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Development of Super Red Dragon Fruit (*Hylocereus costaricensis*) Yoghurt Jam: Variations of Starter and Sucrose Proportions

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Abstract. Yogurt jam products with the addition of red dragon fruit will enrich the sensory and nutritional value. Process engineering is needed to produce the desired sensory quality of yogurt jam. Red dragon fruit yogurt jam should have a spreadable texture and have the sensory qualities expected as a thick jam with the right sweet and sour taste. This study aimed to examine the proportion of yogurt starters and sucrose to produce the right consistency of yogurt jam products with the best nutritional quality. The starter yogurt proportion tested was 10%, 15%, and 20%, and the proportion of sucrose of 10%, 30%, and 50% based on the formulation of the milk and red dragon fruit. The red dragon fruit yogurt jam produced has a reasonably favorable preference for sweetness, sourness, aroma, and consistency, while a good preference level for color and spreadable parameters. The product has a bright red-purple-red color and is easy to spread. The proportion of 20% yogurt starter and 30% sucrose gave better scoring and hedonic test results than the other treatments. The protein content and fat content still fulfill the SNI standard for yogurt SNI 2981: 2009 with a minimum protein content of 2.7% and low-fat yogurt fat content of 0.6-2.9%

INTRODUCTION

Milk is one source of protein with high nutritional content for human needs, and its strategic presence is to produce quality human resources for national development. Therefore, it is necessary to prepare cow's milk production and diversification sustainably. The complete macronutrient and micronutrient content in milk plays a vital role in the growth period, supports health and intelligence, and can play a role in preventing stunting in children.

Indonesian people's milk consumption in 2020 is still around 16.27 kg/capita/year, which is still lower than in Vietnam and Malaysia. Meanwhile, the demand for milk in Indonesia currently reaches 4.3 million tons per year, and the contribution of domestic milk to the national milk needs is only 22.7%. The fulfillment from imports of this sustainability milk production program is in line with the Indonesian Dairy Blue Print 2013- 2025 issued by the Coordinating Ministry for the Economy. In 2025, the target of getting the national milk needs from domestic fresh milk is 60% [1].

The increase in fresh milk and milk product consumption does not only rely on the consumption of fresh milk, but it is necessary to have a broader diversification of dairy products to increase consumer acceptance. Some people do not like the consumption of fresh cow's milk because the aroma and taste are not acceptable, whereas, on the other hand, the nutritional value is relatively high. Developing technology related to dairy products is necessary to

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increase milk consumption acceptance and enrich milk's nutritional value. Diversification of dairy products will increase milk consumption and expand the marketing of dairy products themselves.

Smith [2] stated that the average chemical composition of cow's milk is a total solid of 12.60%, fat of 3.80%; lactose of 4.75%; protein of 3.35%; casein of 2.78%, and minerals of 0.70%. Empowerment of home industries as fresh milk processors is one solution to add value to fresh milk. The development of a new food industry needs to choose the right technology to improve the community's nutritional status, introduce new types of food, and increase added value.

Yogurt is usually served in its original form with a sour taste or blended with sugar and fruit flavors. The yogurt acceptability can enhance by modifying the processed product based on yogurt in the form of serving yogurt jam. Yogurt product blended with red dragon fruit is one of the ingredients used as an additive in cheese making. In addition to obtaining attractive colors, it also contains anthocyanins and sources of dietary fiber, which are suitable for body health.

The development of yogurt with variations in the addition of fruit and vegetables has been carried out, but in general, the proportion of milk is higher. Andronoiu et al. [3] added walnut and strawberry jam, and Boycheva et al. [4] added blueberry and aronia. Ihemeje et al. [5] developed flavored yogurt and spiced yogurt to increase yogurt's acceptability and functional value. Mixed fruit increases the nutritional value and yogurt flavor, and fruit enhancement provides a considerable role in the consumption and sale of yogurt. The fruit variety has been formulated as probiotic fruit yogurt and probiotic survival in preserved yogurt [6].

