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Emulsion Properties of Synbiotic Yoghurt Red Dragon Fruit Peel Extract (*Hylocereus polyrhizus*) Evaporation with Honey

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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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. Dragon fruit peel synbiotic yogurt produces an unpleasant aftertaste. The addition of honey can improve the functional properties of dragon fruit peel synbiotic yogurt. The purpose of this study was to determine the emulsion of synbiotic yogurt with evaporated red dragon fruit peel extract and honey sweetener. This research was conducted at the Laboratory of Animal Products Technology, Faculty of Animal Husbandry, Universitas Brawijaya. The research material is 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%

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honey to synbiotic. The research method was an experimental completely randomized design with treatment T1 = probiotic yoghurt, T2 = synbiotic yoghurt fortified red dragon fruit (*Hylocereus polyrhizus*) peel extract 20% and T3 = T2 + 2% honey, with 3 replications (v/v).The data obtained were analyzed using analysis of variance (ANOVA), if the test results showed a difference, then the Duncan test (DMRT) was carried out. The results showed that adding evaporated red dragon fruit peel extract and honey sweetener to synbiotic yogurt did not result in a significant difference (P>0.05) in emulsion stability or yogurt turbidity but did result in a significant difference (P>0.05) in emulsion activity. It was concluded that the evaporation of red dragon fruit peel extract with honey sweetener affected the emulsion properties.

Keywords: Emulsion stability; emulsion activity; turbidity; red dragon fruit peel; synbiotic yogurt; honey.

1. INTRODUCTION

"Yogurt is a product obtained from fermented milk using suitable lactic acid bacteria, with/or without the addition of other food ingredients. The physical properties of yogurt play an important role in determining the texture of yogurt products" [1]. "One of the efforts to improve the functional properties of probiotic yogurt is the addition of prebiotic ingredients made from dietary fiber (prebiotics). The addition of prebiotics to probiotic yogurt is called synbiotic yogurt" [2]. Yogurt with the addition of prebiotics is expected to increase the viability of bacteria and store food for microbes in the digestive tract [3]. One of the ingredients that can be used as a prebiotic is the peel of red dragon fruit (*Hylocereus polyrhizus*).

"Red dragon fruit peel becomes waste even though the content contained in red dragon fruit peel can be used as a prebiotic and increases the functional value of yogurt. Red dragon fruit peel contains 46.7% fiber, 10.79% pectin, 150.46/100g betacyanin, alkaloid compounds, steroids, saponins, and tannins" [4]. "The use of additional ingredients such as red dragon fruit peel extract in synbiotic yogurt can stabilize the milk colloid system to prevent phase separation, strengthen the casein network, and reduce syneresis" [5]. Pectin in red dragon fruit peel extract is +10.8% [6]. "Pectin can function as a gelling agent, a thickening agent, and a stabilizer in food. 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 really like" [7].

The addition of natural sweeteners such as honey is an attempt to enhance the sweet taste of yogurt. The addition of honey to the yogurt set improves the quality and nutritional value of yogurt and improves its organoleptic properties [8]. The content contained in honey is 41% fructose, 35% glucose, and 1.9% sucrose [9]. Honey additions of up to 3% can improve yogurt quality without affecting the characteristics of lactic acid bacteria (LAB) or yogurt [10]. The polysaccharides contained in honey will wrap oil droplets with steric repulsion because they have larger hydrophilic groups [11]. Sucrose in honey increases the viscosity and lowers the flow index of the aqueous solution [12].

Yogurt with the addition of dietary fiber from red dragon fruit peel extract (*Hylocereus polyrhizus*) and the natural sweetener honey can be studied to determine the properties of yogurt emulsions. The purpose of this study was to review the physical characteristics of synbiotic yogurt, including emulsion stability, emulsion activity, and turbidity.

