Banana flour as fillers in making tomato paste

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Abstract. Tomatoes are one of the horticultural crops that have high potential value in Indonesia. Statistics of the Ministry of Industry in 2016 shows that tomato sauce is an import commodity worth the US $ 1284 thousand and exports worth the US $ 863 thousand. The raw material for making tomato sauce is tomato paste. Tomato paste is an intermediate product that commonly uses fillers in the form of corn starch which is a lot of imported commodities, CMC, or xanthan gum. This filler can be replaced with other types of carbohydrates that have abundant amounts in Indonesia, including banana flour. Banana flour is one ingredient that can be used as an alternative filler of tomato paste. Both bananas and tomatoes are two commodities that have low prices during the main harvest. This study aims to determine the concentration of banana flour that is suitable for use in making tomato paste. This study uses a completely randomized design (CRD) with the addition of banana flour treatment consisting of 5 levels, namely 0 %, 1%, 2%, 3%, and 4%. The results showed that the addition of banana flour could increase the total dissolved solids, density, and viscosity of tomato paste. The addition of banana flour did not affect the pH of tomato paste. In addition, the addition of banana flour can reduce the value of brightness and redness in tomato paste.

1. Introduction

Banana is one of the leading commodities of Malang, East Java. Malang banana production reached 8914 tons per year. 5245 of them are produced in the Dampit District. The most widely planted banana is Mas Kirana banana, Candi banana, kepok banana, etc. The banana is classified into Grade A, Grade B, and Grade C. Grade A for sale on the premium market, grade B is sold to the local markets, and Grade C discarded. Production graphs are not continuous in one year. Banana production surpluses occur in certain seasons. The commodity is low priced in certain months and the production is often inadequate in a certain season. Also, banana derivative products industry raw materials supply is unstable for each month. Therefore, bananas are suitable to be converted as intermediate products such as banana flour to extend the shelf-life. Bananas are nutritious as a source of vitamins, minerals, and carbohydrates. The main carbohydrate is starch which contained 70% [1]. In fresh ripe banana, the amylose and amylopectin starch is 20.5% and 75.5%, respectively.

On the other hand, the Ministry of Industry 2018 statistics showed that Indonesia is importing a lot of starch-based products such as starch (175,218.4 thousand US $), dextrin and starch modification (93,852.4 thousand US $), corn starch (60,553.7 thousand US $). Malt extract (27,091.2 thousand US $ thousand US $). Gum and thickener (24,774.8 thousand US $), malt (12,339.0 thousand US $),
potato starch (9,737.3 thousand US $), wheat starch (9,694.3 thousand US $), and etc. Starch/carbohydrate as food ingredients are commonly used as a filler of a variety of food and beverage products. Imports of food ingredients in the form of starch are due to lack of natural material processing into intermediate products that can be used for the food and beverage industry. Banana flour processing in the food industry scale is still very limited due to the high temperature of the gelatinization of starch banana. Banana starch gelatinization temperature higher than on other tubers is at a temperature of 68.8 to 77.5° C [2], it is suspected because of the strong bond in the starch granules. Banana starch has a large particle size with an average value between 20-50 μm [3].

Products that are processed with high temperatures usually require thickeners include tomato sauce. Tomato paste viscosity level is one of the main parameters of the quality of tomato [4]. Tomato sauce thickening is often assisted by using additives such as xanthan gum [5]. Xanthan gum has the disadvantage of having an expensive price [6]. Another alternative in tomato sauce thickener is corn starch which is also imported commodities to the value of imports of 60,553.7 US $ in 2016 [7]. The urge of increasing the viscosity of tomato paste using other raw materials that are cheaper and abundantly available can help reduce the price of tomato sauce production and increasing the added value of products that are very cheap at harvest season.

