Effect of Mokapot brewing temperature on sensory profiling of Dampit and Tulungagung Ijo coffee

K Fibrianto, M H Fakhruddin and E S Wulandari
Sensory and Applied Food Science Research Group, Department of Agricultural Product Technology, Faculty of Agricultural Technology, Universitas Brawijaya, Malang, Indonesia

E-mail: kiki.fibrianto@ub.ac.id

Abstract. Dampit coffee and Ijo coffee has unique characteristics depending on the temperature and brewing method. One of the common coffee brewing methods used is Mokapot. The study aims to determine the sensory characteristics of Dampit coffee and Ijo coffee when brewed with Mokapot method at different temperatures. The method used for characterizing their sensory attributes was RATA (Rate-All-That-Apply) method. Consumer respondents were asked to select all perceived attributes and their intensities. The result indicated that sensory characteristic of both coffees change along with different brewing temperature. It is also important to note that bitter taste tends to be constantly rated along with different brewing temperature. Meanwhile, bitter aftertaste tends to decrease as the increase of brewing temperature.

1. Introduction

Coffee is a leading export commodity produced in Indonesia because it has a relatively high economic value in the world market. Indonesia coffee has many variants of type and taste, where almost every province in Indonesia has coffee with different characteristics for each region.

Dampit coffee is a coffee variant that grows in the area of Dampit. Dampit is a sub-district located in Malang district which has geographical location in Southwest of Semeru Mountain with altitude about 800 meters above sea levels. Dampit coffee is dominated by Robusta Coffee. Robusta Dampit coffee becomes one of East Java’s export commodities. Tulungagung Green Coffee has unique flavors and textures compared the other coffees. Ijo Coffee obtained from the dried-process coffee beans. Ijo coffee is roasted using selected firewood and clay pan instead of the fire from a stove.

Coffee brewing is one of the most important parts of the coffee making process the quality of brewed coffee is influenced by various factors such as coffee grind size, ratio between water and ground coffee, and brewing coffee method. The brewing method affects the chemical composition, odor, flavor and taste of coffee. The most commonly used brewing method in the world is using hot water [1]. One of the commonly used brewing methods is the Mokapot method. Mokapot is a brewing method that is categorised as pressurized methods. Commonly, mokapot technique uses Where mokapot is a method that uses water pressure, the level coarse-fine ground coffee and the process of tamping of ground coffee to extract coffee.
2. Materials and Methods

2.1. Materials

The materials used in this study were Dampit coffee and Ijo coffee with standard ground coffee grind size. Other consumables were aquades, Whatman papers, mineral water and cucumber as palate cleanser.

2.2. Methods

The method used in this study was RATA (Rate-All-That-Apply) method. RATA method is a method developed from the CATA (Check-All-That-Apply) method, where RATA method is method approach in the form of questions where consumers are asked to select some attributes and their intensity in accordance with the perceived in sample [2]. In this study involved 110 consumer panelist were randomly recruited at the scope of Universitas Brawijaya with age in the range of 18-25 years.

2.3. Analysis

2.3.1. Total plate count (TPC) analysis

This intended to show the number of microbes contained in a product by calculating bacterial colonies grown on agar media. Foods product can be categorized as safe if the total bacterial colonies (TPC) do not exceed 1x10^8 coloni forming units/ml (CFU/ml). Potatoes Dextrose Agar (PDA) was used as medium for the analysis. Sample was put into a test tube containing 9 ml of distilled water (10^1), then vortexed. Dilution was carried out until 10^6. Then each dilution was inserted into the petri dish and microbial growth media was included. Finally, the petri dishes were put into an incubator at 35°C for 48 hours and observed the growth of the colon [3].

2.3.2. Color analysis

Color analysis in this study used a color reader. The analysis procedure was the sample placed into a clear plastic. Then the color reader was turned on and the reading was set to L*, a*, b*. Then the reading results are recorded [3].

2.3.3. Caffeine analysis

A spectrophotometric method was chosen to measure caffeine concentration. A 75 ml of brewed coffee was added by 0.75 g of CaCO_3. Then it was filtered using fine filter paper. Afterwards, it was inserted to a separating funnel and added 12.5 ml of chloroform then waited until it separated. The bottom layer was taken, evaporated and added distilled water up to 50 ml. The final solution was measured using a Uv-Vis Spectrophotometer at 275 nm [4].

The data was analyzed using ANOVA General Linear Model (GLM) in Minitab 17 at 95% confidence interval.

3. Results and Discussion

3.1 Total plate count (TPC) test

Microbiological test conducted in the form of Total Plate Count (TPC) test that aims to determine the number of microbial colonies in the sample in this study. In Table 1 below is the result of TPC that has been done.

