Effect of Mocaf and Sugar Addition on the Quality and Preference Level of Pineapple Dodol

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Abstract. Pineapple dodol is a traditional food of Subang, West Java made from glutinous rice flour as raw material. The aim of this study was to determine the effect of mocaf and sugar addition on the quality and level of preference for pineapple dodol. A completely randomized design in factorial experiment was used in this study with mocaf and sugar addition as treatments. There are three levels in the first factor (mocaf addition), i.e. 0, 50 and 100% mocaf addition. While, for the second factor (sugar addition), i.e. 50, 55, and 60% sugar addition based on pineapple puree. The physicochemical properties and preferences of panelists’ tests have been carried out on the pineapple dodol product. The result indicated that the best treatment is the pineapple dodol with 50% mocaf and 50% sugar addition. The physicochemical properties of dodol include hardness, yield, moisture content, and activity water (aw) have the following values 121.67 mm/g/sec, 40.96%, 11.21% and 0.74, respectively. The panelist preference score of taste, flavor, color, hardness, stickiness and overall liking were 5.5 (like moderately), 5.6 (like moderately), 5.3 (like moderately), 5.2 (like moderately), 5.8 (like moderately), and 5.54 (like moderately), respectively.

Keywords: mocaf, sugar, pineapple dodol

1. Introduction

Pineapple is one of the many cultivated fruit plants in Indonesia. One of the regions producing pineapple is Subang, West Java. In 2014, pineapple production in Subang reached 136,567 tons with production centers located in the sub-district Jalancauk, Ciater and Cijambe [1]. Pineapple is included as perishable food because of its high moisture content, i.e., 84% [2]. Therefore, proper post-harvest handling is necessary in order to reduce the risk of fruit being wasted due to decaying in processed food products that have high economic value. One form of post-harvest handling is processing the pineapples into dodol [3].

Dodol is a processed food made from glutinous rice flour, sugar and coconut milk which is boiled until it becomes thick, oily and non-sticky. When cooled, the paste will become solid, chewy and can be sliced. The types of dodol vary greatly depending on the ingredients and how they are made [4]. Dodol includes intermediate moisture food that has moisture content 10-40 %; aw 0.70-0.85; so that it is not effective for microbial growth, not easily damaged and resistant to storage without the use of any preservatives [5]. Good quality dodol has a good texture that is not soft, has a glossy surface, distinctive taste and not rancid. Consumers prefer dodol that has a dense texture and non-sticky [6].
Glutinous rice flour is the main raw material in the dodol production process which serves as a binding material that can increase the number of carbohydrates in fruit dodol, while sugar serves as a sweetener and to extend the shelf life of the product. Glutinous rice flour is one of the factors that influence the taste, color, texture and chemical properties of dodol [7]. Several previous studies have been carried out in order to reduce the use of glutinous rice flour that is through substitution using other types of flour. Murtiningrum and Cepeda [8] stated that substitution of tapioca flour 15% by weight of glutinous rice flour and red fruit pasta is the best formulation based on organoleptic and physicochemical properties of red fruit dodol. Meanwhile, Supiani [9] stated that Raja banana dodol made with substitute wikau maombo flour 75% and glutinous rice flour 25% had a good effect on organoleptic assessment of panelists.

However, the addition of mocaf (modified cassava flour) flour to the production of dodol has not been widely done. The selection of mocaf flour as a substitute material is based on the price of which is cheaper than glutinous rice flour and as a form of efforts to realize food security through local resource-based food diversification. The aim of this study was to determine the effect of mocaf and sugar addition on the quality and level of preference for pineapple dodol.

2. Materials and Methods

2.1. Raw materials
Pineapple dodol ingredients used in this study were pineapple puree, glutinous rice flour, sugar, mocaf, coconut milk, salt, and butter. Pineapple, glutinous rice flour, coconut milk, sugar, salt, and butter were obtained from the local market in Subang. While mocaf flour made by fermenting cassava chips for 12 hours using a starter mocaf.

2.2. Pineapple dodol preparation
Production of dodol pineapple begins with making pineapple puree. Then, pineapple puree is poured into a pan containing flour, sugar, coconut milk, and salt, and was stirred until the dough became homogenous. Dodol is cooked using medium heat (<80 °C) for 13 min. During cooking, the dough was stirred continuously in order to prevent it from burning. It is then removed from heat after the mixture began to thicken and become non-sticky. Butter is added into the cooked dough and stirred until it is smooth, before spreading it into trays. The pineapple dodol is left at room temperature for 12 h, then cut and packed using polypropylene (PP) plastic with a thickness of 0.8 mm.