The dragon fruit consumers are most interested in today is the super red dragon fruit (*Hylocereus costaricensis*) because the super red dragon fruit has a sweeter taste without any unpleasant taste than other types and has an attractive color. In addition, super red dragon fruit has a higher anti-radical ability than white dragon fruit. Super red dragon fruit is also an antibacterial [7]. It contains betacyanin (150.46 ± 2.19 mg/100 g) and pectin of 10.8% [8].

This research aimed to examine the diversification of fresh cow's milk products into super red dragon fruit yogurt jam to increase the acceptability of fresh cow's milk and its added value. The target to be achieved from the research results is to develop fresh cow's milk-based products with good acceptability and the ability to be applied industrially in the context of commercialization.

EXPERIMENTAL DETAILS

Materials

Pasteurized cow milk (Greenfields), super red dragon fruit flesh (*Hylocereus costaricensis*) obtained from Tajau Pecah, Pelaihari District, Tanah Laut Regency, aquades, sucrose, yogurt starter (Biokul). Chemicals include NaOH (Merck), Na_2CO_3 (Merck), $CuSO_4$ (Merck), K_2SO_4, HgO (Merck), and Hexane (Merck).

Design of Experiment

Red dragon fruit yogurt jam was prepared at a ratio of cow's milk and dragon fruit pulp of 30: 70 (based on the best proportion results). There are two factors tested, namely the proportion of yogurt starter (10%, 15%, and 20%) and the proportion of sucrose (10%, 30%, 50%).

Preparation of Red Dragon Fruit Pulp

The super red dragon fruit pulp was washed, peeled, cut into pieces, and mashed for 5 min to obtain fine pulp, then heated at 80°C for 5 minutes.

Yogurt Jam-Making Process

Cow's milk is added with sugar (according to the treatment) and pasteurized at a temperature of 80°C for 15 minutes. Pasteurized milk is cooled to 43°C. Milk is added with super red dragon fruit pulp with the proportion of milk and red dragon fruit 30: 70, then stirred evenly. The milk and dragon fruit pulp mixture was added with a yogurt starter (according to treatment) and stirred again to homogenize. Then it was incubated at 43 °C for 24 hours.

Parameter of Analysis

Parameters of analysis included moisture content, pH, protein content, fat content, and organoleptic tests, including scoring and hedonic test of color, taste, aroma, texture, and ease of spread. Moisture, crude protein, and crude fat content were determined according to the method recommended by the Association of Official Analytical Chemists (AOAC) [9]. Water content was determined using the oven drying method (AOAC Method 977.11), crude

protein using Kjeldahl's method (AOAC Method 955.04), Crude fat using the Soxhlet method (AOAC Method 960.39).

RESULTS AND DISCUSSION

Water Content

The water content in yogurt jam products is an essential parameter because the water content will affect the consistency and thickness of the product. Diluted yogurt jam products show high water content and lower total solids. The water content in red dragon fruit yogurt jam ranges from 73%-80%, and the data is presented in Fig. 1.

