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DEPARTEMENT OF AGRICULTURAL ENGINEERING
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THE QUALITY OF FERMENTED CACAO BEANS IN SMALL-SCALE

Dwi Dian Novita[1], Cicih Sugianti[1], Kartinia Sari[1]

[1]Department of Agricultural Engineering, University of Lampung, Jl. Soemantri Brojonegoro No. 1 Gedong Meneng Bandar Lampung, Lampung, Indonesia

Email: dwi.diannovita@fp.unila.ac.id

ABSTRACT

Farmers are rarely to conduct the fermentation process of cacao beans due to it requires a long time and should be done in a large scale. Indeed, they are not consider an uniform of maturity level during cacao beans are harvested. This research has purpose to determine the minimum mass of cacao bean in small scale and the effect of maturity level on fermentation product.

The main materials and equipments used cacao which was Lindak from Gedong Tataan Districts and small fermentation boxes (26 x 20 x 45 cm). This research conducted by using factorial RAL. The first factor was maturity levels (A, B, and C) and the second factor was mass cacao beans (10, 15, and 20 kg) that used three repetitions. The measured of parameter involved temperature, pH (acidity level), cut-test, and fat content. The data were analysed by using ANOVA and LSD for futher testing.

The result of ANOVA indicated that only mass factor had significant on temperature during fermentation process, total full fermented beans, and fat content of cacao beans. As a result, the mass recomendation of cacao beans for small-scale in fermentation process is 20 kg.

Key words : cacao beans, mass, maturity level, small-scale fermentation

I. INTRODUCTION

Kakao is one of the best product of Indonesian plantation. In 2010, the production of cacao in Indonesia reached the third position in worldwide after Pantai Gading and Ghana (Karmawati *et.al.*, 2010). In 2014, Indonesian cacao productions experienced about 709.331 ton with the plantation areas were approximately 1.719.087 ha and the biggest portion at 95% was community plantation (Dirjen Perkebunan, 2014). Therefore, this condition creates cacao being the important product in economic development of farmers in Indonesia.

According to SNI 2323-2008, the good quality of cacao comes from Mulia cacao or Lindak cacao which has been fermented, with or without washed, dryed, and cleaned (BSN, 2008). Indeed, the fermentation is one of an essential process in postharvest handling of cacao. This step has aims to inactive of seed so the changes happened inside of seed can be done easily such as, the colour changes, the improvement of flavour, and odour also.

Most of farmers dry process of cacao seeds use the poor equipment and simple process, so there is 90% of the bad cacao beans which are produced by farmers. The main characteristics do not passing fermented process, are less dried, are attacked by fungus, and had a contaminant. Besides lack of facilites and skill for handling, the farmers are not interest to apply the standard of process due to the minimum of cost incentive. In other words, there is no differences of the price between a good and bad cacao processed by passing handling methods.

To improve the quality of cacao bean produced by the farmer, it needs government's contribution to provide a box for fermentation. In contrast, those support is not the effective way because the majority farmers rarely conduct the fermentation. They consider that the fermentation should be done in a large scale. The average capacity of cacao which wants to be added to fermentation in the boxes has at around 40-50 kg for each process, while many farmers processing the cacao bean are less than that capacity. From those reason, the research about the quality of fermented cacao bean in small scale is needed to conduct. This research has purpose to determine the minimum mass of cacao bean in small scale and the effect of maturity level on fermentation product.

II. MATERIALS AND METHODS

This research was conducted from April to October 2016 in Bioprocess Engineering and Post-Harvest Handling Laboratory, Department of Agricultural Engineering. The instruments used include small fermentation boxes 26 x 20 x 45 cm (Fig. 1), analytical balance, magnetic stire, desicator, pH scale, blender, oven, measuring cylinder, and

volumetric flask. While the object of this research used cacao beans with different maturity levels (Fig. 2), aquades, and petrolium benzen.

Fig. 1. A small fermentation box (26 x 20 x 45 cm)

(a) (b) (c)

Fig. 2. Maturity levels of cacao; (a) Yellow color covers at all of the skin, (b) Yellow color appears only on the grove and backs' fruit, and (c) Yellow color appears only on the grove.

A. Design Experiment

This experiment conducted with Completely Randomized Design of Factorial. The first factor was maturity levels A, B, and C and the second factor was the mass of fermentation (10, 15, and 20 kg) used three times for each experiment. The data were analysed by ANOVA and LSD for futher testing using SAS software.

