Effect of varieties and processing practices on the physical and sensory characteristics of Gayo Arabica specialty coffee

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Effect of varieties and processing practices on the physical and sensory characteristics of Gayo Arabica specialty coffee

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Abstract. Nowadays, sensory characteristics are considered as basic requirement for coffee quality, which determined its future commercial value. Gayo Arabica coffee is one of specialty coffees known by international buyers due to its unique taste and complex aroma. However, the sensory characteristics of gayo arabica coffee vary based on type of local varieties and the processing technique practiced. The present study aims to determine the effect of variety and processing methods towards physical and sensory properties of Gayo Arabica coffee. Four Gayo local varieties (Tim-tim, Borbor, Ateng Super and Multi-varieties) and three processing practices (full-wash, semi-wash and honey natural process) were investigated. The measured parameters were moisture contents and cupping quality based on Specialty Coffee Association of America (SCAA) procedure. The statistical analysis showed that local varieties and processing attributes has significant influenced ($P \leq 0.01$) on the certain sensory attributes. The interaction of both factors showed significant effects ($P \leq 0.01$) towards flavour, acidity and balance attributes. Ateng Super variety showed a high score of overall cupping attributes whilst among processing practices it showed no differences. In conclusion, all experiments produced specialty coffee based on SCAA cupping test. Ateng Super local varieties showed the highest score (85.36±0.14) and full-wash processing produced the highest cupping quality compared to others (84.79±0.03). The Q-grader also remarked that Gayo Arabica coffee has distinguished flavours such as chocolate, dark-chocolate, caramel, nutty and spicy in all experiments. However, several unpleasant remarks also appeared in honey natural process such as sour, slightly aged and over fermented taste.

1. Introduction

World coffee consumption has grown steadily in the last few years and rises up to 158,901,000 bags (60 kg per bags*)* in 2017. This figure is depicting an increase of 4.7% in coffee consumption, compared to that of 2014. As coffee consumption grows, number of consumer who requires a good quality coffee also increases, especially consumer who wants a specialty grade coffee, [1, 2]. It has also reported that export market of Indonesian coffee (both robusta and arabica) increases by 25% in 2017 [3,4]. Therefore, Indonesia, as the third world coffee producer who produced 10,902,000 bags of

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green bean in 2017, became an important supplier of good quality coffee. Therefore, Indonesian farmer should improve their farming practice, as well as maintain their coffee bean quality.

Consumer drinks coffee mainly because of its magnificent taste and the health benefit. A good quality coffee should have a high cup score and provide a great taste demanded by coffee drinkers. Coffee taste (cup quality) relates strongly with its green bean quality, including variety, geographical location, farm altitude, harvesting practice, postharvest handling, and storage [5], continued with roasting process [6]. Flament and Thomas [7] mentioned that, due to heat application, bean roasting has triggered chemical reaction, named as Maillard reactions, which is leading to the formation of unique chemical compound which will impart specific flavour characteristics and taste of coffee. Type and amount of compound formed highly depend on the composition of precursors available in the green bean. One type of coffee may produce different compositions of volatile and non-volatile compound resulting in a quiet different coffee flavour, taste and aroma [8].

One of the main region producing arabica coffee in Indonesia is Gayo Highland (in Aceh Province), which contribute to about 60-70% of Indonesian arabica coffee production. As demand and price of Arabica coffee increases, as well as the shifting trend towards specialty and single origin specialty coffee. Farmers or coffee producers are forced to improve their practices and coffee quality, in order to win the competition in world market. For the case of arabica Gayo coffee, it has known in the world market as one of Indonesian specialty coffee with a premium quality, but improper postharvest handling and processing practices actually block out this chance.

Farmers in the Gayo Highland area carry out several processing methods such as full wash, semi wash, honey natural and few others. However, the quality needs to be improved [9]. Abubakar et al. [10] reported that processing methods and coffee variety influenced sensory characteristic of gayo arabica coffee. Furthermore, they reported that superior local variety such as Tim-Tim, Borbor, and Ateng Super produced different flavour characteristic when harvested from farms at different altitude. Farmers or collectors who plan to produce high quality coffee should consider these factors. Unfortunately, the relationship among these factors has not explored widely yet, especially the influence between superior varieties and processing methods, which was designed to be objective of this study. The results of this research is expected to be used by farmers to optimize their processing technique to obtain a high quality coffee, which in turn will increase the coffee price and their income accordingly.

