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Research Article

Quality and Sensory Profile of Synbiotic Yogurt Enriched with Strawberry Pulp

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ABSTRACT

This study aimed to evaluate the effect of adding strawberry pulp (*Fragaria × ananassa*) at different concentrations on the sensory attributes of synbiotic yogurt. Sensory parameters, including texture, aroma, taste, and color, were assessed using a hedonic test. The sensory data were analyzed using the Kruskal–Wallis test followed by the Mann–Whitney post hoc test. The probiotic cultures used in this study were *Lactobacillus fermentum L23*, *Streptococcus thermophilus*, and *Pediococcus acidilactici* BK01. The treatments consisted of varying levels of strawberry pulp added to the synbiotic yogurt: P0 (0%), P1 (5%), P2 (10%), P3 (15%), and P4 (20%). The results indicated that strawberry pulp addition had a significant effect ($P < 0.05$) on the sensory scores of texture, aroma, taste, and color. The best sensory acceptance was observed in treatment P1, corresponding to the addition of 5% strawberry pulp to the synbiotic yogurt.

Keywords: probiotic, sensory, strawberry, synbiotic, yogurt

INTRODUCTION

Yogurt is produced by fermenting heated milk with certain lactic acid bacteria, most notably *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus*, resulting in a semi-solid product (Nguyen *et al*., 2018). Broadly, yogurt is divided into standard yogurt and probiotic yogurt (often called bioyogurt) (Pandey *et al*., 2017). Standard yogurt uses only the traditional starter cultures, while probiotic yogurt includes additional probiotic strains that contribute to potential health benefits when consumed in sufficient amounts. Yogurt provides a substantial amount of vital nutrients, which has contributed to its status as one of the most widely consumed health-oriented foods. As consumer demand increases, manufacturers are exploring the incorporation of functional components such as probiotics to enhance the nutritional and therapeutic qualities of yogurt.

In this study, yogurt samples were produced, including a control and formulations fermented with *Pediococcus acidilactici BK01* as a probiotic strain, combined with varying concentrations of strawberry pulp. Over recent decades, interest in functional foods enriched with natural bioactive compounds has steadily increased, highlighting their health-promoting potential and driving further research (Helkar *et al*., 2016). Consumer demand for probiotic and synbiotic dairy products continues to expand, with yogurt remaining one of the most popular choices due to its

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diverse textures, fat levels, and flavors. Standard yogurt is typically fermented by *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus thermophilus*, whereas synbiotic yogurt incorporates additional probiotic strains such as *Bifidobacterium* and *Lactobacillus*, which must remain viable in sufficient numbers to confer health benefits. As such, yogurt represents an effective nutritional medium for delivering beneficial microorganisms to the human body (Turgut and Cakmakci, 2018; Nontasan *et al*., 2012).

Many studies have been conducted on yogurt with the addition of fruit. Various quality parameters of fruit-based yogurts have also been observed after incorporating different concentrations of white dragon fruit juice (Jayasinghe et al., 2015). Similar evaluations were performed on yogurts supplemented with 5%, 10%, and 15% mango juice (Kabir et al., 2016). Other fruits such as jackfruit (Sarmini et al., 2014) (Dey et al., 2014), banana (Çakmakçi et al 2012), blueberry (Cinbas and Yazici, 2008), carob (Atasoy, 2009), as well as a 1:1 mixture of apple and orange juices (Shree et al., 2017), have also been used in several studies for yogurt development.

In the present study, yogurt samples were prepared with different levels of strawberry pulp addition, namely P (0% or plain yogurt) and other treatments containing 5%, 10%, 15%, and 20% strawberry pulp. Sensory evaluation was conducted to support the product development process.

MATERIAL AND METHODS

Sample Preparation

The starters used in this study, namely *Streptococcus thermophilus*, *Lactobacillus fermentum* L23, and *Pediococcus* BK01, were obtained from the Animal Product Technology Laboratory, Faculty of Animal Science, Universitas Andalas. UHT milk (Greenfields™ brand) totaling 750 mL was used for bacterial rejuvenation and yogurt starter preparation. Pasteurized fresh milk (Greenfields™ brand) totaling 6.000 mL was used for the production of synbiotic yogurt. Strawberries (*Fragaria × ananassa*) originating from Nagari Balingka, IV Koto District, Agam Regency, West Sumatra, were used in an amount of 2.000 grams. After cleaning, the strawberries were packed in polyethylene bags and frozen in a freezer for 24 hours. Subsequently, the frozen strawberries were blended until they became pulp. The strawberry pulp was then pasteurized at 85°C for 3 minutes.

