Physical characteristics of Gayo arabica coffee with semi-washed processing

Sherly, H Sinaga* and E Julianti
Department of Food Science and Technology, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Indonesia.

E-mail: *hotnida.sinaga@uq.net.au

Abstract. Gayo, Aceh, Sumatera Island that are famous for producing coffee with distinctive characteristics due to the unique geographical condition and climate. The objective of this study was to determine physical quality of Gayo Green Coffee Bean using Indonesia Semi-Washed Processing Method compared to Full-Washed Processing Method (traditional method). Result showed that green bean had lower moisture content due to over exposure while drying. Green coffee bean was produced in small batch (10kg of coffee cherries) that made it easier to control over production condition which resulting in lower triage percentage and defect point. Colour and aroma of green coffee bean also indicated good result of processing which is bluish-green colour and pleasant aroma of fresh grass and sweet sugar cane aroma. Compare to full washed, semi-washed had more triage and defect point due to some processing steps which could be improved by more controlled processing steps or sortation on ready to stored green bean.

1. Introduction
Increasing demand of coffee recently had driven several increases in production of coffee in Indonesia. According to [1] Indonesia is the world number 4 coffee producer, this is improvement which in 2016, Indonesia are still world number 6 coffee producer. Sumatra island is Arabica coffee producer which contributes 30% of Indonesia national coffee production. Specialty coffee is coffee that grows in a special micro-geographic climate resulting in a distinctive and unique taste that is well-known among the international community. Specialty coffee also tends to be stated as high quality and unique coffee because of its special processing [2].

Gayo, Aceh is a large coffee producing area that has received certificate of geographical indication since 2010 as a large coffee-producing area that produces superior coffee characteristics due to the geographical conditions and climate. In 2018, Aceh 124,236,000 HA of coffee plantation with 70,774,000 Ton of coffee production. According to [3], Specialty Coffee Association of America (SCAA) categorized Gayo Arabica Coffee as Specialty coffee because of thick body, complex flavour, with distinctive aroma made Gayo Arabica coffee one of the most popular coffee on the International market.

However, the intense competition in the international market requires coffee products that are not only unique but also of high quality and sustainable. Post-harvest processing is one of the most critical factors affecting coffee quality since coffee cherries transform into green coffee bean through processing [4]. Unfortunately, the value of Indonesian coffee is also not optimal because most of the coffee beans exports are in form of green beans which could be maximized by exporting Roasted coffee bean instead.
According to [5], the problem of Indonesian Coffee marketing, especially in the international market is the low quality of the coffee production.

Semi-washed coffee processing is a combination of dry processing and wet processing/full-washed. The combination of mechanical peeling in dry processing could shorten the processing and fermentation time, therefore, wet processing can improve the coffee quality [6]. There is different style of semi-washed processed between Indonesia and another country. In another country, Ethiopia, for example, according to [7], semi-washed coffee was made by washing mucilage off immediately after pulping mainly by rubbing them on cloth until it came off and then dried until 11-12% of moisture content before hulling. According to [8], semi-washed coffee in Indonesia was made by pulping coffee mechanically and then washed of mucilage after storing and then dried until 30-35% moisture content before hulling and then dried again to desirable moisture content.

Mucilage began to come off after fermentation, indicating coffee is ready to be washed. Coffee is partially sun-dried until moisture content are around 30-35% which is enough to went through hulling. The coffee bean is sun-dried again until the moisture content reach 13% and then the coffee bean is ready to be stored. Semi-washed processing usually produce coffee with more intense flavour and bold body that support the characteristics of Sumatra coffee. Removing mucilage from coffee parchment is important since mucilage could prolong drying time and lead to the unwanted growth of microorganisms [9]. In the meanwhile, full-washed coffee processing is a conventional form of coffee processing in general. In this process, the pulp and skin of coffee cherry are removed by using water and fermentation. Mucilage could be removed by controlled washing, which is done after 12-48 hours of fermentation [8]. However, full-washed coffee had some problem which is according to [10], semi-washed coffee produced coffee with bolder body and lower acidity compare to coffee with full-washed processing. These characteristics are often believed to match with Indonesia coffee characteristic. Another purpose of most farmer while using semi-washed also because of lower requirement of water usage compare to full-washed processed. Semi-washed processed also respectively shorter in processing time. In this study, full-washed and semi-washed processing are evaluated to compare physical quality of two processing.

