Physical and hedonic properties of cow milk yogurt containing different levels of avocado pulp (*Persea americana*, Mill)

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Abstract. The research aimed to analyze physical and hedonic properties of cow milk yogurt containing different levels of avocado pulp (*Persea americana*, Mill) and determine the best level of avocado pulp on cow’s milk yogurt. The material used were fresh milk of Holstein Friesian crossbred dairy cow, avocado pulp and commercial starter plain yogurt. The research design used a completely randomized design (CRD) of direct pattern with five treatments including P₀ = 100 ml yogurt + 0% avocado pulp, P₁ = 97.5 ml yogurt + 2.5% avocado pulp, P₂ = 95 ml yogurt + 5.0% avocado pulp, P₃ = 92.5 ml yogurt + 7.5% avocado pulp, and each treatment consisted of five replications. The data were analyzed by variance analysis, and difference treatment was continued with Duncan’s New Multiple Range Test (DMRT). The results showed that different levels of avocado pulp affected on viscosity adhesiveness and cohesiveness of yoghurt (P<0.05). However, the treatment did not affect hardness (P>0.05). Hedonic test showed that adding avocado pulp into yogurt did affect (P<0.05) color and flavor, and also taste of yogurt was high significantly effected (P<0.01). Overall, it can be seen that the different levels of avocado pulp in cow milk yogurt can increase physical properties of yogurt including viscosity and hedonic quality. The best level of avocado pulp added to cow milk yogurt was 7.5%.

1. Introduction

The dairy products have a special target for the functional food market due to efficient carriers of probiotic bacteria[1,2]. Yoghurt is common fermented milk product and widely consumed because of its functional value and good vehicle to deliver probiotics to consumers[3]. Numerous studies have been reported on utilization of probiotics to achieve a product with satisfactory quality characteristics and good acceptance by consumers[4].

The texture is a fundamental characteristic of yogurt. It can be improved by the use of gelling, thickening, or stabilizing agents[5]. Textural properties of yogurt, such as viscosity[6], smoothness and thickness[7], and structural resistance to stress[8], are important attributes to determine its consumer acceptance. Hardness is the most important parameter for evaluation of yogurt texture. It is regarded as the force required to attain a certain deformation and is considered as a measure of firmness of the yogurt[9]. Many methods have been used to improve the quality of the yogurt, such as increasing the solids in milk (adding fat, proteins, or sugars such as sucrose and fructose), addition of stabilizers...
(pectin, starch, alginate, and gelatin)[10,11]. However, these approaches did not satisfy the consumers demand for products with as few food additives as possible.

Yogurt has various types included set yogurt, stirred yogurt, sweet drinking yogurt, fruit yogurt, yogurt cheese, frozen yogurt dan dried yogurt[12]. Several yogurt are marketed with the addition of either fruit or vegetables rich in bioactive food [13]. The addition of flavors using essences, fruit and/or fruit extracts and honey may be a better option than artificial flavorings for use in the development of new dairy products [14]. The product is accepted by consumers for its flavor, (mainly acetaldehyde) and pleasant texture[15].

Some studies on avocado processing involved the incorporation of additives to improve the sensory quality and avoid syneresis[16]. The processed avocado pulp is an alternative to utilize fruits, which can be used in various value-added food products[17]. Based on all yogurt categories, 74% is yogurt mixed with fruit (fruit yogurt). Additional fruit flavor, pure fruit of fruit extract can improve taste, color and texture flexibility of yogurt to consumers [18]. Avocado in the immature state that has been freshly harvested is characterized by having an extremely firm texture[19]. The composition differences of the fruit also influence its physical properties such as texture and color[20]. In this case, the higher avocado fat and water content of harvest can be another factor that influences the progressive changes in fruit texture [21]. The physical attributes of yogurts, including the lack of visual whey separation and perceived viscosity, are crucial aspects of the quality and overall sensory consumer acceptance of yogurts [11].

Based on the description, it is necessary to study cow's milk yogurt incorporated by fruit pulp. Hence, the aims of this research were to analyze physical and hedonic properties of cow milk yogurt containing different levels of avocado pulp (Perseaamericana, Mill) and determine the best level of avocado pulp on cow's milk yogurt.

2. Materials and Methods
The materials of this research were fresh milk of Friesian Holstein crossbred, avocado pulp brought at local market, and commercial starter plain yogurt.

