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SENSORY ATTRIBUTES PROFILING OF DAMPIT ROBUSTA COFFEE LEAF TEA (*Coffea canephora*)

Sudarminto Setyo Yuwono[1], Kiki Fibrianto[1*], Laila Yum Wahibah[1], Aswin Rizky Wardhana[1]

[1]Sensory and Applied Food Science Research Group, Faculty of Agricultural Technology, Universitas Brawijaya, Malang, Indonesia
**kiki.fibrianto@ub.ac.id*

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ABSTRACT
Abundant leaf waste resulted from the maintenance of coffee plants can alternatively be made into coffee leaf tea. The results of this study indicate that old Robusta coffee leaf significantly have increasing total phenol, pH and color, but decreasing the level of caffeine. The fermentation process can significantly reduce total phenol, caffeine content, pH and color. Meanwhile, the brewing temperature only gives a real effect on the color of steeping tea. Based on the method of Rate-All-that-Apply (RATA), coffee leaf tea powder has aroma characteristics (green, wood, floral, earth and sweet), while the steeping tea has characteristics of having green aroma and flavor as well as bitter taste and astringent in mouth. The most dominant profile of aromatic compounds of coffee leaf tea with GCMS HS-SPME method is green which might be attributed by 2-heptanol (CAS), 2-hexen-1-ol, 1-furfuryl-2-formyl pyrrole, safranal, beta-cyclocitral, 4-heptanal,(Z)-(CAS), hexanal (CAS), nonanal, benzeneacetaldehyde, benzaldehyde, 2-heptanone (CAS).

1. Introduction

Coffee is one of the most widely consumed beverages worldwide, due to its distinctive flavor and aroma (Campanha et al., 2009). Brazil, Vietnam, Colombia and Indonesia are the main coffee producing countries because they are located in suitable areas to grow (WBCM and ICO, 2017). Coffee plants will be trimmed regularly because it can grow up to 1.5 - 4.6 meters. Pruning is needed to optimize fruit production and plant maintenance (Jonathan et al., 2009). However, pruning produces abundant waste in the form of coffee leaves that are not utilized in large quantities. Therefore, it is necessary to find out alternative use of coffee leaves.

One alternative use of coffee leaves is using them as a material for making tea. Coffee leaf tea is one of Indonesia's typical drinks, precisely derived from the realm of Minang in Padang, West Sumatra (Ratanamarno and Subskar, 2017). During the Dutch colonial period of 1847-1908, the population of West Sumatra Minangkabau experienced a system of colonial exploitation in the system of forced cultivation. Residents had to submit all the coffee beans cultivated to the Dutch, so people who wanted to enjoy coffee could only use the coffee leaves for beverages. Drinks from the coffee leaves are known as "Kopi Daawa Melayu or "Kopi Kawa" (Akira, 1977 in Booth et al., 1988).

Ratanamarno and Surbkar (2017) suggest that the differences of leaf age, the pre-treatment, and brewing time, affecting the differences on caffeine and catechin contents of Arabica leaf tea (*Coffea arabica*). Young and non-fermented coffee leaves tent to have hinger levels of caffeine and catechins than those of old leaves. They also suggest that the recommend brewing time is 5 minute, to minimize caffeine level. According to Yitayal and Achame (2015) revealed the effects of caffeine on a mixture of coffee leaves and spices that are processed differently by Roasted, Raw and Majengir. The caffeine content of the Roasted type was not significantly different from Majengir type in both solvents. Tea mixed coffee leaves and spices can be used as an alternative to coffee drinks that are low in caffeine in Ethiophia. In further research (Yitayal and Titalun, 2017) reported the nutritional value of coffee leaf tea in the form of proximate and mineral composition. Coffee leaf tea contains essential and vital nutrients for energy and health, so this drink can be used to meet the nutritional needs of the community.

