Post-harvest handling of cocoa commodities

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Abstract. The purpose of this research is to get the management of cocoa commodity post-treatment and is explicitly to know the feasibility of the post-harvest handling, knowing the costs incurred by farmers during post-harvest, analyzing fat content, moisture content, and the levels of cocoa bean polyphenols production. The research was conducted in Marioriwawo, Lilirilau, Citta, and Liliriaja, Soppeng regency. Testing of chemical properties in the Laboratory of Chemistry Engineering Makassar Polytechnic. Results of post-harvest treatment stages include harvest time, fruit picking, fruit breakdown, sorting of seeds, fermentation, drying, packaging, and storage. The process of post-harvest handling phase is, post-harvest handling conducted by farmers can be said to be worthy because almost 100\% of farmers do post-harvest handling following the guidelines technical improvement movement of national cocoa production and quality. The cost of farmers who do the fermentation is higher than the cost incurred by farmers who do not ferment. The level of cocoa beans has been following the prevailing SNI (Indonesian National Standard). The fat of cocoa beans has not been a valid SNI, but it has a quite high-fat content.

1. Introduction
The process of handling and processing the Post-harvest cocoa beans is an essential activity because, at this stage, activities determine the quality of cocoa beans. One of the phases of the process of handling and processing of cocoa beans from harvesting to packaging and storage that determines the quality of cocoa beans is fermentation because this stage is a characteristic flavor of cocoa formed. However, to date, the cocoa beans from the plantation people still characterized by the character of the taste are still weak, high levels of dirt and many contaminated by insects, fungi, and mycotoxin. This situation, in addition to making the price of Indonesia cocoa at least valuable, also caused the quality image of Indonesian cocoa, especially those that come from the continuous.

Soppeng Regency is a land and hills with an area of 1,500 Km\textsuperscript{2}. With a land area of 700 Km\textsuperscript{2} is at an average altitude of approximately 60 M above sea level. The hills with a total area of 800 Km\textsuperscript{2} are at an average altitude of 200 M above sea level, to produce cocoa as much as 12,200 tonnes, and become the 8th largest production district of cocoa in Sulawesi [1].

In general, the purpose of this research is to get the feasibility stage of cocoa commodity post in Soppeng Regency and is explicitly to know the feasibility of post-harvest commodities, analyzing the cost of farmers incurred during the post crops, as well as analyzing the fat content, moisture content,
and the levels of the cocoa bean polyphenols production of Soppeng Regency, as an indicator of the feasibility of post-harvest handling.

2. Methods

2.1. Location and time
This research activity held in districts Marioriwawo, Lilirilau, Citta, and Liliriaja, Soppeng regency. Cocoa beans that used in this research are cocoa beans are processed by Perkebunan Rakyat in 4 sub-districts elected as the research site. Testing of chemical properties in the Laboratory of Chemistry Engineering Makassar Polytechnic.

2.2. Population and sample technique
The population used in this research is 40 cocoa farmers who cultivate the people's plantations in the districts of Marioriwawo, Lilirilau, Citta, and Liliriaja, in the Soppeng regency. Which in the four sub-districts can be considered representative of cocoa production centers in Soppeng Regency based on cocoa production data. In 4 selected sub-districts, each sub-district randomly selected by five farmers who do cocoa fermentation, five farmers who do not ferment.

2.3. Instrument data
The data required in this study divided into two categories: primary data and secondary data. Primary Data obtained directly through field observations, in-depth interviews with cocoa farmers. Secondary Data in the form of all written materials that have relation to cocoa production areas, cocoa beans, cocoa chemical characteristics, and the cocoa post-harvest process.

2.4. Data and information analysis
The method of data analysis in this research is done gradually, namely: (a). Retrieval of information through interviews (questionnaire) about the post-harvest process of cocoa farmers includes handling analysis on harvest time, harvesting method, solving/ Fruit cleavage, sorting of seeds, fermentation, drying, as well as packaging and warehousing, at the designated research site; (b). Sampling the cocoa beans in the field randomly, based on the designated cocoa region. (c). The analysis of cocoa beans to its chemical properties, including the analysis of fat levels, polyphenols, and moisture content.