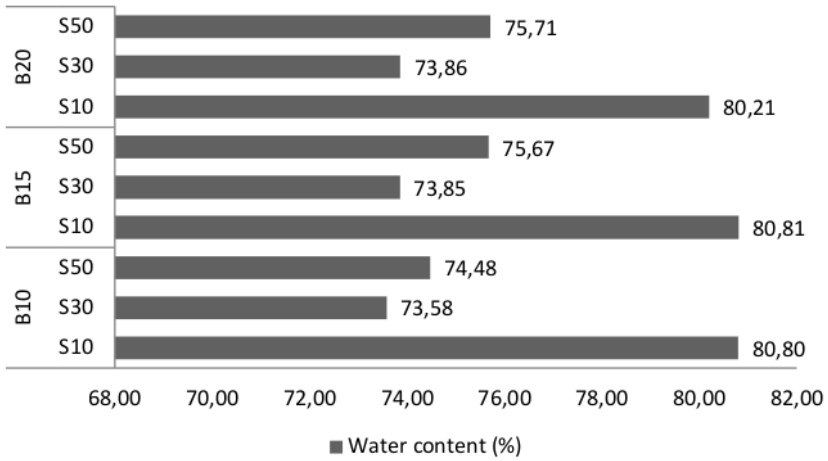

FIGURE 1. Water content in red dragon fruit yogurt jam in the treatment of starter yogurt proportion (B) and sucrose proportion (S)

Figure 1 shows that water content in jam products is not affected by the amount of starter added. The water content of the yogurt jam tends to be higher in the 10% sucrose proportion treatment, which is in the range of 80%. It tends to be lower in the 30% and 50% sucrose treatments. The sugar concentration of 30% can be utilized optimally by lactic acid bacteria from the starter, resulting in a more solid mass.

In the yogurt jam fermentation process, besides the conversion of lactose from milk, sugars from dragon fruit, including glucose, sucrose, and fructose, will be fermented to produce organic acids, one of which is lactate. The acid formation will decrease in pH and also result in a viscous polysaccharide structure that will increase the total solids in the yogurt jam. The water content of papaya yogurt with a proportion of 5%-15% papaya ranges from 85.12% - 87.88%, while plain yogurt has a water content of 89.00% [10]. The data is in line with its red dragon fruit yogurt jam. The moisture content will decrease as the total solid content in the formulation decreases.

pH

The yogurt jam fermentation process will produce some organic acids, including lactic acid, which will lower the pH of the product. The fermentation process of yogurt jam products at a temperature of 43°C for 24 hours will reduce the initial pH of the product mixture from pH 6.10 - 6.20 to pH 3.5-3.8.

Figure 2 shows that the proportion of yogurt starters and the proportion of added sucrose did not significantly affect decreasing pH. The pH of plain yogurt after one day of fermentation has a pH of 4.35, yogurt with strawberries has a pH of 3.87, and banana yogurt has a pH of 4.32 [11]. The type of fruit will affect the level of acidity added because the fruit has a different organic acid composition.

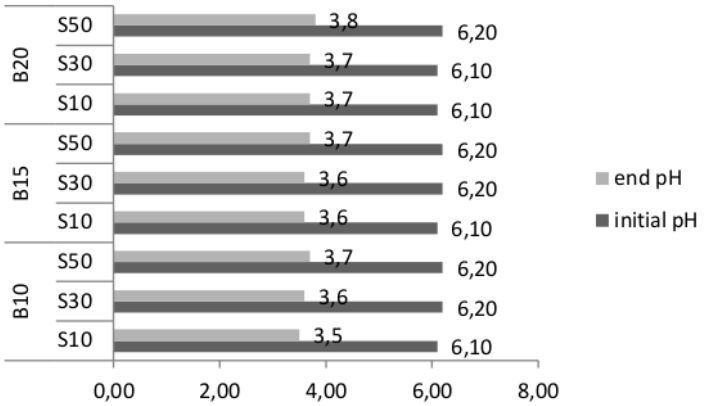

FIGURE 2. pH on red dragon fruit yogurt jam in the treatment of starter yogurt proportion (B) and sucrose proportion (S)

Lowering the pH will help in inhibiting the growth of pathogenic bacteria. Likewise, organic acids support the formation of flavors and aromas and their sour taste. Acidic pH conditions are conducive to maintaining yogurt's quality and yogurt jam during storage [12].

Crude Protein

Milk and its derivative products become products that can be used as a source of protein. This yogurt jam product combines cow's milk and red dragon fruit. This product is served as a spreadable and nutritious jam. The fermentation process in a mixture of milk and red dragon fruit that produces organic acids can lower the pH, replacing the function of citric acid as an acidifier. The acid will coagulate the protein in the milk to produce a semi-solid mass. The protein content in yogurt hours ranges from 4.19% to 6.81%; the data is presented in Fig. 3.