2.3. Analysis of pineapple dodol
2.3.1 Hardness and yield determination
Force is required to compress food between the molars in order to attain a given deformation. The higher the number obtained, the softer is the product [10]. Hardness was determined using Universal Penetrometer (merk Humboldt, Type H 1200) and the spindle (H1270).

The yield was calculated by comparing the weight of the final results with an initial weight of the material that was used to make the dodol.

2.3.2 Moisture Content and Water Activity Determination
Moisture content was determined using the gravimetric method [11]. In this method, the samples in the coded, dry and clean crucible were heated in the oven (Memmert) at 105 °C until successive weighing. The moisture content of the samples is calculated based on the loss in weight of the samples on drying process. Water activity was determined using a meter (Smart Water Activity Meter Model no.HD-3A).

2.3.3 Best Treatment Determination (Effectiveness Index)
Best treatment was determined using Effectiveness Index [12] and were done before sensory analysis. Effectiveness index calculation procedure is to weigh the value of each variable on the relative numbers 0-1.
2.3.4 Sensory Analysis
Several samples selected based on effectiveness index were tested for sensory analysis. It was performed by 30 untrained panelists in order to evaluate taste, flavor, color, hardness, stickiness, and overall liking of dodol, using a 7-point hedonic scale (1-dislike very much, 2-dislike fairly, 3-dislike moderately, 4-neither like nor dislike, 5-like moderately, 6-like good, 7-like very good).

2.4. Experimental Design and Statistical Analysis
This study uses a completely randomized design with two factors. There are three levels in the first factor (mocaf addition), i.e. 0, 50 and 100% mocaf addition. While, for the second factor (sugar addition), i.e. 50, 55, and 60% sugar addition based on pineapple puree.

Data were analyzed and means were compared by Duncan’s multiple range test with significance determined at the 0.05 level. The data analysis was assisted by statistical software (SPSS for Windows Ver.13.0, SPSS Inc.).

3. Result and Discussion
3.1. Hardness and Yield of Pineapple Dodol
The result of the hardness analysis is shown in Fig. 1, which is the effect of mocaf treatment and sugar addition to the hardness of pineapple dodol. Mocaf addition has shown to be significantly different (p<0.05) to the hardness of pineapple dodol. On the 50% sugar addition, dodol is made with the addition of mocaf 0, 50, and 100% that results in the hardness of 27.30, 24.50, and 31.20 mm/g/sec, respectively.

![Figure 1](image)

**Figure 1.** Effect of mocaf and sugar addition to hardness of pineapple dodol

Dodol made from 100% mocaf has a higher hardness value than dodol made without the addition of mocaf (dodol made from 100% glutinous rice flour). High hardness value indicates soft texture of the pineapple dodol. Hence, pineapple dodol made from 100% mocaf has a softer texture than dodol made from 100% glutinous rice flour. This occurs due to the influence of the ratio of amylose and amylpectin in the starch. A higher amylpectin ratio will cause a harder texture in the resulting product. Glutinous rice flour contains higher amylpectin than amylose, which is about 98% of the total starch [13,14]. Amylopectin in glutinous rice flour is also higher than in mocaf flour, resulting in lower hardness level than the latter.

The level of hardness dodol at different sugar addition is influenced by the type of flour used. Glutinous rice flour and mocaf have different gelatinization profile and water binding capabilities. Meanwhile, sugar also has the ability to bind water. Sugar has a high water binding capacity, where at high sugar concentrations, it can cause to bind water out of the material [15]. This affects the availability of water in dodol, hence affecting its texture. The more water that is bound, the harder will be its texture. Sugar is the main ingredient of dodol which is known to be able to give effect to the texture of dodol, as well as, the taste [6,16].
Fig. 2 shows the yield of pineapple dodol which is in the range of 37.84 - 46.67%. The higher the mocaf and sugar addition increases the yield of dodol. This is directly proportional to the moisture content of dodol that is made from 100% mocaf flour and has the highest moisture content among other treatments.

![Fig. 2. Effect of mocaf and sugar added to yield of pineapple dodol](image)

### 3.2 Moisture Content and Water Activity (aw)

Fig. 3 shows that sugar addition was not significantly different (p>0.05) on moisture content of pineapple dodol, whereas mocaf addition was significantly different (p<0.05) on moisture content of pineapple dodol. Pineapple dodol made from 50% sugar and 0% mocaf addition has the lowest moisture content than other treatments.

