Effect of different manual brewing techniques to the sensory profile of the Indonesian Arabica and Robusta “natural coffees”

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Abstract. The “natural coffee” produced through sun-drying has been a common coffee post-harvest processing practice and well-known to exhibit specific sensory characters. However, the sensory profile of coffee in a cup could be influenced by many other factors including the brewing techniques. The objective of this research was to study the effect of different manual brewing techniques i.e. Indonesian “tubruk” method, Vietnam drip, cold brew, and aero press to the sensory profile of two Indonesian “natural coffees” origin i.e. Robusta Gayo and Arabica Kerinci. Evaluation was performed on 33 sensory attributes using Sensory Descriptive Analysis method employing 10 trained student panellists. Data analysis was performed using Minitab 17 and the Unscrambler® X MVA software. The result showed that in total; as many as 21 attributes were rated by the panellist. The two samples showed different sensory profiles, particularly in some sensory attributes assessed. The different manual brewing techniques was also found to have significant impact (α = 0.05) on 17-18 sensory attributes, showing that each technique will be responsible for certain sensory characters perceived by coffee consumer.

1. Introduction
The consumption of coffee has become a lifestyle and a global trend. According to the International Coffee Organization (ICO) [1], global coffee consumption is continually increasing. Similar consumption trend was also experienced in Indonesia especially in the last decades, where coffee shops and cafes can be found almost everywhere.

There are four coffee species cultivated in Indonesia i.e. Arabica, Robusta, Liberica, and Excelsa. Robusta and Arabica are the two major species. Indonesian coffee production is dominated by Robusta coffee, reaching 90% of the total coffee produced, while the remaining 10% is generally for Arabica. Based on commodity market share, around 85% of world coffee is Arabica, while Robusta coffee accounts for 10%, and the remaining 5% is Liberica and Excelsa species [2]. This study used two major species i.e. Arabica and Robusta.

There are two basic coffee post-harvest processing applied by coffee farmers and industries in the world, namely dry (or natural) processing and wet (or wash) method. Different post-harvest processing factors had been previously reported to have a significant influence on coffee sensory quality [4]. As the simplest method of coffee processing, natural method has been much appreciated as the eco-friendly coffee processing method due to its benefit of reducing the use of water resources. The “natural coffee”
produced also exhibit specific sensory characters. However, it is well-understood that the sensory profile of coffee could be influenced by many other factors including the different brewing techniques applied [3].

Amongst several brewing techniques available nowadays, manual brewing technique is getting popular since it is quite simple and easy to be applied for home consumption, while still producing a pleasant cup of coffee [3]. The common manual brewing techniques in Indonesia are Indonesian “tubruk” method, Vietnam drip, cold brew, and aero press. The effect of those techniques on coffee sensory profiles were evaluated in this study. This research will provide information on coffee sensory characters produced through specific techniques, and therefore, might aid in choosing which technique might be more appropriate to achieve brewed coffee with expected sensory notes.

2. Materials and Method

2.1. Materials

Robusta Gayo (obtained from Aceh special region, Sumatra island, Indonesia) and Arabica Kerinci (mount Kerinci area in Jambi province, Sumatra island, Indonesia) coffees used in this research were the “natural coffees”. Green beans were obtained from coffee farmers and freshly roasted at the medium level in a local commercial coffee roaster. Water used for brewing was mineral water with a normal pH of 7 purchased locally.

2.2. Methods

Nested Design (ND) was applied for the experiment. The two factors involved in this study were coffee species (Arabica and Robusta) and the coffee brewing techniques, with 4 (four) different techniques such as the Indonesian “tubruk” method (further written as tubruk), Vietnam drip, cold brew, and aero press.