B. Measurement Data

1. Temperature

The temperature measurement used the thermometer that located in stack of cacao beans during fermentation process in 3 different spots such as one in the upper, three spots in the central, and three spots in lower part of stuck cacao beans.

2. pH (Acidity Level)

The pH level determines the acidity level of cacao beans. In this case, the highest of pH level indicates a low acid content. The method for measuring pH started from crushing of cacao beans to putting 1 gram which was dissolved by 5 ml aquades for 3 minutes. In addition, The pH level was measured by the pH meter calibrated by standard buffer.

3. Cut Test

This testing was done by observing the colour changes visually and subjectively. There were 50 cacao beans cutted longitudinal in the exact center of beans with same shapes. The other 100 cut-beans ware observed one by one and it depend on its colours. In this research, The cacao beans has been divided into 3 levels such as the slaty colour classified as the unfermented levels, the beans have the purple dominant color classified as the underfermented level, and the brown color became the primer color classified as the fermented level. A percentage of those classification calculated by using this formulas:

$$\% \text{ unfermented beans} = \sum \frac{\text{total of slatty color beans}}{\text{total of cacao beans}} \text{ x } 100\% \quad (1)$$

$$\% \text{ underfermented beans} = \sum \frac{\text{total of purple colour beans}}{\text{total of cacao beans}} \text{ x } 100\% \quad (2)$$

$$\% \text{ fermented beans} = \sum \frac{\text{total of brown colour beans}}{\text{total of cacao beans}} \text{x } 100\% \quad (3)$$

4. Fat Content

The measurement of fat content conducted in State Polytechnic of Lampung. A procedure to determine of fat content started from crushing of 2 gram that wrapped in filtering paper before entering in soxhlet extraction cylinder to an extraction's process which requires for 4-5 hours use Petrolium Benzen to solve about 75-100 ml. The next process was the drying process that adoptes the temperature at approximately 100–105°C for 30 minutes. This process produced a recidue that measured as solid fat content. Fat content pointed in the percentage as follows:

$$\% \text{ Fat content} = \frac{(B-C)}{(A)} \text{ x } 100\% \quad (4)$$

Note : A = sample weight
B = cup + fat content
C = empty cup

III. RESULTS AND DISCUSSION

A. Temperature

The average temperature of cocoa beans in the box increased to 40.7 °C on the 4th day. This indicates the activity of microorganisms that generate heat energy during the fermentation process. Yusianto *et.al.* (2008) stated that fermentation can occur in small boxes with a temperature distribution of 40-45ºC although the number of wet beans fermented only 20 kg. The temperature change during fermentation at each treatment is shown in Fig. 3.

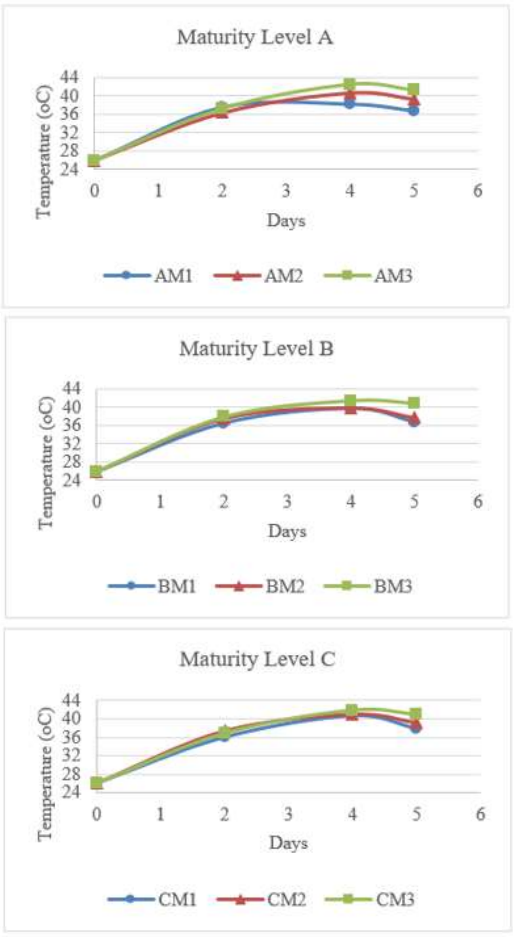

Fig. 3. The temperature change during fermentation at each treatment

Based on ANOVA result known that cocoa bean mass factor have an effect on fermentation temperature while fruit level maturity factor and interaction of both factors have no effect. LSD test results showed that the mass of 20 kg of cocoa beans gave a significantly different effect (Table 1).

