Physical and sensory quality of Java Arabica green coffee beans

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Abstract. Demand on high quality coffee for consumption is continually increasing not only in the consuming countries (importers) but also in the producing countries (exporters). Coffee quality could be affected by several factors from farm to cup including the post-harvest processing methods. This research aimed to investigate the influence of different post-harvest processing methods on physical and sensory quality of Java Arabica green coffee beans. The two factors being evaluated were three different post-harvest processing methods to produce green coffee beans (natural/dry, semi-washed and fully-washed processing) under sun drying. Physical quality evaluation was based on The Indonesian National Standard (SNI 01-2907-2008) while sensory quality was evaluated by five expert judges. The result shows that less defects observed in wet processed coffee as compared to the dry processing. The mechanical drying was also proven to yield a higher quality green coffee beans and minimise losses.

1. Introduction

Coffee is one of the most popular beverage worldwide and become the most important traded commodity after petroleum. It's significant impact on the world economy and people welfare has been well-recognized. World Coffee Outlook [1] reported that exporting and re-exporting activities have been growing consistently in the last five decades. Considerable growth has been observed after the year 2000 [1].

Demand on high quality coffee for consumption is continually increasing not only in the consuming countries (importers) but also in the producing countries (exporters). This high quality of coffee could be affected by several factors from farm to cup including the post-harvest processing methods as comprehensively reviewed previously by [2]. Amongst those factors, post-harvest processing method of coffee cherry into green coffee beans was thought to have an important role on the quality.

The impact of this post-harvest processing on coffee quality may vary due to other factors such as environmental involvement that may be specific on certain coffee. This may lead to the choice made by farmers on which processing might be best for the quality of their coffee. This research aimed to investigate the influence of different post-harvest processing methods (natural/dry, semi-washed and fully-washed processing) on physical and sensory quality of Java Arabica green coffee beans

cultivated on Arjuno Mountain, UB Forest, Malang, East Java. Expected outcome of this research will be recommendation on best green coffee beans post-harvest processing methods applicable for farmers on Arjuno Mountain.

2. Materials and Methods
2.1. Materials
Coffee cherries (10 kg) used in this research was Java Arabica coffee cultivated on Arjuno Mountain, UB Forest Malang, East Java. Machineries used were locally made such as pulper (75 kg/h), huller (50 kg/h), and electric cabinet dryer (50 kg/h). Other equipment involved includes Sartorius balance, CR 310 photometer (Konica Minolta Imaging, Dietikon, Switzerland), vacuum oven, fermentation buckets with lid.

2.2. Methods
The two factors being evaluated were three different post-harvest processing methods to produce green coffee beans (natural/dry, semi-washed and fully-washed processing) and two drying methods i.e. sun drying and mechanical drying. Sun drying process involves drying on the bamboo racks for 5 days up do 3 weeks while mechanical drying utilized electric cabinet dryer set at $\pm$ 40°C for few days up to 2 weeks.

Prior to drying, the harvested red cherries were sorted (floated under water) and follows series of processing based on the methods of choice to produce dried coffee or coffee parchment. For the natural method, whole cherries were dried under sunlight. The other two methods (semi-washed and fully-washed) involved pulping and washing of the red cherries. For semi-washed process, the coffees were dried soon after pulping and washing without fermentation process. For the fully-washed process, the coffees were fermented under water in a closed bucket for ±18 h followed by further washing prior to drying. The coffee husk, parchment, and skin were removed by using dry huller to yield green coffee beans that were analysed further.

Physical quality evaluation on green coffee beans including coffee size and defects was performed based on [3]. Moisture content was analyzed based on [4] method 979.12 gravimetric method II using vacuum oven. Colour (CIE L*a*b*) was measured using CR 310 photometer (Konica Minolta Imaging, Dietikon, Switzerland). Sensory quality was evaluated using descriptive analysis by five expert judges from local coffee industries. Statistical data analysis was performed using Minitab 17 Statistical Software (Minitab Inc., State College, Pennsylvania, USA) and The Unscrambler® X (CAMO, Oslo, Norway, AS).

