Effect of fermentation container and thickness of bean mass during fermentation process of cocoa bean (*Theobroma cocoa* L*)*

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Abstract. Fermentation is used mainly to free the beans from the pulp, preventing growth, improving appearance, and facilitating subsequent process. Nowadays, fermentation becomes one of the important steps for better quality and taste of chocolatte. Fermentation methods may vary from country to country. Indonesian farmers mostly use wooden container instead of stacking the beans on the ground. Due to the simplycity and practical important to the farmers in improving quality of cocoa beans, available containers which are easy to be found around the village is used. The containers choosen in this reasearch are wooden box, rattan bucket and plastic bucket. The percentage of fermented beans and their mass temperatures are affected by the thickness of bean mass. Therefore, it is necessary for adjusting the thickness of beans which are placed in different containers and different size. The aim of this research is to improve the quality of fermented cocoa beans by selecting appropriate type of fermenting containers, size, and their optimal thickness of the bean mass. The variable of these research are containers (wooden box, palstic bucket, and rattan bucket) and bean mass depth (30, 40 cm). During fermentation, changes in temperature, pH, and sugar content were recorded within 12 hours interval time. Analysis of dried fermented beans included water content, fat content, pH, cut test, and free fatty acids. Results shows that bean mass temperature highly increased up to the third day and slowly decreased on the fourth and the fifth day. The highest temperature was 43.4^{o}C occurred in beans placed in rattan bucket at thickness of 40 cm. Unlike pH, during fermentation, the pH becomes extremely acidic occurred from intial day (5.45-5.85) to the third day (3.05-3.25), but on the fifth day the trend of pH value is increased. Sugar content shows that the initial sugar content average was 9.5% and then decreased to 3.4% on the first day. On the second day, the amount of sugar was below 2% and decreased to 0.3% on the fifth day. Among different containers wooden box shows highest fermented beans compared to other containers.

Key words: Fermentation, Cocoa bean, quality, containers, wooden box, rattan bucket

Introduction

Fermentation used to pulp freed from bean, appearance increased, killed bean and easy handled for the next processing. Nowadays, fermentation is a must process conducted, would to ensure the qualified bean and has flavor and chocolates characteristic taste (Minifie 1999)

The correct fermentation and drying of cacao are a vital importance as no subsequent processing of the bean will correct bad practice at this stage. A good flavor in the final cocoa or chocolate is related closely to good fermentation. Fermentation methods may vary from country to country. In Africa most farmer did fermentation by heap the beans are formed into a flat cone on banana leaves, which are also use to cover the heap. Indonesian farmers mostly use wooden container instead of stacking the beans on the ground. Due to the simplycity and practical important to the farmers in improving quality of cocoa beans, available containers which are easy to be found around the village is used.

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Material and Methods

Bean and container preparation

Mature cocoa fruit, was identified by green yellowish skin, dull edge, was harvesting, then was shortaged to have qualified fruit. Spoiled and unripe fruit was removed. The shortaged fruit was laid under the tree to avoid direct sun light. Fruit fermentation was held for 5 to 6 day to get the uniform mature bean. After fruit fermentation completed, pod was broken by hit each other or throw down forcefully. Bean was come out from the pod and fill into

fermentation container. Container used are wooden box (size; length 40 cm, wide 40 cm and depth 60 cm), plastic bucket (size; upper diameter 35 cm, lower diameter 30 cm and depth 40 cm), and rattan bucket (size; length 53 cm, wide 40 cm and depth 40 cm). woodden box and plastic bucket have some 1 cm diameter holes. The holes were made by drill them at every about 12x12 cm square area. The variable of this research are containers and the level of the bean, 30 and 40 cm depth.

Fermentation and drying

Bean was poured into container then wraped it by banana leaves. The containers were placed in the area without direct sun light. Fermentation was conducted for 5 days. During fermentation, temperature, glucose, and pH was detected to find out the profile of each condition. The bean was reverse up side down after 48 hours from first day fermentation. After 5 days, pulp color changed from white become brown and strong acid smell, then bean ready to dry. Drying was conducted by sun drying, and held for 5-6 days till the water content below than 7%. Dried fermented bean was keep in gunny-sack.

Analyzed

The profile of temperature, glucose, and pH was detected during fermentation every 12 hours. Sample taken at every 5 different place of each container, middle and the forth edge in the middle level. For temperature analyse, thermometer was placed by inserting in the middle hole for 5 minute, to have the stable value. Dried fermented bean then, had cut test analysis to proved percentage of fermented bean, slaty bean, purple and partly purple bean, flat, and mouldy bean. The recorded temperature, glucose, and pH will be shown as a graph, at different container and different depth of bean. The affected condition will be find out the relation to the quality of dried fermented bean.