2.5. Chemical properties testing of cocoa beans
Fat analysis [2]. Samples of cocoa beans taken as much as 1 gram (per piece of cocoa beans). Weigh the flask, then connect with the Soxhlet extraction tool. Put the ingredients and pour the chloroform, extract for 4 hours and then darken the solvent by heating the flask over the water bath. Dry the flask in the oven at a temperature of 100°C, up to 2 hours, chill in a desiccator and weigh. Repeat drying until the massive weight difference is less than 0.05%. Calculated fat content:

\[
\text{Fat content} = \frac{100 (M_2 - M_1)}{M_0}
\]

Description:
M0 = Weight of example, (g);
M1 = weight of pumpkin (g);
M2 = weight of pumpkin and fat, (g);

Analysis of polyphenols (Sudarmadji et al., 1989). Two-milliliter filtrate cocoa extract (0.8 mg/ml) inserted into the reaction tube, then into it added successively 1 ml Folin reagents that have been diluted ten times with aqua and 1 ml of Na2CO3 solution (60g/L). The standard curve made from a series of a standard acid solution with a concentration of 0 ppm to 50 ppm. Every 2 ml of the standard
solution is in a pipette, then treated the same as the example above. Blanko made from 2 ml of aquades as a substitute for filtrate samples. Each sample mixture, Standard or Blanko Divorteks, then left for 30 minutes at room temperature. Further measured its absorption with a spectrophotometer at a wavelength of 760 nm.

Moisture analysis [3] Water content determination by weighing samples that have smoothed as much as 3 grams in Petri cups that have been known to weigh. Then dried in the oven with a temperature of 105°C for 4 hours, then inserted in the Desiccator and weighed. After weighed drained back in the oven until weighing constant. Following moisture content is calculated by dry base using the formula:

3. Result and discussion

3.1. Post-Harvest Handling procedure
Results of the stages of cocoa post-harvest handling process include:

3.1.1. Harvest Time. Generally, the respondents of farmers do harvesting in the morning until the afternoon. Farmers in the district Marioriwawo average harvesting every 13 days, farmers in the district Lilirilau average harvesting every 12 days, farmers in the district of Citta average do harvesting every 12 days, and farmers in the District Liliriaja Average are harvesting every 13 days. The farmers were picking up fruit at the time of harvest, with the maturity of the fruit, at the initial cooking, physiological cooking, and cooking.

3.1.1.1. How to Harvest. Picking up fruit can be done using scissors, sickle, or other sharp tools, provided it does not make fruit or fruit pads become damaged. A total of 100% of farmers do defloration of the fruit, cut from the stem. 95% of cocoa farmers fermented using trim scissors, and 15% sometimes used knives. 100% of non-fermented cocoa farmers use crop scissors, and 30% sometimes use knives.

3.1.1.2. Sorting seeds. 85% of cocoa farmers ferment to sorting seeds based on large seeds, 85% also do sorting seeds based on seed colour, and 50% of farmers also do sorting seeds based on quality. Non-fermented cocoa farmer respondents 15% do sorting seeds based on large seeds, 15% also do sorting seeds based on seed colour, and 10% of respondents also do sorting seeds based on quality.

3.1.1.3. Fermentation. A total of 100% of the respondents were fermented farmers, generally using wooden boxes and banana leaves as a tool for cocoa fermentation. The size of the fermentation box used by these respondents varies. As many as 5% of all farmers use boxes with a size of 40 cm x 40 cm x 40 cm (length x width x height), 35% of respondents use boxes with sizes 40 cm x 50 cm x 40 cm, 20% of respondents use boxes with sizes 40 cm x 50 cm x 50 cm, 10% of respondents use squares with a size of 40 cm x 50 cm x 60 cm, 20% of respondents use boxes with a size of 40 cm x 60 cm x 40 cm, 5% of respondents use boxes with a size of 40 cm x 50 cm x 60 cm, and 5% of respondents use boxes with a size of 50 cm x 50 cm x 70 cm.