3. Results and Discussion
Physical evaluation is a fast, easy and applicable technique to assess coffee quality. This evaluation may involves colour, bean size, uniformity, and presence of defects.

As the first important physical criteria to assess green coffee beans quality, colour could be determined objectively using colorimetry based on CIE L*a*b* colour space, where L* measures the lightness, while a* and b* presents coordinates for red/green and yellow/blue, respectively. The chromatic coordinates of the green coffee beans being studied can be seen in Table 1.

Table 1 showed that post-harvest processing factors were found to be significant (α=0.05) on lightness (L*) and yellowness (b*) values of green coffee samples. Besides, there is also a significant difference (α=0.05) between mechanically dried coffee samples and sundried samples on L*, where the mechanical drying produced lighter coffee than its counterpart. However, there is no significant difference on redness (a*) and yellowness (b*) amongst these two drying methods.

Physical assessment results showed general compliance of all samples being studied with quality requirement as stated in [4] such as no living insects, no spoiled aroma, maximum moisture content at

12.5 %, and maximum foreign materials at 0.5 %. The green coffee beans majority were in medium size (± 60 %) while the rest were in small size.

Table 1. Colour of green coffee beans processed under different post-harvest processing and drying methods (n=3)

Post-harvest processing	Drying	L*	a*	b*
Natural	Sun Drying	48.83 ± 3.01	-0.63 ± 1.47	12.80 ± 1.08
Semi-washed	Sun Drying	40.57 ± 4.42	0.37 ± 0.58	7.27 ± 1.60
Fully-washed	Sun Drying	42.97 ± 2.02	-0.83 ± 0.47	10.57 ± 1.06
Natural	Mechanical Drying	49.70 ± 1.20	-0.50 ± 0.80	13.10 ± 0.80
Semi-washed	Mechanical Drying	48.03 ± 1.05	-0.80 ± 0.52	11.87 ± 0.67
Fully-washed	Mechanical Drying	48.27 ± 1.43	-0.60 ± 0.56	11.53 ± 1.03
	n	3	3	3