The result of TPC test in Table 1 shows that the brewed Dampit Coffee and Ijo Coffee at various temperatures is in accordance with TPC microbial contamination standard based on SNI 7388:2009 (1x10^8 colony/g). Thus, it can be concluded that the brewed coffee safe to be served to the panelists.
Table 1. The influence of brewing temperature on microbiological assessment of Dampit and Ijo coffee.

| Sample            | Z Value | V Total | CFU/ml       |
|-------------------|---------|---------|--------------|
| Dampit Coffee 50°C| 97      | 0.1     | 9.7×10⁴      |
| Dampit Coffee 75°C| 6       | 0.1     | 0.6×10²      |
| Dampit Coffee 100°C| 0     | 0       | 0            |
| Ijo Coffee 50°C   | 13      | 0.1     | 1.3×10²      |
| Ijo Coffee 75°C   | 0       | 0       | 0            |
| Ijo Coffee 100°C  | 1       | 0.1     | 0.1×10²      |

3.2. Color analysis

The color of the cup of coffee can be influenced by the roasting process. According to [5], during the roasting process the coffee beans experience a Maillard reaction that produces melanoidin compounds providing a brown color to coffee. The longer the roasting time, the brownish color of the coffee will turn to blackish brown. Color analysis on Dampit and Ijo Coffee was conducted by using color reader. Table 2 below is the result of color analysis from Dampit and Ijo Coffee at various temperatures.

Table 2. The influence of brewing temperature on color parameters of Dampit and Ijo coffee.

| Sample            | L*    | a     | b     |
|-------------------|-------|-------|-------|
| Dampit Coffee 50°C| 23.5  | 3.9   | -3.06 |
| Dampit Coffee 75°C| 25.5  | 3.56  | -0.83 |
| Dampit Coffee 100°C| 25.9 | 4.76  | -2.06 |
| Ijo Coffee 50°C   | 23.9  | 3.3   | -3.3  |
| Ijo Coffee 75°C   | 23.8  | 2.3   | -4.23 |
| Ijo Coffee 100°C  | 24.6  | 2.43  | -3.86 |

Note: L=Lightness, a=red/green coordinate, b=yellow/blue coordinate

3.3. Caffeine analysis

Caffeine is an alkaloid chemical compound that is the dominant component of coffee. The presence of caffeine in coffee gives a bitter taste that a major characteristic of coffee [6]. The caffeine analysis results for brewed Dampit and Ijo Coffee at various temperatures are shown in Table 3 below.

Table 3. The influence of brewing temperature on caffeine content of Dampit and Ijo coffee.

| Sample            | Caffeine Content (%) |
|-------------------|----------------------|
| Dampit Coffee 50°C| 0.24                 |
| Dampit Coffee 75°C| 0.22                 |
| Dampit Coffee 100°C| 0.17                |
| Ijo Coffee 50°C   | 0.31                 |
| Ijo Coffee 75°C   | 0.23                 |
| Ijo Coffee 100°C  | 0.18                 |

The result of caffeine analysis found that the brewed coffee with 50°C temperature has the highest levels of caffeine. This is due to the level caffeine in coffee is affected by the brewing temperature. It was suggested that the higher temperature used can reduce the bitterness of coffee [6].

3.4. Sensory characteristics

Sensory characterization was performed using the Rate-All-That-Apply (RATA) method. Data obtained from the RATA method were analyzed using the GLM. It shows that there were 27 attributes that perceived differently due to different brewing temperature for both types of coffee (Table 4).
Based on Table 4, the dominant sensory characteristics of Ijo Coffee with 50°C brewing temperature were ash aroma, burnt aroma, smoky aroma, ash flavor, burnt flavor, acid flavor, smoky flavor, gritty mouthfeel and black color. The highest intensity burnt aroma may be contributed by the presence of acetone, furfural, formic acid and acetic acid [7]. The ash aroma attribute in Ijo coffee caused by 3-methylthiophene compound [8]. Meanwhile the burnt aroma is caused by the compound furan, pyridine and thiazol [9].

