods that cannot be digested in the upper digestive tract such as the mouth and stomach will be channeled to the lower digestive tract such as the small intestine and will be digested by mold and yeast and existing microbes [23]. The addition of red dragon fruit peel extract can also be an indicator of the increase in mold and yeast. Pectin contained in the red dragon fruit peel extract can be fermented by mold and yeast to increase the population in the ileum [23].

The treatment in P2 decreased the average total value of the amount of mold and excreta yeast. According to Van Riel (2021)[24], some of the factors that can be antifungal in honey are that the fructose-rich composition has caused dehydration of existing microorganisms, and makes microorganisms die. Glucose and fructose in honey can cause mold and yeast to secrete fluids in their bodies, resulting in death [25]. Flavonoid compounds in honey can play a direct role in growth inhibition in fungi by denatured protein bonds in cell membranes and lysis occurs causing mold and yeast to not grow back [25].

3.3 Effect of treatment on the average total *coliform* excreta bacteria in experimental animals given synbiotic yogurt.

Table 3. Average total coliform excreta in experimental animals given synbiotic yogurt (Log CFU/g)

Ileum	P0		P1		P2	
	Before	After	Before	After	Before	After
Coliform	7,69	7,64	7,68	7,22	7,93	7,40

By Table. 8, the average total coliform showed that P0, P1, and P2 treatments decreased. This suggests probiotic yogurt, synbiotic yogurt, and synbiotic yogurt with honey sweeteners have an influence on the amount of coliform. The ability of Lactic Acid Bacteria (BAL) to produce antimicrobial activity because BAL can produce bacteriocins that can inhibit coliform growth [26]. Bacteoricyn secreted in the ileum will attach to the cells of pathogenic microorganisms, damage the cell membrane, and prevent the re-formation of the cell membrane [27]. Colonies of lactic acid bacteria in the ileum will compete with pathogenic bacteria in nutrition. Lactic acid bacteria in the gut compete with pathogenic bacteria by attaching to receptors in the ileum and secreting antibacterials to gain access to nutrients in the ileum [28].

The P1 and P2 treatments decreased due to the addition of red dragon fruit peel extract (P1) and honey sweetener (P2). Pectin and honey as prebiotics can increase the growth and activity of lactic acid bacteria to produce lactic acid. The greater the amount of LAB in yogurt, the higher the lactic acid content [29]. The higher of lactic acid, the lower pH of synbiotic yogurt. Coliform will not survive at low pH and the presence of metabolism from lactic acid bacteria is antibacterial. The presence of antibacterial content in red dragon fruit peel extract and honey can also reduce the amount of coliform. This is in accordance with the research of Yong, *et al*., (2018)[17], betacyanin can reduce the number of gram-negative bacteria by entering pores on the cell wall and reducing permeability. Red dragon fruit peel extract contains flavonoids and phenolics which are active compounds (Sari, 2021). Flavonoid compounds can penetrate peptidoglycan, which is polar because flavonoids are also polar, while on the other hand, phenol compounds damage the bacterial wall by breaking the peptidoglycan bond [30]. The breaking of the peptidoglycan bond will make the cell wall disintegrate and result in the death of coliform cells. In addition, these phenol compounds will damage the permeability of microsomes and lysosomes, [12].

3.4 Effect of treatment on average total *Escherichia coli* excreta bacteria in experimental animals given synbiotic yogurt.

Table 4. Average total Escherichia coli excreta bacteria in experimental animals given synbiotic yogurt (Log CFU/g)

Ileum	P0		P1		P2	
	Before	After	Before	After	Before	After
Escherichia coli	**7,20**	**7,55**	**7,44**	**7,58**	**7,29**	**7,96**

Based on Table 4, the average total *Escherichia coli* bacteria shows the presence of antibacterial activity by synbiotic yogurt of dragon fruit peel extract with honey sweetener. In Table 4, the results of these observations show that the treatment of P0, P1, and P2 has increased. This happens because of the properties possessed by *Escherichia coli*, which is resistant to low acids, namely pH 2 to 2.5 [31]. This causes *Escherichia coli* to pass through the stomach which has a pH of 1 to 3 and towards the ileum [32]. In the ileum, *Escherichia coli* bacteria will grow by utilizing nutrients, resulting from the degradation of complex polysaccharides by anaerobic microbes in the ileum [33].

