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Research Note

The Influence of Leaf Age, Oxidizing Pre-Treatment, and Serving Temperature on Sensory Characteristics of Ampelgading Robusta Coffee Leaves Tea

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Abstract

The cultivation of coffee plants produces leaf-waste which is only currently used for feed and fertilizer. Traditionally coffee leaves tea could be processed as “kopi kawa”, a popular tea-like beverage in West Sumatera, Indonesia. This research was aimed at characterizing the sensory profile of beverage made from Ampelgading Robusta coffee leaves by considering different leaves age, processing method, and serving temperature applying the Rate-All-That-Apply (RATA) method involving 111 consumer respondents. It was observed that the coffee leaves tea were sensorially dominated by green aroma and flavor, bitter taste, and astringent mouth-feel. The leaves age significantly affected 6 sensory attributes, i.e. sweet taste, sour taste, bitter taste, sweet flavor, earthy flavor, and woody flavor. Meanwhile the processing method (oxidized and non-oxidized pre-treatment) as well as serving temperature had no significant effect on the sensory perception of consumer although significant influences were recorded on the changing of total phenolic content, caffeine content, pH, and color parameters. As conclusion, sensory characteristic of Ampelgading robusta coffee leave tea was strongly affected by the age of leaf, regardless the pre-treatment process and serving temperature.

Keywords: coffee leaves tea, leaf age, oxidation, phenolic content, serving temperature

Introduction

Coffee is one of commodities which have high economic values. The plants can grow up to more than 12 m height. Thus, it normally requires to be trimmed to ease harvesting process. The trimming procedure for coffee plants helps to produce new branches, facilitate the entry of light, and facilitate controlling pests and diseases (Setiawan *et al.*, 2019). The trimming process produces leaf-waste abundantly, which is normally further proceed as feed and fertilizer. Traditionally, coffee leaves could be processed as “kopi kawa”, tea-like beverage. Coffee leaf tea is one of popular drinks in West Sumatra. This beverage was initially consumed as coffee substitute as during Dutch occupation, common people were hardly to buy and drink coffee. Thus, people were started to enjoy coffee leaves as the drink has sufficiently coffee flavor (Novita *et al.*, 2018).

Coffee leaves have been reported comprising of chlorogenic acid and mangiferin, which pose high antioxidant effects (Campa *et al.*, 2012). It has also been reported that the chlorogenic acid, mangiferin and isomangiferin in coffee leaves have anti-inflammatory effects, anti-diabetes, anti-hyperlipidemia, antimicrobial as well as antioxidants (Wang *et al.*, 2016). Furthermore, Wang and Ho (2009) reported that coffee leaves contain antioxidant compounds such as flavonoids, alkaloids, saponins, caffeine and polyphenols. It has also been reported in detail that coffee leaves contain caffeine, trigonelin, 3-CQA, 5-CQA, mangiferin, isomangiferin, routine, 3,4-diCQA and 3,5-diCQA which also provide antioxidant effects (Chen *et al.*, 2018).

Some studies which have been mentioned suggest that coffee leaves were potentially developed further as functional herbal drink however less documentation on its status. Thus, investigation of multisensory characteristics of coffee leaf tea is required, therefore this research was aimed at characterizing the sensory profile of beverage made from coffee leaves.

Materials and Methods

Materials

Robusta coffee leaves were taken from Ampelgading Malang, South East Java, Indonesia, at an altitude of 500-600 MASL. They consisted of young (approximately 3 weeks old) and old leaves (approximately 5 weeks old). The young leaves were taken from the tips of leaves until the fourth leaf, while the old leaves were taken from the fifth leaf to the eighth leaf.

Sensory Evaluation

The tests were conducted within 4 days between 09.00 am and 16.00 pm. The panelists were asked to randomly consume single sample at times for 3 various samples. This evaluation was arranged as Completely Randomized Block Design. The main instrument used was a RATA (Rate-All-That Apply) questionnaire with scoring 1-3 to rate the sensory attributes intensity of the sample from low to high. Only relevant attributes were required to be checked (Ares *et al.*, 2014). There were 26 sensory attributes, were asked to the respondents. All these attributes were compiled from literatures following standard protocol for Sensory Spectrum. Those attributes include aroma, taste, flavor and mouthfeel. The aroma and flavor attributes involved 11 descriptions including: green, floral, spicy, fruity, marine, nutty, sweet, fire, mineral, earth and wood. Taste attributes using 3 descriptions, including: sweet, sour and bitter, while for mouthfeel use 2 descriptions, such as: astringency and oily (Theros *et al.*, 2014; Koch *et al.*, 2012; Lee and Chambers, 2007). The lexicon of sensory attributes by RATA analysis was captured in Table 1. There were 111 consumer respondents involved in this current study. They consisted of 69 young men and 42 young women between 20 and 23 years old. The entire panel was university student.