Data mean ± standard deviation

Further investigation were performed based on this standard, particularly on coffee defects. Figure 1 presented the defective beans from all processing factors. Figure 2 showed the interval plot of total defect value based on processings. The pooled standard deviation was used to calculate this intervals. As can be inferred from this Figure 2, green coffee beans dried under the sun were found to have more defects than the mechanically dried samples where the naturally sundried coffee produced more defective beans.
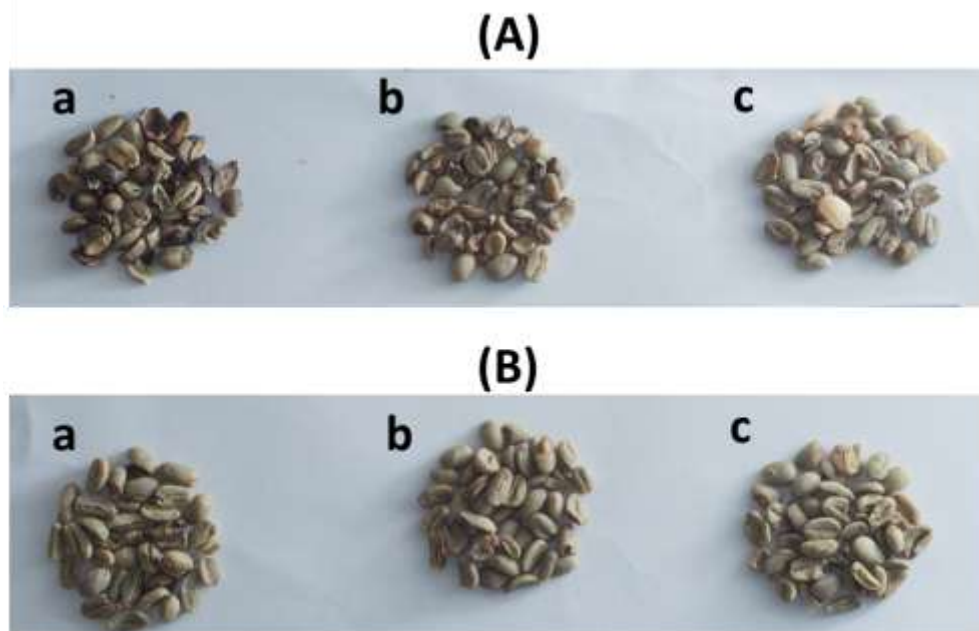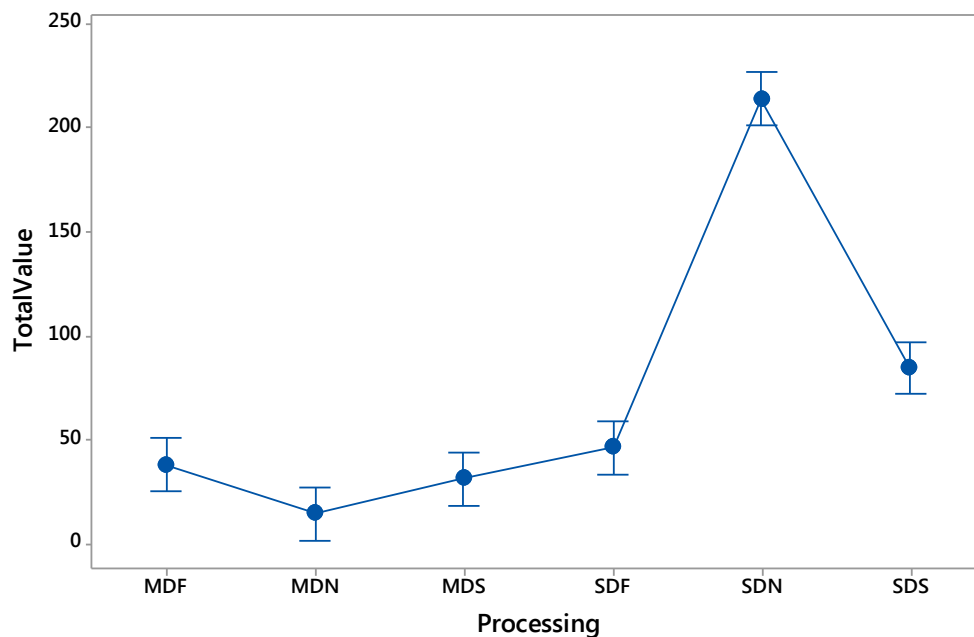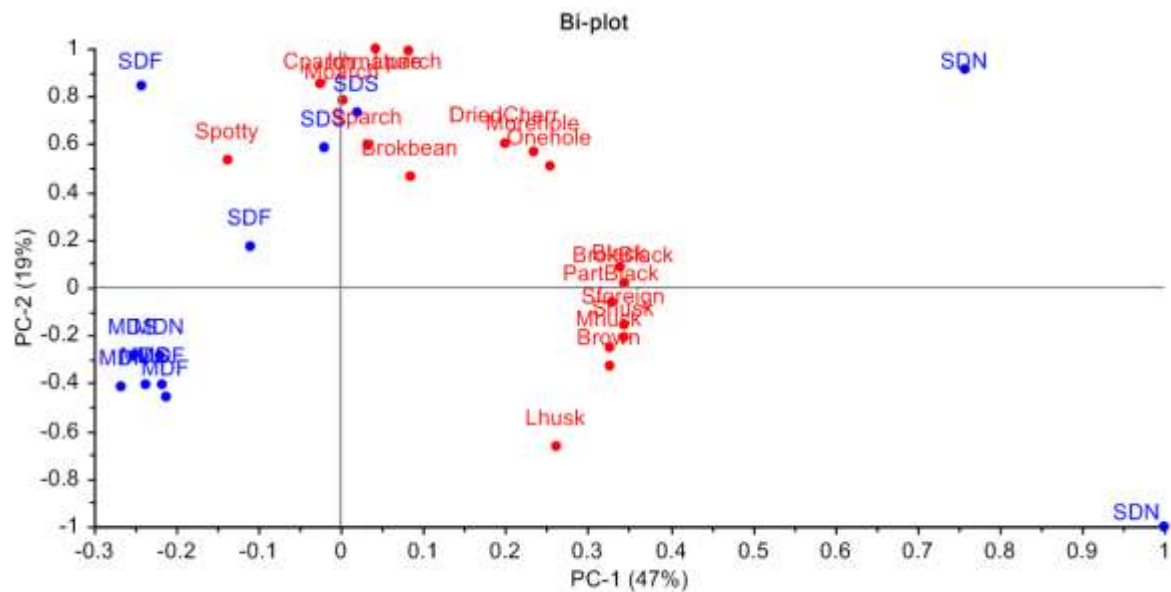