2. Material and methodology

This research used randomized complete block design with two factors, the first factor was Gayo local varieties (V1: Tim-tim; V2: Borbor 2; V3: Ateng Super or Dwarf Tree and V4: Multi-varieties) and the second factor was green bean processing (P1= full-wash, P2= semi-wash and P3= honey natural process). Each treatment was repeated three times, which made the total number of samples to be 36. The data then analyzed by ANOVA and Duncan Multi Range Test with SPSS version 20.0.

The green bean processing was conducted in the farm plantation areas, whilst the moisture contents analyzed in Food Analysis and Agricultural Product Laboratory- Department of Agricultural Product Technology – Syiah Kuala University. The cupping test and physical appearance were conducted by Gayo Cupper Team (GCT) as Q-Grader in Takengon, Central Aceh- Indonesia.

Materials used in this research was Arabica coffee (*Coffea arabica,* L), specifically three local varieties which were mostly planted in Gayo Highland, Aceh Tengah, Indonesia. Tim-tim (V1) was collected from coffee farmers in Bies with elevation 1400 meter above sea level (m.asl). Borbor was collected from Pilar Jaya, Aceh Tengah with elevation 1600-1700 m.asl, then Ateng Super was gathered from Bies Penantan farmers, which has elevation around 1500 m.asl. For Multi-varieties, which refers to mixed variety in Gayo Highland, was collected from Bies and Bies Penantan farmers. The recommendation of elevation level for each variety refers to [10].

The research procedures divided onto three stages, which were collection of coffee cherries in the location mentioned above, green bean processing based on treatment levels and the analytical procedures. Green bean processing stages were divided onto three categories, full wash, semi wash

and honey natural. Full wash (P1) and semi wash (P2) were started with pulping the coffee cherries. Then for full wash (P1) the beans were rinsed and soaked onto water overnight, then it was washed up until clean. Later, the coffee was dried up with sun drying until the moisture content reached approximately 10-12%, then the grain was hulled to obtain the full-wash green bean. For semi wash (P2) the wet beans were rinsed and fermented in container (without water) overnight, then it was washed until clean and dried up under the sun until it reached about 35-40% moisture contents. Then they were hulled to remove the coffee parchment (to produce "kopi labu"; a local term for the half wet bean) and then was continued with sun-drying until moisture contents reached 10-12%. For honey natural process (P3), it refers to pulped dry process, where after pulping, the grains were directly sun-dried until their moisture reached 10-12%. Then the dry coffee grain was hulled to obtain the green bean.

GCT who were professional team recognized by local authority and accessed by coffee exporter did cupping test. The team has three members holding Q-grader certificates that recognized by international buyers. Cupping test was an assessment of sensory quality by descriptive method based on Specialty Coffee Association of America [12]. The coffee preparation started by roasting the coffee bean at maximum one day prior to analysis. The roasting was done in medium roasting degree with colour associated with 55 Agtron scale. Then the coffee bean is ground up to 20 meshes. The brewing techniques started with poured 8.25 gr of grounded coffee with 150 ml hot water (93^{o}C). During the test, both ground and brewed coffee were used.

The cup test objectively measured coffee quality based on ten attributes (fragrance/aroma, flavour, acidity, aftertaste, body, balance, uniformity, clean cup, sweetness and overall). All of the sensory attributes were assessed sequentially. Fragrance and aroma firstly examined during 3-5 min after brewing. Fragrance note was also done at first step, by noising the ground coffee to detect the characteristics of the coffee. The second step was involved flavour, acidity, aftertaste, body and balance, where the temperature of coffee drink was around 71^{o}C, which is commonly occurred roughly 8-10 min from the infusion. The last step was assessment of uniformity, clean cup, sweetness and overall. Finally, when the cupping test were done, all the notes and scores were marked on the cupping form. The score using numeric values from 6 to 9 is shown in table 1. The validity of each score is based on the flavor judgement experiences of the trained assessor. Later the total score was summed up, as accumulation of all individual score of all attributes constitutes. In order to obtain final scores, the defect value was subtracted from the total score. Final score represents the overall quality of the coffee. Scoring key has proven to be a meaningful way to describe the range of coffee quality for the final score.