2. MATERIALS AND METHODS

2.1 Materials

The materials for this research are yoghurt made of skim milk, starter cultures i.e standard yoghurt which contains *Lactobacillus bulgaricus* and *Streptococcus thermophilus* 1:1 (v/v). Twenty % of red dragon fruit peel extract (*Hylocereus polyrhizus*) was added into synbiotic yoghurt. Red dragon fruit (*Hylocereus polyrhizus*) was obtained in Malang City, East Java, and the peel was taken. "Extraction of red dragon fruit peel (*Hylocereus polyrhizus*) was done by using microwave-assisted extraction (MAE). The red dragon fruit peel (*Hylocereus polyrhizus*) then be cut into pieces, 50g of red dragon fruit peel added to 50 ml of distilled water. Extraction was carried out in a microwave at 90℃ for 5 minutes. Furthermore, 50 ml of the extraction solution was put into a 1 L glass beaker then put into the microwave, evaporated at 70℃ for 10 minutes. Probiotic yoghurt (P1) was made from skim milk (10%) with the addition of aquades, synbiotic

yoghurt (P2) was made from P1 with addition of 20% red dragon fruit peel extract (*Hylocereus polyrhizus*), synbiotic yoghurt (P3) was made from P2 with addition of 2% honey. All samples were pasteurized at 72℃ for 15 minutes, then the temperature was lowered to 42℃, and the mixture was well stirred after inoculating starter yoghurt (3%). Incubation is done at room temperature (25-28℃) for 24 hours. In treatment P3, the honey was added at the rate of 2%" .

2.2 Emulsion Stability and Activity

Emulsion stability and activity was measured according to Arioui et al., [13] with modifications. Soybean oil was added to the sample and then homogenized using a hand mixer for 1 minute. Take 0.1 mL of the sample and add 0.1% of SDS-Page per 100 mL and stirred with vortex for 1 minute. Take 3 mL of sample and put it in a cuvette to examined by spectrophotometer with a wavelength of 500nm. Record the absorbance value (A0). Wait for 10 minutes and perform a comparable test (A10). The result measure with formula:

Description:

$$\text{Emulsion stability (\%)} = \frac{\text{A0 x } \Delta\text{t}}{\text{A10}-\text{A0}}$$

A0 = A_{500} at time of 0 minutes; A10 = A_{500} at time of 10 minutes.

$$\text{Emulsion activity (m}^2\text{/g)} = \frac{2 \text{ x } 2{,}303 \text{ x A0 x DF}}{\text{I x } \phi \text{ x C}}$$

2.3 Turbidity

Turbidity was measured according to Liu, et al., [14]. Dissolved 1 ml of sample in 100 ml distilled water. Take 3 ml of sample and put it in a cuvette. Analyze in spectrophotometer with determined absorbance of 600nm. Record the result.

3. RESULTS AND DISCUSSION

3.1 Emulsion Stability

Based on Table 1, the average stability of the yogurt emulsion shows an increase in value. Emulsion stability indicates material stability. The emulsion contained in the material does not tend to form a separate layer. The protein in milk that is used for yogurt has properties as an emulsifier. Proteins have emulsification properties because of their amphipathic nature (having hydrophobic and hydrophilic groups) and their ability to form layers at the interface with oil and water [15]. The layer formed can reduce the rate of aggregation due to electrostatic repulsion.

Table 1. The average of emulsion stability in various treatments

Treatment	Emulsion Stability (min)
P1	21.96±2.12
P2	25.45±4.79
P3	25.61±2.80

The P2 treatment increased due to the addition of extra red dragon fruit peels to the yogurt. Red dragon fruit peel extract contains pectin, which is a polysaccharide. Natural polysaccharides, such as pectin contained in red dragon fruit peel extract (*Hylocereus polyrhizus*) can be good emulsifiers because they have proteins bound to their hydrophilic carbohydrate chains [16]. In addition to polysaccharides, red dragon fruit peel extract contains saponins. Saponins in dragon fruit peel extract can also be used as emulsifiers because they dissolve in water and have hydrophilic carbohydrates that have bonds with non-polar aglycone groups [17]. *Lactobacillus bulgaricus* and *Streptococcus thermophilus* in synbiotic yogurt can synthesize polysaccharides and produce a stabilizer, namely exopolysaccharide. Exopolysaccharides in large quantities can improve the texture in yogurt [18]. Probiotics that produce exopolysaccharides are known to improve texture and become gel-thickening agents and stabilizers in yogurt [19].

The P3 treatment experienced an increase in value due to the addition of red dragon fruit peel extract and honey. Honey has a sugar content of 41% fructose and 35% glucose [20]. The addition of sugar to yogurt can stabilize the oil-water emulsion [21]. The addition of honey with a sugar content of 41% can prevent the formation of oil droplets into larger droplets so that they will remain separate [22]. The polysaccharides contained in honey will wrap the oil droplets with steric repulsion because they have larger hydrophilic groups [23]. The mechanism of the stabilizer is to form a thin layer that will envelop the emulsified particles, thereby reducing the surface tension and preventing these particles from joining with similar particles [24].