Sensory Descriptive Analysis was performed to assess coffee sensory profiles. As many as 10 trained panellist were employed to rate the selected 33 attributes on an unstructured 15 cm line scale. Samples of roasted coffee beans were analysed for water content [5], protein [5], fat [5], total sugar [6], and caffeine [7]. The coffees were subject to further brewing using Indonesian “tubruk” [3], Vietnam drip, aero press, and cold brew techniques [3,8]. The brews were analysed for pH by using hand digital pH meter (pH5-3C), and Total Dissolved Solids (TDS) by using Lab coffee refractometer.

Analysis of Variance (ANOVA) was performed in Minitab 17 Statistical Software (Minitab Inc., State College, Pennsylvania, USA) followed by a Fisher LSD post-hoc test with a confidence interval of 95% for any significant difference.

3. Results and Discussion

3.1. Coffee composition

The chemical composition of roasted coffee beans used in this research (Robusta Gayo and Arabica Kerinci) can be found in Table 1.

| Parameter          | Concentration based on analysis (%) | Concentration based on literature (%) |
|--------------------|-------------------------------------|---------------------------------------|
|                    | Robusta Gayo | Arabica Kerinci | Robusta | Arabica |
| Water content      | 3.92 ± 0.04<sup>a</sup> | 2.84 ± 0.04<sup>b</sup> | max. 7'' [9] | max. 7'' [9] |
| Protein content    | 14.26 ± 0.05<sup>b</sup> | 9.23 ± 0.12<sup>a</sup> | 7.5-10 [10] | 7.5-10 [10] |
| Fat content        | 11.77 ± 0.06<sup>b</sup> | 15.51 ± 0.03<sup>a</sup> | 6.8 [11] | 12-17 [11] |
| Total sugars       | 4.76 ± 0.07<sup>b</sup> | 7.1 ± 0.04<sup>a</sup> | 1.6'' [10] | 4.2'' [10] |
| Caffeine content   | 1.6 ± 0.02<sup>a</sup> | 1.25 ± 0.01<sup>b</sup> | 2.4-2.5 [10] | 1.1-1.3 [10] |

Notes: Concentration of the components in samples, data mean ± standard deviation (n=3). Different notations show significant differences (α = 0.05). *Indonesian National Standard for coffee powder (SNI 01-3524). ** as sucrose (tr)
Based on the compositional proximate analysis, it can be seen that the samples are different in every parameter. The Robusta has significantly ($\alpha = 0.05$) higher protein and caffeine content, while it contains lower fat and sugars than the Arabica counterparts. Besides compositional diversity due to species or genetic difference i.e. between Arabica vs Robusta, it should be noted that the different origin of Gayo and Kerinci, particularly agro-ecological factors may also contribute to this compositional difference, as previously explained [12].

The corresponding coffee brews were evaluated for pH, and Total Dissolved Solids (TDS). The result is provided in Table 2.

Table 2. Physicochemical characteristics of the coffee brews

| Coffee species | Origin | Brewing Techniques | pH   | TDS (%) |
|----------------|--------|--------------------|------|---------|
| Robusta        | Gayo   | Tubruk             | 5.8  | 1.35    |
|                |        | Vietnam Drip       | 5.8  | 1.67    |
|                |        | Aeropress          | 5.8  | 1.21    |
|                |        | Cold Brew          | 6.0  | 1.67    |
| Arabica        | Kerinci| Tubruk             | 4.9  | 1.03    |
|                |        | Vietnam Drip       | 4.8  | 2.02    |
|                |        | Aeropress          | 4.9  | 1.6     |
|                |        | Cold Brew          | 5.1  | 1.74    |

Table 2 provides information that pH of the brews was ranged between pH 4.8 to 6, with the Arabica showed a lower pH than the Robusta coffee. Besides species diversity, the growing areas were suggested to involve in the coffee acidity, where coffees grown at higher altitudes and in mineral rich volcanic soils were perceived to have more acidity. This could be the case for the samples for Kerinci, which is the highest mountain in Sumatra island, and the highest volcano in Indonesia. The coffees were grown at least at between 1,300 – 1,700 meters above sea level (masl), where Gayo highland was approximately at a lower altitude. However, no direct comparison could be made for altitude effect since the coffees were already genetically diverse.