The economic value of coffee is determined apart from its origin as well as by its quality. In the other word, price of exported green coffee bean is defined determined based on their quality such as moisture content, defects, chemical compounds and cup tasting. Determining quality of green coffee bean must be done efficient, quick and easy to be practiced [11]. The quality of green coffee beans can affect organoleptic value of the product and consumer’s acceptance. This is because quality of green coffee bean could affect organoleptic value of the product. The aim of this study is to determine the physical quality of Gayo Coffee produced with Semi-Washed Processing.

2. Materials and methods

The raw component for this research was ripe and only red coffee cherries from Gayo, Aceh. The ideal characteristic of coffee cherry for harvesting is entirely bright red. Size and how long does cherry take to ripe depends on variety and climate with geographical condition.

2.1. Research methods

2.1.1. Semi-washed process. Gayo Coffee cherries were sorted by soaking coffee cherries in a soaking tank. The purpose of soaking coffee cherries is to distinguish floater and sinker in which floater includes cherries that does not meet standard like rotten, broken or unripe cherries and other foreign material. After soaking, coffee cherries then went through pulping to remove outer skin of coffee cherries. After pulping, coffee with mucilage still attached stored in plastic burlap 12-48 hours for fermentation. The purpose of fermentation is to remove mucilage and when the mucilage began to come off, it indicates that coffee is ready to be washed with water. After washing, coffee was dried under the sun until partially dried around 30-35% of moisture content and then went through hulling. After hulling, coffee bean then dried under the sun until 13%. After drying, green coffee bean was ready to be stored.
2.1.2. **Full-washed process.** Gayo Coffee cherries were sorted by soaking coffee cherries in a soaking tank. After soaking, coffee went through pulping to remove outer skin of coffee cherries. After pulping, coffee with mucilage still attached will be soaked in water in the soaking tank. Soaking took 12-48 hours until mucilage started to come off. Coffee then washed with water until mucilage came of entirely. After washing, coffee then dried until 13-15% before being hulled.

2.1.3. **Moisture content.** Moisture content determination of sample was carried out based on AOAC (1995) [12]. 5 grams of sample was put into aluminium plates which had been dried for 1 hour at 105°C and the weight of aluminium plates was known. The sample was heated at 105°C for three hours then cooled in a desiccator for 15 minute and then weighed. Heating and cooling are repeated until a constant sample weight is obtained. Wet basis moisture content was obtained by calculating percentage of water content from total weight of initial sample.

2.1.4. **Triage test.** Triage test was done by grading and sorting dried coffee bean manually from 300 gram of sample. Abnormal bean and bad bean were sorted and weighed. Triage was obtained by calculating percentage of weight of abnormal and bad bean from total weight of initial sample.

2.1.5. **Defect point.** Defect point was calculated according to SNI 01-2907-2008 [13]. Abnormal bean obtained from triage test then categorized and calculated according to defect point table.

2.1.6. **Colour and aroma.** Colour and aroma of green coffee bean were determined by simple observation.

2.2. **Data analysis**

This analysis used a non factorial completely randomized design with no factor with 4 replications comparing coffee from semi-washed processing and full-washed processing. Parameter analysed were moisture content, triage test, defect point, colour and aroma of green bean and size of green coffee bean.

3. **Results and discussion**

Moisture content and physical analysis on the sample including triage test, defect point and colour and aroma test can be seen in the Table 1. below. Each test was done with 4 repetition and averaged.

| Coffee type                   | Moisture content (%) | Triage test (%) | Defect point | Colour and aroma                                           |
|-------------------------------|----------------------|-----------------|--------------|------------------------------------------------------------|
| Gayo green coffee bean semi-washed | 9.829%              | 12.25%          | 26           | Bluish-green, pleasant aroma of fresh grass and sugar cane |
| Gayo green coffee bean Full-Washed | 9.774%              | 11.5%           | 24           | Greenish, Pleasant aroma Sugar cane and basmati rice       |

In semi-washed processing, water usage was no necessary as much as full-washed. Water were used when coffee cherry is soaked in soaking tank for sorting and when washing off mucilage after fermentation. While in full-washed, water was used in sorting, soaking for fermentation and bean washing after fermentation. Semi-washed is a good option for farmer in an area that has sort water supply.