B. pH (Acidity Level)

The average pH of cocoa beans increased for 5 days of fermentation. The average initial pH of 4.85 then to 5.47 at the end of fermentation. The increased pH value means a decrease in the acidity of the cocoa beans. This is similar to Pato *et.al.* (2003) that cocoa pH increased from 4.8 to 5.6 for 5 days of fermentation. Marwati *et.al.* (2013) also showed that changes in the pH of cocoa beans during fermentation ranged from 4.31 to 6.61. The pH change during fermentation at each treatment is shown in Fig. 4.

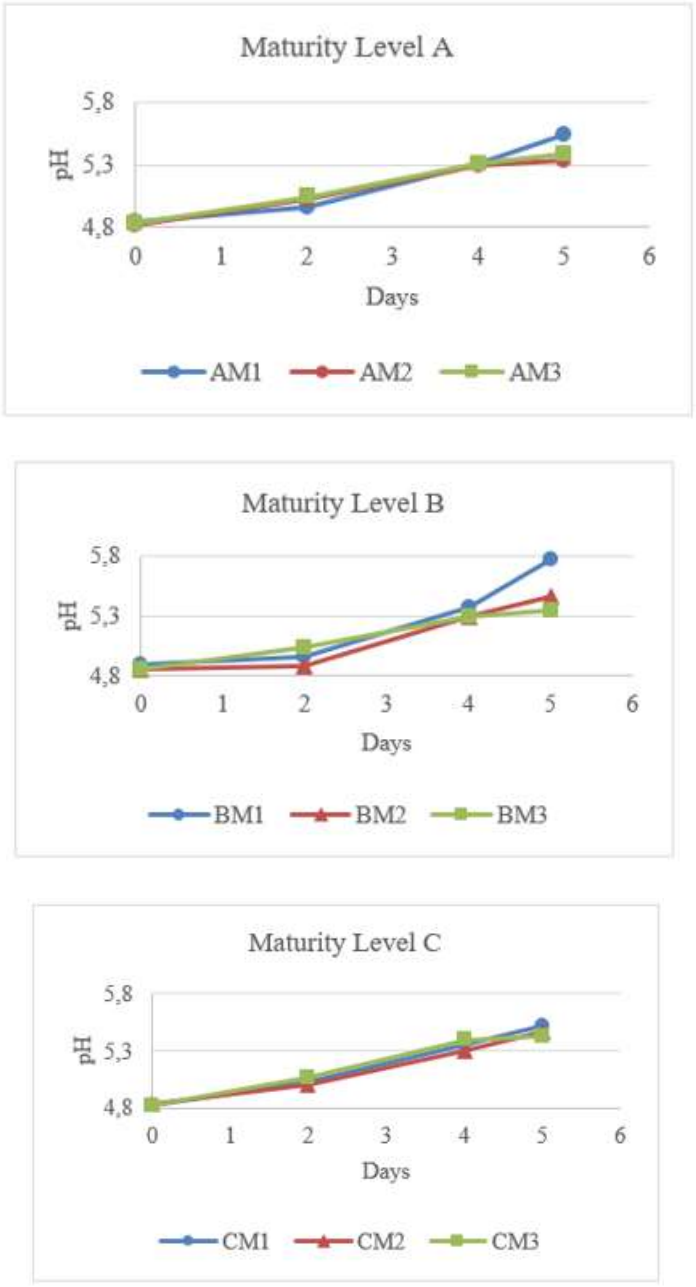

Fig. 4. The pH change during fermentation at each treatment

C. Cut Test

The cut test is performed to assess the success of the cocoa bean fermentation process based on the color of the seed pieces. Full fermented cocoa beans are brown and porous according to SNI 2323-2008 (BSN, 2008). Based on the ANOVA result, it is known that only the cocoa bean mass factor has an effect on the total fermented cocoa beans. The LSD test results show that the effect of mass 15 and 20 kg of cocoa beans is not significantly different with total fermented beans 69.51% - 70.12% (Fig. 5).

