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Effect of fermentation on physicochemical properties of fermented cassava flour

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Abstract. Cassava *(Manihot esculenta Crantz)* is the most important carbohydrate food source in third place within the tropical regions, after rice and maize. One of the derived products is fermented cassava flour which is processed using cell modification of cassava. The focus of this study was to compare the effect of fermentation using *Saccharomyces cereviseae* and *Rhizopus oryzae* in the production of fermented cassava flour. Physicochemical properties of fermented cassava flour using *Saccharomyces cereviseae* were then determined and compared with the fermented cassava flour using *Rhizopus oryzae.* The results showed that the fermented cassava flour using *Rhizopus oryzae* had yield 34.89%, moisture content 8.34%, starch content 49.11% and whiteness 82.49%. The results microstructure analyzed using Scanning Electron Microscopy showed an alteration in the starch granules of fermented cassava flour using *Saccharomyces cereviseae.* When compared to the fermented cassava flour using *Rhizopus oryzae*, it had a lower whiteness than fermented cassava flour using *Saccharomyces cereviseae*, which was 83.14%. These results indicate that fermentation on cassava within 72 hours could provide a greater extent of modification cassava flour.

1. Introduction

Fermented cassava flour is one of commodity cassava tuber which is produced using fermentation process. The most common microorganism for fermented cassava flour production is lactic acid bacteria. In the current study, the production of fermented cassava flour was done by [6] using *Lactobacillus plantarum, Saccharomyces cereviseae,* and *Rhizopus oryzae.* The results showed that protein content of fermented cassava flour was increasing.

The aim of this study was to compare the effect of fermentation using *Saccharomyces cereviseae* and *Rhizopus oryzae* in the production of fermented cassava flour. Physicochemical properties of fermented cassava flour using *Saccharomyces cereviseae* were then determined and compared with the fermented cassava flour using *Rhizopus oryzae.*

2. Method

2.1. Inoculum Preparation

Saccharomyces cereviseae and *Rhizopus oryzae* were obtained from School of Life Science and Technology (SITH), Institut Teknologi Bandung, Bandung, West Java, Indonesia. The media for inoculum contained (g/l): glucose, 50; yeast extract, 5; urea, 7.50; K_2HPO_4, 3.50; $MgSO_4.7H_2O$, 0.75; $CaCl_2.2H_2O$, 1 and 0.05 M citrate buffer (pH 5.5). 50 ml media were sterilized using autoclave at 121^0 C. Inoculum cultures were grown anaerobically in 250 ml Erlenmeyer flasks for 30 h, 30^0C, and 130 rpm. Samples from cultivation were centrifuged to get the biomass of *Saccharomyces cereviseae* and *Rhizopus oryzae.*

