



Application of Several Post-Harvest Processing Technologies to Several Types of Coffee Plants (*Coffea* sp)

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Abstract

So far, post-harvest processing of people's coffee is usually always a drying process using sunlight, the drying process is usually carried out for 15 to 17 days until a moisture content of 18 to 20% is reached. But if the rainy season takes up to 3 weeks more and this results in the quality of the coffee being not good because it is moldy and smells bad. In post-harvest handling, especially the drying process remains a problem in the field. Post-harvest processing of coffee in the small and medium coffee industry usually uses several methods, including: honey process, honey wet hulling process, natural process, full wash process, semi wash process and wine process. In addition to the processing after harvest, the type of variety harvested also greatly affects the quality of the crop. Arabica and Robusta coffee plants provide different tastes, aromas, levels of acidity for coffee lovers so that there is competition for market interest which also encourages farmers to plant Arabica and Robusta coffee. The purpose of this research is to get the best post-harvest coffee processing method according to the taste expected by consumers. From the research that has been done, it can be concluded that the processing method greatly influences the taste of the coffee, both Arabica coffee powder and Robusta coffee powder. The best post-harvest processing of coffee according to the taste expected by consumers with the honey method for both Arabica and Robusta coffee. This is influenced by the mucilage in coffee beans containing mucilage which gives rise to its own taste in the final result of coffee powder.

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1. Introduction

Coffee (*Coffea* sp.) is one of West Sumatra's local wisdom commodities, where West Sumatra coffee production averages 70 thousand tonnes per year with an area of coffee plantations of around 27 thousand hectares. 20 percent of them are Arabica coffee that grows in the highlands and the other 80 percent is Robusta coffee.

As world coffee consumption increases, the issue of coffee quality has begun to be raised by foreign exporters by certifying coffee products.

However, local coffee farmers object to this assessment, because they tend to assess the low quality of their coffee. This is because small and medium business actors do not yet have adequate processing technology, knowledge about relatively traditional post-harvest handling.

As a result, the quality of coffee as a raw material for the coffee processing industry is relatively low, or it is most difficult to obtain consistent quality, making it difficult to compete in the world market [1]

The post-harvest process carried out by farmers in general is coffee that is picked by farmers and then dried in the sun until the coffee cherries dry, the aim is to make it easier to peel the outer skin, then wash it to remove mucus on the hard skin and then dry it, then peel the hard skin to get dry coffee beans and dried again.

The whole drying is carried out in an open place using a plastic mat or tarpaulin under conditions of hot sunlight, after that the first collector sells to the next collector to be sold to the coffee processing industry.

The post-harvest processing method for people's coffee is always drying, using sunlight, the drying process is usually carried out for 15 to 17 days until a moisture content of 18 to 20% is reached. But if the rainy season takes up to 3 weeks more and the quality of the coffee is not good because it is moldy and smells bad [2].

In post-harvest handling, especially the drying process remains a problem in the field.

Post-harvest processing of coffee in the small and medium coffee industry usually uses several methods, including: honey process, honey wet hulling process, natural process, full wash process, semi wash process and wine process.

In addition to the processing after harvest, the varieties harvested also greatly affect the quality of the crop.

Arabica and Robusta coffee plants provide different tastes, aromas, levels of acidity for coffee lovers, resulting in competition for market interest which also encourages farmers to plant Arabica and Robusta coffee according to the conditions of their respective lands [3]

The purpose of this research is to get the best post-harvest coffee processing method according to the taste expected by consumers.

2. Research methodology

This research was conducted in Tabek Patah, Tanah Datar District. The duration of the research is 2 months and starts in March 2023 until May 2023.

2.1. Tools and materials

The equipment used for this research activity are: solar dryer dome, analytical balance, pH meter, electric oven, stationery, fermentation tub, basin, huller machine, roaster machine, spectrophotometer, terratester

The materials used in the study were: Arabica and Robusta coffee cherries, water, wooden nets, labels, plastic bags, etc.

2.2. Research methods

The study used a completely randomized factorial design where factor A in this study was the coffee plant variety and factor B was the method of post-harvest processing with several processing methods.