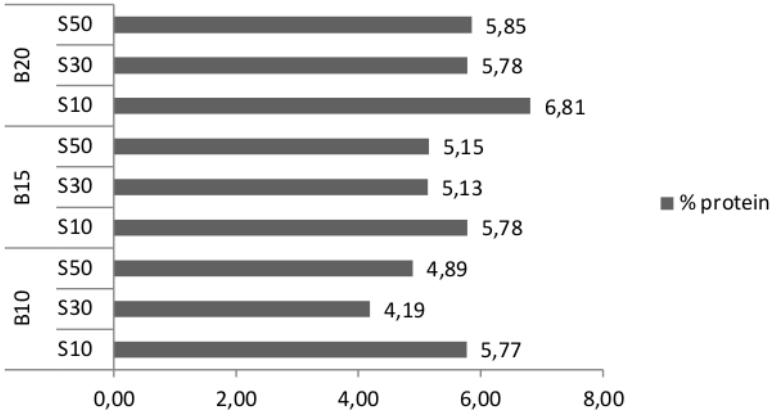

FIGURE 3. Protein content in red dragon fruit yogurt jam in the treatment of starter yogurt proportion (B) and sucrose proportion (S)

Yogurt jam with a proportion of 20% yogurt starter tends to produce a higher protein content than the starters 10% and 20%. The presence of lactic acid bacteria cells will be analyzed as some proteins, thereby increasing the

amount of protein in the product. The proportion of 10% sucrose is relatively higher than that of 30% and 50% sucrose. Matter et al. [10] found that the protein content of papaya fruit yogurt in the proportion of 5%-15% obtained a protein content of 3.60-3.72%. The quality of yogurt is based on Indonesian National Standard (SNI) 2981: 2009, the protein content in yogurt is at least 2.7%. The protein content in red dragon fruit yogurt jam still fulfills the yogurt's SNI standard [13]. Yogurt was added with 20% dragon fruit had a protein content of 2.71%, a water content of 86.37%, and a fat content of 3.69% [14].

Fat Content

The fat content of red dragon fruit yogurt is around 0.11% - 0.95%. The proportion of cow's milk in red dragon fruit yogurt jam is 30% of the formulation. The fat content in yogurt products will be affected by the type of milk used, regular, low-fat, or non-fat. Low-fat yogurt has a fat content of 0.5-2.0%, while on-fat yogurt is less than 0.5% [15]. Based on Indonesian National Standard 2981: 2009 regarding yogurt products, the standard fat content is at least 0.3%, and low-fat yogurt is 0.6-2.9%.

Yogurt jam products are more similar to low-fat yogurt with low-fat content. The decrease in fat content will cause a texture with a less thick consistency, affecting smoothness and creaminess [16].

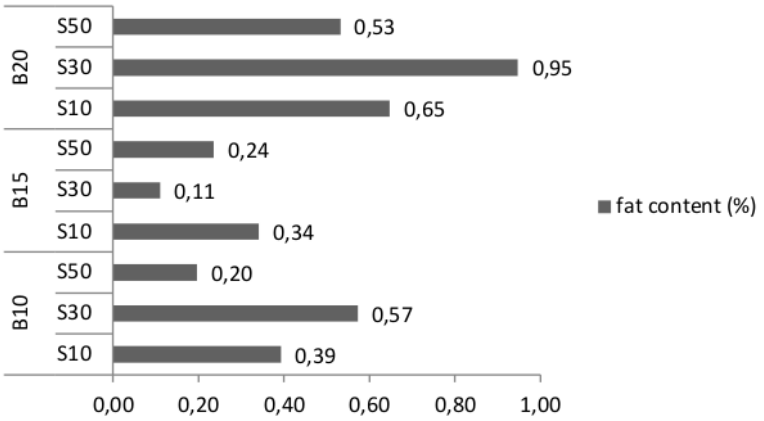

FIGURE 4. Fat content in red dragon fruit yogurt jam in the treatment of starter yogurt proportion (B) and sucrose proportion (S)

Sensory Test

Sensory testing on food products is intended to determine the sensory quality expected by consumers. The sensory parameters' value level includes the color of the yogurt jam product, the sweetness, the sourness, the distinctive aroma of yogurt, the texture or consistency, and the spreadable.