A total of 95% of respondents fermented cocoa farmers did a re-check of fermentation box holes before inserting the seeds. 5% of respondents fermented cocoa farmers do a check back if there are damaged seeds or foreign objects, 95% of the respondents of the fermented cocoa farmers do the registration of fermentation time, 100% of respondents fermented cocoa farmers do the stirring Seeds, and 100% of the respondents fermented cocoa farmers do the reversal of the fermentation box. Besides, 95% of farmers also re-check the fermentation box before inserting the seeds, 95% of farmers do the recording of fermentation time, and 100% of the farmers do seed stirring and reversal of the fermentation box after 48 hours.

A thick layer of cocoa beans in the Fermentation box done 75% of farmer respondents is 40 cm, and 25% with a thick coating of 50 cm. The length of fermentation carried out by 45% of the
respondents of fermented cocoa farmers is five days, while 30% of cocoa farmers do fermentation of 6
days, and as much as 40% of the respondents of cocoa farmers fermented seven days. The difference
in the length of fermentation happened caused by differences in the size and layer thickness of cocoa
beans in the fermentation box. The seed color resulting from the fermentation process by 100% of the
respondents of fermented cocoa farmers is brown.

3.1.1.4. Drying. The length of the drying of the cocoa beans carried by the respondents depends
heavily on the weather and the moisture content desired by the buyer. 35% of respondents fermented
cocoa farmers do drying for four days, 55% of the respondents of fermented cocoa farmers also
sometimes drying for five days, 5% of the respondents of fermented cocoa farmers sometimes drying
for six days, and 5% The respondents of fermented cocoa farmers occasionally drying for seven days.
As many as 25% of non-fermented cocoa farmers do drying for four days, 60% of the non-fermented
cocoa farmers also occasionally drying for five days, and 15% of non-fermented cocoa farmers
sometimes drying for seven days.

The thick layer of the beans dried by the respondents fermented farmers as much as 25% is
3 cm, and 75% of the respondents of cocoa farmers fermented 4 cm thick. While on non-fermented farmer
respondents, 40% dry with thick Layer/pile of 3 cm seeds, and 60% dry with a thick coating/pile of 4
cm. This handling corresponds to the technical guidelines of the production improvement movement
and the National Cocoa Quality (2009), stating that the drying layer of the dried seeds reaches 5 cm
(2-3 layers of seeds).

3.1.1.5. Sorting and Grading. 100% of farmers, whether fermenting or not, are all doing no sorting
after drying, it is because they have done stages of sorting cocoa beans, shortly before drying or
fermentation.

3.1.1.6. Packaging and Storage. As much as 100% of the total respondents, packing cocoa beans that
have dried in a plastic bag. 100% of the respondents of fermented cocoa farmers kept the dried cocoa
beans on wooden floors, which did not touch the ground/cement floor. A total of 90% of respondents
of non-fermented cocoa farmers kept cocoa beans that have suspended on hardwood floors that did not
touch the ground/cement floor, and 15% of non-fermented cocoa farmers also sometimes kept cocoa
beans that were already on the floor.

3.1.2. Post-harvest Cost

Table 1. The cost of post-harvest for cocoa at four districts.

| District     | Land (Ha) | Total production (Kg/GKP) | Cost of post-harvest (Rp) |
|--------------|-----------|---------------------------|---------------------------|
|              | Non Ferment | Ferment | Non Ferment | Ferment | Non Ferment | Ferment |
| Marioriwawo  | 0.9       | 1.1     | 76          | 200     | 177,302     | 310,447 |
| Lilirilau     | 1.3       | 1.16    | 140         | 118     | 225,101     | 302,798 |
| Citta         | 2.2       | 3       | 260         | 229     | 276,789     | 454,980 |
| Liliriaja     | 1.1       | 1.1     | 190         | 156     | 231,090     | 360,736 |
| Total         | 5.5       | 6.36    | 666         | 703     | 910,282     | 1428,961 |
| Average       | 1.375     | 1.59    | 166.5       | 175.75  | 227,571     | 357,240 |

The cost of post-harvest in the district Marioriwawo for cocoa non-fermentation is Rp. 177,302,-and
the post-harvest cost of cocoa fermentation is Rp. 310,447-. The cost of post-harvest in the Lilirilau
subdistrict for non-fermented cocoa is Rp. 225,101,-and the post-harvest cost of cocoa fermentation
is Rp. 302,798-. The post-harvest cost in Citta subdistrict for non-fermented cocoa is Rp. 276,789,-and
the post-harvest cost of cocoa fermentation is Rp. 454,980-. The cost of post-harvest in the Liliriaja
sub-district for non-fermented cocoa is Rp. 231,090,- and the post-harvest cost of cocoa fermentation is Rp. 360,736-.