2. Materials and Method

2.1. The process of making tomato paste
Tomatoes are washed and blanched at a temperature of 95 °C for 1 min. Then, the blanched tomatoes were crushed with a blender without addition of water. Banana flour was added at various concentrations (i.e. 0%, 1%, 2%, 3%, and 4%). The tomato mixture was heated at 90 °C for 10 minutes with a thickness of 5 mm through continuous mixing.

2.2. Experimental design
This experiment was carried out using a descriptive method with the addition of banana flour, which consisted of 5 levels i.e. 0%, 1%, 2%, 3%, and 4%. Each treatment was repeated 4 times.

2.3. pH measurement
pH was measured using a pH meter probe, which placed in the stirred tomato paste. Prior use, pH probe was calibrated. pH probe was also cleaned when measuring pH value between different samples to avoid cross contamination and error value.

2.4. Total solid measurements
Tomato paste was diluted in a way taking a sample of 1 g of distilled water, and then added up to 10 mL. The diluted sample was dripped on the refractometer prism, and then observed the refractometer screen reader. Read the numbers on the scale and then multiplied by the dilution factor used to obtain °Brix value.

2.5. Color measurement
Color measurement was done by software Colorimeter. The tomato paste was inserted into a transparent container measured by the camera within 15 cm in size 2.5x5 room with 18-Watt LED lights with a distance of 2.5 m making the point made at the same point.

2.6. Yields
Measurements yield was performed by comparing the amount of end products with the initial product.

2.7. Texture analysis measurements
Tomato paste texture profile analysis was conducted by using the Compression test method, following the test conditions of Texture Analyzer profile, Target: 10 mm, Data Rate: 4, Probe: TA15 / 1000, and Fixture: TA-BT-KI.
3. Results and Discussion

3.1. Color analysis
Color is very important parameter in food products. There are a variety of color measurement systems such as RGB color system, Hunter Lab, CIE XYZ, CIE L*a*b*, CIE LCH, and etc. In tomato derived products, color is crucial because the tomato red color pigment (lycopene) can be degraded by a heat-induced process or by non-enzymatic changes [8, 9]. Parameter L* indicates the brightness of tomato-based products. During fruit ripening, the value of L decreases which means that the colors turn darker. The study showed that the addition of banana flour at the highest concentration increases the lightness value of tomato paste. The lightness of tomato paste with the addition of banana flour at various concentrations was between 21.63-34.87 (Figure 1). Chroma showed the brightness value of a product as bright or toned down. The results showed that the addition of up to 3% banana flour can decrease the brightness value of tomato paste. While the addition of 4% banana flour in tomato paste developed chroma value which almost equal to that of treatment without banana flour addition (Figure 2).

![Figure 1. Tomato paste lightness value](image1.png)

![Figure 2. Tomato paste chroma value](image2.png)

Hue angle (h) shows the angle of a color value from redness. The results showed that the color of tomato paste was likely near the redness line with a value of 1.2°-5.7° (Figure 3). The highest Hue value was produced from tomato paste with the addition of 3% banana flour (5.7°) which near irish coffee color, and with addition of 4% banana flour which closed to the bole brown (4.4°). This color
change might be due to a reaction which changed the color of glucose in the banana flour as influenced by the heating process. The \( a^*/b^* \) ratio may indicate an increase in the amount of lycopene from tomato [10]. Previous studies showed that blanched tomatoes for 4 minutes have a higher lycopene content than those blanched for 0.5 minutes. In this study, the \( a^*/b^* \) ratio from all treatments was between 1.5 to 1.75 (Figure 4). Increasing the concentration of banana flour may increase the \( a^*/b^* \) ratio of tomato paste.

\[ \text{Figure 3. Tomato paste Hue value} \]

\[ \text{Figure 4. Tomato paste } *a/^*/b^* \text{ ratio} \]