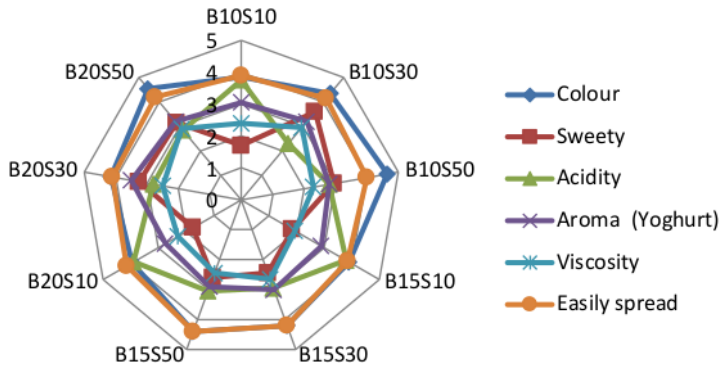

FIGURE 5. Sensory test scoring scale pattern on red dragon fruit yogurt jam in the treatment of yogurt starter proportion (B) and added sucrose proportion (S)

Figure 5 shows the color of red dragon fruit yogurt jam range from 3.85-4.65, which is close to bright red to purplish red with an average value of 4.22 (bright red). Treatments with 50% sucrose content in the number of starters 10%, 15%, and 20% tend to have a more robust color close to purplish red. The color of yogurt jam is dominant to the natural color of dragon fruit because the proportion of fruit added is quite large, which is 70% (Fig. 6). The purple-red color is an anthocyanin color that can be useful as an antioxidant.

a) b)

FIGURE 6. a) super red dragon fruits; b) yogurt jam-based super red dragon fruit

The sweetness of yogurt jam is 1.70-3.60 (slightly sweet-close to sweet), with an average of 2.59 (slightly sweet). The sweet taste tends to be proportional to the amount of sugar added. Sugar not converted to acid will give a sweet taste sensation, so the proportion of 30% and 50% sugar will give a sweet taste scale on a score of 3, which is quite sweet.

The sourness correlates with the amount of organic acid in red dragon fruit yogurt jam. The sour taste is produced from the process of fermenting sugar from milk or fruit to become acid. In yogurt, lactose, fructose, and glucose will be converted into lactic acid. The sour taste in yogurt jam products averages 3.13, which is quite sour. The highest score of sourness at 10% sucrose content in all proportions of yogurt starters, an average of 3.8 (sour taste). Excess sugar will neutralize the acid in the yogurt jam ingredients so that the acidity will be more tasted in a smaller proportion of sugar.

The aroma of yogurt was detected at an average of 3.03, which was quite tasted. The 20% yogurt starter treatment tends to give a more concentrated yogurt aroma. A higher number of yogurt starters will affect the number of lactic bacteria more. Lactic acid bacteria convert sugar into lactic acid and some volatile components typical of yogurt.

Lactic acid is the main component that significantly affects the flavor of yogurt. The presence of volatile and non-volatile acid components and carbonyl compounds influence the final aroma of yogurt [17]. Essential aroma components include acetaldehyde, acetoin, and diacetyl acetone, as well as formic, butanoic, and propionate acetic acids. Several factors that affect the aroma of yogurt are the type of starter used, process parameters such as the source of milk, and additional ingredients that affect the aroma of yogurt [18]. The symbiotic activity of *L. bulgaricus* and *S. thermophiles* produced carbonyl components and volatile fatty acids at 22-31 hours of fermentation. In the red dragon fruit yogurt jam, there is a combination of a relatively flat fruit aroma with the yogurt aroma from the resulting process. The aroma will be more dominant than yogurt.