It shows that coffee leaf tea can have health effects because they contain caffeine and polyphenols, but for some people caffeine can lead to increase heart rate, at risk of cholesterol buildup (Hoeger et al., 2001), stomach disorders, anxiety, diminished memory, and insomnia. The caffeine content also affects bitter flavor correlated with other bitter taste-forming compounds such as alcohol, caffeine, trigonelline and guinine, and correlated with chlorogenic acid, polyphenols, catechins and other compounds (Calvert et al., 2015).

This study aims to introduce the coffee leaf tea as a traditional drink from Sumatra Indonesia, focusing on profiling sensory attributes. This study also aims to determine the effect of leaf age, the process of manufacture, and temperature of serving on the physicochemical, sensory and aromatic compounds.

2. Materials and methods

2.1. Tea Samples and Physicochemical Analysis

Coffee leaves were harvested from Robusta coffee plants (*Coffea canephora*), growing under natural environment in Dampit, Malang, Indonesia. Young leaves were picked from bud to the 4th leaves, while old leaves were picked from the 5th to 8th leaves. The chemicals and reagents used consisted of folin-ciocalteu's phenol reagent and gallic acid for phenol total (Spectrophotometry), sugar total (refractometer), petroleum eter for fat content (soxhlet), indicator fenolpthhalein and NaOH for total acid (titration), and buffer pH 4 and pH 7 for pH measurement (pH meter).

2.2. Coffee Leaf Tea Processing

Non-fermentation method: young or old coffee leaves were washed and cut into small pieces, after that dried with an electric oven at the temperature of 70 ± 2 ºC for 4 hours. As for the method of fermentation: young or old coffee leaves were washed and cut into small pieces, then withered and rolled at room temperature of 23-27 ºC for 18-24 hours, followed by drying with an electric oven at the temperature of 70 ± 2 ºC for 4 hours. The 4 samples of dried coffee leaf tea were ground using a blender at 3000 rpm and 3 ± 1 minute duration, then they were divided into small plastic clips and given a three-digit random code of 2 grams per bag. Samples of dried coffee leaf tea were brewed with hot water at 90-96 ºC. Then each sample was presented in 3 different serving temperatures i.e. cold temperatures ranging from 8-12 ºC, normal temperature of 23-27 ºC, and warm temperature of 40-44 º C.

2.3. Phenol Total Analysis

Phenol total analysis followed Pal et al., (2012). The 1 ml sample was diluted with distilled water at a ratio of 1:10. The mixture was placed on the test tube, and 1ml ethanol was added. 5 ml of distilled water and 0.5 ml of the Folin-Ciocalteu reagent (50%) were added to the test tube and mixed. After 5 minutes, 1 ml of Na_2CO_3 (10%) was added in the tube and mixed until homogeny. The mixture was then placed in a darkened room or covered with aluminum foil for 60 minutes. After that, the absorbance was measured with a wavelength of 725 nm. The standard curve was made in the same way by replacing the sample with an error acid made with some concentration. Total polyphenol content in tea functional drinks was expressed in mg/L.

2.4. Caffeine Analysis

Caffeine stock solution (1000 ppm) was prepared in distilled water. Different working solutions were prepared by serial dilution with the addition of 1.0 ml hydrochloric acid. The 0.25 g sample was weighed and diluted accurately in water and prepared with a net volume of 20 ml with distilled water. The 20 ml sample solution was pipetted in a 250 ml flask and 10 ml of 0.01 mol/l hydrochloric acid and 2 ml acetic acid solution were then added. The final volume was prepared with distilled water. The 50 ml solution was filtered and added to a 100 ml flask. 0.2 ml of 4.5 moles of sulfuric acid was added and again made to a clean and filtered volume. The absorption of work standards and samples was measured on the UV/Vis (Shimadzu) spectrophotometer. The level of caffeine from the sample was calculated through the regression equation of the best line according to the standard (Christian, 1994).

