Diversification derivatives product of ripe banana: banana leather

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Abstract. The banana leather is one of the ripe banana derivatives in sheet form. This product is categorized as a snack food. The purpose of this study was to determine the effect of the addition of egg and cheese on chemical properties and panelist preference of the banana leather product. Three samples of banana leather were prepared, i.e. control treatment, egg addition treatment, and cheese addition treatment. The samples were analyzed to assess the chemical properties, which included the water, ash, fat, protein, carbohydrate, calcium, and phosphorus contents. Then, an organoleptic assessment was done to assess the panelists’ preference of the color, aroma, taste, crispness, and overall preference. The addition of egg whites and cheese increased the nutritional value of the banana leather products, particularly in the ash, fat, and protein contents, and the total energy. The ash content of control was 3.49% and then increased to 3.9-5.28% with the addition of egg white and cheese. Meanwhile, the fat content increased from 0.54% to 0.77-12.95%, the protein content rose from 4.11% to 9.52-11.7%, and the total energy rose from 363.42 kcal/100g to 364.97-410.37 kcal/100g. The addition of cheese on the banana leather product also increased the calcium and phosphorus content to 4578 mg/100g and 5947.98 ppm, respectively. However, it reduced the carbohydrate content to 6.72%. In the organoleptic assessment, the addition of egg whites on the banana leather product increased all parameters, which was aroma, color, crispness, crispness, taste and overall preference, with highest overall preference score of 5.93.

Keywords: banana leather, chemical properties, panelist preference

1. Introduction
Banana (Musa paradisiaca) is a horticulture commodity with high potential for food diversification, food security, and agribusiness in Indonesia. Bananas contain carbohydrate, mineral, and fiber that meet the requirements of food commodities and food diet. The number of harvested bananas often excessive during the harvest season. One method to address this issue is by processing banana into flour, which also aims to extend the shelf life of the banana.

The preparation of banana flour from unripe banana has been informed by Rodriguez-Ambriz et al., Vatanasuchart et al., Daramola and Osanyinlusi, Anyasi et al., while the observation of banana flour in various ripening stages has been reported by Bugaud et al., Egbebi and Bademosi, Abbas et al [1-7]. Meanwhile, the making of ripe banana has been informed by Abbas et al [8]. Unripe banana flour has high dietary fiber and resistant starch which have many benefit for human’s health [9-10]. The
production of ripe banana flour can propose new products with a standardized nutrient composition for domestic and industrial uses. The advantages of ripe banana flour include high sugar content that is suitable for incorporation into food products requiring sweetness, solubility, and high energy content. Ripe banana flour has a good banana flavor compared to the unripe one. Meanwhile, ripe banana flour has low yield because of low starch content, high-cost production, and still limited application. So that required the development of other products based on ripe bananas. Another innovative product base on the ripe banana is banana leather.

The banana leather is one of the ripe banana derivatives in sheet form. This product is categorized as a snack food. The similar product that has been already on the market is made from seaweed that is known as nori and other snack food in sheet form that is called crepe [11]. The crepes made from various flours, edible oil, skim milk, and egg flour [12]. In this study, banana leather was made from ripe banana flour mixed with egg and cheese. The addition of egg and cheese aimed to improve the nutritional value of the banana leather as the ripe banana flour has high sugar content but low protein content. The ripe banana flour had 3.15% protein and 12.8% sugar [6]. Tricalcium phosphate, an anti-caking agent, was also added to prevent the formation of lumps in the banana flour due to the high sugar content with hygroscopic nature. The purpose of this study was to determine the effect of the addition of egg and cheese on chemical properties and panelist preference of the banana leather product.

2. Materials and Methods

2.1. Raw materials

The banana leather was formulated with these following ingredients: banana puree, egg white, cheese, and tricalcium phosphate. The banana puree was prepared from ripe banana (Musa paradisiaca sp. AAA group, dessert subgroup that called locally as ‘Pisang Ambon Hijau’). Other ingredients were obtained from the local market. This research use chemical reagents with an analytical grade.