Table 1. The lexicon of sensory attributes by RATA analysis

Attributes		Lexicon
Aroma	Green	smell like leaves
	Floral	smell like flowers (jasmine or roses)
	Spicy	smell like spices (pepper, or ginger)
	Fruity	smell like fruits (lemon, orange apricot jam or cooked apple)
	Marine	smell like sea (breeze or seaweed)
	Nutty	smell like nuts (almonds or peanuts)
	Sweet	smell like sweet (honey, sugar, or caramel)
	Fire	smell like burn (ash or smoke)
	Mineral	smell like minerals (metal or medical)
	Earth	smell like soil (yeasty or dusty)
	Wood	smell like wood (smoky or bushy)
Taste	Sweet	taste like sweet (honey, caramel)
	Sour	taste like sour (citrus)
	Bitter	taste like bitter (caffeine)
Flavor	Green	flavor like leaves
	Floral	smell like flowers (jasmine or roses)
	Spicy	smell like spices (pepper, or ginger)
	Fruity	smell like fruits (lemon, orange apricot jam or cooked apple)
	Marine	smell like sea (breeze or seaweed)
	Nutty	smell like nuts (almonds or peanuts)
	Sweet	smell like sweet (honey, sugar, or caramel)
	Fire	smell like burn (ash or smoke)
	Mineral	smell like minerals (metal or medical)
	Earth	smell like soil (yeasty or dusty)
	Wood	smell like wood (smoky or bushy)
Mouthfeel	Astringent	dry sensation in the mouth and a little sticky
	Oily	oily sensation

Sample Preparation

There were 2 types of coffee leaf, i.e. young (3 weeks old) and old (after 5 weeks old). Both types were undergoing oxidation and non-oxidation pre-treatment. Samples were prepared by orthodox method. The dried coffee leaves were brewed with hot water at a temperature of 93±3°C. The 30 ml of brewed samples were presented in a paper cup with a three-digit random code. Those samples were presented at 3 different serving temperature; cold (10±2°C), room (25±2°C) and warm (42±2°C).

Total Phenolic Compound

For the total phenolic compound analysis, 0.1 ml of the sample was diluted in 1 ml methanol with a ratio of 1:10. Then 0.2 ml of diluted sample was taken in the test tube, and mixed with 0.8 ml Na_2CO_3 (10%, PA Merck, Germany) and 1 ml of Folin-Ciocalteu reagent (7.5%, PA Merck, Germany) until it was entirely homogeny mixed. The mixture was covered with aluminum foil for 30 minutes. The absorbance was measured at 765 nm. The standard curve was made in the same way by replacing the sample with gallic acid standard (PA Merck, Germany) ($y = 0.0122x + 0.041$; $R^2 = 0.9944$; concentration range between 30 and 61 mgGAE/l). The total phenolic content was expressed in mgGAE/l (Pal *et al.*, 2012).

Caffeine Analysis

As much as 2 grams of dried coffee leaf was extracted by adding 100 ml of distilled water and simmering for 5 minutes before filtering. Exactly 2 g of $CaCO_3$ (PA Merck, Germany) was added to the filtrate and then heated for 5 minutes and cooled at room temperature. A separating funnel was inserted and 15 ml of chloroform (technical grade, Merck, Germany) as well as 2 ml of the mixture. After separated, the bottom layer was taken. This step was repeated 3 times. The diluted extract was then injected UV-Vis 270-300 nm spectrophotometer (Shimadzu, Japan) (Ashour *et al.*, 2015).

pH Measurement

Exactly 1 gram of sample was added to 100 ml of hot water. The pH measurement was waiting until it cooled down. It was measured using a pH meter (Hanna, Romania) which was calibrated at pH 4 and pH 7 (Jang *et al.*, 2014).

Data Analysis

The responses to sensory attribute intensity considering leaf age factor, pre-treatment process, and temperature of presentation were analyzed using GLM (General Linear Model) and PCA (Principle Component Analysis) performed by Minitab 17.