2.5. Volatile Compounds Evaluation

Analysis of volatile compounds in coffee leaf tea was done by GCMS (Gas Chromatography Mass Spectrometry) and SPME (Solid Phase Micro Extraction) 4000 variant of GCMS (Variant, Inc., USA) consisting of 3,800 GC with CP-8410 auto injector (Bruker, USA), and 4,000 Ion Traps MS detector with CP-1177 split/spitkess injectors, at a temperature of 300 °C and a 1.0 μL injection volume. Each splitless mode: Agilent focus liner with glass wool deactivation was done in triplicate Manually Chromatographic. Separation was done by using Zebron MultiResidue-1 columns (30 m × 0.25 mm x 0.25 μm; Phenomenex Inc., USA); internal diameter × 0.25 μm; film thickness) capillary column (Restek, Bellefonte, PA, USA) (Lee et al., 2013).

2.6. Sensory Analysis

Sensory analysis was used the RATA (Rate-All-that-Apply) method with two stages, namely to know the characteristics of powder sensory and coffee leaf tea steeping. The panelists were used untrained panelists of 110 people, who consisted of men and women with an age ranging from 18 to 45 years. The main instrument was used the RATA questionnaire with scores 1-3 to describe the sample of sensory characteristics, i.e. score 1 for low intensity attributes, score 2 for moderate intensity attributes, and score 3 for high intensity attributes. Sensory attributes that do not describe sensory characteristics need not be ticked (Ares et al., 2014).

2.7. Data Analysis

The sensory intensity attributes responding on leaf age factor, pre-treatment , and serving temperature were analyzed using GLM (General Linear Model). In addition, GLM was used to find out the results of chemical and physical tests on samples with different factors. The datas were analyzed using statistical analysis program MiniTab 17.

3.Results and discussions

3.1. Characteristics of Coffee Leaf Tea

Table 1 shows that the various leaf ages of the processing stage gives significant difference ($p < 0.05$) to water content, ash content, fat content, total sugar, total acid, reddish color intensity (a +) and yellowish (b +), but not significant (p> 0.05) for brightness intensity (L *).

Young leaf tea in Table 1 tends to have higher water content than old leaf tea, because the older the age of the leaves the more decreasing the water content. Young leaves have a relatively soft texture, because they have more moisture content than old leaves (Osman et al., 2004). Fermentation of the old leaves causes a difference in water content which increases along with the longer fermentation time. This is due to the oxidative fermentation reaction of catechins with oxygen to produce water vapor and result in increased water content (Bradley and Vanderwam, 2001).

When the water content (H_2O) in the material increases, the ash content decreases. Thus, the ash content on old leaves decreases with the fermentation process. This is as a result of the abundance of water-soluble minerals and fats, so it will come together during the drying process. Decrease of the ash content can occur because of during the fermentation process there will be an increase in organic material due to the degradation of substrate by microbes. The less organic matterdegradation , the less decrease of ash content (Hatakka, 2001).

In old coffee leaf tea, the fat content tends to be higher in Table 1 because the moisture content of the leaves is lower. During the drying process there has been decomposition of the water molecule bonding component H_2O and increasing the sugar, fat, minerals and protein content, there by rising the ash content. In addition, the decrease in the fat content is caused by the degradation of lipase enzyme (Bhara, 2009).

Sucrose is a disaccharide found in plants, included in non-reducing sugars because the active groups are already bonded to each other. Sweet-tasting components such as sugar, aldehydes, sulphide and benzoate emerge during the fermentation. Reduced sugar content will increase due to sucrose hydrolysis to glucose by invertase enzyme. The decrease in total sugar in Table 1 and the drying process breaks down the water molecule bond component (H_2O) and increases the sugar content (Bhara, 2009).

Coffee leaf tea has caffeine content which will evaporate when drying or roasting, forming components such as acetone, furfural, ammonia, trimethylamin, formic acid and acetic acid (Khan and Mukhtar, 2007). The longer the fermentation, the more the acidity of coffee leaves as described in Table 1. This is because of the formation of aliphatic acids during fermentation. If the fermentation is extended, there will be aliphatic chemical composition changes to esters of carboxylic acids resulting in the taste of rottenness (Famwort, 2005).

