Effect of manual brewing techniques on the sensory profiles of Arabica coffees (Aceh Gayo *wine process* and Bali Kintamani *honey process*)

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**Abstract.** Post-harvest processing is known as one of the most important factors that influence coffee flavour quality. Amongst many different fermentation techniques, honey and wine processing are getting more popular in the country these days. Therefore, many single origins coffees processed following these techniques. There are also several manual brewing techniques readily available for Indonesian coffee consumers, and those techniques may give distinctive sensory characteristics to the brewed coffees. This research was aimed to study the effect of manual brewing techniques i.e. Indonesian “tubruk” method, Vietnam drip, cold brew, and aero press on the sensory profiles of two Arabica coffee samples i.e. Aceh Gayo wine process and Bali Kintamani honey process. As many as 10 selected, validated and trained student panellists were employed to assess 33 sensory attributes based on Sensory Descriptive Analysis method. Data analysis was performed using Minitab 17. The result has indicated that 22 to 24 sensory attributes were significantly different ($\alpha = 0.05$) as influenced by different manual brewing techniques, while different coffees with different post-harvest processing created significant effect particularly in the fermented, berry, woody, and sweet notes.

1. **Introduction**

Coffee is a popular beverage with an increasing consumption or demand worldwide. According to the International Coffee Organization (ICO) coffee consumption is continually increasing, with an estimated consumption in the world of 9534.96 tons during 2016 to 2017, and an increased annual average of 2.2% since 2013 [1].

Genetically, coffee species has many varieties, but the most popular and widely cultivated are Arabica and Robusta. Robusta coffee has a flavour that tends to be more bitter and has a thicker characteristic whereas the Arabica coffee is more popular in the specialty coffee or premium market for less bitter and richer in flavour [2]. Besides genetic, different growing regions of Arabica and Robusta coffees also contributes to its unique flavour quality due to differences in agro-ecological factors such as growing environment, cultivation, climate, soil fertility, slope, temperature and exposure to sunlight [3]. There are also other factors that can affect coffee cup quality, such as harvesting, post-harvest processing, roasting and brewing techniques. Post-harvest processing methods is vital to the quality of coffee as is explained by Sunarharum, et al. [2]. At present, a wide range of post-harvest processing techniques including honey and wine methods had been developed and implemented in Indonesia.
However, according to the author knowledge, there is still limited publication related to those methods and the profile of coffees resulted from those methods in Indonesia.

Honey processing method involves stripping the skin and the coffee fruit (pulping) without a subsequent washing process. In the honey process, all or some of the mucilage is still attached to the beans [2]. The method of coffee wine processing is not producing wine from coffee, but coffee ripe cherries are picked and dried under sunlight, as that of natural processing. However, wine processing requires a longer drying time to approximately 3-6 weeks or even longer, where natural methods only need around 2-3 weeks [3, 4].

In addition to the post-harvest processing, brewing techniques also provide an important role in translating flavour of the roasted coffee to the brewed beverage. There are several brewing techniques available nowadays, and manual brewing is getting popular to the coffee consumers. Those techniques may also give distinctive sensory characteristics to the brewed coffees. This research was aimed to study the effect of manual brewing techniques i.e. Indonesian “tubruk” method, Vietnam drip, cold brew, and aero press on the sensory profiles of two Arabica coffee samples i.e Aceh Gayo wine process and Bali Kintamani honey process.

2. Materials and methods

2.1 Materials

Materials used in this study was Arabica Aceh Gayo wine and Bali Kintamani honey green coffee beans obtained from coffee farmers. Both coffee beans were roasted under medium level in a local commercial coffee roaster. Chemical used includes standard caffeine (Sigma Aldrich), hexane (Merck), citric acid, sugar, salt, MSG and mineral water purchased locally. Sterile aquadest was purchased from local company, PT. Ikapharmindo, Jakarta, Indonesia.