Yogurt Production Process

This study used three bacterial combinations following Meliat et al. (2022), namely *S. thermophilus*, *L. fermentum* L23, and *P. acidilactici* BK01. Pasteurized fresh milk (Greenfields™ brand) was used as the raw material for producing synbiotic yogurt. The milk was pasteurized at 85°C for 10 minutes and then cooled to 43°C. Yogurt starter culture at 5% (v/v) was added to the milk, followed by the addition of strawberry pulp at concentrations of 0%, 5%, 10%, 15%, and 20%. The mixture was then incubated at 37°C for 12 hours. After incubation, sensory evaluation of the product was conducted.

Measurement of Sensory Properties

The sensory evaluation was based on Setyaningsih et al., (2010), who stated that the sensory parameters used include texture, aroma, taste, and color of the yogurt, which were assessed using a hedonic or preference test. The hedonic test was conducted with 40 untrained panelists to determine the level of acceptance of the yogurt. The hedonic evaluation criteria were based on a 5-point hedonic scale.

Statistical Analysis

The sensory data in this study, including texture, aroma, taste, and color, were analyzed using the Kruskal–Wallis test (α = 0.05), followed by the Mann–Whitney post hoc analysis.

RESULTS AND DISCUSSION

Sensory Properties

Texture Sensory Value

The average sensory texture scores of yogurts with different levels of strawberry pulp addition ranged from 3.23 to 4.07. The highest score was obtained by treatment P0 (0%) with a value of 4.07 (liked), while the lowest score was recorded in treatment P3 (15%) with a value of 3.23 (slightly liked).

In treatments P1 (5%) and P3 (15%), a decrease in panelists' preference for the texture of synbiotic yogurt was observed. This occurred because the yogurt without strawberry pulp (P0, 0%) had a denser texture compared to synbiotic yogurts with strawberry pulp addition. In contrast, treatments P1 (5%) and P3 (15%) produced a more liquid texture. Although an increase was observed at P2 (10%), the difference was not statistically significant compared to P0 (0%).

The decline in texture preference was caused by the increased percentage of strawberry pulp addition. This finding is consistent with Sinaga (2020), who stated that the higher the proportion of strawberry juice added to yogurt, the lower its viscosity. In this study, Misdawati (2023) reported that strawberry pulp contains 93.10% moisture, which contributes to a more diluted texture in synbiotic yogurt as the pulp addition increases. This is also supported by Nofrida et al. (2018), who explained that the lower the water content in food materials, the firmer the texture, and conversely, the higher the water content, the softer the resulting texture.

Aroma Sensory Value

The average sensory aroma scores of yogurts with different levels of strawberry pulp addition ranged from 3.33 to 3.85. The highest scores were obtained in treatments P0 (0%) with a value of 3.85 (liked) and P2 (10%) with a value of 3.83 (liked), while the lowest scores were recorded in treatments P3 (15%) with a value of 3.38 (slightly liked) and P4 (20%) with a value of 3.33 (slightly liked).

The decrease in aroma preference observed in treatment P3 (15%) was due to the higher proportion of strawberry pulp, which affected the final aroma of the synbiotic yogurt. This is related to the presence of volatile organic compounds in strawberries that contribute to their distinctive aroma. According to Jetti et al. (2007), esters represent the main group of aroma compounds in strawberries, accounting for approximately 90% of the total volatiles in ripe fruits. Similarly, Hadi et al. (2013) reported that ester compounds in strawberries consist of methyl and ethyl butanoate, butyl acetate, and methyl and ethyl hexanoate. This finding is consistent with Lu et al. (2020), who stated that the volatile organic components in strawberries include esters, aldehydes, ketones, alcohols, terpenes, and furanones.

Taste Sensory Value

The average sensory taste scores of yogurts with different levels of strawberry pulp addition ranged from 3.33 to 4.00. The highest scores were obtained in treatments P0 (0%) with a value of 3.95 (liked) and P1 (5%) with a value of 4.00 (liked), while the lowest scores were recorded in

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treatments P2 (10%) with a value of 3.48 (slightly liked), P3 (15%) with a value of 3.33 (slightly liked), and P4 (20%) with a value of 3.48 (slightly liked).