Figure 1. The defective beans from three post-harvest processing method ([a]natural, [b]semi-washed, and [c]fully-washed) dried under sundrying method (A) and machine drying method (B)

Notes: SDN (Sun drying natural), SDS (Sun drying semi-washed), SDF (Sun drying fully-washed), MDN (Machine drying natural), MDS (Machine drying semi-washed), MDF (Machine drying fully-washed)

Figure 2. Interval plot of coffee total defect value vs 6 processing 95% CI for the mean (n=2)

The data was further explored using PCA to see potential clustering in the dataset as well as relationships between variables (Figure 3). PCA was constructed on data of 20 defect variables measured on coffee processed under three different post-harvest processing and two drying methods (n=2). The PCA bi-plot revealed that defects on the naturally sundried samples were driven by some parameters such as black, partly black, brown, the presence of husk (large, medium, small size), dried cherry, and the presence of holes (one or more holes) on PC 1 (47 %). Semi- and fully-washed samples were clustered mainly due to particular defects on PC 2 (19 %) including spotty beans, broken beans, and beans with coffee parchments (large, medium, small size). Mechanical drying yield less defective beans as compared to the sun drying method. However, it should be noted that this is an initial evaluation on green coffee beans soon after processing and no prior sortation performed. This is beneficial for farmers or producers to check yield and potential losses under different processing method. Green coffee beans for commercial purposes will surely undergo series of sortation to achieve specific quality requirements.

Notes: Black (black bean), PartBlack (partly black bean), BrokBlack (broken black bean), DriedCherry (dried cherry), Brown (brown bean), Lhusk (large size coffee husk), Mhusk (medium size coffee husk), Shusk (small size coffee husk), Cparch (coffee parchment), Lparch (large size coffee parchment), Mparch (medium size coffee parchment), Sparch (small size coffee parchment), Brokbean (broken bean), Immature (immature bean), Onehole (bean with one hole), Morehole (bean with more than one hole), Spotty (spotty bean), Lforeign (large foreign material), Mforeign (medium foreign material), Sforeign (small foreign material). SDN (Sun drying natural), SDS (Sun drying semi-washed), SDF (Sun drying fully-washed), MDN (Machine drying natural), MDS (Machine drying semi-washed), MDF (Machine drying fully-washed)

Figure 3. PCA Bi-plot of 6 coffee samples (n=2) based on 20 variables, PC 1 (47%) vs PC 2 (19%)

Sensory quality of the samples were further explored. Five expert judges were employed to develop and to assess aroma attributes of the green coffee beans. Table 2 presented the definition of the aroma attributes developed during the evaluation process while the results of sensory evaluation can be seen in Figure 4.