Table 1. Physical characteristics of coffee leaf tea powder

Sample	Water Content (%)	Ash Content (%)	Fat Content (%)	Total Sugar (%)	Total Acid (%)	L*	a+	b+
MNF	10.57^{a}	5.01^{d}	1.23^{c}	0.61^{d}	2.11^{b}	41.90^{a}	2.73^{a}	9.77^{b}
MF	10.56^{a}	5.29^{c}	0.82^{d}	4.17^{b}	2.85^{a}	42.93^{a}	2.87^{a}	10.70^{a}
TNF	6.73^{b}	6.51^{a}	4.28^{a}	0.80^{c}	1.87^{c}	43.40^{a}	1.90^{ab}	11.00^{a}
TF	6.83^{b}	6.10^{b}	3.22^{b}	4.37^{a}	2.87^{a}	42.87^{a}	1.03^{b}	9.07^{b}

Note: (MNF) young leaf with a non fermented method; (MF) young leaf with a fermentation method; (TNF) old leaf with a non fermented method; (TF) old leaf with a fermented method; (^{a,b,c,d}) notation of real difference with Tukey statistics (p <0,05)

Table 2. Physicochemical characteristics of coffee leaf tea

Factor	Treatment	Phenol Total mgGAE/g	Caffeine (%)	pH	L*	a+	b+
Leaf Age	Young Leaf	67.76^{b}	0.56^{a}	5.66^{b}	29.67^{b}	2.82^{b}	5.27^{b}
	Old Leaf	78.77^{a}	0.52^{b}	5.77^{a}	32.14^{a}	3.42^{a}	10.39^{a}
Process	Non Fermented	75.23^{a}	0.55^{a}	5.73^{a}	32.34^{a}	4.53^{a}	10.06^{a}
	Fermented	71.31^{b}	0.53^{b}	5.69^{b}	29.47^{b}	1.70^{b}	5.61^{b}
Temperature of serving	Cold	73.11^{a}	0.54^{a}	5.69^{a}	31.03^{a}	3.19^{b}	8.62^{a}
	Room	73.96^{a}	0.53^{a}	5.72^{a}	32.92^{a}	4.32^{a}	9.73^{a}
	Warm	72,73^{a}	0,53^{a}	5,73^{a}	28,77^{b}	1,83^{b}	5,14^{b}

(^{a,b,c,d}) notation of significant difference with Turkey statistics (p <0,05)

Table 3. Volatile components of coffee leaf tea analyzed with GCMS HS-SPME

No	Compound	MNF	MF	TNF	TF	Aroma Description
1	(methyl benzoate) Benzoic acid, 2-(acetyloxy), methyl ester (CAS)	√			√	fragrant, fruity
2	2-furanmethanol (CAS)	√		√		caramellic, coffee, bready, sweet, burnt, brown
3	2-heptanol (CAS)	√	√		√	fresh, herbal, sweet, floral, green, fruity, green, earthy
4	Linalool	√	√	√	√	fruity, floral, rose-like
5	Phytol	√	√	√	√	floral, oily, balsamic, herbal, magnolia, orchid
6	2-Hexen-1-ol	√			√	fresh, fruity, green, grassy
7	1-Hexanol,2-ethyl- (CAS)	√	√	√	√	newly cut grass
8	1-Furfuryl-2-formyl pyrrole	√			√	roasted, chocolaty and green
9	(Safranal)1,3-Cyclohexadiene-1carboxaldehyde,2,6,6trimethyl(CAS)	√	√	√	√	herbal, woody, sweet, green floral, herbaceous, somewhat tobacco
10	Beta-Cyclocitral	√	√			minty, herbal, rose, green, fruity, tea
11	4-heptanal,(Z)-(CAS)	√		√		green, biscuit, cream, fat, fishy, rotten
12	2,4-heptadienal	√	√	√	√	fatty, nutty, hay, fishy
13	Butanal-2-methyl (CAS)	√		√	√	almond, cocoa, fermented, hazelnut
14	Hexanal (CAS)	√	√	√	√	green, fatty, leafy, fruity and woody
15	(Furfural) 2-furancarboxaldehyde (CAS)	√		√		almond-like
16	Eugenol	√	√	√	√	sweet, spicy, woody, phenolic, warm
17	Nonanal		√		√	grassy, green, tea, vegetable
18	Benzeneacetaldehyde	√	√	√	√	honey, floral, rose, chocolate, spicy
19	2-hexenal	√	√	√	√	green, banana, aldehydic, fatty, herbal, spicy, fresh
20	Pentanal	√		√		almond, bitter, malt, oil, pungent
21	Benzaldehyde		√	√	√	bitter almond, burnt sugar, cherry, green, roasted pepper
22	6-methyl-5-hepten-2-one	√		√		citrus, pepper, strawberry
23	1-pentanol (CAS)	√				mild, fusel-like, unpleasant
24	Benzeneethanol (CAS)	√	√	√	√	floral, rose, burn, almond
25	Pyridine	√	√	√	√	sour, putrid, fish-like
26	Napthalene	√	√	√	√	floral, fruity