The determinant of whether the coffee bean has finished fermentation and ready to be washed is the mucilage. If the coffee beans are not sticky and began to had rough surface, then fermentation would be stopped and the coffee bean will be washed. The duration of fermentation depends on climate since it...
will affect the temperature of fermentation. There is no difference in fermentation time in semi-washed or full-washed processing which the fermentation was done in 24 hours.

3.1. Moisture content
Moisture content is one of the most important coffee quality point because it relates to shelf life, texture, appearance and cup taste [14]. In the coffee industry, moisture content is the benchmark whether it is done or not coffee drying is completed. Usually, farmer will use Ceratester to test moisture content of coffee bean.

In this study, moisture content tested using oven method. Semi-washed green coffee bean and full-washed had 9-10% moisture content after dried under the sun and ready to be stored. Excessive drying is due to hot climate in Indonesia which causes rapid evaporation of water and small batch of coffee process causing coffee to dried easily. Moisture content of both semi-washed and full-washed coffee were similar because the products were dried under the same condition and controlled by measuring moisture content before storing so it is stored at the same moisture content level.

The same result was obtained by other researcher [15], in which final moisture content of Gayo semi-washed green coffee bean is 9.32%. The resulted moisture content was in accordance with Indonesia Standards SNI which is good enough according to SNI and good in condition for storing according to experienced local farmer from Gayo. Maximum moisture content of stored coffee bean according to SNI 01-2907-2008 which show the product is in good condition for storing according to experienced local farmer from Gayo. The moisture content of coffee beans must always be checked before they are stored. Previous study [16] and SNI suggested that moisture content between 8-12% is suitable for green coffee bean storage to avoid microbial growth and altered sensory quality of coffee.

3.2. Triage test
Triage or ‘Trase’ or ‘defect’ were obtained from 300 gram of coffee sample. The higher the triage percentage, the worse the quality of the coffee bean. Defect obtained from green coffee bean were done manually by picking abnormal beans which later were classified at coffee defect point test. Defective coffee beans after coffee production processes represented around 15-20% on weight basis [17].

Low triage percentage in the study were caused by small batch of production which led to more selected raw material and more controlled condition of production than industries large scale production. In a large scale production, it tends to have foreign material enter during drying process and the coffee cherries that are unripe or bad. This condition results in a high triage percentage.

Semi-washed green coffee bean appeared to have higher triage point than full-washed coffee. In full-washed processing, drying was conducted only once and the step of processing were fewer than semi-washed process. This is simpler method during processing could minimise foreign material (like pebble, stone or dry leaf) contamination while the product is sun dried. In contrast, during semi-washed processing, coffee bean was hulled when moisture content still quite high which cause coffee bean easily damaged and broken into smaller pieces.

Similar result was found by other study [18], in which, higher defect value was obtained from sundried semi-washed processes compare to processing with full-washed. Defects mainly are spotty beans, broken beans and coffee with parchment. Defects are affected by post-processing method and drying method, where sundried coffee appeared to had higher defects percentage than mechanical drying.

3.3. Defect point
Coffee grading was carried out based on defects points in 300 gram of green coffee bean. Coffee grading was done manually by counting the number of defects in the sample [19]. Regulation for determining coffee defects point in Indonesia are determined based on SNI 01-2907-2008 or by SCAA standard. The higher the defects point in coffee, the lower the grade of the coffee bean quality.

It is shown earlier in Table 1. That defect point of that Gayo Green Coffee Bean with semi-washed processed were 26 and 24 respectively. Processed were done in small batch and using only ripe and red
coffee cherry resulting in lower defects point. More defect point on semi-washed was caused by higher level of broken beans due to hulling processed that were done while beans were still high in moisture content level and coffee that still had parchment attached. This led to crack even broken of coffee beans caused higher defect point.

In this study, sundried semi-washed coffee was more exposed to defects such as coffee parchment, spotty bean and broken bean. Sundried full-washed were least exposed to defect. Semi-washed defect is most likely spotty and broken bean than that full-washed processing. This result was in line with previous study [17], which reported that hulling the beans at moisture content 30% could lead to some coffee parchment.

