Physical Characteristics of Modified Cassava Flour Wastewater at Room Temperature

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Abstract. Cassava is an agricultural material that is considered as important raw resources in the industrial sector. The benefits are even greater after being modified using lactic acid bacteria. However, the mocaf industry often causes water and air pollution. Environmental problems arise after the fermentation process. Determination problems with lightness, TDS (Total Dissolved Solid), conductivity and pH analysis are required to measure the impact to the environment. This research was used waste water from mocaf during 3 days fermentation. The wastewater had the highest color level (Lightness) on initial day of fermentation at 83.7±3.73 and then decrease along the day of fermentation at the averages of 65.2±2.0. The highest TDS was resulted from the mocaf wastewater at a value of 1218 ± 4.6 ppm which continued to decline until day 4. The conductivity and pH showed a decrease along the day of fermentation. As conclusion, physical characteristic of wastewater from mocaf production could be analyzed specifically and determined through color, TDS, conductivity, and pH.

Keywords: modified cassava flour, wastewater, physical characteristics, environment

1. Introduction

Cassava (Manihot esculenta Crantz) is the most important source of calories and one of the main plants in the tropics, after rice and corn. Millions of people in Africa, Asia, and Latin America depend on cassava production. Cassava sequences are among the plants in the world that are utilized for starch production [1]. The benefits of cassava are greater after being made modified cassava flour (mocaf) as substitution of wheat using fermented cell technology with the help of lactic acid bacteria [2, 3]. These modifications produce pectinolitic and cellulolytic enzymes that hydrolyze into organic acids, such as lactic acid [2]. The mocaf industry often causes environmental, liquid and gas pollution. After the fermentation process ends, an unpleasant odor accumulates which announces that in wastewater is rich in nutrients for the growth of microorganisms [4]. This nutrients may also contribute to high pollutants in the aquatic environment [5]. The basic indicator of polluted water may be also measured using a change in color, pH, dissolved solids, and odors [6].

Based on color appearance, mocaf wastewater is white to yellowish. The fermentation process dissolves the color-forming component so that the immersion water becomes white to yellowish [3, 7].
If the colored wastewater released directly into the body of water, the potential damage to the clarity and purity of water. During the fermentation process, proteolytic, and cellulolytic enzymes produced by lactic acid bacteria destroys the walls of cassava cells causing starch particles to be free and dissolve in water [2]. Monitoring of solids dissolved in water is very necessary because the higher the concentration, the worse in the quality. In addition, the acidity or alkalinity of the sample represents the concentration of hydrogen ions in the solution. Decrease in pH is caused by lactic acid bacteria which produces various organic acids, especially lactic acid [8]. Furthermore, many chemical reactions are controlled by a very narrow of pH values between 6-8 [9].

This study aims to study the physical characteristics of mocaf wastewater by analyzing the lightness, total dissolve solid (TDS), conductivity, alkalinity that were occurred due to the influence of storage at room temperature.

2. Materials and Method

2.1 Materials
Mocaf wastewater material was obtained from the manufacturing process using cassava as raw material that were purchased from the local market in Tembalang, Semarang. The process for fermentation using the maximum of seven days of treatment at room temperature (±25°C).

2.2. Mocaf wastewater production
Fresh cassava was cleaned from soil and dirt by washing using pure water. A cassava of about 1.5-2 kg were used to produce small cut of peeled-cassava. Soaking in water to maintain the color appearance of cassava for 3 days with a ratio of water : cassava was 2 : 1. Wastewater were stored in a breaker glass as much as 200 mL for 5 days to determine color, pH, conductivity, and TDS that was carried out on each day [2].

2.3. Determination of Color
Color analysis were carried out by Digital Color Meter Mobile Software for iOS using mini studio which was illuminated with LED at 2 pcs of 50 lumen for each pieces. Instrument was calibrated on the CIE LAB color space system using white tiles (Dc: L = 97.79, a = −0.11, b = 2.69). The L* value represents light and the values a* and b* represent redness and yellowness, respectively. Measurement of color of wastewater was recorded for each days [10].

2.4. Determination of pH, conductivity, and TDS
EZDO 8200 was set in the mode of each analysis alternately pH, conductivity, and TDS. Calibration were carried out before the work begins. While the standard solution of TDS and conductivity is a standard solution with a concentration of 1218 ppm. After calibration, the electrodes were dipped into the mocaf wastewater in the breaker glass. Each test was repeated 3 times then was calculated the average±SD [10]. The pH scale has a range of 0-14, with a value of 7 as a neutral pH, under 7 solutions it is called an acid while above 7 a solution is called a base.

2.5. Data analysis
Data collection of lightness analysis, conductivity, total dissolve solid, and pH were processed using MS Excel and analyzed descriptively.

3. Results and discussion
3.1. The Color of Mocaf Wastewater
Mocaf wastewater was detected as clear at initial preservation, however it turned into white and nontransparent color. After fermentation, mocaf wastewater had a lightness level as 83.7±3.73 (Figure 1). The clear color changed cloudy white because of the process of cell breakdown by lactic acid bacteria, so starch particles was decomposed and dissolved with ease [2]. In general, dissolved starch particles would quickly stable up to third day of storage. The other possibility may also from the
immersed $\text{H}_2\text{O}_2$ from cassava root in water [11] and from hetero-lactic bacteria [12]. The lightness of wastewater showed a trend line of reduction with an average value of 65.2±2.0.

![Figure 1](image1.png)
![Figure 2](image2.png)
![Figure 3](image3.png)
![Figure 4](image4.png)

**3.2 Total Dissolve Solid (TDS)**

TDS is the amount of dissolved solids of size $\leq 1$ μm. The high value of TDS indicates the amount of waste organic matter [6]. The highest TDS in mocaf wastewater was 1218±4.6 ppm that were found in waste day 0. The decline was found until day 4 with the initial values of 1053.5±11.5 to 928.7±0.6 ppm (Fig. 2). The highest TDS in mocaf wastewater was found on the first day right at the initial fermentation process of the cassava [13]. The decrease in TDS content was caused by dissolved particles that was converted into gas due to biodegradation process by microorganisms. The particles were dissolved in wastewater through the metanogenic phase resulted in the conversion into gas form [14].

**3.3 Conductivity**

Figure 3 shows the reduction in the conductivity that was similar trend line as TDS with the highest value in the 0 day, starting from 1850±6.50 $\mu$S/cm to 1469±1.0 $\mu$S/cm. The conductivity parameter is a general indicator of water quality especially to determine the amount of dissolved salt and the phenomenon that may be occurred in wastewater treatment [15]. Variation in conductivity values in mocaf wastewater can be appeared due to variations in ion content for example $\text{H}^+$, $\text{OH}^-$, and other compound such as phosphate and nitrate. This decrease in conductivity may due to the end of bacterial
fermentation of cassava chips resulting in no increase in minerals. Therefore, the solids were deposited and degraded by the remaining microorganisms [16].

3.4. Alkalinity (pH)
The alkalinity of mocaf wastewater in Figure 4 shows the rate of decline after the highest value on day 0 was achieved at 4.23±0.02. The reduction was occurred to 4 days of treatment. Low acidity may be appeared due to bacterial activity in the fermentation process [17]. The activity may reduce pH value because of the production in organic acids [18]. After the chips were taken from the soaking water, the pH dropped dramatically and continued to decline until day 4. The possible appeared bacteria in wastewater may be acidophilus since this bacteria may still live in very low pH of 2.0 [19].

4. Conclusion
Mocaf wastewater showed similar appearance of the reduction in lightness, TDS, conductivity, and pH values. However the typical reduction was specifically determined.

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