2.2. Banana leather preparation

Three samples of banana leather were prepared viz. control treatment, egg addition treatment, and cheese addition treatment. The control treatment was made by making banana puree using a chopper, mixing banana puree with tricalcium phosphate using a hand mixer (Philips Mixer, HR Model 1538) for 5 min at speed 4 (1200 rpm), pouring the puree dough on a plastic coated sheet, flattening the dough on baking sheet, drying 55 °C for 9 hours, cutting the sheet into 7 x 10 cm samples, second drying for 15 hours in 55 °C, and packaging. The second treatment was made by making egg foam using a hand mixer (Philips Mixer, HR Model 1538) for 5 min at speed 4 (1200 rpm) and making puree of banana with a chopper, mixing banana puree, egg foam, and tricalcium phosphate, then pouring the puree dough on a plastic coated sheet, baking dough on the pan, drying 55 °C for 9 hours, cutting the sheet into 7 x 10 cm samples, second drying for 15 hours in 55 °C, and packaging. The third sample was made by making banana puree using a chopper, mixing banana puree, grated cheese, and tricalcium phosphate using a hand mixer (Philips Mixer, HR Model 1538) for 5 min at speed 4 (1200 rpm), pouring the puree dough on a plastic coated sheet, flattening the dough on baking sheet, drying 55 °C for 9 hours, cutting the sheet into 7 x 10 cm samples, second drying for 15 hours in 55 °C, and packaging. Drying was done using a cabinet dryer. Before analysis, the samples were stored at freeze temperature in sealed aluminum foil bags.

2.3. Analyses of banana leather

2.3.1. Chemical analysis

Chemical analysis in this study including: proximate, energy total, calcium, and phosphorus content. Proximat analysis referred to National Standardization Agency of Indonesia (SNI 01-2891-1992) regarding analytical methods for food and beverage, which includes proximate (moisture, fat, protein, and ash contents), and carbohydrate content was determined using ‘by difference’ method [13]. Energy total was obtained following Ekafitri et al. and determined by calculation using Atwater factors according to the composition of carbohydrates, fats, proteins of these foods [14]. The energy total of banana leather was determined by adding the multiplication results
between the Atwater carbohydrate (4 Kcal), protein (4 Kcal), and fat (9 Kcal) factors to the levels of carbohydrates, proteins, and fats in product. Calcium and phosphorus content were determined by using ICP-EOS (Inductive Couples Plasma-Optical Emission Spectrometry) Agilent type 720, USA.

2.3.2. Organoleptic assessment. Organoleptic assessment was performed by scoring method in which the samples were given to 30 panelists to be assessed in particular scores within the range of his or her favorite levels, which comprised of strongly dislike (1), dislike (2), moderately dislike (3), neutral (4), moderately like (5), like (6), and really likes (7). Assessment parameters were five quality criteria of color, aroma, taste, sweetness, and overall preference.

2.3.3. Statistical analysis. This research used a completely randomized design (CRD) to evaluate the effect of egg white and cheese addition on the banana leather products. This study used a factorial design in completely randomized design. Factors tested were the type of filler, which comprised of three levels: control, 20% egg white froth addition, and 20% cheese addition. Each treatment was repeated twice. Variance analysis of data of each treatment was carried out on a statistical package SPSS. The significant difference among mean values was analyzed using one-way analysis of variance (ANOVA), and then used Duncan’s test at a significance level of (P < 0.05).

3. Result and Discussion

3.1. Proximate analysis

The proximate content of three samples of banana leather includes moisture, ash, protein, fat, carbohydrate contents are displayed in Table 1.

| Parameter                | Control | Egg addition | Cheese addition |
|--------------------------|---------|--------------|-----------------|
| Water content (%)        | 6.33<sup>ab</sup> | 5.76<sup>a</sup> | 8.32<sup>b</sup> |
| Ash content (%)          | 3.49<sup>a</sup>  | 3.96<sup>b</sup> | 5.28<sup>c</sup> |
| Total fat (%)            | 0.54<sup>a</sup>  | 0.77<sup>a</sup> | 12.95<sup>b</sup> |
| Protein (%)              | 4.11<sup>a</sup>  | 9.52<sup>b</sup> | 11.74<sup>c</sup> |
| Total carbohydrate (%)   | 85.54<sup>a</sup> | 79.88<sup>b</sup> | 61.72<sup>c</sup> |

*values with the same superscript in the same row had no significant difference on 0.05 significance.

The water content of the three banana leather samples ranged from 5.76 to 8.32%, whereas the banana leather samples made with the addition of egg whites were significantly lower than other treatment (p <0.05). The addition of egg whites speeds up the evaporation of water so that in the same drying time, the banana leather sample with the addition of egg whites has lower water content. The water contents of the three samples were less than 10% for dry products, which means that all samples were safe from damage. Winarno stated that the safe water content of food for storage is less than 14%.