3.5 Effect of treatment on average total bacteria *Enterococcus spp* excreta in experimental animals given synbiotic yogurt.

Table 5. Average total bacteria *Enterococcus spp* excreta in experimental animals given synbiotic yogurt (Log CFU/g)

Ileum	P0		P1		P2	
	Before	After	Before	After	Before	After
Enterococcus spp	**6,24**	**6,21**	**6,93**	**6,74**	**6,76**	**6,47**

Based on Table 5, in the P0 treatment, the average total bacteria *of Enterococcus* spp decreased. This indicates the presence of probiotic antibacterial activity against *Enterococcus* spp. Lactic acid bacteria produce lactic acid which has bacteoricyn as an antibacterial. Bacteoricyn secreted in the ileum will attach to the cells of pathogenic microorganisms,

damage the cell membrane, and prevent the reformation of the cell membrane [27]. Lactic acid bacteria compete with pathogenic bacteria in the uptake of nutrients in the ileum. Bacteria of lactic in the intestine are competent with pathogenic bacteria by attaching to receptors in the ileum and secreting antibacterials to gain access to nutrients in the ileum [28]. Lactic acid bacteria produce lactic acid that will diffuse into the cells of pathogenic bacteria and disrupt the nutrient transport system [34].

Based on Table 5, in the P1 treatment, the average total bacteria *of Enterococcus* spp decreased. This is due to the addition of red dragon fruit peel extract in yogurt. Red dragon fruit peel extract has antibacterial content such as betasianin and flavonoids. This is in accordance with research from Tenore, *et al*. (2021) [35], betacyanin content has antimicrobial properties against *Enterococcus* spp. Betacyanin has antimicrobial and antifungal characteristics [15].

Based on Table 5, in the P2 treatment, the average total bacteria *of Enterococcus* spp decreased. This is due to the addition of honey to synbiotic yogurt. Flavonoids contained in honey have antibacterial properties for *Enterococcus* spp. Antibacterial work on *Enterococcus* spp which is a gram-positive bacterium is slightly different from gram-negative bacteria such as *Escherichia coli*. This is because *Enterococcus* spp has a different cell wall than *Escherichia coli* bacteria. The cell wall of gram-positive bacteria consists of very thick peptidoglycan which provides rigidity to maintain cell integrity [36]. Flavonoid compounds can penetrate peptidoglycan, which is polar because flavonoids are also polar, while on the other hand, phenol compounds damage the bacterial wall by breaking the peptidoglycan bond [30]. The mechanism of action of this organic compound as an antibacterial substance is by poisoning protoplasm, damaging, and penetrating cell walls, as well as precipitating microbial cell proteins. Large-molecule phenolic compounds are capable of inactivating essential enzymes inside microbial cells, albeit at very low concentrations. Phenol compounds can break peptidoglycan bonds when breaking through cell walls [37].

4. CONCLUSION

The addition of honey to the synbiotic yogurt of red dragon fruit peel extract can affect the total number of bacteria, mold and yeast, coliform, *Escherichia coli*, and *Enterococcus spp*. Honey has antibacterial properties that can lower the total number of bacteria, mold and yeast, coliform, and *Enterococcus spp*.

REFERENCES

[1] Yao C, Li J, Jingjing E, Wang R, Zhang Q, Wang J. The symbiosis among, and the storage stabilities of, starter lactic acid bacterial strains in biofilms. LWT. 2022;155:112896.

[2] Tari AI, Hartati S. Health Performance of Sprague Dawley Rats Due to Administration of Prebiotic Yoghurt as Antidiarrheal. Technoscience Scientific Journal. 2018;4(2):108-13.

[3] Yaumi Y, Hadju R, Yelnetty A, Lontaan NN. Sensory Quality of Synbiotic Yoghurt Using Modified Starch from Purple Uwi (Dioscorea alata) Tuber. Zootec. 2020;40(1):196-206.