Results and Discussions

Sensory Characteristics of Coffee Leaves Tea

Sensory attributes are terminologies used in describing the characteristics of food products. Those include aroma, taste, flavor and mouth-feel. For aroma and flavor, panelists were able to define 11 aroma attributes, including green, floral, spicy, fruity, marine, nutty, sweet, fire, mineral, earth and wood. Meanwhile only 3 taste attributes such as sweet, sour and bitter were detected. Two mouth-feel attributes such as astringency and oily-feel were sensed. The sensory profile of the coffee leaves tea is captured in Table 2.

It was found that the highest intensity sensory attribute was bitter taste. It was argued that coffee leaf tea had bitter character but acceptable (Chen *et al*., 2018). Coffee leaves contain caffeine at 21.9 g/kg of dry weight, and contain epicatechin, mangiferin, isomangiferin and several other phenolic components. Among the four basic tastes, bitter taste is the most complex and least understood (Yamaoka-Yano and Mazzafera, 1999); (Cherian *et al*., 2018). In this current study, green aroma, green flavor and astringency were found to be dominating. Other sensory attributes that also have high intensity are green aroma, green flavor and mouth-feel astringent. It has been suggested that coffee leaf tea has a very fresh taste, resembling fresh leaf pieces like green tea, namely pungent and greenish (Yuwono *et al*., 2019).

Table 2. The influence of leaf age, pre-treatment and serving temperature on sensory attributes of Robusta Ampelgading coffee leaf tea by RATA

Attribute		p-values of each factor		
		Leaf Age	Pre-treatment	Serving Temperature
Aroma	Green	0.055	0.210	0.808
	Floral	0.684	0.173	0.745
	Spicy	0.827	0.102	0.475
	Fruity	0.374	0.227	0.989
	Marine	0.743	0.098	0.843
	Nutty	0.447	0.278	0.728
	Sweet	0.101	0.221	0.513
	Fire	0.505	0.669	0.854
	Mineral	0.670	0.622	0.242
	Earth	0.200	0.878	0.686
	Wood	0.707	0.085	0.875
Taste	Sweet	0.000*	0.792	0.709
	Sour	0.045*	0.845	0.138
	Bitter	0.000*	0.672	0.619
Flavor	Green	0.501	0.368	0.917
	Floral	1.000	0.078	0.239
	Spicy	0.430	0.244	0.224
	Fruity	0.196	0.397	0.917
	Nutty	0.323	0.235	0.421
	Sweet	0.004*	0.644	0.745
	Fire	0.216	0.726	0.839
	Mineral	0.058	0.254	0.388
	Earth	0.032*	0.997	0.423
	Wood	0.000*	0.832	0.447
Mouthfeel	Astringent	0.396	0.853	0.549
	Oily	0.430	0.388	0.288

Note: (*) significant effect at 95% confident level

Sensory Responses of Coffee Leaves Tea

It was found that the coffee leaves tea from the old was dominated by bitter taste, while the young one was dominated by green-flavor. Calvert *et al.* (2015) stated that some phenolic compounds affect the bitter taste of food and beverages. Another compound that affect the strong bitter taste of steeping tea with young leaves is caffeine. The caffeine content in young leaves was higher than the leaves of half old and old. The results of the total phenol and bitter taste correlation test showed a correlation of 0.844, while the correlation test results of caffeine concentration and bitter taste had a correlation value of 0.430.

Panelists also detected 6 sensory attributes (p-value <0.05), such as sweet taste, sour taste, bitter taste, sweet flavor, earthy flavor and wood flavor (Table 2). The sweet taste attribute was inversely proportional to the taste bitter response. Sweet taste had a higher response in old leaves while bitter taste (bitter) had a higher response in young leaves. This is mainly affected by the fact that sweetness can suppress bitter taste (Campbell *et al*., 2006). Sugar, which is a precursor to sweetness, can suppress the bitter taste caused by caffeine. Sweet and bitter taste is negatively correlated each other. On the other hand, the differences in sourness may be affected by the pH, as the young one is more acidic than the old one. Earth and wood flavor were also detected in this study. It has been suggested that earth flavor is attributed to 2-6-Dimethylcyclohexanol and 2-isobutyl-3-methoxypirazine while wood flavor is attributed to α-Ionone and β-Ionone (Lee and Chambers, 2007; Kumazawa and Mazuda, 2002). Eventhough it is suggested that earth and wood flavor are attributed to different chemical stimulant, and it was found that they were both sensed similarly as shown in Figure 1.