Table 2. Description of aroma attributes.

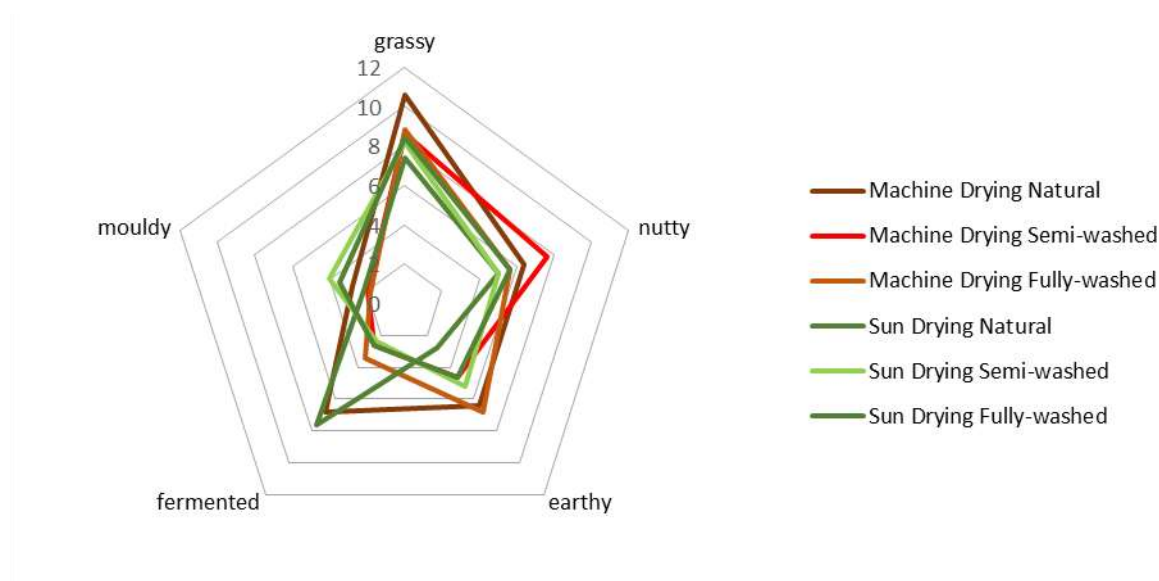| Aroma attributes	Definition
Grassy	Aroma of green grass, wet grass, menthol
Nutty	Aroma of dry peanut and other raw nuts, pea
Earthy	Aroma of earth, wet soil
Fermented	Aroma of overripe fruits, wine
Mouldy	Aroma of mould, wet mushroom, wet wood

Figure 4. Mean score of aroma of 6 green coffee beans assessed by 5 judges

Figure 4 shows an interesting results where mechanically dried samples were found to be more nutty, earthy and grassy as compared to the sundried samples. Sun drying results in more mouldy character probably due to longer drying time. The naturally processed green coffee beans were found to have the highest fermented and grassy characters than the other two processing. Washing and fermentation produced green coffee with nutty and earthy notes as the most dominant aroma. The aroma of green coffee beans might be one of an important consideration when producing certain products such as green coffee powder. Further common processing of coffee including roasting, grinding, and brewing also contributed to the conversion of coffee aroma. However, it is outside the scope of the current research.

4. Conclusion

In conclusion, post-harvest processing factors were found to influence the physical and sensory quality of green coffee beans. The mechanical drying was proven to yield a higher quality green coffee beans and minimize losses due to coffee defects. The quality of sundried green coffee products is acceptable for commercial purpose but more effort are required such as sortation process. The introduction of water and fermentation process under semi-washed and fully-washed method produced coffee with different physical and sensory characteristics. However, since all of different coffee processing will find its marketplace, the choice of processing should depend on some other factors such as environmental factor, product safety, production capability and capital investment.

Acknowledgments

References

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