2.2 Methods

This study was conducted following a nested design with two factors, i.e type of Arabica coffees (Aceh Gayo wine and Bali Kintamani honey), and four manual coffee brewing techniques. Sensory evaluation was performed based on a Descriptive Analysis method, that consists of three steps, which are panel selection and validation, panel training, and formal assessment on an unstructured 15 cm line scales for intensity rating. The attributes were selected based on Focus Group Discussion with the 10 trained student panellists using Coffee taster’s flavour wheel based on Specialty Coffee Association and World Coffee Research [5] as guidance. The roasted coffees were previously tested for water content [6], protein [6], fat [6], total sugars [7] and caffeine [8] compositions. Furthermore, the beans will be ground and brewed with four different brewing techniques i.e. Indonesian “tubruk” method [3,9], Vietnam drip, aeropress, and cold brew [3,10]. The brews were analysed for pH by using hand digital pH meter (pHS-3C), and Total Dissolved Solid (TDS) by using VST Lab coffee refractometer.

The data was collected and tabulated using Microsoft Excel 2013. Analysis of Variance (ANOVA) and post-hoc analysis (Fisher's Least Significance Difference Test) at 95% confidence interval were performed by using Minitab 17 Statistical Software (Minitab Inc., State College, Pennsylvania, USA).

3. Results and discussion

3.1 Raw materials characterization

Raw materials used in this study is Aceh Gayo Arabica (wine process) and honey Arabica Kerinci (honey process) roasted at medium level. The chemical composition of those samples can be seen in Table 1.

Table 1 showed that the two coffees with different post-harvest processing had different chemical characteristics (paired t-test, α = 0.05), particularly such as for total sugars and acids, where honey coffee was found to have higher sugar content and less acids. However, it should be noted that this difference
is not only solely due to the different post-harvest processing applied but could also be contributed by difference on the coffee origins, i.e. from Aceh Gayo and Bali Kintamani.

Table 1. Chemical composition of Arabica coffee being studied

| Parameter          | Concentration (%) | Concentration in Arabica (%)<sup>lit</sup> |
|--------------------|-------------------|-------------------------------------------|
| Water content      | 2.55              | 3.22                                      | 1 - 3.7<sup>11</sup> |
| Protein level      | 8.92              | 9.01                                      | 7.5 - 10<sup>12</sup> |
| Fat level          | 17.75             | 14.3                                      | 11 - 17<sup>12</sup> |
| Total Sugars       | 5.63              | 7.45                                      | 5 - 9<sup>12</sup> |
| Total Acid         | 2.31              | 1.92                                      | 1.9 - 2.5<sup>12</sup> |
| Caffeine Content   | 1.28              | 1.24                                      | 1.1 - 1.3<sup>12</sup> |

3.2 Coffee brews characterization

Physicochemical characteristics of the coffee brews were evaluated as can be seen in Table 2.

Table 2. Physicochemical characteristics of the coffee brews

| Coffee type (post-harvest processing) | Brewing techniques | pH | TSS (% TDS) |
|--------------------------------------|--------------------|----|-------------|
| Wine                                 | Tubruk             | 5  | 0.94        |
| Vietnam drip                        | 4.9                |    | 1.60        |
| Aeropress                            | 4.9                |    | 1.58        |
| Cold Brew                            | 5.1                |    | 1.74        |
| Honey                                | Tubruk             | 5  | 0.76        |
| Vietnam drip                        | 4.9                |    | 0.79        |
| Aeropress                            | 4.9                |    | 1.38        |
| Cold Brew                            | 5.1                |    | 1.40        |

Based on Table 2, it can be seen that the pH of coffee brews was ranged between pH 4.9 to pH 5.1, which is within the range of pH for Arabica coffees as previously mentioned falls between pH 4.95 and pH 5.15 [13]. Correlation between pH or titratable acidity and perceived acidity in flavour has been previously studied [13, 14]. There was no correlation was found between pH or titratable acidity and perceived acidity in flavour or aferesensation [15]. In contrast, a linear correlation between titratable acidity to pH 6 and the acidic taste of different coffee extractions was found in Maier [14], but it was not correlated with the pH of the brews. As many as 67% of the acids contributed to the titratable acidity and to the sensory acidity of the coffee brews, especially acetic and citric acid [14].