27	(Methyl Isopalmitate) Pentadecanoic Acid,14methyl-, methyl ester	√			√	oily, waxy, fatty, oris
28	Methyl salicilate	√	√	√	√	sweet, spicy, minty
29	(guaiacol) Phenol,2-methoxy-(CAS)	√	√	√	√	phenolic, woody, smoky, spicy, eugenol-like
30	(BHT) Phenol,2,6-bis)1,1 dimethylethenyl)-4-Methyl	√		√		slightly, phenolic, off-odor, off-flavor
31	Alpha-ionone	√		√		woody, floral, nutty, berries
32	2-heptanone (CAS)	√				fruity, banana-like, nut, spicy, green, blue cheese
33	Beta-ionone	√		√	√	woody, floral (rose-like), berries, cherry
34	Acetyl pyrole	√	√		√	musty, nutty, walnut, bready, coumarinic, tea-like
35	(3,5-cocoa pyrazine) Pyrazine,2-ethyl-3,5dimethyl-(CAS)	√		√		nutty, roasted, coffee, cocoa, sweet, corn, caramelic

The fermented samples of chlorophyll content will be lost due to maillard reaction, i.e. non-enzymatic browning which turns the color of coffee leaves to brown resembling a coffee bean. In addition, phenolic acids will decrease as temperature increases. With the presence of heat and oxygen, the phenolic compounds can be oxidized because the activity of polyphenol oxidase enzymes to form reactive ortho quinone radicals and can react further into amino compounds form a brown product (Reblova, 2012).

3.2. Characteristics of Coffee Leaf Tea

Table 2 shows that coffee leaf tea with different leaf age and pre-treatment factors shows a significant effect ($p < 0.05$) on total phenol, caffeine, pH and color, but the presented temperatures only give a significant difference ($p < 0.05$) to color.

3.3. Total Phenolic Compound

According to the Table 2, coffee leaf tea from old leaves has a higher total phenol value compared to tea from young leaves. According to Farhoosh et al. (2007), the old leaves of Robusta coffee have higher phenol levels. The high total content of polyphenols is due to the relatively soft texture and high moisture content in young leaves. The long sedimentation time provides greater heat penetration so that the polyphenol oxidase enzyme is inactive faster and results in less polyphenol damage (Osman et al., 2004). Non-fermented coffee leaf tea has a higher total phenol value than tea with fermentation process. According to Pou (2016) during the fermentation process the enzymes present on the leaves will be contact with air and begin to oxidize. Phenolic acids will decrease due to rising temperatures, heat and oxygen, so that the phenol compounds are oxidized because the enzyme activity of polyphenol oxidase forms a reactive radical orthosemiquinone and can react further into amino compounds.

3.4. Caffeine

According to Table 2, the percentage of caffeine in young coffee leaves tea is higher than old coffee leaf tea. According to Zheng and Ashihara (2004), caffeine contents in young leaves are higher than old leaves and gradually replaced by theacrine, which is converted into liberine as the dominant purine alkaloid in young leaves. The older coffee leaves contain smaller caffeine biosynthesis (Keya et al., 2003). The non-fermentation process produces coffee leaf tea with a higher caffeine percentage than the coffee leaf tea with a fermentation process. According to Mandal (Mandal, 2010), during caffeine fermentation other components such as acetone, furfural, ammonia, thrimrthylamine, formic acid and acetic acid evaporate and form. Ratanamarno and Surbkar (2017) suggest that the fermentation is one method to decrease caffeine in coffee. Increasing fermentation time, reducing caffeine levels in coffee. During the fermentation, caffeine is converted into uric acid, 7-methylxanthine and xanthine. (Todar, 2010).