Factor (A) is:

A1. Arabica Sigratautang

A2. Robusta Toraja

Factor B is:

B1. Natural coffee processing

B2 Full Wash processing

B3. Semi Wash Processing

B4. Honey processing

2.3. Research procedure

- **Sampling**

The coffee sample material was taken from a garden belonging to a partner "Bengkel Kopi" in the Tabek Patah area where this garden is located at an altitude of 1050 – 1150 meters above sea level. Each of them is taken as much as 5 kg of coffee that has been harvested or picked directly from the sample plants.

- **Fermentation**

The coffee beans that have been harvested for the initial stage are fermented except for samples that will be dried using natural methods. Fermentation is carried out for 24 hours in a water bath or in drums covered with a plastic lid.

- ***Drainage of fermented products***

After the coffee beans have been soaked for 24 hours, then we drain the coffee beans from the soaking water and immediately place them in the net. This wooden net serves to help the drying process so that after being placed for a while the remaining water will go down by itself.

- ***treatment use***

At this stage, we will treat each sample with a predetermined method, namely natural, full wash, semi wash honey.

A1 = Arabica Coffee

A2 = Robusta Coffee

B1 = Natural treatment: after harvest it is immediately dried, without soaking and without peeling the fruit skin.

B2 = Full wash: after harvesting, soaking in water to make it easier to peel off the fruit skin, then peeling off the fruit skin, washing, drying and peeling off the seed skin/hard skin (hulling).

B3 = Semi wash: after harvesting it is soaked, the fruit skin is then peeled off, washed and the hard skin is peeled off (hulled) and dried.

B4 = Honey: fruit is washed, then fermented for 2 x 24 hours, then dried and the horn skin peeled.

- ***Labeling***

At the time of direct treatment, labels were attached to the ends of the sieve so that the coffee beans with treatment and replication information and the date of the study were not confused.

- ***Storage in Doom Dryer***

After being placed on the respective sieve for each treatment, we put it in and we arrange it in the labeled doom dryer. Later we will observe the changes that occur in the seeds until the 28th day.

- ***Grinding/ Peeling and Roasting***

Grinding or peeling is done with a huller machine to separate the hard skin from the epidermis of the coffee so that it becomes green coffee beans (rice coffee) which are ready to be roasted. These green coffee beans are then roasted using a roaster machine (roster) which can be done directly in a coffee shop in the medium roast category.

2.4. Observation Parameters

Parameter observations that will be observed in this study are:

- **Wet weight of 100 pieces of fruit after harvest**

After the coffee cherries were harvested and before being given the treatment, 100 pods were weighed which were taken randomly, in each treatment, using an analytical balance.

- **Color during drying**

During the drying period in the doom dryer we will observe the color changes of the cherries which we enter into the color categories: very dark, dark, faded and very faded.

- **Drying time**

Calculation of the optimal number of days of dry coffee beans in the drying process in the doom dryer.

- **Weight of dry rice beans 100 coffee beans**

After each dry treatment, 100 seeds were weighed which were taken randomly, in each treatment, using an analytical balance.

- **Seed Yield**

Yield calculation is done by comparing the percentage yield of dry weight with wet weight in each treatment

$$\text{Formula} = \frac{\text{Dry weight}}{\text{Wet weight}} \times 100\% \quad (1)$$

2.5. Coffee Bean Quality Test

Quality is an aspect of a product that meets customer needs so as to provide customer satisfaction.

- **Color**

The color of the coffee beans will be seen with a standard of concentration. By scoring.

- **Aroma**

Fragrance testing is carried out by panelists who are competent and have certificates of expertise in the coffee field by giving them a score.

- **Caffeine**

Caffeine content in coffee for each treatment was carried out by testing using spectrophotometry in the Payakumbuh State Agricultural Polytechnic laboratory.

- **Water Store**

Measurement of the water content in coffee beans for each treatment using the Terratester tool. Where the coffee beans are put into the tool, the water content figure immediately comes out.