2.1. Sample preparation
The treatment of this research was concentration ratio between yogurt and avocado pulp (v/v): P0 = 100 ml:0 ml; A2 = 97.5 ml:2.5 ml; A3 = 95 ml:5 ml; A4 = 92.5 ml:7.5 ml. Yogurt manufacturing according to [22]. Milk from local dairy farmer was pasteurized at 85°C for 15 minutes, and it was cooled around 40 – 45°C. Then, addition of bacteria to milk using plain starter with the Biokul trademark, and it was incubated for 24 hours at 43°C.

The procedure for making avocado pulp followed the method of research conducted by [23]. First, all avocados with same characterististics (age and cultivar) was sorted from dirt and split in the middle and discard. The flesh of avocados was cut into pieces and then blended. Second, mixing avocado pulp into yogurt by putting 100 ml of yogurt into each glass and then adding avocado pulp (P0 = 0%; P1 = 2.5%; P2 = 5.0%; P3 = 7.5%, P4 = 10.0%). And the last, mixture of avocado pulp and cow's milk yogurt was evenly mixed.

2.2. Measurement of physical properties
The samples were mixed and analyzed in duplicate for pH, viscosity, and hardness. Brookfield Viscometer was used to determine viscosity of yogurt. The viscosity was expressed in centipoise (cP). Hardness was measured by TA.XT plus, Texture Analyzer, Stable Micro Systems Ltd., England[24], and The pH was measured with a pH meter (Hanna Instruments 8521).

2.3. Measurement of hedonic properties
Hedonic test of yogurt was carried out using semi-trained panelists with a age range of 20-24 years. The measurement of hedonic qualities included color, aroma, and taste using a 9-point hedonic scale[25].
2.4. Statistical analysis
The experimental design of this research used a completely randomized design method. Data of this study included physical test (viscosity and texture) and hedonic test (color, aroma, taste and overall acceptance) were analyzed using ANOVA with significance differences at $\alpha = 0.05$, and differences between treatment means were further analyzed using Duncan’s New Multiple Range Test. However, pH was analyzed using descriptive statistical by comparing to means of the treatments.

3. Result and Discussion

Physical properties
The result of descriptive analysis showed that the addition of avocado pulp was still within the normal range of a pH of cow’s milk yogurt. The pH value in this study was 4.0–4.1 (Table 1). Fruit-flavored yogurt has pH between 3.9–4.0[26]. Yogurt containing acid is the specific product resulted from fermentation process using Streptococcus thermophilus and Lactobacillus bulgaricus cultures[24]. Change of the pH values from milk inoculated with bacterial cultures to be yogurt decreased from 6.70 to 4.34[27]. The increase solids content in yogurt milk as a result of fortification, and also creates buffering that requires additional acid development by the starter cultures to achieve a similar pH target [28].

Table 1. Evaluation of physical properties of cow’s milk yogurt containing avocado pulp

| Variables      | Treatment (mean±SD) | $p$-value |
|----------------|--------------------|-----------|
|                | P0                 | P1        | P2        | P3        | P4        |
| pH             | 4.10±0.00          | 4.00±0.00 | 4.10±0.00 | 4.10±0.00 | 4.10±0.00 |
| Viscosity (cP) | 173.50±1.48        | 205.37±7.25 | 228.23±1.30 | 230.87±0.45 | 234.57±0.89 | 0.042*    |
| Hardness (g)   | 28.80±1.37         | 26.60±1.29 | 28.80±0.97 | 28.80±0.97 | 27.40±1.11 | 0.767**   |

*Different superscript in the same line showed significantly different ($P<0.05$).
- = variance was not analyzed, * = different significantly, ns = not significantly different.

The addition of avocado pulp showed a significant difference ($P<0.05$) to viscosity of cow’s milk yogurt. Addition of avocado pulp increases the viscosity of cow’s milk yogurt due to the large concentration of total solids added. The amount of solids determines the viscosity of the yogurt liquid, therefore viscosity can also be used as an index of the solid amount contained in the liquid[29]. Addition of avocado pulp up to level 5% increases the quality of yogurt, but viscosity of yogurt at levels 5 to 10% did not increase. The viscosity produced by addition of avocado pulp into cow’s milk yogurt was high viscosity with ranging from 173.5–234.5 cP. The addition of honey was able to increase total solids content and increase the consistency of the product. In accordance to [30], the difference of viscosity level of yogurt was caused by the total solids found in each product and also the difference in acid and pH value.