3.2 Emulsion Activity

Based on Table 2, the average activity of the yogurt emulsion shows an increase in value.

Emulsion activity can be measured by determining the ability of oil to bind to proteins. Emulsion activity indicates the interfacial area that can be obtained between oil and water per unit weight of protein or product [25]. Protein is one of the ingredients that can be used as an emulsifier and is often used in the food industry because it has the characteristic that the surface contains a mixture of hydrophilic and hydrophobic amino acids in the polypeptide chain. The protein layer will surround the oil droplet and result in a decrease in the aggregation rate with electrostatic repulsion if the pH is far from the isoelectric point of the protein [26]. Inhibition of aggression is carried out by electrostatic repulsion, namely binding carbohydrates and forming a thick surface layer [27].

Table 2. The average of emulsion activity in various treatments

Treatment	Emulsion Activity (m^2/g)
P1	7.68 ± 0.70^{a}
P2	8.84 ± 0.49^{b}
P3	8.90 ± 0.28^{b}

Note: a,b,c: different superscript in the same column shows the significant difference (p<0.05)

Result in P2 significantly increased compared to P1 because due to the addition of red dragon fruit peel extract. Red dragon fruit peel extract contained pectin. Pectin is a polysaccharide compound which dissolves in water [28]. Pectin is a negatively charged hydrophilic colloid. The casein molecule has a positive and negative charge at neutral pH. Pectin will not bind to protein at the same charge at a neutral pH, but at a pH below the protein isoelectric (4.6) pectin will be absorbed into the casein micelles through electrostatic interactions causing steric stability [29]. Steric stability will achieve emulsion stability by pectin [30]. Result in P3 not significantly increased compared to P2. This is due to the addition of red dragon fruit peel extract and honey. Honey has osmolarity properties due to the presence of sugar. The osmolarity of honey as an additive in yogurt will attract water to the casein micelles and reduce the release of water into the environment.

3.3 Turbidity

Based on Table 3, the average turbidity of yogurt shows an increase in value. Turbidity is an index to show the presence of protein aggregation [31]. The average yogurt turbidity shows an increase when compared to P1. This was influenced by the addition of red dragon fruit peel extract (*Hylocereus polyrhizus*). Red dragon fruit peel extract will be utilized by lactic acid bacteria to produce turbidity exopolysaccharide caused by the presence of suspended and dissolved organic and inorganic materials as well as inorganic and organic materials in the form of microorganisms. Expolysaccharides from Lactic Acid Bacteria (LAB) will inhibit protein-protein interactions, reduce protein aggregation, and cause a decrease in particle size and turbidity [32]. The molecules contained in yogurt affect the level of absorbance by scattering light. The higher the absorbance value, the more dispersed the metabolites in the yogurt are. Turbidity is related to the size and concentration of dissolved particles [33]. Metabolites released by LAB can increase the absorbance value of yogurt [34].

Table 3. The average of synbiotic yoghurt turbidity in various treatments

Treatment	Turbidity (OD)
P1	0.43±0.33
P2	0.63±0.40
P3	0.57±0.33

The P2 treatment increased due to the presence of red dragon fruit peel extract. Dragon fruit peel contains 20.1% pectin [35]. Dragon fruit peel extract will affect turbidity because pectin will interact with casein. The pectin and casein bonds will form an enlargement of the particle size in yogurt. Pectin will form several layers in casein so that the particle size increases, absorbance increases, and turbidity also increases [36]. The electrostatic interaction that occurs between pectin and casein's negative charge prevents the aggregation of casein [37].

P3 treatment decreased when compared to P2 due to the addition of honey to synbiotic yogurt. The addition of honey to synbiotic yogurt lowers the turbidity value. The decrease in turbidity indicates the uniformity of the particle size in the yogurt. Small and uniform particle size will increase the surface area. The ability to absorb color or the level of clarity is determined by the surface area of the % transmittance, where the greater the surface area of the transmittance, the higher the level of clarity of a solution (clear).

4. CONCLUSION

It can be concluded that 20% fortification of red dragon fruit peel (*Hylocereus polyrhizus*) and 2% honey can improve the synbiotic yoghurt emulsion properties. It is suggested to further research is needed on synbiotic yoghurt with red dragon fruit peel extract with honey as a natural sweetener to increase its functional properties in improving consumer health.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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