3. Results and discussion

3.1 Sensory Profile of Gayo Arabica Coffee Single Origin Based on Processing Methods

Sensory profile of gayo arabica coffee single origin based on different processing methods are shown in Table 1. All of local varieties were classified as specialty coffee, even when it was treated in different processing methods. The Ateng Super local varieties obtained the highest score amongst others (85.36±0.14) and full-wash processing produced the highest cupping quality compared to others (84.79±0.03). It could be observed that for Tim-tim (V1) and Borbor (V2) varieties, full-wash processing method produced coffee with highest cupping score compared to that of other processes. However, Ateng Super or Dwarf Tree (V3) variety processed with honey natural method produced coffee with higher cupping score, while Multi-varieties (V4) obtained high final score if processed with semi-wash method. Bhumiratna et al. [13] mentioned that fragrance of coffee characterized by the origin of coffee varieties. However, it is not considered as the main cause, because coffee quality is influenced by numerous factors and holistic coffee processing practice [14]. As for full-wash and honey natural processing, full-wash tended to produce more aromatic fragrance such as fruity, floral and acidic attributes (sour) as shown in table 3 for both Tim-tim and Borbor varieties. This finding is supported also by Duarte et al. [15] and Leloup et al. [16] who observed that the full wash method

produced more acidic attributes and less bitter, burnt and woody notes, as an impact of the mucilage removal during the wet or full wash process. Mucilage removal is considered as a cause of undesirable fragrance such as soury, herby or greenish which usually found in green bean coffee [13] [17].

In contrast, semi wash process which is a common coffee processing practice originated from Gayo Highland, ultimately can be considered as the main caused of pleasant nutty, choco or chocolate like notes where these notes are regularly found as characters of semi wash process, as presented in table 3 and also highlighted by [10]. Nutty flavor can be defined as a light, brown, slightly musty aromatic flavor associated with nuts where Choco-like or chocolate like refers to sweet, dusty often bitter aromatics associated with cocoa beans or cacao derived product [13].

Table 1. Total score and fragrance remarks of all treatment combinations

Treatments	Final Score	Fragrance Remarks
V1P1	84.76±0.24	Spicy, floral, nutty, grassy, citrusy, Choco-powder, salty, tobacco.
V1P2	84.17±0.38	2/5 sour, over ripe, 1/5 fermented, floral, syrupy, fruity, brown tea.
V1P3	83.67±0.52	Dark Choco, nutty, floral, caramel, citrusy, syrupy, greenish, tobacco.
V2P1	84.75±1.09	Spicy, sugar palm, creamy, toasty, grassy, Choco, fruity, chocolate,.
V2P2	84.00±1.00	Floral, tea like, grassy, malty, syrupy, dry fruit, pineapple, chocolate.
V2P3	83.75±.1.00	Choco, dark caramel, nutty, fruity, malty, spicy, herby, bold, tobacco.
V3P1	85.00±0.87	Bright Choco powder, nutty, fruity, grassy, sugar brown, citrusy.
V3P2	85.25±0.25	Fruity, black tea, floral, over ripe, juicy, chocolate, herby, tobacco.
V3P3	85.83±0.58	Spicy, floral, bright nutty, grassy, citrusy, Choco-powder, tobacco.
V4P1	84.67±1.01	2/5 sour, over ripe, 1/5 fermented, banana, floral, syrupy, fruit tea like.
V4P2	84.92±0.80	Dark Choco, nutty, floral, caramel, citrusy, syrupy, greenish, biscuit.
V4P3	84.33±0.76	Spicy, sugar palm, creamy, toasty, grassy, greenish, Choco, fruity.
Average	84.59	

Table 2. Influence of local varieties, processing method and their interaction towards parameters

Measured Parameters	Local Varieties (V)		Processing Methods (P)		Interaction	
	F-Table	F Value	F-Table	F Value	F-Table	F Value
Moistures[ns]		0.41		0.02		1.18
Fragrance**		8.51		0.02		0.89
Flavour**		6.03		0.68		3.68
Aftertaste[ns]		2.92		0.14		2.50
Acidity*	4.72	2.21	5.61	1.25	2.51	2.92
Body**		7.92		12.80		1.05
Balance*		2.17		3.65		3.59
Overall**		7.92		7.44		1.35
Total**		6.46		1.10		1.58

[ns] Factors and its interaction do not have any significant influence on the measured parameter.
*/** Certain factor has significant/very significant influence towards the measured parameter.