![Fig. 3. Effect of mocaf and sugar addition to moisture content of pineapple dodol](image)

The treatment of mocaf addition affects the moisture content of pineapple dodol. Pineapple dodol made from mocaf has a moisture content greater than dodol that is made from 100% glutinous rice flour. The concoction of pineapple dodol was controlled at the same time. At the same cooking time, dodol made from glutinous rice flour and mocaf flour have different moisture content. This is due to both flour has a different gelatinization profile. Gelatinization profile of glutinous rice flour at a peak time, peak temperature and peak viscosity are 5.87 minutes, 67.47 °C, 3996.25 mPas, respectively. While gelatinization profile of mocaf at a peak time, peak temperature, peak viscosity is 7.74 minutes, 90.6 °C, 5384.00 mPas, respectively [13]. From this profile, gelatinization can be seen that at the same cooking time, dodol made from mocaf has a moisture content greater than dodol made from glutinous rice flour due to peak temperature glutinous rice flour is lower than mocaf flour.

Fig. 4 shows that mocaf addition was significantly different (p<0.05) on water activity (aw) of pineapple dodol. The higher addition of mocaf flour will increase water activity of dodol. Pineapple dodol that made from 0, 50 and 100% mocaf addition have aw 0.73; 0.74; and 0.75, respectively. Water activity (aw) value is directly proportional to the moisture content of dodol. The water content in
food ingredients will affect the resistance to microbial attack, expressed as \( a_w \), i.e., the amount of free water that can be used by microorganisms for growth. Various types of microorganisms have a minimum \( a_w \) in order to grow properly, e.g., minimum \( a_w \) bacteria, yeasts and fungi are 0.90: 0.80-0.90; 0.60-0.70 [17]. The result of \( a_w \) in this study ranged between 0.71-0.78. \( a_w \) in this range of the possible types of microorganisms that can grow are fungi and yeast. Treatment of sugar addition affects the shelf life of the product. High sugar concentration can inhibit the growth of microbial spoilage. Sugar that is added to the food would bind with the water contained in the material so that the value of water activity is lower [18].

![Figure 4. Effect of mocaf and sugar addition to water activity (\( a_w \)) of pineapple dodol](image)

### 3.3 Best Treatment Selection (Effectiveness index)

From all treatments, four of the best treatment were selected for using effectiveness index. Parameter assessment was moisture content, \( a_w \), hardness, and the yield of each treatment. Four best treatments from de Garmo analysis, e.g 0% mocaf addition and 60% sugar; 50% mocaf addition and 55% sugar; 50% mocaf addition and 50% sugar; and 100% mocaf addition and 60% sugar with effectiveness index 0.32; 0.32; 0.31 and 0.29, respectively.

### 3.4 Sensory Evaluation

Sensory test (organoleptic) was conducted to determine consumer acceptance of a product. According to Soekarto [19], physical, chemical, and nutritional testing can show a high-quality food product, but that does not mean the product cannot be consumed because it is not tasty or not acceptable organoleptically. Sensory data for pineapple dodol were presented in Table 1. Six characteristics of dodol (taste, color, flavor, hardness, stickiness and overall liking) were analyzed for acceptability.

| Treatments | Parameter | Taste | Color | Flavor | Hardness | Stickiness | Overall |
|------------|-----------|-------|-------|--------|----------|------------|---------|
| 0% mocaf:60% sugar | 5.3<sup>a</sup> | 5.00<sup>b</sup> | 4.77<sup>a</sup> | 4.63<sup>a</sup> | 4.40<sup>a</sup> | 4.93<sup>b</sup> |
| 50% mocaf:55% sugar | 4.73<sup>a</sup> | 4.77<sup>a</sup> | 4.77<sup>a</sup> | 5.10<sup>a</sup> | 4.83<sup>a</sup> | 5.04<sup>b</sup> |
| 50% mocaf:50% sugar | 5.50<sup>b</sup> | 5.60<sup>b</sup> | 5.30<sup>a</sup> | 5.20<sup>a</sup> | 5.80<sup>b</sup> | 5.54<sup>c</sup> |
| 100% mocaf:60% sugar | 5.53<sup>b</sup> | 5.43<sup>b</sup> | 5.20<sup>a</sup> | 4.80<sup>a</sup> | 4.77<sup>a</sup> | 5.29<sup>b</sup> |

Taste is a very important attribute in determining the consumer decides to accept or reject a food product. The acceptance of taste ranged from 4.73 to 5.53 (Table 1), which means the preference level is neither like nor dislike to like moderately. Statistical analysis showed that the preference level for the taste of dodol made with 50% mocaf addition and 55% sugar was significantly different (p<0.05) from the other treatments. Table 1 shows that the panelists like dodol made of mocaf flour and 60% sugar with the highest score are 5.53, which means that the panelists like dodol with a sweet taste.