3.5. pH

According to Table 2 in the leaf age factor, the pH of steeped old coffee leaf tea is higher than steeped young coffee leaf tea. The young leaves contain higher moisture content and softer texture than the old leaves, so that the timber will provide greater heat penetration and result in easier polyphenol damage (Osman et al., 2004). According to Fulder (2004), the processing step results in oxidizing polyphenol component to theaflavin. If there is further oxidation, it will turn into thearubigin. If more thearubigin is formed, then the pH will decrease.

3.6. Color

The boiling or brewing processes oxidize the flavonoid compounds into phenol compounds, which later become quinone due to oxidize of heat. Further oxidation of the quinone will produce thearubigin which causes darker color in boiled tea water (Shahidi and Neczk, 2005) According to Reblova (2012), tea production requires heating, as the increase in temperature can lead to oxidize and browning marked color change in tea drinks. Temperature changes trigger the reactions of amino acids such as alanine, leucine, isoleucine, valine and tannins in the tea, releasing carbon dioxide molecules that will form the aldehyde complex that affects the brewing color.

3.7. Correlation of Powders and Coffee Leaf Tea

In general, coffee is consumed by the community in the form of powder that is brewed using hot water. Meanwhile, in the processing and brewing of tea, the tea should be brewed with the possible optimum concision to maximally utilize the content in the tea powder. Tea brewed with different water temperatures and durations will create different tastes. Tea brewed over makes more caffeine extracted. Even though polyphenols such as tannins require longer time to be extracted to give color and flavor, because too long brewing will leave a bad aftertaste (McAlpine and Ward, 2016). The extraction time refers to the amount of tea leaf time in contact with water and thus, the brewing time may occur. If the time is optimal, some compounds in the tea leaf will reach the point of equilibrium, meaning that the concentration of the compound in the leaves will be equal to the concentration of the compound present in the brewing water (Gerbely, 2016).

3.8. Panelists' Response to Coffee Leaf Tea

According to panelist’s responses, coffee leaf tea has green smell as described in Figure 1. Green and similar terms such as grass have been used in many sensory analysis descriptions of various foods (Baldwin et al., 2004). Hexane is the compound most often associated with green characteristics such as cut grass (Buettner and Mestres, 2005) and herbs (Jordan et al., 2003). Alex Probyn in Grey (2013) mentions that coffee leaf tea has a very fresh taste, resembling fresh leaves like green tea, pungent and greenish.

Higher responses show that steeped old coffee leaf tea has a sweet flavored attribute than young coffee leaf tea, as described in Figure 2. According to Campbell et. al., (Campbell et al., 2006) carbohydrates in young leaves are still abundant in the form of starch, so the sweet taste is still low. Starch will be broken down into simple sugars such as glucose, fructose and sucrose during the aging process or maturation, so it becomes sweeter.

The bitter taste attribute is one significant difference, referring to Figure 2. The young leaves tea has a higher average intensity than old leaves. The higher bitter taste in younger leaves is thought to be due to the influence of caffeine content in younger leaves that are higher than in the old leaves. Ratanamarno and Subskar (2017) suggest that caffeine and phenol form the immune systems in leaves , causing bitterness. The caffeine content on young leaves is hinger than the old leaves. (Izzreen and Fadzelly, 2013).