The result of Total Dissolve Solids (TDS) was found not within the optimum extraction range set for golden cup by Specialty Coffee Association of America (SCAA) at between 1.15% -1.35% [16]. Brewing techniques such as aeropress and cold brewing tend to give stronger coffee, while tubruk and Vietnam drip showed a bit lower TDS value. These differences in coffee TDS could be influenced by several factors or variation such as the type of coffee, the use of pressure, water to coffee ratio, temperature and time of extraction, the particle size of brewed coffee and the different techniques. TDS is often associated with sensory attributes of coffee such as 'body'. It is related to the extraction of the chemical and flavour compounds from the ground coffee into water, and therefore the higher the value, the stronger the coffee and vice versa. Extraction will determine coffee balance, and thus coffee cup quality.
3.3 Coffee sensory profiles

In the sensory evaluation, there were 33 attributes scored by the trained panellists. Aroma and flavour were scored separately. The result has indicated that 22 sensory attributes were significantly different ($\alpha = 0.05$) as influenced by different manual brewing techniques applied for Bali Kintamani honey, while 24 sensory attributes each coffee were significant ($\alpha = 0.05$) in Arabica Gayo wine coffee. Sensory attributes that were significantly different was not the same between those two coffee samples, where the Bali Kintamani missed out the berry notes. Different post-harvest processing resulted in significant difference ($\alpha = 0.05$) mainly on the fermented, berry and woody notes. Figure 1 provides the mean intensity scored by panellists for each sensory attributes for Bali Kintamani honey coffee, while Figure 2 is for Aceh Gayo wine coffee.

Based on Figure 1, it was revealed that on Arabica Bali Kintamani honey coffee, the sensory attributes dominant on “tubruk” was burnt aroma and flavour, bitterness, strong body and quite woody, indicating more flavour compounds extracted by this technique. The Vietnam drip showed quite similar character to “tubruk” style for some attributes including the bitterness, burnt and woody notes as indicated by Fisher LSD analysis (Table 3 and Table 4). The aeropress offers the cleanest coffee brew that was sour and highly scored for citrus aroma and flavour while cold brew was the sweetest and the most fermented, astringent and salty. In Figure 2, Aceh Gayo wine showed similar profile trend to that of Figure 1, except that the fermented aroma and flavour are 2-4 times higher than Bali Kintamani honey, and there were additional attributes of berry aroma and flavour scored highest for “tubruk” technique, while woodiness could not be perceived. Table 3 showed mean scores of each sensory attributes for four techniques applied on brewing the Bali Kintamani honey coffee followed by notation based on Fisher LSD, while Table 4 is for Arabica Aceh Gayo wine sample.

![Figure 1](image-url)  
**Figure 1.** Mean intensity scores for sensory attributes of Arabica Bali Kintamani honey coffee
Figure 2. Mean intensity scores for sensory attributes of Arabica Aceh Gayo wine coffee

Bitterness of “tubruk” or Vietnam drip techniques may occur due to excessive coffee extraction. Extraction using hot water (high temperature) will accelerate extraction speed of the chemical compounds as indicated by higher total dissolve solids (TDS). However, since the TDS of “tubruk” coffee extract and Vietnam drip were found to be lower, the bitter perception could be due to less acid, less sweet compounds and less fats or other compounds extracted in the brew. Should those compounds were more diluted or extracted, the bitterness could potentially be masked. This could be the case as explained by Coupland and Hayes [17] that interaction between different components in emulsion system could give masking effect to the bitterness perception.

The significantly high sweetness in Bali Kintamani honey coffee as compared to the Aceh Gayo wine was suggested mainly due to the contribution of post-harvest processing factors, the honey process, even though the origin variation might also give influence. The sweet taste of the brewed coffee produced is derived from carbohydrate content that reach more than 50% by weight of the beans [18]. This compound may trigger maillard reaction and caramelization, and the products of those reactions are important determining factor for sweetness and sweet flavour of the coffee brew. Honey processing allows the mucilage and some pulp to be attached on coffee while drying, creating brownish/yellowish/reddish colour of the dried coffee with the parchment due to an exposure of sugary fruit pulp to higher air drying temperature (of approx. 40-45°C).
Table 3. Mean scores of sensory attributes of Arabica Bali Kintamani honey coffee based on four manual brewing techniques