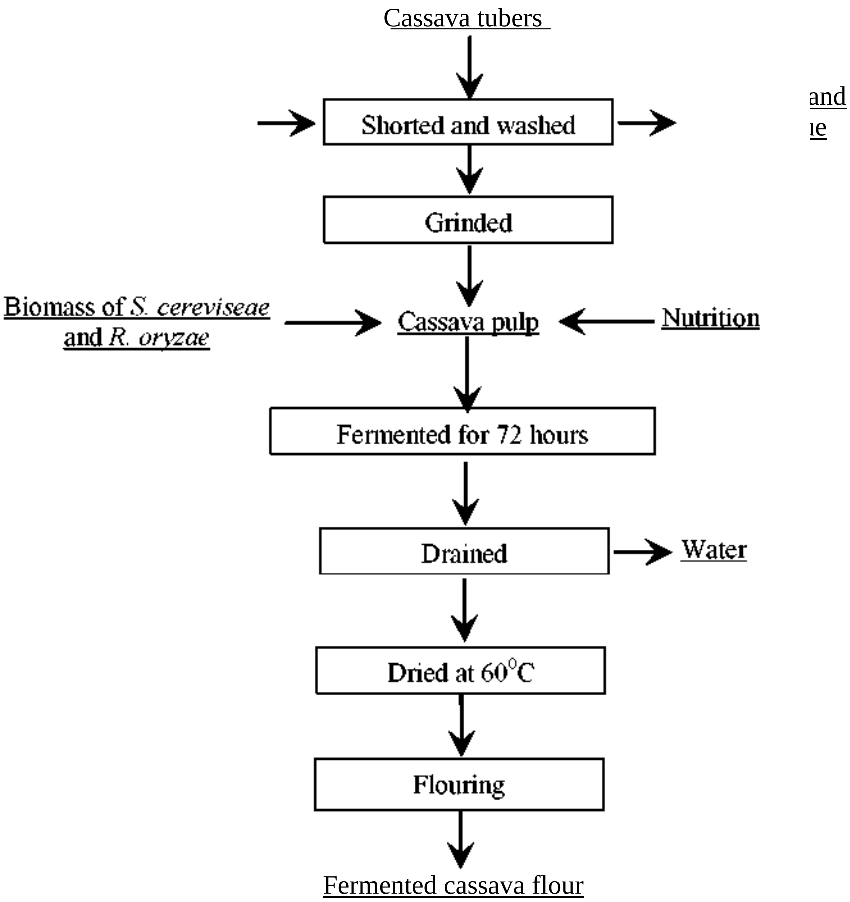

Figure 1. Flow chart of fermented cassava flour production

2.2. Cassava Fermentation

Cassava tubers were obtained from Pasar Balige, a local market at Toba Samosir Regency, Province of North Sumatera, Indonesia. The flow process of cassava fermented production can be seen in Figure 1. The cassava tubers were peeled, washed, and grinded using grinder. The cassava pulp (100 g) was put into 250 ml-fermenter. The biomass of *Saccharomyces cereviseae*, *Rhizopus oryzae* and 73 ml nutrition which contained urea (8.00 g), $MgSO_4.2H_2O$ (7.00 g), KH_2PO_4 (1.30 g) and citrate acid (2.00 g) were added into fermenter. The fermentations were conducted for 3 days (72 h), at 30°C, and the relative humidity was 90 - 93%. The fermented cassava flour was analyzed covering moisture content
[7] , starch content [7], yield [7], color using color reader [8], and microstructure using SEM (Scanning Electron Microscope) ZEISS.

3. Results and Discussion

Table 1 showed the results of fermented cassava flour using *Saccharomyces cereviseae* and *Rhizopus oryzae*. The yields of cassava flour were obtained from the mass of fermented cassava flour which was formed from the mass of processed cassava. The yields of fermented cassava flour using *Rhizopus oryzae* and *Saccharomyces cerevisiae* for 72 hours were 34.89 % and 34.77 %, respectively.

Table 1. Analysis results of fermented cassava flour

Components (%)	*R. oryzae*	*S. cerevisiae*
Yield	34.89	34.77
Moisture content	8.34	8.14
Starch content	49.11	48.83
Whiteness	82.49	83.14

The results of water content in fermented cassava flour using *Rhizopus oryzae* and *Saccharomyces cerevisiae* fermentation for 72 hours was 8.34 and 8.14, respectively. These results differ from unfermented cassava flour were reported by [9], which was 9.51%. The moisture content of fermented cassava flour is lower than unfermented cassava flour, it is caused by during fermentation process the starch is degraded and water released from the cell of cassava tubers [10].