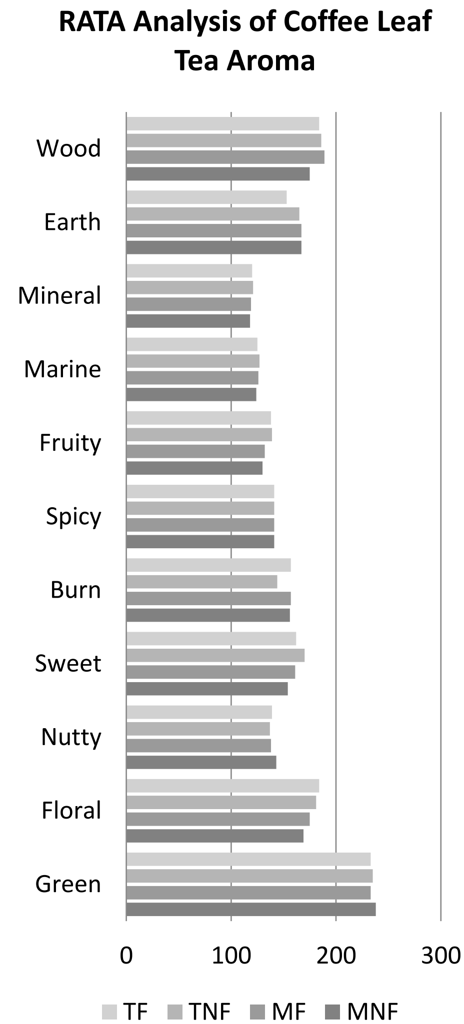

Figure 1. RATA analysis of coffee leaf tea aroma

Another distinct attribute is thesour taste . Young coffee leaf tea has a higher intensity than that in old coffee leaf tea, as described in Figure 2. The pH of young leaf tea is lower than that of old leaves. Lower pH indicates a more sour taste. According to Chan et. al. (2016), as the pH increases, the hydrogen ion concentration in the sample decreases, resulting in the release of hydrogen ions by phenolic compounds (antioxidants) in the sample. Furthermore, the decreasing pH decreases the antioxidant activity.

Earth and woody flavors in this study also have significantly different results, as described in Figure 2. The earth flavor in the tea is resulted from the 2-6-dimethylcyclohexanol and 2-isobutyl-3-methoxypirazin compounds (Lee and Chambers, 2006; Kumazawa and Masuda, 2002). Zecuppa (2017) explains that flavor wood resembles dry wood, wooden barrels, oak, dead wood, or cardboard. Woody flavors in coffee leaf tea can be caused by α-Ionone and β-Ionone (Lee and Chambers, 2006).