3.2. Fragrance attribute

Fragrance attribute of Gayo single origin coffee were varied from 7.60 to 8.16 (very good to excellent quality scale) with a mean value of 7.98±0.04 (excellent) as shown in Figure 1. As stated in Table 2, only local varieties had significant (P≤0.0) influenced on this attributes, where all treated varieties were significantly different from each other. Ateng Super yielded the highest score of fragrance (8.16) amongst others, whereas Tim-tim placed as the lowest while Borbor and Multi-varieties were in between. These observations are supported by Hulupi et al. [18] who stated that in term of fragrance, which measured quality of ground coffee aroma, Tim-tim has lower score than Borbor. As the local varieties used here were considered as of optimum quality based on its farm elevation referred to [10], the results were satisfactory since all of varieties were yielded very good up to outstanding qualification, according to SCAA standard.

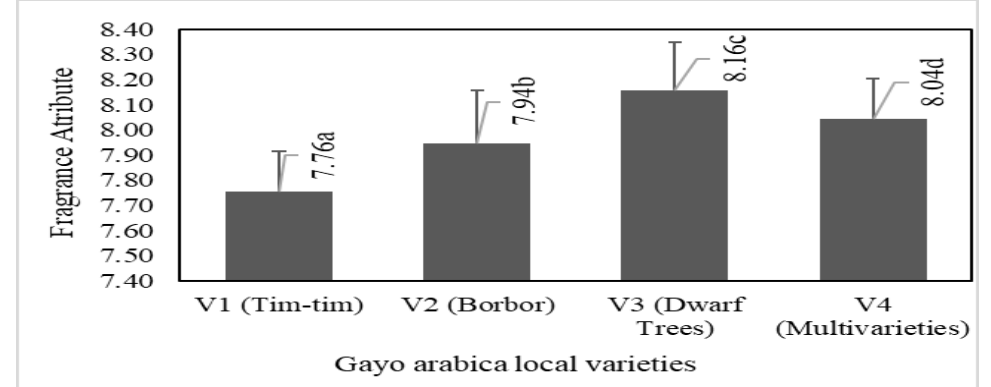

Figure 1. Influence of local varieties (P≤0.01) on fragrance attributes of Gayo Arabica coffee, $DMRT_{0.05}$= 0.179, 0.189 and 0.195 (numbers which followed by different alphabet showed significant differences).

3.3. Flavor attribute

Table 3. Effect of interaction factors on flavor, acidity and balance attribut**es**

Treatments	Flavor	Acidity	Balance
V1P1	7.93±0.12b	7.50±0.00a	8.00±0.00b
V2P1	7.93±0.12b	7.93±0.17b	7.87±0.12ab
V3P1	7.87±0.12b	7.60±0.17ab	7.60±0.17a
V4P1	8.00±0.00c	7.53±0.25a	7.60±0.17a
V1P2	7.80±0.00b	7.50±0.00a	8.00±0.00b
V2P2	7.93±0.12b	7.93±0.29b	7.70±0.17ab
V3P2	7.93±0.12b	7.80±0.00b	7.83±0.29ab
V4P2	7.93±0.12b	7.70±0.17ab	7.88±0.12ab
V1P3	7.60±0.17a	7.87±0.12b	7.60±0.17a
V2P3	7.90±0.10b	7.90±0.29b	7.67±0.15a
V3P3	8.10±0.17c	7.80±0.00b	7.87±0.12ab
V4P3	7.93±0.12b	7.60±0.17ab	7.60±0.17a
DMRT0.05	0.180-0.210	0.266-0.312	0.249-0.298

numbers which followed by different alphabet showed significant differences).

Flavor of Gayo single origin coffee were varied from 7.60 to 8.10 (very good to excellent quality scale) with an average score of 7.91±0.05 (excellent) based on SCAA standards. Variability of flavors among local varieties processed by semi wash and full wash were very small, except flavor of multi-varieties processed by full wash that differed significantly from others. However, variability of flavors of local coffee processed by honey natural method were very significant. Within honey natural process, flavor of Ateng Super which was the highest, differed significantly from the other three varieties, whereas flavor of Tim-tim being the lowest and those of Borbor and Multi-varieties were in between (Table 3). Tim-tim and Borbor has been suggested to be planted in farm with elevation above 1200 m.asl for diseases and cupping quality reasons [18]. Moreover, Abubakar et al. [10] also found that Tim-tim harvested from farm at 1200 m.asl and Borbor from 1600-1700 m.asl yielded a higher cupping scores than those from lower or higher farm elevation level. Ateng Super, as a hybrid of Katai varieties, showed good cupping quality on flavor and fragrance.