[4] Jamilah B, Shu CE, Kharidah M, Dzulkily MA, Noranizan A. Physico-chemical characteristics of red pitaya (Hylocereus polyrhizus) peel. International Food Research Journal. 2011;18(1).

[5] Nirmalawaty A, Mahayani AA. Chemical Analysis of Dried Bakpia Substitute Dragon Fruit Peel Flour. STIGMA: Unipa Journal of Mathematics and Natural Sciences. 2020;13(1):15-23.

[6] Sert D, Akin N, Dertli E. Effects of sunflower honey on the physicochemical, microbiological and sensory characteristics in set type of yogurt during refrigerated storage. International journal of dairy technology. 2011;64(1):99-107.

[7] Yurliasni Y, Hanum Z, Hikmawan R. The potential of honey in improving the quality of kefir drinks. Journal of Animal Products Science and Technology (JITEK). 2019;14(1):50-9.

[8] Baguna R, Yelnetty A, Siswosubroto SE, Lontaan N. The effect of using honey on the pH value, syneresis, and total lactic acid bacteria of synbiotic yogurt. Zootec. 2020;40(1):214-22.

[9] Varga L. Effect of acacia (Robinia pseudo-acacia L.) honey on the characteristic microflora of yogurt during refrigerated storage. International journal of food microbiology. 2006;108(2):272-5.

[10] Izudin I, Regar R, Wahyuningsih A, Hanifa I. In vitro inhibition of Lactobacillus reuteri against Escherichia coli and Staphylococcus aureus. J-PHAM. 2020;2(2):66-71

[11] Sugito S, Manalu W, Astuti DA, Chairul C. Intestinal morphometrics and performance of broiler chickens given heat stress and n-hexane extract of "jaloh" stem bark (Salix Tetrasperma Roxb). Animal Husbandry Media. 2005; 30 (3) :150992.

[12] Munfaati PN, Ratnasari E, Trimulyono G. Antibacterial activity of meniran herbal extract (Phyllanthus niruri) against the growth of Shigella dysenteriae bacteria in vitro. Bio Lantern. 2015;4(1):64-71.

[13] Ferdaus F, Wijayanti MO, Retnonigtyas ES, Irawati W. Effect of pH, substrate concentration, addition of calcium carbonate and fermentation time on lactic acid recovery from banana peels. Widya Teknik. 2017;7(1):1-4.

[14] Setiarto RH, Widhyastuti N. Effect of lactic acid bacteria starter and the addition of modified taro flour on the quality of synbiotic yogurt. Indonesian Journal of Industrial Research. 2017;11:18-30.

[15] Spórna-Kucab A, Bernaś K, Grzegorczyk A, Malm A, Skalicka-Woźniak K, Wybraniec S. Liquid chromatographic techniques in betacyanin isomers separation from Gomphrena globosa L. flowers for the determination of their antimicrobial activities. Journal of Pharmaceutical and Biomedical Analysis. 2018;161:83-93.

[16] Cowan MM. Plant products as antimicrobial agents. Clinical microbiology reviews. 1999;12(4):564-82.

[17] Yong YY, Dykes G, Lee SM, Choo WS. Effect of refrigerated storage on betacyanin composition, antibacterial activity of red pitahaya (Hylocereus polyrhizus) and cytotoxicity evaluation of betacyanin rich extract on normal human cell lines. LWT. 2018;91:491-7.

[18] Zakaria Y. Chemical, microbiological and organoleptic properties of yogurt using different percentages of Lactobacillus casei and sugar content. Agripet Journal. 2008;8(1):21-4.

[19] Watanabe T, Katayama S, Matsubara M, Honda Y, Kuwahara M. Antibacterial carbohydrate monoesters suppressing cell growth of Streptococcus mutans in the presence of sucrose. Current microbiology. 2000;41(3):210-3.

[20] Górniak I, Bartoszewski R, Króliczewski J. Comprehensive review of antimicrobial activities of plant flavonoids. Phytochemistry Reviews. 2019;18(1):241-72.