There was no significant difference found in pH of the brews due to different brewing techniques applied, except for cold brewing that offered a slightly higher pH. It means that cold brews coffee was less acidic than the other three brewing techniques, since less free hydrogen ions ($H^+$) were donated in the solution. However, coffee acidity is far more complex and might not be well-indicated by pH only. Titratable acidity was mentioned as more appropriate to predict coffee acidity [13, 14] even though more thorough investigation on coffee acidity might be useful to give further explanation.

The Total Dissolved Solids (TDS) of coffee brews in this study vary from 1.03% to 2.02%. Some of the value were not in a range of golden cup ideal region for optimum balance at between 1.15% - 1.35% [12]. In particular, the Vietnam drip and cold brew produced high TDS value or a stronger coffee. This result reveals that coffee extraction has lots of variable to control in order to achieve a perfect coffee in a cup.

3.2. Coffee sensory profiles

The trained panel evaluated 33 sensory attributes in the coffee brews including aroma and flavor attributes. The result showed that the panellist had successfully rated 21 attributes in total, out of 33 attributes, showing that the sensory task is challenging and may cause panel fatigue due to many attributes assessed. There were 18 attributes found to be significantly different ($\alpha = 0.05$) for Robusta Gayo, while 17 sensory attributes were found to be significant for Arabica Kerinci coffees, as a result of different manual brewing techniques applied. Those attributes can be seen in Table 3.
Based on Table 2, it can be indicated that Robusta Gayo and Arabica Kerinci had different sensory profiles that is suggested due to different genetic and agro-ecological factors. The Robusta tend to be “darker” where bitterness and burnt, woody, and earthy notes were dominating. The Arabica Kerinci seems “lighter” and more refreshing and pleasant with higher citrus, acidic and sweet-related characters such as sweet and chocolate. The woody and earthy aroma and/or flavour for Arabica Kerinci were found as not significantly different, but considered as significant (α = 0.05) for Robusta Gayo, where tubruk technique showed the highest score. In contrast, citrus aroma and flavour were found to be significantly different in Arabica Kerinci, but not in Robusta Gayo.

**Table 3.** Mean scores of sensory attributes of Robusta Gayo and Arabica Kerinci coffees based on four manual brewing techniques