3.2. Fat content

![Fat content in cocoa](image)

**Figure 1.** Fat content in cocoa.

Non-fermented cocoa bean fat content in the District Marioriwawo is 48.73%, and the fat level of fermentation is 50.74%. The fat content of non-fermented cocoa beans in the district of Liliriau is 49.08%, and the fat content of fermented beans is 51.68%.

3.3. Moisture content

![Moisture content in cocoa](image)

**Figure 2.** Moisture content in cocoa.

The non-fermented cocoa bean water content in the Marioriwawo subdistrict is 7.62%, and the water content of fermented beans is 5.58%. Non-fermented cocoa bean water content in the Liliriau subdistrict is 7.16%, and the water content of fermented beans is 6.57%. The moisture content of non-fermented cocoa beans in the Citta subdistrict is 7.76%, and the moisture content of fermented beans is 7%.
3.4. Total Polyphenols

![Figure 3. Total polyphenols in cocoa.](image)

The level of non-fermented cocoa beans in the Marioriwawo subdistrict is 242.43 mg/100g, and the level of polyphenol fermentation beans is 274.685 mg/100g. The non-fermented cocoa bean polyphenols levels in Lilirilau subdistrict is 234.175 mg/100g, and the concentration of polyphenol fermented beans is 267.455 mg/100g. The non-fermented cocoa bean polyphenols levels in Citta subdistrict is 248.73 mg/100g, and the concentration of polyphenol fermented beans is 264.44 mg/100g. The level of non-fermented cocoa bean polyphenols in the district of Liliriaja is 285.425 mg/100g, and the level of polyphenol fermentation seeds is 287.16 mg/100g mg/100g.

The stages of post-harvest handling carried out by farmers in Soppeng district started from picking up fruit, solving fruit, sorting seeds, fermentation (for farmers who fermented cocoa beans), drying, packaging, and storage. The post-harvest handling process conducted by farmers in Soppeng Regency can be said to be worthy because almost 100% of farmers do post-harvest handling under the technical guidelines of the production improvement movement and the national cocoa quality. The cost of farmers who do the fermentation is higher than the cost incurred by farmers who do not ferment. The level of cocoa beans in Soppeng has been following the prevailing SNI. The fat of cocoa beans has not been compliant with SNI but has high levels of fat.

Fruit picking should be done at the beginning of cooking and physiological and should avoid the harvest when the fruit is too ripe, because the fruit that slowly harvested will lower the quality of the seeds, especially growing numbers of sprawl seeds and seeds germinate. Farmers do not 100% do harvesting as advised by the technical guide Book of production Improvement movement and National Cocoa Quality (2009), but can be said it is still feasible to meet the standards of harvesting because the fruit harvested 60% still included In the maturity phase of the fruit suggested being plucked/harvested [4].

The technical guide to the national production and Quality Improvement Movement [4], stating that cutting the stem of the fruit with a trim/sickle, does not draw or twist the fruit as it can damage the fruit-bearing. The thing that must be observed at the time of harvesting is to keep the fruit undamaged or broken, and to keep the fruit-bearing also not damaged because it is the place of interest growth for the next period.[4] Cutting fruit stalks with pruners or knives made by farmer respondents have been
eligible according to the guidelines suggested by the National Cocoa Quality Production Improvement Movement (2009), of which 100% of farmers are fermented, and 95% of non-fermented farmer respondents carried out a fruit stem cutting by using clean scissors. Solving the fruit with wood beater is done 100% by fermented farmers, 95% of non-fermented farmers do the breakdown of fruit by using knives. This treatment is following the technical guidance of the national production and Quality Improvement Movement (2009) that it is advisable for farmers to breakdown the fruit with a wood-beater knife.