The consistency of yogurt jam is an average of 2.49, which is thick. This viscosity value correlates with spreadable characteristics, the average yogurt jam on the easily spreadable scale. The characteristics of jam must be easy to spread on bread, which means it is easy to spread on the surface, with flow properties that are neither too runny nor too thick. The consistency of yogurt added with several types of fruit, such as strawberry, apricot, and peach, was no different [11]. On the other hand, Najgebauer-Lejko et al. [19] found no sensory difference between plain yogurt and vegetable yogurt, while the sensory differences could be caused by the type of fruit added [11].

The consistency of the red dragon fruit yogurt jam is supported by the total solids of the red dragon fruit. Consistency can be improved by more prolonged heating to evaporate some of the water, thereby increasing the total solids, adding milk solids and stabilizers [20].

The hedonic test aimed to get the consumer's favorite response to a developed product. Figure 7 shows the red dragon fruit yogurt jam, the score on the level of like (4) is obtained on the color and ease to spread parameters. The parameters of sweetness, sourness, aroma of yogurt, and viscosity meet the quite favorable scale (3).

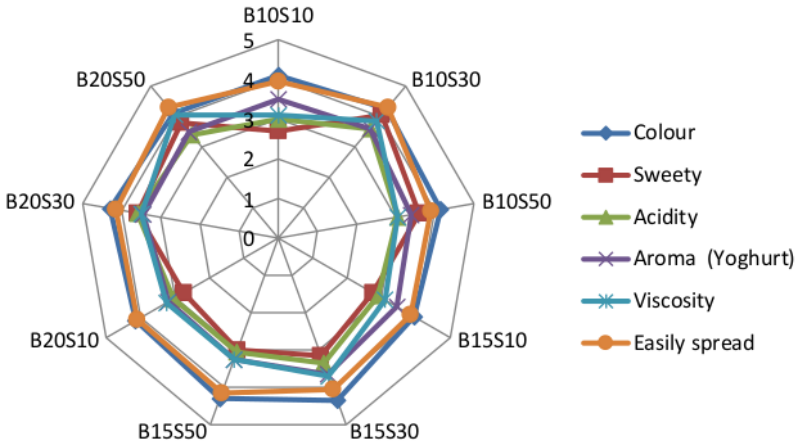

FIGURE 7. Sensory test hedonic scale pattern on red dragon fruit yogurt jam in the treatment of starter yogurt proportion (B) and sucrose proportion (S)

The red dragon fruit yogurt jam is a developed product to unite the sour sensation in yogurt as part of the red dragon fruit jam. The combination process is carried out through simultaneous fermentation of cow's milk, dragon fruit pulp, and sucrose, with the final characteristics expected to be close to jam. The sour taste of yogurt will be balanced by sugar, and vice versa. The development of this product is an effort to expand and improve dairy products, especially yogurt, with its probiotic content. The simultaneous yogurt jam fermentation process tries to maintain the probiotic bacteria in the product, making dragon fruit a prebiotic.

CONCLUSION

The treatment of 20% yogurt starter proportion and 30% sucrose resulted in a red dragon fruit yogurt jam with a preference for a bright red color score with a slightly sour taste and a quite tasted yogurt aroma. The sour taste and aroma of yogurt correlate mainly with the amount of yogurt starter added, and the red dragon fruit yogurt jam has a slightly thick consistency and is easy to spread. The red dragon fruit yogurt jam at the preference level in this

treatment was quite favorable. The protein content of 5.78% and fat content of 0.95% still fulfill the Indonesian National Standard for yogurt SNI 2981: 2009 with a minimum protein content of 2.7% and low-fat yogurt fat content of 0.6-2.9%.

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