| Sensory Attributes | Robusta Gayo | Arabica Kerinci |
|--------------------|--------------|-----------------|
|                    | Tubruk | Vietnam | Drip | Aeropress | Cold Brew | Tubruk | Vietnam | Drip | Aeropress | Cold Brew |
| Taste              |        |         |      |          |            |        |         |      |          |            |
| Bitter             | 10.12a | 8.34b   | 8.34b | 8.33b     | 6.38a      | 5.39b  | 5.37b   | 5.36b |
| Sweet              | 0.49b  | 0.45b   | 0.41b | 1.46a     | 2.4b       | 2.41b  | 2.42b   | 4.34a |
| Acid               | 1.37b  | 1.42b   | 2.48a | 1.30b     | 6.6b       | 6.52b  | 8.44a   | 6.51b |
| Salty              | 0.25b  | 0.25b   | 0.25b | 1.72a     | 0.5b       | 0.5b   | 0.51b   | 3.43a |
| Aroma              |        |         |      |          |            |        |         |      |          |            |
| Burnt              | 11.65a | 10.38b  | 10.34b| 9.73c     | 9.73a      | 9.73a  | 9.71a   | 3.24b |
| Chocolate          | 3.53a  | 3.51a   | 4.62a | 3.50b     | 7.36a      | 6.34b  | 6.39b   | 6.34b |
| Nutty              | 3.70a  | 3.77a   | 3.71a | 1.37b     | 4.49b      | 6.31a  | 4.45b   | 4.48b |
| Sweet              | 0.49b  | 0.46b   | 0.41b | 6.01a     | 2.66b      | 2.62b  | 2.6b    | 6.41a |
| Woody              | 7.57a  | 7.52a   | 7.51a | 3.94b     | 3.33a      | 2.36b  | 2.35b   | 0c    |
| Earthy             | 8.35a  | 5.82b   | 5.81b | 5.80b     | ns         | ns     | ns      | ns    |
| Citrus             | ns     | ns      | ns    | ns        | 3.28b      | 3.28b  | 4.47a   | 3.28b |
| Flavor             |        |         |      |          |            |        |         |      |          |            |
| Burnt              | 7.43a  | 7.48a   | 7.33a | 3.25b     | 7.27a      | 7.26a  | 7.24a   | 2.86b |
| Nutty              | 1.38b  | 1.43a   | 1.37b | 1.34b     | 1.54b      | 4.75a  | 1.54b   | 1.52b |
| Sweet              | 1.38b  | 1.34b   | 1.37b | 1.43a     | 1.52b      | 1.52b  | 1.54b   | 4.75a |
| Woody              | 6.4a   | 6.36a   | 6.34a | 3.03b     | ns         | ns     | ns      | ns    |
| Earthy             | 8.4a   | 3.81b   | 3.81b | 3.84b     | ns         | ns     | ns      | ns    |
| Citrus             | ns     | ns      | ns    | ns        | 3.38b      | 3.31b  | 4.6a    | 3.33b |
| Aftertaste         |        |         |      |          |            |        |         |      |          |            |
| Astringent         | 2.62b  | 2.65b   | 4.6a  | 2.62b     | 3.04b      | 3.10b  | 4.05a   | 3.04b |
| Bitter             | ns     | ns      | ns    | ns        | ns         | ns     | ns      | ns    |
| Clean              | 2.41c  | 6.82b   | 7.01a | 2.42c     | 3.41c      | 6.54b  | 7.50a   | 3.48c |
| Mouthfeel          |        |         |      |          |            |        |         |      |          |            |
| Body               | 5.05a  | 4.55b   | 4.58b | 4.51b     | 7.36a      | 3.35b  | 3.39b   | 3.33b |

Notes: ns = not significant. Different notations show significant differences (α = 0.05)
Different manual brewing techniques generally have no significant influence (α = 0.05) on the bitterness aftertaste score for both coffee samples. It means that panellist rated the aftertaste or residual of coffees brewed using different techniques as the same bitter despite having significant difference in the bitter taste. The tubruk technique provides a “dark” characters as the most bitter coffee brews, as well as showing the thickest body. It is suggested that tubruk technique extracted more components in the ground coffees during brewing. The Vietnam drip also generally found to have more similarities to the tubruk technique. Cold brew tend to produce a sweeter and the most salty coffees but less acidic, while the aeropress is considered to yield the most acid coffee as compared to other manual brewing techniques that are currently being investigated. Aeropress technique resulted in the most acid and cleanest coffees. Differences in coffee brewing techniques will have an impact on the extraction of coffee components, such as caffeolyquinic acid, trigonelline and other compounds responsible for coffee bitterness. These compounds will contribute to the astringent mouthfeel, bitter taste and the bitter aftertaste of coffee [11,15].

4. Conclusions
In conclusion, it is revealed that two Indonesian “natural coffees” origin i.e. Robusta Gayo and Arabica Kerinci had different sensory profiles to some extent. The Robusta has more burnt, woody, and earthy notes, where the Arabica Kerinci produce higher citrus, acidic and sweet-related characters. The different manual brewing techniques i.e. Indonesian “tubruk” method, Vietnam drip, cold brew, and aero press had an influence on the diversity of sensory profiles of the coffee brews. In total, 21 attributes were rated by the panellist, where 17-18 sensory attributes were found to be significantly different (α = 0.05). Each different technique will be responsible for certain sensory characters perceived by coffee consumer, such as tubruk that produce a “darker” character as compared to the other techniques. However, since the coffees were from different origins, it should be noted that there are other variables such as the agro-ecological factors that might contribute to the diversity of coffee sensory profiles.

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