

Quality Assessment of Fermented Functional Foods and Their Effects on Gut Health Under Varying Fermentation Conditions

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Abstract. The aim of this work is to study the effect of yeast concentration and steaming time on the characteristics of fermented purple sweet potato (tapai). Experiment was conducted on completely randomized factorial design, with two treatments, namely yeast concentration (0.25%, 0.50%, and 0.75%) and steaming time (20 minutes, 30 minutes and 40 minutes). The measuring parameters was consisted physical properties (texture and color) and chemical properties (reducing sugar, ethanol content, total lactic acid, pH, and moisture content). The result show that yeast concentration treatment had a very significant effect on texture, total lactic acid, and pH. Steaming time had a very significant effect on texture, pH, and significantly affected the total lactic acid. In conclusions, the best treatment is obtained from the treatment of steaming time 30 minutes with 0.75 % yeast.

1. Introduction

Tapai is traditional Indonesian foods produced by fermenting carbohydrate sources using ragi as starter culture [1]. There are two types of tapai produced commercially in Indonesia, cassava tapai and glutinous rice tapai [2]. Tapai as one of the fermented foods has a distinctive taste. It has an alcoholic aroma with combination of sweet-sour-bitter taste and sometimes sparkling feel [3,4]. Sweetness, acid, and aromas that arise are the result of the breakdown of carbohydrate components into glucose, organic acids, and alcohol by the activity of yeast during fermentation. Purple sweet potato is a good source of carbohydrates for tapai [3].

Purple sweet potato is an important source of dietary fiber, minerals, vitamins, anthocyanins, and so on [5]. The purple sweet potato contains anthocyanin colour pigments. Total purple sweet potato anthocyanin content was 519 mg / 100 g fresh weight [6]. Anthocyanin from purple sweet potato has various biological activities, including as an antioxidant, anti-inflammation, anticancer, antimutagenic, and anti-hyperglycemic [7]. The purple pigment (anthocyanin) in purple sweet potato is useful as an antioxidant because it can react with free radicals in the body cells to reduce the capacity of free radicals that can cause damage in the body. Given the many benefits contained in purple sweet potato, innovation and creation are needed to process the purple sweet potato. One way to process purple sweet potato is to produce fermented purple sweet potato (tapai) [6].

Based on the above report research was conducted to study "Quality of fermented purple sweet potato (*Ipomea batatas* var. *Ayamurasaki*) (Tapai) in various yeast concentration and steaming time".

2. Material and Method

2.1. Purple sweet potato preparation

Purple sweet potato was obtained from Lawang traditional market, Malang. Purple sweet potato were sorted to choose good quality ones. Then peeled and cut (5 x 4 x 3 cm) the purple sweet potato and washed with clean water. After washing, the purple sweet potato are drained.

2.2. Fermentation tapai

100 g of purple sweet potato was steamed at 75 °C for 20 minutes, 30 minutes, and 40 minutes. Then cooled at room temperature. 0.25%, 0.50%, and 0.75% of yeast tapai was mixed purple sweet potato (w/w). Fermentation was carried out for 42 hours at room temperature (28-30 °C).

2.3. Statistical analysis

Variables observed were physical properties (texture and color) and chemical properties (reducing sugar, ethanol content, total lactic acid, pH, and moisture content). Data compiled were analyzed with analysis of variance and continued with HSD 5 % test. Those treatments are repeated three times.

3. Result and Discussion

3.1. Texture

The results of the analysis showed that a yeast concentration treatment had a very significant effect on texture and steaming time had a very significant effect on texture. Table 1, show that the longer the steaming time, the tapai texture decreases. The decreases occurred because the steaming time too long, the texture of the tapai was easily crushed, on the other hand steaming in short time would make the tapai still hard [8].

Table 1. The average texture of tapai with different treatment.

Steaming time	Texture N(m ²)	BNJ 5%
20 minutes	0,9178 c	
30 minutes	0,7689 ab	0.0669276
40 minutes	0,7667 a	
Yeast concentration	Texture (N/m ²)	BNJ 5%
0,25 %	0,8756 b	
0,50%	0,8244 b	0.0669276
0,75%	0,7533 a	

Table 1 shows that the texture of fermented purple sweet potato decreased with increasing steaming time and yeast concentration. The treatment took 20 minutes of steaming time and yeast concentration of 0.25% had the highest texture value, namely 0.967 N (m²). While the treatment of 40 minutes of steaming time and yeast concentration of 0.75% had the lowest texture value, namely 0.68 N (m²). It can be seen that the greater the yeast concentration on the tapai, the resulting decrease in the texture of the sweet potato tapai. In this case, the results of this study are in accordance with the literature which states that the amount of yeast used affects the fermentation process of the tapai, if the amount of yeast is too little it will inhibit the microorganisms that play a role in the fermentation process of tapai, while too much yeast will slow down the fermentation process of the tapai [9].

3.2. Color

The Purple sweet potato has purple flesh due to the presence of anthocyanin content. This is what causes the purple sweet potato to turn purple. Anthocyanins are natural pigments that can provide color to fruits, flowers and leaves. The results of the steaming time and yeast concentration not significant effect on color. Based on the results of the analysis of the color that there is no interaction between the two treatments of the purple sweet potato tapai color.

3.3. Reducing sugar

The results of the steaming time and yeast concentration not significant effect on reducing sugar. Based on the results of the analysis of the variety of reducing sugar levels, it shows that there is no interaction between the two treatments on the reducing sugar content of fermented purple sweet potato. The average effect of steaming time and yeast concentration on reducing sugar content of purple sweet potato tapai is presented in Table 2. Table 2 shows that the reduction sugar content of purple sweet potato tapai with the highest value is at the yeast concentration of 0.50%, namely 1.698%. While the lowest value was at the yeast concentration of 0.75% which was 1.322%.