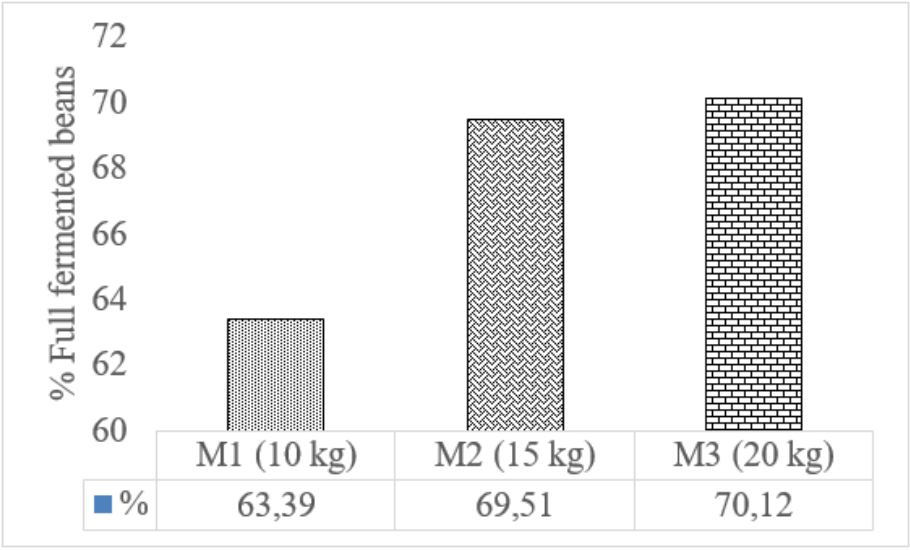

Fig. 5. Total full fermented beans

D. Fat Content

Fat is the most expensive component of cocoa beans. The average fat content of fresh cocoa beans was 1.23%, 2.35%, and 2.73% for the maturity levels C, B, and A. This value increased to 41.75% - 48.55% after fermentation. Based on the ANOVA results it is known that only the cocoa bean mass factor has an effect on the fat content. LSD test results showed that the mass of 20 kg of cocoa beans gave a significantly different effect (Fig. 6). Several previous research results show fermented cocoa fat content of 32.60% - 50.99% (Marwati *et.al.*, 2013) and by 47.8% - 49.5% (Widayat, 2015).

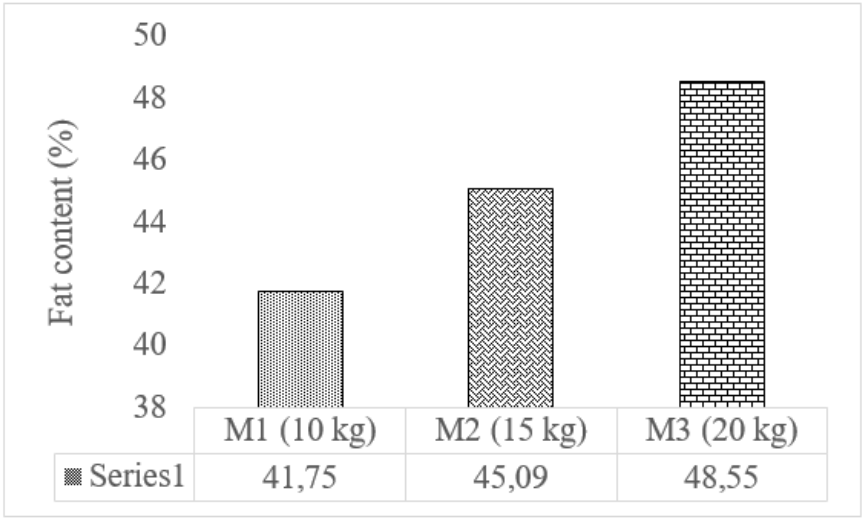

Fig. 6. Fat content of fermented beans

Table 1. The result of LSD test on mass variations

Cacoa Mass	Parameters		
	Temperature (°C)	Cut Test (% Full Fermented)	Fat Content (%)
M1 (10 kg)	39,52 b	63,39 b	41,75 b
M2 (15 kg)	40,52 b	69,51 a	45,09 b
M3 (20 kg)	41,92 a	70,12 a	48,55 a

IV. CONCLUSION

The result of ANOVA indicated that only mass factor had significant on temperature during fermentation, total full fermented beans, and fat content of cacao beans. As a result, the mass recomendation of cacao beans for small-scale in fermentation process is 20 kg.

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