Result and discussion

Temperature of bean during fermentation in the container

Temperature result from each container during fermentation shows in figure 1. Initial temperature vary 28 to 29,4^{o}C, then rise to highest temperature that depent on container at different day reach. The different depth of bean also shows different temperature profile. The temperature getting increased at every 12 hours analysed. Wooden box (fig.1a) shows the highest temperature is 42,7^{o}C at the third day at 40 cm depth level. the temperature then slighly decrease to 39,9^{o}C at the fifth day. During fermentation in wooden box, level 40 cm depth always shows higher temperature compare to 30 cm depth. The same trend aslo shows at plastic bucket (figure 1.b) and rattan bucket (figure 1.c). However, at plastic bucket the highest temperature was 42.5^{o}C at the nearly fifth day. It means that the reaction of alcohol and acid forming later happend in palstic bucket compare to wooden box. Rattan bucket has the highest temperature 43,4 ^{o}C at the forth day, later compare to the wooden box, third day, and the temperature reached lower compare to the other container.

From all containers, rattan bucket has highest temperature reach, 43,4^{o}C at the forth day. This is due to the mass of rattan bucket heavier (78 kg) compare to plastic bucket (32 kg) and wooden box (60 kg) at level 40 cm depth. These condition has affected to maintain the heat keep in. The higher mass content the higher temperatura reached. On the other hand, the aeration was also needed for microorganism activity, that affected heat loss. Aeration is needed for microorganisme to forma cid from alcohol, at the second step reaction. There are two kinds of microorganism responsible of the fermentation. Khamir is going to change glucose become alcohol, then kapang will change alcohol to form lactic and acetic acid. The second reaction more exotherms compare to the first reaction.

However, even aeration would loss heat, the temperature still raising, and it is proved that both reaction is really done, and also identified by alcohol smell and acid smell surrounding the container. Level of bean mass depth shows that level 30 cm depth reaching lower temperature of the 40 cm depth. It is because the abiltiy of maitaning heat loss is lower at the lower mass. The hole of container also affected to the heat loss even bean has wrapped by banana leaves. Rattan bucket has more hole compare other container, but mass of bean more affecated keep heat in compare to hole area of the container.

Mulato (2005) state that fermentation process happen naturally by microb and avalaible of the oxygen from the air. Initially, many microbs growth surrounding the bean. Since the availabe oxygen limited, only an-aerob khamir survived that its activity will

change glucose to alcohol. After 24-30 hours fermentation, pulp will melt and flow out throw container hole.

Ideal temperature for fermentation are 45°C Sarmidi (1994), but in this researh, only reached 42-43°C. Most cocoa harvesting during rainy season, this condition, affected to the bean temperature in the cntainer. Temperature during rainy season are 26°C in the morning and 27°C at evening, meanwhile dry season have 30-34°C temperature. The differences temperature during season probably is the reason why the tempterature cannot reached higher than 43°C.

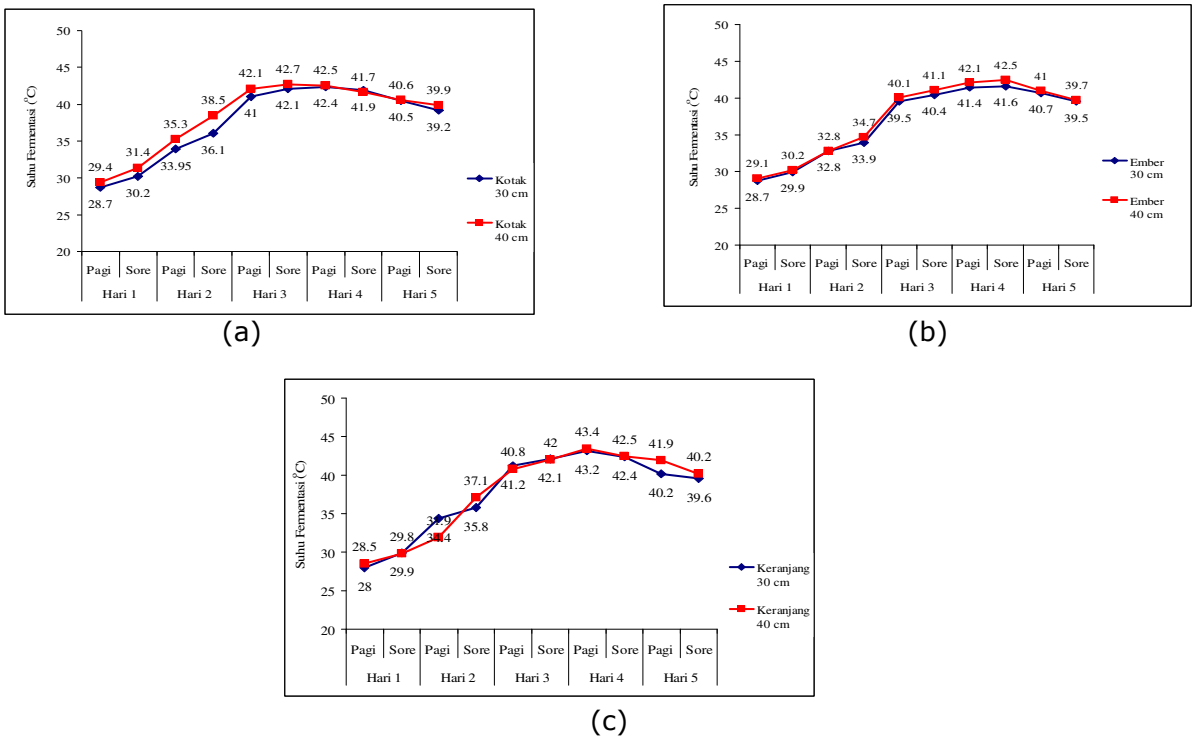
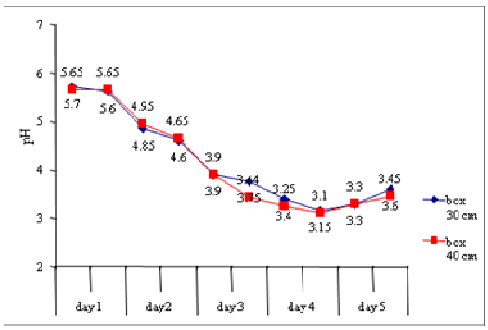