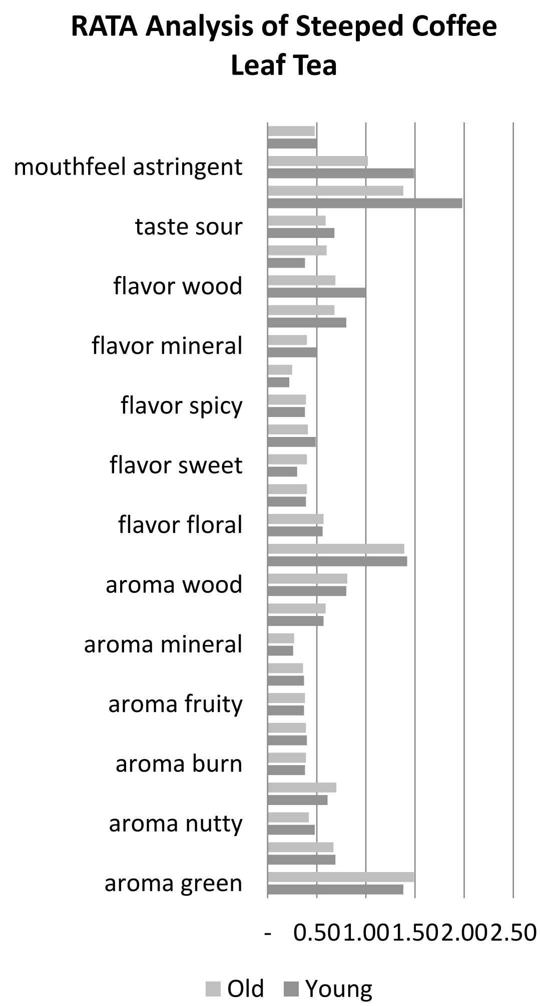

Figure 2. RATA analysis of steeped coffee leaf tea

3.9. Volatile Compound on Coffee Leaf Tea

The volatile compound is only about 0.01% of the total weight of the dry tea, but its contribution to overall tea quality is very important (Pripdeecech and Wongpomchai, 2013). In the coffee leaf tea analyzed by GCMS using SPME extraction, there were 71 volatile compounds in a non-fermented young leaf (MNF), 54 volatile compounds in fermented young leaf (MF), 62 volatile compounds in non-fermented old leaf (TNF), and 60 volatile compounds in the fermented of old leaf (TF). Large 35 volatile compounds presented in coffee leaf tea and aroma description can be seen in Table 3.

Volatile compounds of coffee leaf tea are dominated by green and floral fragrances that can be seen in Table 3. The predominant smell identified in coffee leaf tea is green in 11 out of 35 large compounds, such as 2-furanmethanol (CAS), 2-heptanol (CAS), 2-heptanol (CAS), safranal, beta-cyclocitral, hexanal (CAS), 4-heptanal(Z)- (CAS), benzeneacetaldehyde, benzaldehyde, nonanal, and alpha-ionone. The "green" sensory characteristics are commonly used in describing the characteristics of various fresh vegetables, raw fruits, food products, and gentle fragrances. The term green and similar terms such as grass have been used in many sensory analysis descriptions of various foods (Balwon et al., 2004). Waltner-Law *et. al.* (2002) grouped volatile compounds found in green tea into the categories of green flavors, floral scents, baked and spicy scents, and off-flavor (stale, burning smoke).

3.10. Effect of Volatile Compounds on the Sensory Attributes of Coffee Leaf Tea

Sensory attributes of coffee leaf tea are described in Figure 1. Aroma attribute consists of green, floral, spicy, fruity, marine, nutty, sweet, burn, minerals, earth, and woody. Meanwhile, the sensory attributes of steeped leaf coffee tea are categorized into aroma, taste, flavor, and mouthfeel . The flavor and aroma attributes consist of green, floral, spicy, fruity, marine, nutty, sweet, fire, minerals, earth, and woody. The taste attribute is detected using papilla on the tongue. The taste attribute consists of 3 attributes i.e. sweet, sour, and bitter. The mouthfeel attribute consists of astringent and oily, as described in Figure 2.

The sensory attribute of powder and coffee leaf tea is the green aroma, as described in Figure 1 and 2. This is due to the presence of hexenal, benzaldehyde, 2-hexenal, 2-heptanone, alpha-ionone, and 2-hexen-1-ol. According to Kim *et al.*, (2016), the smell of leaves in the tea is due to the presence of volatile components such as hexanal, benzadehyde, 2-hexenal, and 2-heptanone. The high intensity aroma sensory attributes of other coffee leaf tea are wood, floral, earth and sweet.

The highest intensity sensory attribute is thebitter taste , illustrated in Figure 2. Alek Probyn in Gray (2013) argues that coffee leaf tea has a bitter but acceptable character. Coffee leaves contain caffeine of 21.9 g/kg per dry weight, epicatechin, mangiferin , isomangiferin n, and some other phenolic components. Among the four basic tastes, bitterness is the most complex and least understood (2005). Other sensory attributes that also have high intensity are green, flavor green, and astringent. Alex Probyn in Gray (2013) also mentions that coffee leaf tea has a very fresh taste, resembling fresh leaf like green tea, pungent and greenish. The different processing and serving temperatures do not have a significant effect to the sensory attribute.

4. Conclusions

The results conclude that the coffee leaf tea has high intensity of green, wood, floral, earth and sweet. The steeping tea has characteristics of bitter taste, strong aroma and flavor of fresh leaves (green). The age of coffee leaves gives a significant influence on the 6 sensory attributes, namely the sweet taste, sour taste, bitter taste, sweet flavor, wood flavor, and earth flavor. Processing treatment and serving temperature do not give a significant effect on any sensory attributes.

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