The decrease in taste preference for yogurts with increasing levels of strawberry pulp was attributed to the rise in acidity caused by the addition of strawberry pulp. This was due to the presence of organic acids such as citric acid, phenolic acids, and tannins in strawberries. This observation is supported by Emsley (2007), who stated that the characteristic taste of strawberries results from a combination of glucose, fructose, sucrose, and organic acids such as citric and phenolic acids, as well as tannins, which interact with the fruit's aromatic compounds. Furthermore, Sumayku and Tanor (2022) reported that the sugar and acid content in strawberries determines the flavor profile of the fruit.

Color Sensory Value

The average sensory color scores of yogurts with different levels of strawberry pulp addition ranged from 3.45 to 3.98. The highest scores were obtained in treatment P3 (15%) with a value of 3.98 (liked) and P0 (0%) with a value of 3.88 (liked), while the lowest scores were recorded in treatments P1 (5%) and P4 (20%), both with a value of 3.45 (slightly liked).

The improvement in yogurt color up to the 15% strawberry pulp addition level was attributed to the brighter final color produced. This finding is supported by Nurhossain et al. (2012), who reported that yogurts enriched with fruit juice are generally more acceptable in terms of quality and organoleptic properties. The yogurt produced in this study exhibited a pinkish to purplish color, resulting from the bright red hue of the strawberries used. According to Ariestini et al. (2018), the red color in strawberries is due to anthocyanin compounds, which impart vivid pigmentation to the fruit. This is further supported by Widyastuti et al. (2016), who stated that red pigments in fruits contain lycopene and anthocyanin compounds.

Table 1. The Result of Mean Sensory Scores of Synbiotic Yogurt with Different Levels of Strawberry Pulp

Treatments	Texture	Aroma	Taste	Color
P0 (0%)	$4,07^{a} \pm 0,94$	$3,85^{a} \pm 1,07$	$3,95^{a} \pm 1,06$	$3,88^{ac} \pm 0,97$
P1 (5%)	$3,45^{b} \pm 0,90$	$3,45^{ab} \pm 0,93$	$4,00^{a} \pm 0,64$	$3,45^{b} \pm 0,71$
P2 (10%)	$4,00^{a} \pm 0,64$	$3,83^{a} \pm 0,84$	$3,48^{b} \pm 1,04$	$3,58^{ab} \pm 0,84$
P3 (15%)	$3,23^{bc} \pm 0,95$	$3,38^{b} \pm 0,97$	$3,33^{b} \pm 0,97$	$3,98^{c} \pm 0,62$

Note: ^{abc} Different superscripts are significantly different (P<0.05)

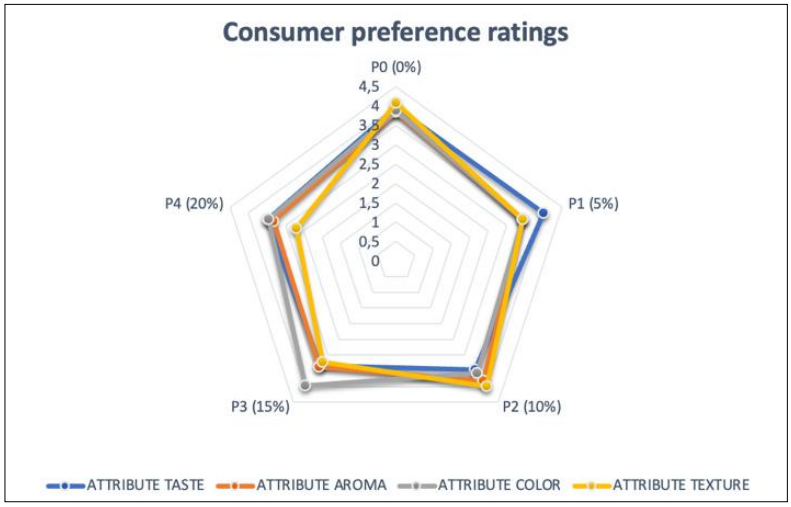


Figure 1. Consumer preference ratings of synbiotic yogurt containing various concentrations of strawberry pulp

CONCLUSIONS

The addition of strawberry pulp to yogurt significantly affected its texture, aroma, taste, and color attributes. The best sensory results were obtained from the treatment with 5% strawberry pulp addition.

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