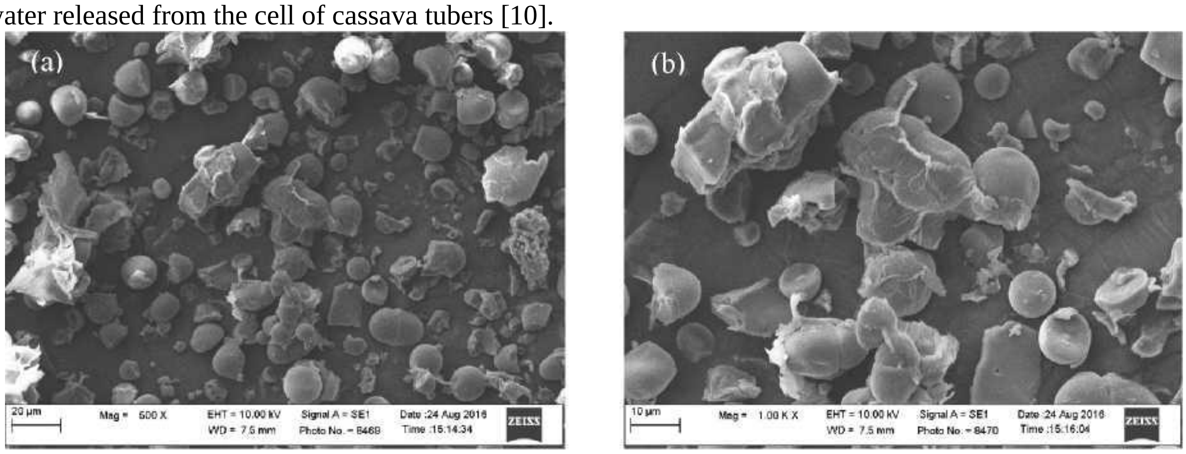

Figure 2. Microstructure of fermented cassava flour using *Rhizopus oryzae* for 72 h (a) magnification 500X; (b) magnification 1.000X

The decreasing moisture content in fermented cassava flour is necessary because it can affect the process storage of flour. Analysis results of fermented cassava flour can be seen that the moisture content have met the quality requirements of flour [11], it is 12%. On the other hand, reducing of moisture content of the flour

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is affected by the pressing process and drying [12].

[13] reported that the starch content of cassava flour was 75.09%. Starch content analysis results obtained in fermented cassava flour using *Rhizopus oryzae* and *Saccharomyces cerevisiae* were 49.11 % and 48.83, respectively. In the fermentation process, starch content of fermented cassava flour is decrease, it is caused by the microbes breaking down starch into simple sugars. Amylase activity contained in cassava is optimized to hydrolyze starch into simpler components [14].

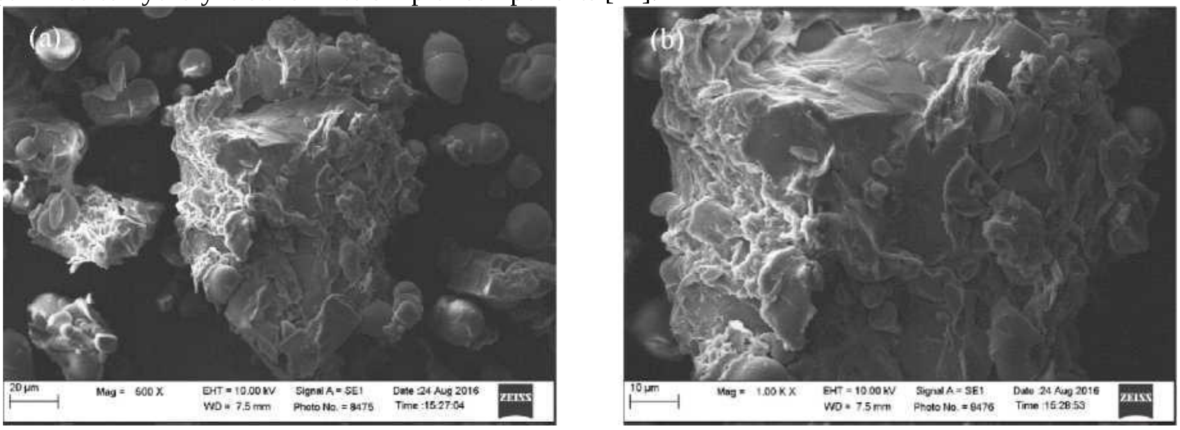

Figure 3. Microstructure of fermented cassava flour using *Saccharomyces cereviseae* for 72 h (a) magnification 500X; (b) magnification 1.000X