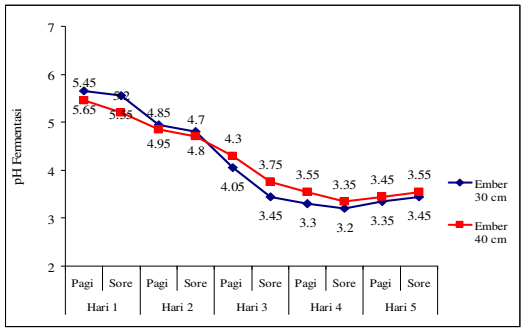
Figure. 1. Temperature of bean at wooden box (a), plastic bucket (b), and rattan bucket (c) and bean mass depth (30, 40 cm) during fermentation.

pH during fermentation process.

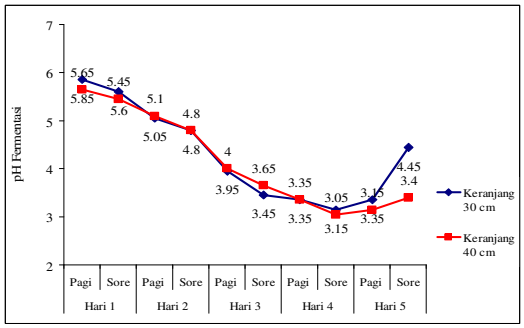
Profile of pH show in figure 2. Like temperature, pH also shows has the same trend at all containers and at different level bean depth. Inital pH at 5,4-5,6 at the first day getting decrase to the lowest pH, 3,05-3,35 at the forth day. The acid formed at the second reaction, is alcohol change to be acetic and alctic acid. So it is acceptable that lowest pH is occuring at the fourth day. Even, the first reaction, alcohol forming also produced acid, but the acid concentration higher during acid fermentation compare to alcohol fermentation.

Zubaidah (1998) announce that, only acetic and lactic acid bacteria could survived at pH very low. Generally all volatile acid and non volatile acid is included in cocoa bean, dominantly acetic acid and lactic acid. The percetange of these acid about 1-2%, half of them loss flowed by pulp drain. These acids in play a big role to chocolate flavour formation in the bean.





(a) (b)



(c)

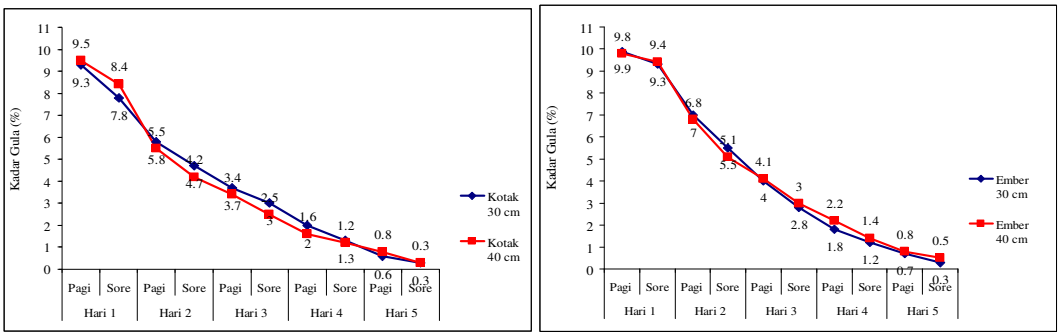
Fig.2 pH of bean at wooden box (a), plastic bucket (b), and rattan bucket (c) and bean mass depth (30, 40 cm) during fermentation