3.4. Colour and aroma

Colour and odour test of green coffee were carried out by simple observation. Gayo green coffee bean with semi-washed processed showed pleasant aroma of fresh grass dan sweet aroma of sugar cane which indicate that green coffee bean is fresh and has not been stored for a long time. Other study noted that, the longer the coffee is stored, the more it will develop flat, woody and stale aroma [20]. In addition, colour of green coffee bean is significantly affected by storage duration [21]. According to SCAA standard [22], only Blue- green, green-bluish or bluish green and green are qualified to be specialty coffee.

Both semi-washed and full-washed coffee had different but still pleasant aroma. According to [23], while treated with good processing, drying and harvesting of coffee cherry will prevent green bean from having unpleasant odour. The difference in aroma between Semi-Washed and full-washed was caused by different fermentation process. According to [24] sugar in coffee mucilage was break down by microorganism like bacteria, yeast and fungi and then they produce alcohols and acid that affected aroma and taste of coffee.

Previous study [4], also reported that sundried semi-washed coffee is higher in compared redness colour than sundried full-washed coffee that are lighter and more greenish. Moreover, odour of semi-washed green coffee bean also more grassy and earthy while sundried full-washed are more fermented and grassier. It was found that the colour of Java arabica coffee [17], was different with the colour of Gayo arabica coffee used in this study. Different origin could produce different characteristic though going through same processing due to genetic, environmental and chemical composition [25].

4. Conclusions

Gayo green coffee bean with semi-washed processed had higher triage and defect points compare to full-washed processed. However, semi-washed coffee is still acceptable because triage and defects point are still categorized in “Muti 2” (2nd grade Quality) according to SNI 01-2907-2008. Although the colour and odour of both coffee processing are different. Pleasant odour, bluish and greenish colour of green bean are the sign of acceptable green coffee bean. This finding result can be used as preliminary study for evaluating the effect of coffee processing method and roasting degree on physiochemistry and sensory quality of Gayo Specialty Coffee. Future examination on cupping test is required.

References
[1] International Coffee Organization 2018 Trade Statistics International Coffee Organization Available from: http://www.ico.org/trade_statistics.asp
[2] Saragih J R 2018 Aspek ekologis dan determinan produksi kopi arabika spesialti di wilayah dataran tinggi Sumatera Utara [Ecological aspects and determinant of arabica specialty coffee production in Sumatera Utara highland] Jurnal Wilayah dan Lingkungan 6 pp 74–87
[3] Mawardi S 2008 Panduan Budidaya dan Pengolahan Kopi Arabika Gayo [Guidance of Gayo Culture and Arabica Coffee Processing] (Banda Aceh: Pusat Penelitian Kopi dan Kakao Indonesia [Indonesian Coffee and Cocoa Research Center])
[4] Sunarharum W B, Yuwono S S and Nadhiroh H 2018 Effect of different post harvest processing on the sensory profile of Java arabica coffee Advances in Food Science, Sustainable Agriculture
and Agroindustrial Engineering 1 pp 9–13

[5] Kustiari R 2007 Perkembangan pasar kopi dunia dan implikasinya bagi Indonesia [Market development of world coffee and its implication for Indonesia] Forum Penelitian Agro Ekonomi 25 1 pp 43–55

[6] Cortez J G and Meneez H C 2000 Coffee Biotechnology and Quality: Recent developments in brazilian coffee quality: new processing systems, beverage characteristics and consumen preferences Proceedings of the 3rd International Seminar on Biotechnology in the Coffee Agro-Industry, Londrina, Brazil pp 339–46

[7] Ameyu M A 2017 Influence of havesting and postharvest processing methods on the quality of arabica coffe (Coffea arabica L.) in Eastern Ethiopia ISABB. J. Food Agric. Sci. 7 1 pp 1–9

[8] Poltronieri P and Rossi F 2016 Challenges in specialty coffee processing and quality assurance Challenges 7 19 pp 1–22

[9] Haile M and Kang W H 2019 Review Article: The role of microbes in coffee fermentation and their impact on coffee quality Journal of Food Quality ed S Fiszman 2019 p 1–6