| Sensory attributes | Brewing techniques |          |          |          |
|-------------------|--------------------|----------|----------|----------|
|                   | Tubruk             | Vietnam drip | Aeropress | Cold Brew |
| Taste             |                    |          |          |          |
| Bitter            | 3.30a              | 2.71b    | 2.38c    | 2.34c    |
| Sweet             | 6.08c              | 6.21b    | 6.18b    | 7.03a    |
| Sour              | 7.16c              | 7.05d    | 8.41a    | 7.44bc   |
| Salty             | 1.28b              | 1.24b    | 1.28b    | 1.50a    |
| Aroma             |                    |          |          |          |
| Burnt             | 10.17a             | 10.13a   | 10.04ab  | 3.31b    |
| Brown             | 3.26a              | 2.92b    | 3.32a    | 3.29a    |
| Nutty             | 4.29b              | 5.25a    | 4.29b    | 4.36b    |
| Sweet             | 6.27b              | 6.27b    | 6.33b    | 8.02a    |
| Woody             | 2.73a              | 2.48ab   | 2.43b    | 2.41b    |
| Fermented         | 2.22c              | 2.24c    | 2.48b    | 4.10a    |
| Citrus            | 5.23bc             | 5.34b    | 6.29a    | 5.16c    |
| Flavour           |                    |          |          |          |
| Burnt             | 10.91a             | 10.32b   | 10.07c   | 3.09d    |
| Chocolate         | 3.35a              | 3.28a    | 3.35a    | 3.30a    |
| Nutty             | 1.29bc             | 2.19b    | 2.22b    | 2.23a    |
| Sweet             | 7.06c              | 7.29b    | 7.26b    | 9.04a    |
| Woody             | 1.49a              | 1.45b    | 1.43b    | 1.45b    |
| Fermented         | 1.30b              | 1.32b    | 1.43b    | 3.17a    |
| Citrus            | 3.35c              | 3.59b    | 5.10a    | 3.43c    |
| Aftertaste        |                    |          |          |          |
| Astringent        | 1.19b              | 1.23ab   | 1.25ab   | 1.29a    |
| Bitter            | 3.27a              | 1.32b    | 1.09c    | 1.29b    |
| Clean Finish      | 3.11c              | 5.18b    | 8.09a    | 3.12c    |
| Mouthfeel         |                    |          |          |          |
| Body              | 3.57a              | 2.43b    | 2.43b    | 2.45b    |

Different notation showed significant difference (α = 0.05)
Table 4. Mean scores of sensory attributes of Arabica Aceh Gayo wine coffee based on four manual brewing techniques

| Sensory attributes | Tubruk | Vietnam drip | Aeropress | Cold Brew |
|--------------------|--------|--------------|-----------|-----------|
| Taste              |        |              |           |           |
| Bitter             | 4.58a  | 3.90b        | 3.48c     | 3.30c     |
| Sweet              | 2.17c  | 2.37b        | 2.41b     | 4.52a     |
| Sour               | 6.96c  | 7.29b        | 9.97a     | 7.53b     |
| Salty              | 1.30d  | 1.48c        | 1.63b     | 3.31a     |
| Aroma              |        |              |           |           |
| Burnt              | 9.99a  | 9.83b        | 9.56c     | 3.09d     |
| Chocolate          | 2.96bc | 3.27b        | 7.14a     | 2.83c     |
| Nuts               | 1.15c  | 2.45a        | 1.47b     | 1.24c     |
| Sweet              | 2.07d  | 2.34c        | 2.54b     | 4.71a     |
| Fermented          | 6.02c  | 6.26b        | 6.36b     | 8.10a     |
| Citrus             | 2.97b  | 3.07b        | 4.47a     | 2.77c     |
| Berry              | 5.10a  | 2.57b        | 2.44c     | 2.24d     |
| Flavour            |        |              |           |           |
| Burnt              | 10.55a | 10.26b       | 9.84c     | 3.09d     |
| Chocolate          | 3.31b  | 3.35b        | 6.02a     | 3.20b     |
| Nutty              | 1.29bc | 2.19a        | 1.41b     | 1.18c     |
| Sweet              | 2.26c  | 2.53b        | 2.58b     | 7.05a     |
| Fermented          | 4.21c  | 4.56b        | 4.68b     | 6.72a     |
| Citrus             | 2.92c  | 3.09b        | 4.68a     | 2.91c     |
| Berry              | 3.03a  | 2.02b        | 1.86c     | 1.72d     |
| Aftetaste          |        |              |           |           |
| Astringent         | 3.24b  | 3.38a        | 3.06c     | 3.09c     |
| Bitter             | 6.11a  | 4.91b        | 4.54c     | 4.81b     |
| Clean Finish       | 2.22d  | 6.62b        | 7.05a     | 2.45c     |
| Mouthfeel          |        |              |           |           |
| Body               | 4.09a  | 3.09c        | 3.38b     | 3.23c     |