From the results of the questionnaire, it can say that the farmers do sorting the seeds based on the seed quality of the color and large seeds. So the sorting of seeds done by farmers respondents can be said to be worthy. The fermentation process done by farmers respondents can be said to be worthy and under the technical guidelines of the National Cocoa production and Quality Improvement Movement (2009), because 100% of respondents use a fermentation box lined with banana leaves. Fermentation is one of the processes that determine the taste of cocoa products; fermentation can be done commonly, one of them by fermentation with a wooden box [5].

The drying process carried out by farmers of respondents, can be said to be worthy, this is in accordance with the technical guide of the National Cocoa production and Quality Improvement Movement (2009), that the clothesline applied on a particular base such as mat/tarp Plastic, bamboo Sesek (para-para) or sun-dried floor. Sorting is usually done manually by Labor. 100% of farmers, whether fermenting or not, are all doing no sorting after drying, since they have done stages of sorting cocoa beans, shortly before drying or fermentation. From the results of the percentage of the questioner, the cocoa bean packaging carried out by farmers packaged in plastic bags, it is not in accordance with the technical guidelines for the production improvement movement and the National Cocoa Quality (2009), because the farmers package the cocoa beans that has dried in a plastic sack, not with the burlap sack as advised.

Farmers are storing cocoa beans by farmers who have been crowned, on wooden floors. It is following the technical guidelines of the National Cocoa production and Quality Improvement Movement (2009), stating that the burlap sack containing dried cocoa beans should not be placed on the cement floor, because dried brown beans can absorb water from the floor.

The cost of post-harvest for cocoa non-fermentation and fermentation is located in the district of Citta, because the farmers in the district, the average has a broader land than farmers in other sub-districts.

According to the Indonesian National Standard (SNI) 01-2323-2000, the levels of cocoa beans for seed quality I, II, and II are at least 55%, while the average yield of cocoa beans levels in the four sub-districts of research location is 50.10%. Low levels of fat in cocoa beans determined by the type of plant material and the season factor. The moisture of cocoa beans from productivity is ranging from 5.58% to 7.76%. Furthermore, the moisture content of cocoa beans has been dried between 6-7%, to be safe from fungal attacks when stored — drying done by farmers respondant can be said to be worthy because it still meets the standard of water content set by SNI (01 – 2323 – 2000), that the moisture content for dried cocoa beans quality I, II, and II, which is a maximum of 8% [6].

The levels of polyphenols in cocoa fats can give excess taste to the tongue. Joseph. (2008) States this is due to excessive polyphenols in chocolate interacting with rich protein proline in saliva and precipitating it. The chocolate flavor increased along with the increase in the degree of polymerization of the polifenol [7].

4. Conclusion
The stages of post-harvest handling carried out by farmers in Soppeng district started from picking up fruit, solving fruit, sorting seeds, fermentation (for farmers who fermented cocoa beans), drying, packaging, and storage. The post-harvest handling process conducted by farmers can be said to be worthy because almost 100% of farmers do post-harvest handling under the technical guidelines of the production improvement movement and the national cocoa quality. The cost of farmers who do the fermentation is higher than the cost incurred by farmers who do not ferment. The level of cocoa beans
has been following the prevailing SNI (Indonesian National Standard). The fat of cocoa beans has not been compliant with SNI but has high levels of fat.

References
[1] Statistics Indonesia Sulawesi Selatan Province 2010 Plantation (Makassar: Statistics Indonesia Sulawesi Selatan Province)
[2] Djatmiko B and Wahyudi T 1986 Aspek pengolahan dan mutu coklat lindak dan mulia (Jember: Balai Penelitian Perkebunan)
[3] Apriyantono A, Fardiaz D, Puspitasari N L and Sedarnawati B S 1989 Analisa pangan (Bogor: IPB)
[4] Departemen Pertanian Direktorat Jenderal Perkebunan 2009 Buku panduan teknis budidaya tanaman kakao (Jakarta: Direktorat Jenderal Perkebunan)
[5] Misnawi 2005 Peranan pengolahan terhadap pembentukan citarasa cokelat War. Pus. Penelit. Kopi dan Kakao 21
[6] Wood G A R 1987 Form Harvest To Store (New York: John Willey and Sons. Inc)
[7] Wahyudi T, Pangabean T R and Pujianto P 2008 Panduan lengkap kakao manajemen agribisnis dari hulu hingga hilir (Jakarta: Penebar Swadaya)