[21] Auchtung TA, Fofanova TY, Stewart CJ, Nash AK, Wong MC, Gesell JR, Auchtung JM, Ajami NJ, Petrosino JF. Investigating colonization of the healthy adult gastrointestinal tract by fungi. MSphere. 2018;3(2):e00092-18.

[22] Scupham AJ, Presley LL, Wei B, Bent E, Griffith N, McPherson M, Zhu F, Oluwadara O, Rao N, Braun J, Borneman J. Abundant and diverse fungal microbiota in the murine intestine. Applied and environmental microbiology. 2006;72(1):793-801.

[23] Hillman ET, Lu H, Yao T, Nakatsu CH. Microbial ecology along the gastrointestinal tract. Microbes and environment. 2017;1(1)

[24] Van Riel SJ, Lardenoije CM, Oudhuis GJ, Cremers NA. Treating (recurrent) vulvovaginal candidiasis with medical-grade honey—concepts and practical considerations. Journal of Fungi. 2021;7(8):664.

[25] Rahmatillah H. Effectiveness of honey as an antifungal in inhibiting the growth of candida albicans using the microdilution method (Doctoral dissertation, Wijaya kusuma surabaya university).

[26] Mayo, B., Aleksandrzak-Piekarczyk, T., Fernndez, M., Kowalczyk, M., & Bardowski, J. Updates i

[27] Hussien H, Abd-Rabou HS, Saad MA. The impact of incorporating Lactobacillus acidophilus bacteriocin with inulin and FOS on yogurt quality. Scientific Reports. 2022;12(1):13401.

[28] Anee IJ, Alam S, Begum RA, Shahjahan RM, Khandaker AM. The role of probiotics on animal health and nutrition. The Journal of Basic and Applied Zoology. 2021;82(1):1-6.

[29] Mulyani S, Legowo AM, Mahanani AA. Viability of lactic acid bacteria, acidity and melting time of probiotic ice cream using Lactobacillus casei and Bifidobacterium bifidum starters. J. Indo. Trop. Anim. Agric. 2008;33(2):120-5.

[30] Dewi MK, Ratnasari E, Trimulyono G. Antibacterial activity of Majapahit leaf extract (Crescentia cujete) on the growth of Ralstonia solanacearum bacteria that causes wilt disease. LanternBio. 2014;3(1):51-7.

[31] Castanie-Cornet MP, Penfound TA, Smith D, Elliott JF, Foster JW. Control of acid resistance in Escherichia coli. Journal of bacteriology. 1999;181(11):3525-35.

[32] Gänzle MG, Hertel C, van der Vossen JM, Hammes WP. Effect of bacteriocin-producing lactobacilli on the survival of Escherichia coli and Listeria in a dynamic model of the stomach and the small intestine. International Journal of Food Microbiology. 1999;48(1):21-35.

[33] Maltby R, Leatham-Jensen MP, Gibson T, Cohen PS, Conway T. Nutritional basis for colonization resistance by human commensal Escherichia coli strains HS and Nissle 1917 against E. coli O157:H7 in the mouse intestine. PIS one. 2013;8(1):e53957.

[34] Putriningtyas ND, Mardiana M, Cahyati WH. Antibacterial potential of red dragon fruit peel yogurt (hylocereus spp.) against bacillus subtilis bacteria in hypercholesterolemic wistar rats. Indonesian Nutrition Journal (The Indonesian Journal of Nutrition). 2021;9(2):159-65.

[35] Tenore GC, Novellino E, Basile A. Nutraceutical potential and antioxidant benefits of red pitaya (Hylocereus polyrhizus) extracts. Journal of functional foods. 2012;4(1):129-36.

[36] Ajizah A, Thihana T, Mirhanuddin M. Potential of ironwood extract (Eusideroxylon zwageri T et B) in inhibiting the growth of Staphylococcus aureus bacteria in vitro. Bioscientiae. 2018;4(1).

[37] Zulhawa, Diniati J. The inhibition of Sumbawa honey against the growth of Staphylococcus aureus isolate from surgical wound infections at the Islamic Amal Sehat Hospital, Sragen. 2010. Thesis