According to Fennema [20], color is the most important quality attributes. The acceptance of color ranged from 4.77 to 5.60 (Table 1), which means the preference level is neither like nor dislike to like moderately. Statistical analysis showed that the preference level for color of dodol made with 50%
mocaf addition and 50% sugar was significantly different from the preference level for color of dodol made 50% mocaf addition and 55% sugar (p<0.05). High sugar addition can also cause the color difference in dodol. In production of dodol, there is a heating process that can cause the caramelization process in the sugar, which can affect the color of dodol. Based on color acceptance, it is known that color preferred by panelist is pineapple dodol made from 50% mocaf and 50% sugar.

Flavor is a subjective sensation produced by the olfactory (smelling). In the food industry, testing of the flavor is considered important as it can quickly provide an assessment of product acceptance [19]. Panelists’ preference on flavor were ranged between 4.77 to 5.30, which means that the level of preference is neither like nor dislike to like moderately. Statistical analysis of the four treatments showed that the level of preference for the flavor was not significantly different (p>0.05). Table 1 shows that the dodol made from 50% mocaf addition with 50% sugar has the highest preference level for flavor parameter, with a score of 5.30. The flavor of pineapple dodol has a distinctive smell that comes from its main ingredient, which is the ripe pineapple. At the time of fruit, ripening occurs, there is a decreased level of phenolic compounds that lead to reduced astringent taste due to decreased in organic acids and higher volatile substances affecting the typical taste and flavor of the fruit [21]. In the ripening fruit process, starch hydrolysis and increasing of sugar occur. Panelists tend to prefer the refreshing taste and flavor of pineapple.

Hardness and stickiness are the two parameters used in testing the sensory properties by using the senses of touch that are expressed in either hard or soft and sticky. The mean score for hardness varied from 4.63 to 5.20 (Table 1). It means the level of preference for pineapple dodol is neither like nor dislike to like moderately. Statistical analysis showed that the preference level for hardness was not significantly different (p>0.05). The result shows that the maximum value corresponded to the sample prepared with 50% mocaf and 50% sugar addition which has a score of 5.20. The texture is acceptable when the product is under normal condition and depending on the specific ingredient [22]. The acceptance of dodol stickiness ranged between 4.40-5.80 (Table 1), which means the level of preference neither like nor dislike to like moderately. Statistical analysis showed that the level of preference for dodol stickiness that made from 50% mocaf addition with 50% sugar was significantly different from the other treatment (p<0.05). It is due to the low concentration of sugar that produces dodol which is not sticky. Panelists prefer pineapple dodol with low stickiness as it is more convenient to hold by hand without the packaging.

Testing the overall quality of all factors which include taste, color, flavor, hardness, and stickiness, aims to determine the level of acceptance of a product. The mean score for overall acceptability is from 4.93 to 5.54 (Table 1). It means the preference level is neutral to like slightly. Statistical analysis showed that the level of preference for overall acceptability of dodol made from 0% mocaf:60% sugar was significantly different with 50% mocaf:50% sugar (p<0.05). The maximum and the minimum value corresponded to the samples of dodol prepared by adding 50 % mocaf:50% sugar and 0% mocaf: 60% sugar is 5.54 and 4.93, respectively.

4. Conclusion
Mocaf addition significantly affects the hardness, yield, moisture content and water activity (Aw) of pineapple dodol. The result indicated that the best treatment is the pineapple dodol with 50% mocaf and 50% sugar addition. The physicochemical properties of dodol include hardness, yield, moisture content, and activity water ($a_w$) have the following values 121.67 mm/g/sec, 40.96%, 11.21% and 0.74, respectively. The panelist preference score of taste, flavor, color, hardness, stickiness and overall liking were 5.50 (like moderately), 5.60 (like moderately), 5.30 (like moderately), 5.20 (like moderately), 5.80 (like moderately), and 5.54 (like moderately), respectively.

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