- **Acidity Level (pH)**

To test the acidity level (pH) of coffee beans, it was carried out in the Payakumbuh State Agricultural Polytechnic laboratory.

- **Overalls**

The overall test includes hedonic testing or the panelist's level of preference for the taste, aroma and color of Arabica and Robusta ground coffee.

3. Results and Discussion

3.1. Wet Weight of 100 seeds Post Harvest

Table 1: Weight of 100 wet coffee beans.

No	Treatment	Weight (gram)	
		Arabica (A1)	Robusta (A2)
1	Natural (B1)	102,23	98,24
2	Full Wash (B2)	103,79	97,38
3	Semi Wash (B3)	99,47	97,09
4	Honey (B4)	98,93	96,59

From table 1. It can be seen that Arabica coffee has a higher wet weight than Robusta coffee in general. This is suitable because Arabica coffee beans have thicker fruit skins, are slightly larger and oval in shape, while Robusta coffee beans are smaller and rounder [4].

3.2. Colour during drying

Table 2: The colour of coffee beans when drying.

No	Treatment	Colour	
		Arabica (A1)	Robusta (A2)
1	Natural (B1)	Dense	Dense
2	Full Wash (B2)	Faded	Faded
3	Semi Wash (B3)	Faded	Faded
4	Honey (B4)	Very dense	Dense

From Table 2 it can be seen that up to the 20th day of the study the results of the coffee bean color obtained

were that in the natural process both Arabica coffee and Robusta coffee were still densely colored, and for the full wash and semi wash processes the colors had faded. As for the honey process, Arabica coffee is very dark in color, and Robusta coffee is thick.

3.3. Drying time

Table 3: Drying time.

No	Treatment	Average drying days	
		Arabica (A1)	Robusta (A2)
1	Natural (B1)	33,4	32,9
2	Full Wash (B2)	26,3	26,8
3	Semi Wash (B3)	22,7	24,6
4	Honey (B4)	27,4	25,5

In table 3 it can be seen that the treatment of several post-harvest processing methods greatly affects the drying time. Where the lowest number is seen in the natural method because the skin of the coffee cherry seeds is not peeled, so it takes time to penetrate the rice seeds, while other treatments have peeled the hard skin.

3.4. Weight of dry rice beans 100 coffee beans

Table 4: Weight of 100 dry coffee beans.

No	Treatment	Weight (gr)	
		Arabica (A1)	Robusta (A2)
1	Natural (B1)	18,01	17,26
2	Full Wash (B2)	17,42	16,17
3	Semi Wash (B3)	16,98	15,99
4	Honey (B4)	17,13	16,23

From Table 4 it can be seen that the dry weight of rice grains is relatively the same with various post-harvest processing methods. In addition, the dry weight of 100 Arabica coffee beans can be concluded to be heavier than the dry weight of 100 Robusta coffee beans. This can also be seen by naked eye from the shape, type and size of Arabica and Robusta.

3.5. yield

Table 5: Yield of Coffee Beans.

No	Treatment	Weight (gr)	
		Arabica (A1)	Robusta (A2)
1	Natural (B1)	0,142	0,139
2	Full Wash (B2)	0,168	0,166
3	Semi Wash (B3)	0,171	0,165
4	Honey (B4)	0,173	0,168

From Table 5. it can be seen that the yield of coffee beans is obtained from the results of comparing the percentage of dry weight with fresh weight in each treatment. The highest yield was obtained for Arabica coffee

with natural processing methods, and for Robusta coffee the highest yield was also obtained for natural processing. The high and low yields are due to the evaporation of volatile substances such as aldehydes, furfurals, ketones, alcohols, and esters. In addition to evaporation of volatile compounds, the yield is also influenced by the pyrolysis reaction of hydroxide compounds which causes weight loss in coffee beans which are dried with a certain light intensity. This is also in line with [5] that the longer the drying time, the less water content during the processing process, which results in a decrease in yield.

3.6. Coffee Bean Quality Test

- *Color*

Coffee color has an important role in consumer acceptance and attractiveness. Even though it has the desired taste, but has a color that does not match what consumers want, the acceptance power will be low

Table 6: Color of coffee beans.