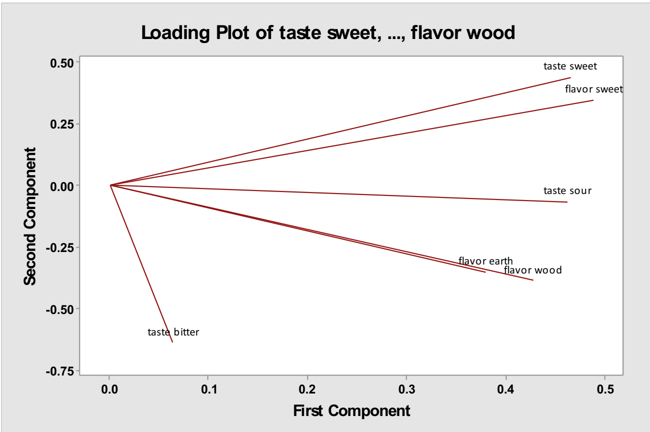

Figure 1. Loading plot of steeped Robusta Ampelgading coffee leaves tea

While the influences of leaf age were significantly observed (p-value<0.05) for several sensory attributes, there was no significant influences sensed by panelist related to the effect of oxidation pre-treatment as well as serving temperature. As suggested by PCA (Principal Component Analysis) in Figure 2, the sensory responses were not affected by the gender and the age of panelists.

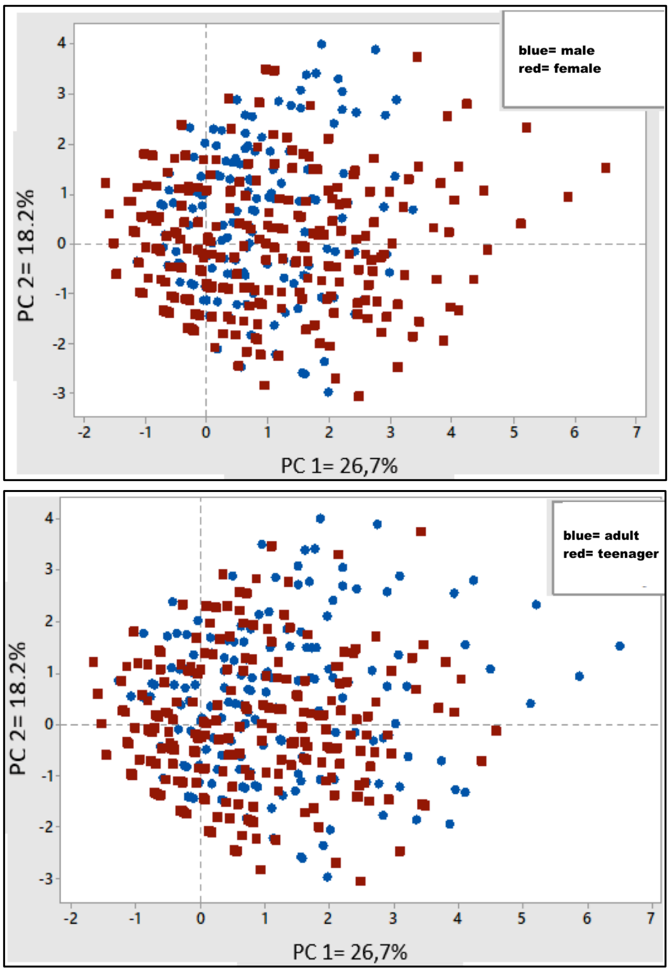

Figure 2. PCA of steeped Robusta Ampelgading coffee leaves tea

Chemical Parameters Coffee Leaves Tea

Phenol is a component that influences the sensory characteristics of coffee leaves tea. It was observed that leaves age and pre-treatment process significantly affected on total phenol of steeping (α <0.05) while the serving temperature has no significant effect (Table 3). Old coffee leaves had a total phenolic compound value higher than the young. Similar trend was also observed for caffein concentration as well as the pH of the steeping tea.

Table 3. The influence of leaves age, pre-treatment and serving temperature on chemical analysis of Robusta Ampelgading coffee leaves tea

Factor	P-value		
	Total Phenolic Content	Caffeine (%)	pH
Leaf age	0.000*	0.003*	0.000*
Pre-treatment	0.001*	0.001*	0.000*
Serving temperature	0.607	0.171	0.229

Note: (*) significant effect at 95% confident level

Conclusion

The coffee leaves tea had bitter taste, strong fresh leaves (green) aroma and flavor. The age of leaves significantly influenced 6 sensory attributes, i.e. sweet taste, sour taste, bitter taste, sweet flavour, wood and earth flavor. On the other hand, pre-treatment processes and serving temperature didn't have significant effect on any sensory attributes.

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