The results of this research showed that addition of avocado pulp had no effect ($P>0.05$) on the texture (hardness) of cow milk yogurt. Addition of avocado pulp does not decrease the texture of yogurt. Hardness of yogurt remains almost same and then decreased with increase in partially hydrolyzed guar gum concentration[9]. Similar effects when yogurt samples were enriched with oat-maltodextrin[31], and also the increase in yogurt softness with addition of mango pulp[32].

Hedonic properties
The yogurt samples containing different levels of avocado pulp showed significantly different to color, taste and flavor. The addition of avocado pulp gave a significant difference ($P<0.05$) in increasing yogurt color. Greenish color of yogurt can increase panelists’ hedonic for yogurt which are generally white. The green and violet colors of most vegetables are contributed by chlorophyll and anthocyanins[33], therefore the degradation of color in avocado fruit spreads can be most likely to be related to the degradation of chlorophyll [34]. Significant differences were shown in the addition of avocado pulp at levels 7.5 and 10% to 0%, while the level of P4 showed a significant difference also.
to P1 at the level of 2.5%. Adding avocado pulp to level 7.5 on yogurt can increase the preference for color in the product. Color and appearance decrease may be due to mango pulp particles settling at the bottom in set yoghurt at higher mango pulp concentrations[32].

| Variables | P0 | P1 | P2 | P3 | P4 | P-value |
|-----------|----|----|----|----|----|---------|
| Color     | 5.83±1.37 | 6.00±1.29 | 6.23±0.97 | 6.53±0.97 | 6.73±1.11 | 0.018*   |
| Flavor    | 5.93±1.57 | 5.93±1.46 | 5.67±1.45 | 6.63±1.03 | 6.37±1.03 | 0.042*   |
| Taste     | 4.47±1.41 | 5.17±1.32 | 4.57±1.52 | 5.97±1.43 | 5.70±1.49 | 0.0001** |

*abc Different superscript in the same line do not differ significantly (p> 0.05).
* = different significantly. ** = highly significantly different.

The results of variance analysis showed that the addition of avocado pulp had a significant difference (P <0.05) in increasing flavor of yogurt. The typical flavor of yogurt is obtained by the formation of lactic acid, acetaldehyde, acetic acid and diacetyl [35]. The avocado's distinctive flavor was able to eliminate the distinctive flavor of yogurt so that there was an increase of panelists hedonic of yogurt products. The difference was shown by addition of 5% avocado fruit pulp (P2) to an addition level of 7.5% (P3). All stirred fruit yogurts were scored higher on average by the panelists than plain yogurt in terms flavor, possibly reflecting a combined contribution from flavor compounds in fruit juice and higher viability of L. acidophilus LA-5, which may also produce flavor compounds. Acetaldehyde for example is recognised as a major flavor component in yogurt and the presence of lactobacilli in the starter culture can influence the total content of acetaldehyde in final product [36]. The results of this study indicated that there was an increase in taste score compare to control treatment. Taste produced by cow's milk yogurt with addition of avocado pulp was able to reduce sour taste due to a typical avocado flavor. A previous study found that the addition of fruit juice positively influenced the acceptance of goat yogurt, improving its taste and suggesting a positive influence of sugars naturally found in fruit on these sensory attributes [37]. Consumers prefer yogurt which has a less acidic taste and still tastes sweet. The acidity of yogurt therefore also affects the taste preference in cow milk yogurt. The typical avocado flavor and mixed acid produced can increase panelists' preference for the product[38]. A very significant difference was shown by the addition of avocado pulp level P3 and P4 at level 7.5 and 10% to levels P0 and P2 at levels 0 and 5%, while at the level of P3 it was significantly different from P1. Adding avocado juice to level 7.5 in yogurt can increase the taste for the product. Flavored yogurts including fruit (apple, apricot, black cherry, black currant, blue berry, lemon, mandarin, raspberry, strawberry, peach), cereal, vegetables, chocolate, vanilla, caramel, ginger) gave a wide array of tastes, but also increases sweetness of the product[39].

4. Conclusion
Addition of avocado pulp into cow milk yogurt can improve the physical quality of yogurt including viscosity (thickness) and hedonic level of yogurt, namely color, taste, and flavor. The best level of adding avocado pulp into cow milk yogurt was 7.5%.

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