No	Treatment	Scoring	
		Arabica (A1)	Robusta (A2)
1	Natural (B1)	2,89	3,98
2	Full Wash (B2)	4,67	4,81
3	Semi Wash (B3)	4,68	3,76
4	Honey (B4)	5,3	5,35

Table 6 shows that each treatment with several different post-harvest methods had no significant effect on the color level of the brewed coffee, both arabica and robusta powder. Scoring levels from 1 to 7 (yellow-very black). The highest score was in the honey treatment with almost the same score for both Arabica and Robusta coffee grounds. The black color of both arabica and robusta coffee grounds is due to the millard reaction which forms volatile compounds, caramelization of carbohydrates, and the formation of CO₂ as a result of oxidation during roasting. According to [6] other factors that affect the color of coffee apart from temperature and roasting time are also influenced by the process of caramelization of sugar which causes the color to turn black.

- *Aroma*

Table 7: The aroma of coffee grounds.

No	Treatment	Scoring	
		Arabica (A1)	Robusta (A2)
1	Natural (B1)	2,44	3,01
2	Full Wash (B2)	3,76	4,21
3	Semi Wash (B3)	4,11	4,98
4	Honey (B4)	5,36	5,21

The character of the smell of coffee in general shows the taste of the coffee. The aroma of coffee includes fragrance (the smell of coffee when it is still dry/powdered) and aroma (the smell of coffee when brewed with hot water). Flavor is the combination that is felt on the tongue and aroma on the sense of smell. The average score for the aroma of Arabica and Robusta coffee powder can be seen in the following table:

The results of the analysis of variance showed that the different processing methods were significantly different from the honey treatment in Robusta coffee to the aroma of the brewed ground coffee. This is because the mucilage in coffee beans contains mucilage which gives rise to its own taste [7]The average score for the aroma of arabica brewed coffee powder in the highest treatment was the honey method which was 5.36 which means the coffee aroma was strong and the lowest was in the natural treatment with a score of 2.44 which means the coffee aroma was not very strong. The same is true for Robusta coffee with the honey method with the highest score of 5.21 with a strong coffee aroma. The aroma is preferred because at 20 minutes the coffee beans during roasting pass through the level of maturity and first cracks occur in the coffee beans.

- **Caffeine**

The results showed that post-harvest processing had a significant effect on the caffeine content of Robusta coffee.

Table 8: Caffeine.

No	Treatment	Average caffeine	
		Arabica (A1)	Robusta (A2)
1	Natural (B1)	0,249%	0.189%
2	Full Wash (B2)	0,456%	0,432%
3	Semi Wash (B3)	0,563%	0,365%
4	Honey (B4)	0,656%	0,541%

The results showed a decrease in the percentage of caffeine content in Arabica and Robusta ground coffee due to the effect of post-harvest treatment. This is also related to the optimal length of drying time for each treatment so that it affects the process of evaporation of compounds such as aldehydes, acetic acid, furfural, ketones, alcohols, formic acid which are volatile. (Mulato and his colleagues 2010)

Caffeine content in kpi is also influenced by planting area, plant variety, planting age, growing season length and rainfall. The caffeine content of Arabica ground coffee does not meet the minimum limit of SNI 01-3542-2004 standards with a maximum of 2% and a minimum of 0.9% caffeine content, this is presumably due to the long storage time of Arabica coffee beans \pm 6 months, according to opinion [8].

- **Water content**

Table 9: Moisture Content of Coffee Beans.

No	Treatment	Weight (gr)	
		Arabica (A1)	Robusta (A2)
1	Natural (B1)	12,3%	12,1%
2	Full Wash (B2)	11,8%	11,5%
3	Semi Wash (B3)	11,5%	11,4%
4	Honey (B4)	11,9%	11,3%

Moisture content is the amount of water contained in the material expressed as a percentage on a wet or dry basis.