3.2. Physical and chemical analysis (total solids (°Brix), pH and Yield)

The total solid values for tomato paste resulted in this study were in the range of 14.3 to 15 °Brix (Table 1). These values were still below the standard value for tomato paste. In terms of pH values, this study indicates that the addition of banana flour did not have a significant influence. The pH value of the tomato paste ranged from 3.8 to 4 (Table 1). Yield, as an important parameter in food manufacture, is needed to be improved. Similarly, in this study, the addition of banana flour was intended to enhance the yield of tomato paste. Table 1 shows that increasing the concentration of banana flour increases the yield of tomato paste. Without the addition of banana flour, the yield of tomato paste was 32.5%. The highest yield was achieved by adding 4% banana flour, with the value of 51.44%. The banana flour helps to trap water inside the tomato paste.
Table 1. Tomato paste physicochemical characteristic with different concentration of banana flour

| Banana starch addition concentration (%) | Average Total Solid (°Brix) | Average pH | Average Yield (%) |
|-------------------------------------------|----------------------------|------------|-------------------|
| 0%                                        | 15.0                       | 4.0        | 32.50             |
| 1%                                        | 15.0                       | 3.8        | 37.47             |
| 2%                                        | 14.3                       | 3.8        | 45.57             |
| 3%                                        | 14.7                       | 3.9        | 43.74             |
| 4%                                        | 15.0                       | 3.8        | 51.44             |

3.3. Texture analysis

Hardness is a parameter that is used to measure the amount required to form the deformation. Hardness can be analyzed using TPA [11]. Tomato paste hardness values were varied from 11.3 to 27.3 g. The level of hardness of tomato paste decreased with an increase in the concentration of banana flour (Table 2). However, when adding 3% of banana flour, the hardness value increased to 22.2 g. Banana flour as filler material is also functioned as a water binder, therefore lower addition of banana flour may resulted in a higher water loss, in which contributed to higher hardness values.

Adhesiveness shows the strength of a product when attached to another product. Adhesive property is an important parameter for the product as complementary materials. The adhesive force of tomato paste with the addition of banana flour was in the range of 3.8 to 5.7 g, which was well within that of the commercial tomato paste.

Table 2. Tomato paste physico-chemical characteristics with different concentration of banana flour

| Parameters                        | Banana starch concentration (%) | Commercial |
|-----------------------------------|---------------------------------|------------|
|                                   | 0%                              | 1%         | 2%         | 3%         | 4%         | 0.02-0.07  |
| Hardness (g)                      | 27.3                            | 18.9       | 19.8       | 22.2       | 11.3       | 16.4       |
| Adhesive force (g)                | 5.1                             | 5.0        | 4.6        | 5.7        | 3.8        | 4.1        |
| Resilience                        | 0.05                            | 0.02       | 0.04       | 0.07       | 0.05       | 0.07       |
| Stringiness length (mm)           | 0.75                            | 2.25       | 4.55       | 5.04       | 2.78       | 6.81       |

Resilience is the ability of a product to return to initial position after being exposed to a pressure or traction. The increase in the value of resilience is comparable to the increase in the stringiness value. Resilience shows how the power of a molecule back into the resting phase. At one point, the value of the resilience of tomato paste may decline. This study indicated that the resilience value of tomato paste ranged between 0.02-0.07 (Table 2). Tomato paste is a food product that requires a slow recovery.

Stringiness is a parameter used to measure the strength of the surface properties of the food product when exposed to traction [12]. Stringiness is also referred as stretchability. This property is essential for tomato paste, for its utilization as a filling material in food products or as a spreading ingredient in pizza. Stringiness length of tomato paste to the addition of banana flour was in the range of 0.75 to 5.04 mm. The study shows that tomato paste with the highest stringiness value was resulted from the treatment with 3% of banana flour addition. This value was still below the commercial value for tomato paste (Table 2).

4. Conclusions

The findings in this study suggest that the use of banana flour in production of tomato paste may provide an effective way to increase the yield of tomato paste. The addition of banana flour until 3% did not degrade the color quality of tomato paste. Addition of banana flour have positive effect in
maintaining a good textural quality of tomato paste. However, several improvements are still required, i.e. the stringiness value, for instance through physical modification of banana flour.

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