Table 2. The average reducing sugar of tapai with different treatment.

Steaming time	Reducing sugar (%)
20 minutes	1,24
30 minutes	1,51
40 minutes	1,74
Yeast concentration	Reducing sugar (%)
0,25%	1,486
0,50%	1,698
0,75%	1,322

3.4. Ethanol content

The results of the steaming time and yeast concentration not significant effect on ethanol content. Based on the results of the analysis of the variety of ethanol levels, it shows that there is no interaction between the two treatments on the ethanol content of fermented purple sweet potato. The longer the steaming time, the ethanol content obtained tended to increase. The average effect of steaming time on ethanol content of purple sweet potato tapai is presented in Table 3. Table 3 shows that the ethanol content of purple sweet potato tapai with the highest value is at the yeast concentration of 0.25%, namely 0.172%. While the lowest value is at the yeast concentration of 0.50%, which is 0.164%.

Table 3. The average ethanol content of tapai with different treatment.

Steaming time	ethanol content (%)
20 minutes	0,176
30 minutes	0,156
40 minutes	0,17
Yeast concentration	ethanol content (%)
0,25%	0,172
0,50%	0,164
0,75%	0,166

3.5. Total lactic acid

The result show that yeast concentration treatment had a very significant effect on total lactic acid. Steaming time had a significant effect on total lactic acid. Based on the results of the analysis of the total variety of lactic acid, it showed that there was no interaction between the two treatments of purple sweet potato tapai lactic acid. Table 4 shows that the highest total value of lactic acid in the treatment of 20 minutes of steaming time and yeast concentration of 0.25% is 1.46%. While the lowest total value of lactic acid was in the 30 minutes steaming time and the yeast concentration was 0.75%, which was 0.83%.

Table 4. The average total lactic acid of tapai with different treatment.

Steaming time	Total lactic acid (%)	BNJ 5%
20 minutes	1,244 b	
30 minutes	0,967 a	
40 minutes	1,144 ab	
Yeast concentration	Total lactic acid (%)	0,2069
0,25 %	1,289 b	
0,50%	1,111 ab	
0,75%	0,956 a	

Table 4 it can be seen that the greater the concentration of tapai yeast, the total of purple sweet potato tapai lactic acid produced decreases. This is presumably because in tapai yeast there are not only sugar-decomposing and ethanol-producing microbes, but also other compound-producing microbes. The condition of the media is getting more acidic, due to the presence of *Acetobacter aceti* bacteria which is able to oxidize alcohol to acetic acid. *Pediococcus* sp bacteria in tapai yeast are able to convert glucose into lactic acid.

3.6. pH

The result show that yeast concentration treatment had a very significant effect on pH. Steaming time had a very significant effect on pH. Based on the results of the analysis of various pH values, it shows that there is no interaction between the two treatments of the pH of fermented purple sweet potato. Table 5 shows that the pH value of fermented purple sweet potato decreases on average along with the increasing duration of steaming and the concentration of yeast given.

The treatment in 30 minutes of steaming time and yeast concentration of 0.75% had the highest pH value of 4.3. While the treatment for 40 minutes of steaming time and yeast concentration of 0.25% has the lowest pH value, which is 3.96. The average effect of steaming time on the pH of purple sweet potato tapai is presented in Table 5.

Table 5 shows that a short steaming time can produce a hard-textured tapai, while the longer the steaming, the pH value of the resulting sweet potato tapai decreases. The decrease in pH is one of the results of the fermentation process that occurs due to the accumulation of lactic acid as the main product of bacterial activity.

Table 5 shows that the pH value of purple sweet potato tapai increases with the increasing duration of steaming and the concentration of yeast given. The treatment took 40 minutes of steaming time and yeast concentration of 0.25% had the lowest pH value of 3.96. While the treatment of steaming time of 30 minutes and yeast concentration of 0.75% has the highest pH value, which is 4.3.

Table 5. The average pH of tapai with different treatment.

Steaming time	pH	BNJ 5%
20 minutes	4,2 b	
30 minutes	4,178 b	
40 minutes	4,067 a	
Yeast concentration	pH	0,079
0,25 %	4,056 a	
0,50%	4,133 ab	
0,75%	4,256 c	

Fermentation is a specific microbial action activity. In the fermentation process, carbohydrates are broken down into glucose, then glucose is broken down again into alcohol, acetic acid and other organic compounds. With the higher the acid value, the pH of the tapai will decrease, but conversely the lower the acid value, the pH of the tapai will increase.

3.7. Moisture content

The results of the steaming time and yeast concentration not significant effect on moisture content. Based on the results of the analysis of the variety of water content, it shows that there is no interaction between the two treatments on the water content of fermented purple sweet potato. The average effect of steaming time on water content of purple sweet potato tapai is presented in Table 6. Table 6 shows that the water content of purple sweet potato tapai with the highest value at 40 minutes steaming is 70.97 %. Meanwhile, the lowest value at 30 minute steaming is 65.04 %.

Table 6. The average moisture content of tapai with different treatment.

Steaming time	Moisture content (%)
20 minutes	69,34
30 minutes	65,04
40 minutes	70,97
Yeast concentration	Moisture content (%)
0,25%	67,96
0,50%	70,82
0,75%	66,56

Table 6 shows that the water content of purple sweet potato tapai with the highest value is the yeast concentration of 0.50%, which is 70.82 %. While the lowest value was at the yeast concentration of 0.75% which was 66.56 %.

4. Conclusions

The result show that yeast concentration treatment had a very significant effect on texture, total lactic acid, and pH. Steaming time had a very significant effect on texture, pH, and significantly affected the total lactic acid. The best treatment is obtained from the treatment of steaming time 30 minutes with 0.75 % yeast.

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