3.4. Acidity attribute

Acidity attributes from all coffee samples were varied between 7.47 and 7.87 (very good scale quality) with an average score of 7.63±0.07 (very good). The ANOVA assumed that only interaction between the two factors that had significant influenced to the acidity of brewed coffee. Table 3 shows that Borbor variety yielded the highest acidity scores in all processing methods examined in this research, where the acidity of each variety were comparable across all processing method. However, it is extremely surprising that Tim-tim variety processed by full wash and semi wash methods yielded the bean with the lowest acidity score compared to that of honey natural method. Ateng Super and Multi-varieties have similar range of acidity in all processing methods. For the multi-varieties, this could occur due to the absence of characteristics notes, as multi-varieties were coming from or a mix of all varieties planted in the region. Some researchers also proposed that acidity could be influenced by climate condition as well as farm elevation [20]. In this research, Borbor were manually harvested from the areas, which was higher than that of other varieties (1600-1700 m.asl).

It can be seen in Figure 3 that wet processing, for both full wash and semi wash, produced coffee with higher acidity. The acidity from wet process was significantly different from the one that from honey natural, which was considered as dry process. This finding is also supported by Mazzafera and Purcino [21] who mentioned that wet processing has superior coffee with higher acidity and more aroma than the coffee obtained from dry process. The differences were due to the impact of pulping and fermentation process [22].

3.5 Balance attribute

Balance score was varied from 7.60 to 8.00 in all samples (very good to excellent quality) with a mean value of 7.77±0.04 (very good). ANOVA showed that processing method and interaction from both factors had significant influences on balance, as presented in Table 3. Tim-tim had superior balance score over the other varieties when it was produced in wet process, but the score was declined when it was processed using honey natural method (dry process). Furthermore, the balance score of Ateng Super and Multi-varieties appeared to be higher when semi wash process was applied. Moreover, honey natural process seemed to produce lesser balance score over the other processing methods across the varieties, except for Ateng Super which produced a higher balance score compared to that of the other two methods. Balance which defines as an equilibrium of flavor, acidity, aftertaste and body is considered as prominent quality standard of specialty coffee. Therefore, wet process, which is assumed could preserve intrinsic quality of each local variety yields higher score than the natural method.

3.6 Body attributes

Body of single origin arabica coffee produced from this research varied from 7.87 to 8.27 (very good to excellent quality) with an average score of 7.99±0.08 (excellent). ANOVA showed that both factors have significantly influenced ($P \leq 0.01$) the body attributes as seen in figure 4 and figure 5. Figure 4

shows that Tim-tim yielded the lowest score for the body while Ateng Super and Multi-varieties were claimed as the varieties with the highest body, which were significantly different (P≤0.01) from Tim-tim. Hulupi et al. [18] also reported that Borbor variety had higher body score than Tim-tim. This was due to the genotype source of each local variety, which were habitually and indigenously selected by farmers, which should be explored in detail in the future. However, for Multi-varieties, the logical reasons could be resolved, as the sample consisted of a mix of the other three varieties.

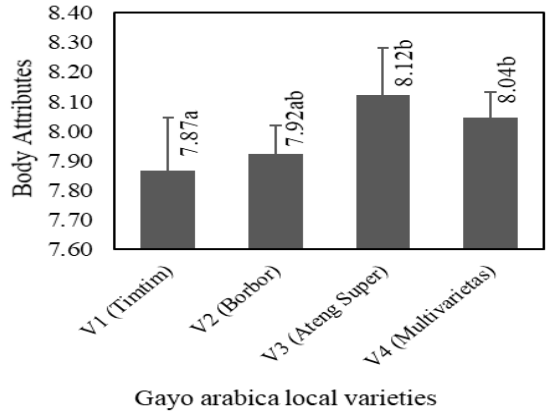

Figure 4. Influence of local varieties (P≤0.01) on body attribute of Gayo Arabica coffee, $DMRT_{0.05}$=0.21; 0.22; 0.23 (numbers which followed by different alphabet showed significant differences).

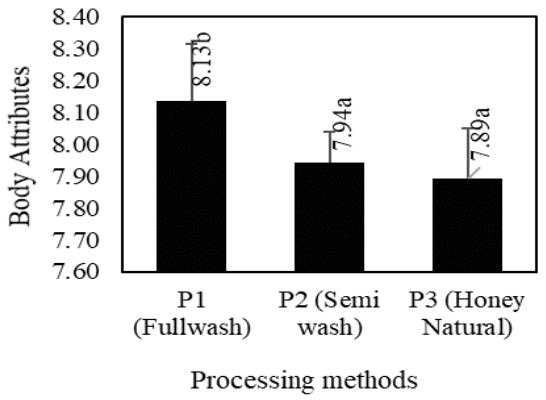

Figure 5. Influence of processing methods (P≤0.01) on body attribute of Gayo Arabica coffee, $DMRT_{0.05}$=0.21; 0.22 (numbers which followed by different alphabet showed significant differences).