The ash content of banana leather products ranged between 3.49-5.28%, and the ash contents of the three products were significantly different at p <0.05. Table 1 shows that the addition of egg white and cheese increased the ash content of banana leather. The addition of egg whites increased the ash content to 3.96%, and cheese treatment increased the ash content to 5.28%. This increase in ash content can be caused by the mineral content in egg white and cheese. Egg whites contain calcium, magnesium, phosphorus, sodium, and zinc and cheese contain minerals such as calcium, iron, magnesium, sodium, phosphorus, and zinc with different compositions depending on the type of milk used in cheese making and cheese ripening process [16-17]. Meanwhile, Wall explained that bananas contain minerals such as calcium, phosphorus, magnesium, sodium, and high concentration of potassium that reaches 2.7% [18-19]. Ash content roughly describes the mineral content contained in a
food product. Ash is a carbon-free residue after the food is burned. The higher the ash content of a product, the higher the minerals contained in it. Thus, the addition of egg white and cheese increased the ash content of the product.

The total fat content of banana leather products ranged from 0.54 to 12.95% (Table 1). The fat content of banana leather control (0.54%) and the samples with egg whites addition (0.77%) was not significantly different (p>0.05), but the fat contents of these two treatments were significantly different from the fat content of the sample with cheese addition (12.95%) at p <0.05. The addition of cheese increases the fat content of the product. According to the Food Standard Agency, cheese has a fat content of 32 g/100g of material, which is higher than the fat content of egg white that reaches 11.5% [20]. Hence, the addition of cheese increased fat content higher than the egg white at the product.

The protein content of banana leather products ranged from 4.11 to 11.74% (Table 1). The protein contents of the three samples were significantly different at p <0.05. The samples with egg white and cheese addition had higher protein levels. The addition of egg whites increased the protein level to 9.52%. Egg whites contain 12.8% protein [20]. The addition of cheese raised the protein level to 11.74%. According to the Food Standard Agency cheese contains 25.4% protein [21]. Egg whites and cheese are food sources of protein. In this study, the addition of the two ingredients aimed to increase the protein content of banana leather, and the results showed that the objective had been met.

The total carbohydrate content of banana leather products ranged from 61.72 to 85.54% (Table 1). The carbohydrate content of the control was larger (85.54%) and significantly different from the samples with the egg whites (79.88%) and cheese (61.72%) addition. This is due to the decreased percentage of ripe bananas in the total dough with the addition of egg whites and cheese. Ripe bananas are a source of carbohydrates. According to Sogo et al., ripe bananas contain 24.57% carbohydrates [22]. Even though egg whites and cheese are high-protein foods, they only have a slight amount of carbohydrates. The carbohydrate content of egg whites and cheese are 0.7% and 0.1%, respectively [22-23].

3.2. Total energy

Based on carbohydrate, protein, and fat contents, the total energy of the banana leather product was then calculated. Total energy was obtained by calculating the value of protein content multiplied by 4 kcal, carbohydrate content multiplied by 4 kcal, and the fat content multiplied by 9 kcal. The results exhibit that the total energy of the banana leather product ranged from 363.42-410.37 kcal/100g (Figure 1). Figure 1 shows that the total energy of banana leather control was not significantly different (p>0.05) with the sample with egg whites addition and significantly different (p <0.05) with the sample with cheese addition. This could be caused by the fat and protein content of the sample with cheese addition was higher than the other two treatments.

![Figure 1. The total energy of the banana leather product.](image-url)
3.3. Mineral content (calcium and phosphorus)
The calcium content of banana leather products ranged from 299.87-457.86 mg/100g (Figure 2). Treatment with cheese addition was significantly higher than control and egg white addition treatment (p<0.05). The highest calcium content was obtained in the sample with cheese addition that reached 457.86 mg/100g because the cheese contains calcium of 739 mg/100g, while egg whites only contain 6 mg/100g calcium and banana only has 3.8-9.7 mg/100g calcium [18,20]. The calcium content in the banana leather products also came from the anti-caking agent, which is tricalcium phosphate with 0.25% concentration.

![Figure 2. Calcium content of banana leather.](image1)

3.4. Organoleptic assessment of the banana leather products
The organoleptic assessment of banana leather products was tested by a hedonic rating test of taste, aroma, color, crisp, and overall acceptance parameters with average values are displayed in Figure 4.