Glucose profile during fermentation

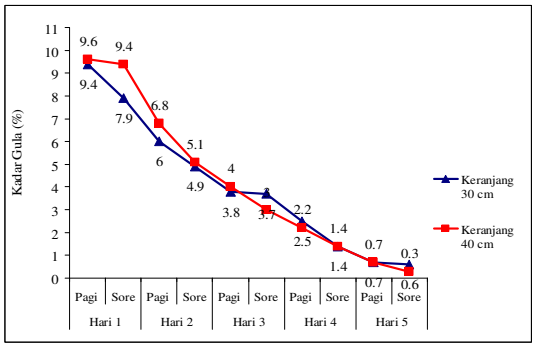
Glucose profile during fermentation in this result shown at figure 3. Initial glucose is about 9.3-9.9%. The graph, shows that glucose content decrease strongly up to 0.3-0.6% at the fifth day.

Generally, Glucose getting slowly decrease at the third day, this is due to khamir getting slowly activity. The condition of acid and limited glucose exist was inconvenient for khamir to survived. After the third day, kapang taken place of majority microorganism that will responsible to produced acid. However, during producing acid, glucose slowly decreased.

The bean mass levet at 40 cm has lower glocuse content compare to level 30 cm depth. Glucose exist also affected of khamir efecient work, which is depend on pH and temperature of the bean. Those condition probalby, much glucose was used by khamir in a better temperature as shown in figure 1. The bean mass level 40 cm depth has higher temperature compare to 30 cm depth of bean mass at every container. This is indicate that the higher temperature reached the more activity of khamir and the higher glucose became alcohol.



(a) (b)



(c)

Fig 3. Glucose profile at wooden box (a), plastic bucket (b), and rattan bucket (c) and bean mass depth (30, 40 cm)

Cut test analysis

Dried bean can be fermentation proved by doing cut test. The result of cut test bean shown in Table 1, and to classify bean was refer to figure 4. During fermentation the color of bean change from purple to brown, if unsucsesfully fermented, some of the color still purple or partly purple, and sometimes slatty. From Table 1, the higest fermented bean obtain from wooden box container at level 40 cm depth, the lowest fermented bean found from plactic bucket. Meanwhile un fermented bean, e.g slaty, partly purple, and purple higher at rattan bucket at level 30 cm depth. Luckily no mouldy bean found, this is probably, good shortaged before fermentation conducted. The flat bean can be reduced by another shortage before storing. The result of slaty probably position of bean was not in proper part of the container or ununiform condition, and unripe fruit harvest caused an mature bean. The purple color was due to unfinished fermented bean. The un-uniform condition, eg temperature in every part, container aeration, and level of depth will cause the variety fermented bean produced.

Even the highest temperature reached at rattan bucket container, it is not guarantee that the highest fermented bean found. Wooden box container got reahced higest temperature earlier (third day) than other conatiner (forth and fifth day). The glucose profile (fig.3) also shown slowly decreased starting the third day, so it is indicate that moroorganisme activity condition more affected to the fermented bean.

Table 1. Cut Test analysis

Container (level depth)	Slaty (%)	Mouldy (%)	Partly purple (%)	Full purple (%)	Full fermented (%)	Flat bean (%)
Wooden Box (30 cm)	5.5	0	24.5	4.5	62	3.5
Wooden Box (40 cm)	4.5	0	19	4.5	69	3
Plastic bucket (30 cm)	4.5	0	26	7	60	2.5
Plastic bucket (40 cm)	5	0	31	6	56.5	1.5
Rattan bucket (30 cm)	6.5	0	27.5	6.5	58	1.5
Rattan bucket (40 cm)	4	0	29	2	62.5	2.5

Figure 3. Clasified performance of cut bean

Conclusion

Fermented bean higher found by using wooden box compare plastic bucket and rattan bucket. Level of bean mass at 40 cm depth resulting higher fermented bean at wooden box and rattan bucket, except plastic bucket. Rattan bucket has higher temperature reached, but it was not directly correlated to the amount of fermented bean. The amount of fermented bean also related to the earlier to reached the highest temperature (at the third day). The amount of glucose strongly decrease up to the third day and slowly decrease till the fifth day.

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