From Table 9 it can be seen that the water content of coffee beans for all treatments except natural has reached the dry limit where the water content for dry coffee beans is 11.5 – 12.5%. [3]Rice coffee beans with water content are carried out in the next stage, namely sorting rice coffee beans which functions to separate coffee beans from non-coffee impurities, small leaves, coffee skin and sorting coffee beans physically or based on size and mute defects with the provisions of SNI 01 – 2907 – 2008 so that the observation of organoleptic quality analysis can be continued (BSN, 2008). The longer the drying time, the lower the water content in Arabica and Robusta ground coffee, where the natural treatment experiences the longest number of hours of drying which affects the water content of roasted ground coffee to maintain the durability of Arabica ground coffee storage, as well as affecting the taste, aroma and coffee taste

- **Acidity Level**

Acidity or pH is one of the factors that affect the taste of coffee, acidity in coffee is influenced by the fermentation process, both dry fermentation by stacking coffee in the shade for 2-3 days and wet fermentation by soaking in water for 36-40 hours [9]

Table 10: Acidity Level.

No	Treatment	pH	
		Arabica (A1)	Robusta (A2)
1	Natural (B1)	4,97	5,25
2	Full Wash (B2)	5,15	5,36
3	Semi Wash (B3)	5,06	5,42
4	Honey (B4)	4,83	5,8

This shows that the level of acidity is still above normal, not exceeding pH 7. The best percentage of acidity is close to neutral pH because the level of acidity is not too high. The decrease in the acidity value itself is due to the evaporation of several acids, both chlorogenic acid and carboxylic acids during drying which causes the acid content in coffee to decrease. This is in accordance with [8] opinion that coffee beans naturally contain various types of volatile compounds such as aldehydes, furfural, ketones, alcohols, esters, acetic acid which evaporate easily when exposed to heat.

- **Overalls**

Table 11: Average hedonic test overall score.

No	Treatment	Scoring	
		Arabica (A1)	Robusta (A2)
1	Natural (B1)	2,24	2,11
2	Full Wash (B2)	4,16	3,67
3	Semi Wash (B3)	4,12	3,45
4	Honey (B4)	4,64	3,81

The overall test includes hedonic testing or the panelist's preference level for taste, aroma and color of Arabica coffee powder. The mean overall hedonic test scores for Arabica and Robusta ground coffee with several post-harvest processing methods can be seen in the following table:

The results of the analysis of variance showed that the differences in treatment were significantly different (honey) on the overall hedonic test of Arabica and Robusta brewed coffee grounds. The mean treatment score for the hedonic test of Arabica brewed coffee powder was the highest in the honey method with a score of 4.64 which means like, and the lowest in natural with a score of 2.24. The same thing happened to Robusta coffee powder, although the honey method was safe with a score of 3.81, which means it liked it, but the figure was lower than Arabica and the lowest was in the natural treatment with a score of 2.11. The hedok test of Arabica and Robusta brewed ground coffee for aroma, taste and color is influenced by the length of drying time, which returns to the post-harvest treatment to speed up the optimal drying process of the coffee beans. During the drying process, many of the compounds contained in the coffee beans evaporate [8] The hedonic test (overall) for the aroma, taste and color of the brewed coffee that the panelists liked was at P4 with a score of 4.64. The resulting taste is formed from a combination of sour, bitter and sweet flavors that are formed from the post-harvest processing. This also results in the degradation of the constituent components so that they form a single unit. The taste of coffee is influenced by the degradation of carbohydrate compounds which are converted into sucrose during roasting which produces a sweet taste, the degradation of alkaloids into caffeols and the breakdown of crude fiber which forms a bitter taste, while the sour taste is formed due to the degradation of chlorogenic acid and other acids in coffee.

4. Conclusions and recommendations

From the research that has been done, it can be concluded that the processing method greatly influences the taste of the coffee, both Arabica coffee powder and Robusta coffee powder. The best post-harvest processing of coffee according to the taste expected by consumers with the honey method for both Arabica and Robusta coffee. This is influenced by the mucilage in coffee beans containing mucilage which gives rise to its own taste in the final result of coffee powder.

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