3.7 Overall attribute

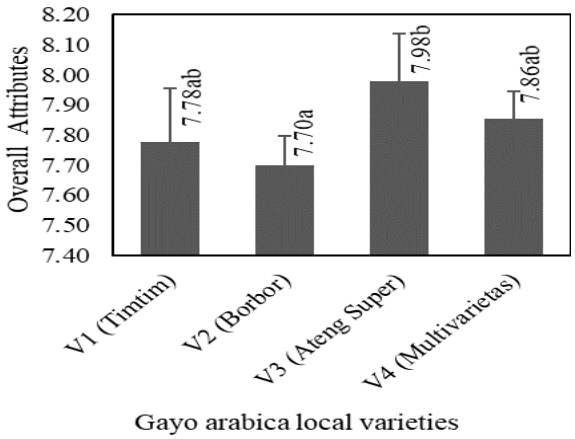

Figure 7. Influence of local varieties (P≤0.01) on overall attributes of Gayo Arabica coffee, , $DMRT_{0.05}$=0.21; 0.22; 0.23 (numbers which followed by different alphabet showed significant differences).

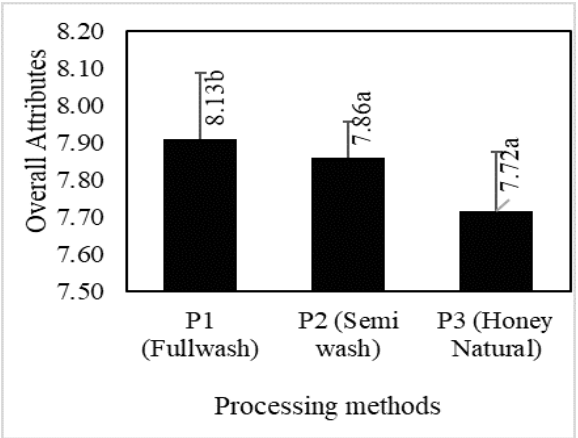

Figure 8. Influence of processing methods (P≤0.01) on overall attributes of Gayo Arabica coffee, $DMRT_{0.05}$=0.21; 0.22 (numbers which followed by different alphabet showed significant differences).

Overall score was in range of 7.60 to 8.00 with an average score of 7.83±0.10 (very good to excellent quality) based on SCAA quality scale. Then ANOVA assumed that both factors have significant influences on overall attributes, as presented in figure 7 and figure 8. Figure 7 shows that Ateng Super variety was assumed superior in terms of overall attributes, as well as other sensory attributes, but it only showed significant differences to that of Borbor variety. Borbor which was considered as variety with lowest overall attribute, showed no significant differences to those of Multi-varieties and Tim-tim.

Moreover, figure 8 shows the effect of coffee processing method on the overall attributes of Gayo arabica coffee single origin. As overall attribute measures the level of homogenization of the sensory attributes over the samples in five cup assessments, full wash processing methods showed the highest score over the other two methods in this research. As proposed by several researchers [13], [17], [14] and [23], wet process techniques, either full or semi wash methods are able to minimize coffee bean defects during green bean processing compared to dry process or honey natural process.

4 Conclusion

It can be concluded that the three local varieties of Gayo arabica coffee yield a specialty-coffee quality with specific characteristics notes, which are varied across the samples. Full wash and semi wash methods appeared to maintain the intrinsic quality of Tim-tim and Borbor and produces a "very good specialty" quality-classification compared to that of honey natural process for both mentioned varieties. In general, Ateng Super variety showed the highest score (85.36±0.14), while full-wash processing methods produced the highest cupping quality (84.79±0.03) compared to others. The Q-grader also remarked that Gayo Arabica coffee has distinguished flavour such as chocolate, dark-chocolate, caramel, nutty and spicy in all experiments. Furthermore, honey natural processing method can improve balance score of Ateng Super variety. However, the method tends to produce coffee with unpleasant fragrance remarks such as sour, slightly aged and over fermented. Further investigations related to chemical composition need to be carried out in order to determine the relationship between processing methods and chemicals associated with cupping performance of each local Gayo Arabica coffee variety.

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