![Figure 3. The phosphorus content of banana leather.](image2)

The phosphorus content of banana leather products ranged from 1875.45 – 5947.98 ppm (Figure 3). The phosphorus content of the control and was not significantly different (p> 0.05) with the sample with the egg whites addition but significantly different (p <0.05) with the sample with cheese addition. The highest phosphorus content was obtained in the sample with cheese addition that reached 5947.98 ppm. Abubakar and Usmiati reported that low-fat white cheese made from modified milk contained phosphorus ranging from 346.62 - 832.15 mg/100g, while egg contains 0.18 mg/100g [23-24].
Figure 4. The spider web of the average scores of consumers’ preference on various parameters of the banana leather products.

The average of the taste score of banana leather products ranged from 4.90 to 6.13. Figure 1 shows that the sample with egg whites addition had the highest average (6.13) and was significantly different ($p < 0.05$) from the averages of the control (5.27) and the sample with cheese addition (4.90). The sample with cheese addition had the lowest average of the taste score that could be caused by the salty and savory flavor of cheese addition disguised the taste of bananas. The 20% addition of cheese was probably higher than what the panelists favored. Chambers et al. explain that cheese had flavors associated with dairy-related attributes (dairy fat, dairy sour, dairy sweet), fundamentally tasted (bitter, salty, sour, and sweet) sharp and astringent, which were found in every type of cheese tested [25]. Cheese also has a different flavor depending on the type.

The average of the aroma score of banana leather products ranged from 4.77 to 5.27. The sample with egg whites addition had the highest average (5.23), but it was not significantly different ($p > 0.05$) from the averages of the control (4.77) and the sample with cheese addition (4.77). This suggests that the addition of egg whites and cheese can maintain the banana aroma on the banana leather products. Facundo et al. stated that the main factors that affect the banana consumption were aroma and taste [26]. Chemically, the aroma and taste of bananas are caused by the presence of volatile components received by the olfactory receptors. More than 150 volatile components are present in bananas, especially isoamyl and isobutyl ester groups together with 2-pentanone [27].

The average of the color score of banana leather products ranged from 4.50 to 5.27. As shown in Figure 1, the sample with egg whites addition had the highest average (5.27). The sample with cheese addition was significantly lower than control and egg white addition sample. This suggests that the addition of cheese increased the preference for color while on the contrary, the addition of cheese decreased it. The addition of egg whites produced a brighter banana leather than the controls while the addition of cheese produced banana leathers with a darker color. This could be caused by the higher protein content in cheese so that when drying occurred, protein denaturation resulting the darker color of banana leather products.

The average of the crispness score of banana leather products ranged from 3.17 to 6.17. Figure 1 displays that the sample with egg whites addition had the highest average (6.17), and it was significantly different from the averages of the control (3.17) and the sample with cheese addition (3.77). This suggests that the addition of egg whites increased the preference for crispness. This could be caused by the porous nature due to the addition of egg whites. The drying process with foaming produces better product reconstruction and quality than the dried product without foaming [28]. The drying process with foaming created a product that was more porous and preferred by consumers.
The average of the overall preference for banana leather products ranged from 4.17 to 5.93. The sample with egg whites addition was significantly higher than control and the sample with cheese addition. This suggests that the addition of egg whites increased the overall preference compared with the other two treatments. The addition of egg whites on the banana leather product increased all parameters of the organoleptic assessment, which was taste, aroma, color, crispness, and overall preference.

4. Conclusion

The addition of egg whites and cheese increased the nutritional value of the banana leather products, particularly in the ash, fat, and protein contents, and the total energy. The ash content of the control was 3.49%, then increased to 3.5-5.28% with the addition of egg whites and cheese. Meanwhile, the fat content increased from 0.54% to 0.77-12.95%, the protein content rose from 4.11% to 9.52-11.74%, and the total energy rose from 363.42 kcal/100g to 364.97-410.37 kcal/100g. The addition of cheese on the banana leather product also increased the calcium and phosphorus contents to reach 457.86 mg/100g and 5947.98 ppm, respectively. However, it reduced the carbohydrate content to 61.72%. In the organoleptic assessment, the addition of egg whites on the banana leather product increased all parameters, which were aroma, taste, color, crispness, and overall preference, with the highest overall preference score of 5.93. Therefore, it can be concluded that the addition of cheese improved the nutritional value of the banana leather product, but the sample with the egg whites addition was more preferred by the panelists.

5. References

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