Different notation showed significant difference ($\alpha = 0.05$)

4. Conclusion

Based on the results, it can be concluded that different coffee manual brewing techniques affect the variation of sensory profiles of the brews. There were 22 and 24 significant sensory attributes ($\alpha = 0.05$) were found in Bali Kintamani honey and Arabica Gayo wine coffee, respectively, as influenced by different manual brewing techniques. Different coffees with different post-harvest processing created significant effect particularly in the fermented, berry, woody, and sweet notes. The difference in post-harvest processing methods itself, might also contribute to this distinctive profiles, especially for few main attributes. However, it should be noted that the coffees were also from different coffee origins, and that the agro-ecological factors might also have contributed to the variation of coffee properties.
References
[1] International Coffee Organization (ICO) 2015 ICO Annual Review 2013-2014
[2] Sunarharum WB, Yuwono SS, Fibrianto K, Waziiroh E, Murtini ES, Siadi, Wulandari ES, Wahibah LY, Nadhiroh H and Pangestu NBSW 2017 Teknologi Pengolahan Kopi [Coffee Processing Technology] (Indonesia: Nusa Creative Media Poor)
[3] Sunarharum, WB, Fibrianto K, Yuwono SS and Nur M 2019 Sains Kopi Indonesia [Indonesian Coffee Science] (Indonesia: UB Press (in press))
[4] Siswoputranto PS 1992 International Coffee and Indonesia (Yogyakarta: Canisius)
[5] Specialty Coffee Association (SCA) and World Coffee Research (WCR) 2016 The coffee taster’s flavour wheel (Specialty Coffee Association and World Coffee Research)
[6] AOAC 2007 Official Methods of Analysis 18th ed, 2005 Current through revision 2, 2007 (on line) (AOAC International, Gaithersburg, MD)
[7] Dreywood R 1946 Qualitative Test for Carbohydrate Materials Journal of Industrial & Engineering Chemistry Analytical Edition 18 pp 499-9
[8] Belay A, Ture K, Redi M and Asfaw A 2008 Measurement of Caffeine in Coffee Beans with UV-is Spectrometer Food Chem 108 pp 310-5
[9] Fibrianto K, Febryana YR, Wulandari ES 2018 Effect of Brewing Technique and particle size of the Ground Coffee on Sensory Profiling of Brewed Dampit Robusta Coffee IOP Conf Series: Earth and Environmental Science 131 (2018) 012009
[10] Moldvaer A 2014 Coffee Obsession (United States: DK Publishing)
[11] Illy A and Viani R 2005 Espresso Coffee: The Science of Quality, 2nd ed (San Diego: Elsvier Academic Press)
[12] Farah A 2012 Coffee Constituents Coffee: Emerging Health Effects and Disease Prevention Chu, YF (Ed) (New York, USA: John Wiley and Sons) ISBN: 9780470958780 pp 21-58
[13] Sivetz M 1972 How Acidity Affects Coffee Flavour Food Technol 26 pp 70-7
[14] Maier HG 1987 Les Acides du Café Café Cacao Thé 31 pp 49–58
[15] Gloess AN, Schonbachler B, Klopprogge B, D'Ambrosio L, Chatelain K and Bongartz A 2013 Comparison of Nine Common Coffee Extraction Methods: Instrumental and Sensory Analysis European Food Research and Technology 236 pp 350-5
[16] Specialty Coffee Association America (SCAA) 2015 SCAA Standard, Golden Cup (USA: Specialty Coffee Association America)
[17] Coupland JN and Hayes JE 2014 Physical approaches to masking bitter taste: lessons from food and pharmaceuticals Pharmaceutical Research 31 (11) pp 2921–39
[18] Flament I 2002 Coffee Flavour Chemistry (England: John Wiley and Sons, Ltd.)