[10] Suswono 2012 Pedoman pasca panen kopi [A guide of coffee Post Harvest] Lampiran Peraturan Menteri Pertanian Nomor 52/Permentan/OT.149/9/2012 [Attachement of Regulation of Agriculture Ministry Number 52/Permentan/OT.149/9/2012] Available from: http://ditjenpp.kemenkumham.go.id/arsip/bn/2012/bn909-2012lamp.pdf

[11] Bicho N C, Leita O A N E, Ramalho J C and Lidon F C 2014 Application of colour parameters for assessing the quality of arabica and robusta green coffee Emir. J. Food Agric. 26 1 pp 9–17

[12] AOAC 1995 Official Methods of Analysis (Washington D.C: The Association of Official Analytical Chemists)

[13] Badan Standardisasi Nasional [BSN- National Standardization] 2008 Biji Kopi [Coffee bean] SNI 01-2907-2008 (Jakarta, Indonesia: Badan Standardisasi Nasional Indonesia [BSN- National Standardization of Indonesia])

[14] Rita H, Marlihah A and Rosita F 2012 Sifat kimia dan evaluasi sensori bubuk arabika [Chemical characteristics and sensory evaluation of arabica coffee powder] J. Floratek 7 pp 66–75

[15] Hardi A, Ichwana and Khatir R 2019 Kajian pengering kopi Gayo semi basah menggunakan alat pengereng tipe hohenheim [Study of drying semi washed Gayo coffee use dryer type hohenhiem] Jurnal Ilmiah Mahasiswa Pertanian 4 pp 353–61

[16] Caporaso N, Whitworth M B, Greby S and Fisk I D 2018 Rapid Prediction of single green coffee bean moisture and lipid content by hyperspectral imaging J Food Eng. 227 pp 18-29

[17] Ramalaksmi K, Kupra I R, and Rao L J M 2007 Physicochemical Characteristics of green coffee: comparison of graded and defective beans J Food Sci. 72 5 pp 333–7

[18] Sunarharum W B, Yuwono S S, Pangestu N B S W and Nadhiroh H 2018 Physical and sensory quality of Java arabica green coffee beans. IOP Conf. Ser.: Earth Environ. Sci 131 p 1-6

[19] Kusumo J J 2014 Rancang bangun perangkat lunak mengklasifikasi kualitas biji kopi dengan metode backpropagation (study kasus: material warehouse PT. Santos Jaya Abadi) [Software design to classify the quality of coffee beans with backpropagation method (case study: material warehouse PT. Santos Jaya Abadi)] Jurnal Tugas Akhir Universitas Narotama p 1-10

[20] Selmar D, Bytolf G and Knopp S-E 2008 The storage of green coffee (Coffea arabica); decrease of viability and changes of potential aroma precursors Annals of Botany Company 101 pp 31–8

[21] Yusianto, Hulupi R, Sulistyowati, Mawardi S and Ismayadi C 2007 Mutu fisik dan cita rasa beberapa varietas kopi arabika harapan pada beberapa periode penyimpanan [Physical and flavour quality of some potential varieties of arabica coffee in several interval storage periods] Perkebunan 23 3 pp 205–230

[22] Specialty Coffee Association of America (SCAA) 2009 SCAA Protocols-Grading Green Coffee pp 1-2 Available from: https://www.scaa.org/PDF/resources/grading-green-coffee.pdf

[23] Tesfa M 2019 Effect of drying methods on raw quality of selected cultivars of arabica coffee (Coffea arabica L. ) grown in South West, Ethiopia International Journal of Science and Research 8 11 pp 1412–20
[24] Klingel T, Kreemer J I, Gottstein V, Rezende T R D, Schwarz S and Lachenmeier D W 2020 A review of coffee by-products including leaf, flower, cherry, husk, silver skin, and spent grounds as novel food within European Union *Foods* 9 665 pp 1–20

[25] Gloes A N, Vietri A, Wieland F, Smrke S, Schonbachler B, Lopez J A S, Petrozzi S, Bongers S Koziorowski T and Yeretzian C 2014 Evidence of different flavour formation dynamics by roasting coffee from different origins; on-line analysis with PTR-ToF-MS *International Journal of Mass Spectrometry* 366 pp 324–37