The color of fermented cassava flour was measured by color reader (L*, a+, b+). L value of color reader is 0 to 100, where value 0 is darkness and value 100 is brightness [15]. The whiteness of fermented cassava flour using *Rhizopus oryzae* and *Saccharomyces cerevisiae* were 82.49 % and 83.14 %, respectively. The amylose content of the food materials is affected by its amilograph properties [21] [22]. The results of microstructure using SEM can be used as information about the amilograph properties of cassava flour.

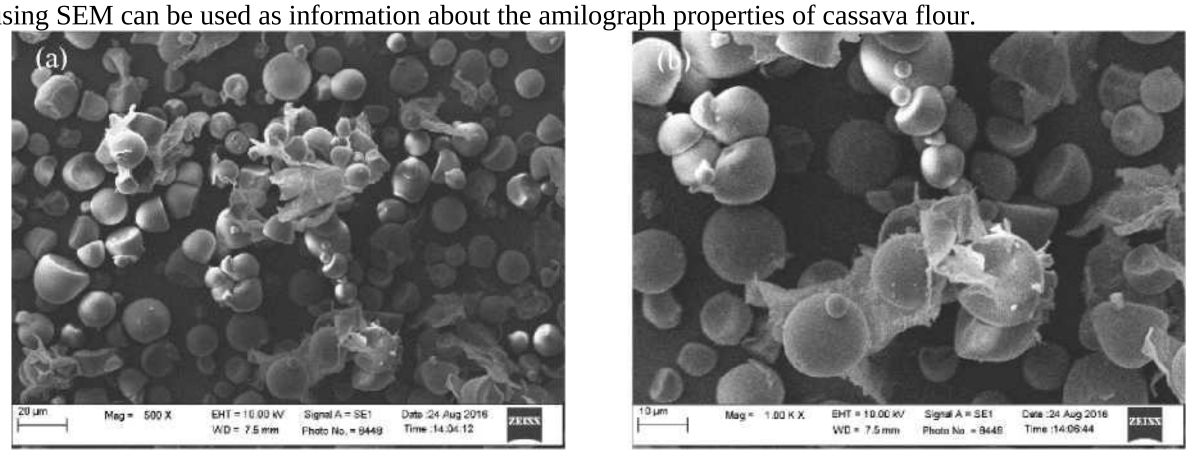

Figure 4. Microstructure of unfermented cassava flour (a) magnification 500X; (b) magnification 1.000X

The results were different than the whiteness of unfermented cassava flour, it was 93.25%. The difference of the whiteness is caused by degradation process of pigment during fermentation for 72 h and also caused by browning reaction during drying process [16] [9]. [17] and [18], reported that color is one of the most important factor making food and beverage more interesting. The main factors in food quality are color, texture, and taste [19].

Figure 2, 3 and 4 are the results of microstructure of fermented cassava flour using *Rhizopus oryzae, Saccharomyces cereviseae,* and also unfermented cassava flour, respectively. The microstructures for fermented and unfermented cassava flour are seen having the starch granules with 1000 X magnification. Micrograph of starch granules have different sizes for fermented cassava flour and unfermented. The difference is caused by fermentation process. During fermentation process, cell wall of cassava tubers is broken and the liberation of the starch granules to be very extensive. Modifications of starch can affect the functional properties of starch [20].

4. Conclusion

The fermentation using *Saccharomyces cereviseae,* and *Rhizopus oryzae* in the production of fermented cassava flour effected physicochemical properties through analysis of yield, moisture content, starch content, whiteness, and the results microstructure using SEM.

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