Smoky aroma was detected both in Ijo and Dampit coffee. The compounds responsible for this attribute are phenolic compounds [10]. The phenolic compound is 4-ethyl-methoxyphenol compound [8]. The high intensity of smoky aroma in Ijo coffee might be contributed by the dark roasting process in which requires high temperature and long time [9].

| Sensory Attributes | Dampit 50°C | Dampit 75°C | Dampit 100°C | Ijo 50°C | Ijo 75°C | Ijo 100°C |
|--------------------|-------------|-------------|-------------|----------|----------|----------|
| Aroma              |             |             |             |          |          |          |
| Roasty             | 1.79<sup>a</sup> | 1.39<sup>b</sup> | 1.35<sup>b</sup> | 0.75<sup>d</sup> | 0.82<sup>cd</sup> | 1.11<sup>bc</sup> |
| Ash                | 0.35<sup>cd</sup> | 0.62<sup>c</sup> | 0.12<sup>d</sup> | 1.87<sup>a</sup> | 1.68<sup>a</sup> | 1.33<sup>b</sup> |
| Burnt              | 0.85<sup>c</sup> | 0.43<sup>c</sup> | 0.41<sup>d</sup> | 2.39<sup>a</sup> | 1.54<sup>b</sup> | 1.76<sup>b</sup> |
| Scorched           | 1.16<sup>c</sup> | 0.89<sup>c</sup> | 0.33<sup>d</sup> | 2.29<sup>a</sup> | 1.94<sup>b</sup> | 1.84<sup>b</sup> |
| Smokey             | 0.78<sup>c</sup> | 0.66<sup>c</sup> | 0.61<sup>c</sup> | 1.89<sup>a</sup> | 1.23<sup>b</sup> | 1.52<sup>b</sup> |
| Nutty              | 0.21<sup>bc</sup> | 0.63<sup>a</sup> | 0.29<sup>b</sup> | 0.19<sup>bc</sup> | 0.08<sup>c</sup> | 0.22<sup>bc</sup> |
| Cocoa              | 0.37<sup>b</sup> | 0.29<sup>bc</sup> | 0.85<sup>a</sup> | 0.13<sup>cd</sup> | 0.05<sup>d</sup> | 0.16<sup>bd</sup> |
| Taste              |             |             |             |          |          |          |
| Bitter             | 1.93<sup>b</sup> | 2.10<sup>ab</sup> | 1.82<sup>b</sup> | 2.31<sup>a</sup> | 2.04<sup>ab</sup> | 1.98<sup>ab</sup> |
| Sour               | 0.42<sup>b</sup> | 0.42<sup>b</sup> | 0.15<sup>c</sup> | 0.23<sup>c</sup> | 0.81<sup>a</sup> | 0.42<sup>b</sup> |
| Sweet              | 0.16<sup>b</sup> | 0.05<sup>b</sup> | 0.51<sup>d</sup> | 0.06<sup>b</sup> | 0.09<sup>b</sup> | 0.07<sup>d</sup> |
| Mouthfeel          |             |             |             |          |          |          |
| Thick              | 0.26<sup>b</sup> | 0.39<sup>ab</sup> | 0.60<sup>b</sup> | 0.53<sup>bc</sup> | 0.47<sup>bc</sup> | 0.38<sup>bc</sup> |
| Gritty             | 0.17<sup>cd</sup> | 0.28<sup>cd</sup> | 0.25<sup>d</sup> | 1.14<sup>a</sup> | 0.82<sup>b</sup> | 0.56<sup>bc</sup> |
| Greasy             | 0.58<sup>ab</sup> | 0.48<sup>b</sup> | 0.70<sup>ab</sup> | 0.73<sup>ab</sup> | 0.85<sup>a</sup> | 0.47<sup>b</sup> |
| Flavor             |             |             |             |          |          |          |
| Roasty             | 1.11<sup>a</sup> | 0.73<sup>b</sup> | 0.96<sup>ab</sup> | 0.88<sup>bc</sup> | 0.85<sup>bc</sup> | 0.87<sup>bc</sup> |
| Burnt              | 0.75<sup>ab</sup> | 0.85<sup>ab</sup> | 0.45<sup>b</sup> | 1.65<sup>c</sup> | 1.29<sup>ab</sup> | 1.28<sup>ab</sup> |
| Sharp Acid         | 0.24<sup>bc</sup> | 0.18<sup>bc</sup> | 0.22<sup>bc</sup> | 0.37<sup>ab</sup> | 0.58<sup>a</sup> | 0.05<sup>c</sup> |
| Ash                | 0.48<sup>c</sup> | 0.46<sup>c</sup> | 0.31<sup>c</sup> | 1.71<sup>a</sup> | 1.52<sup>a</sup> | 1.06<sup>b</sup> |
| Smokey             | 0.53<sup>cd</sup> | 0.64<sup>c</sup> | 0.33<sup>d</sup> | 1.77<sup>a</sup> | 1.25<sup>b</sup> | 1.21<sup>b</sup> |
| Woody              | 0.35<sup>b</sup> | 0.76<sup>a</sup> | 0.32<sup>b</sup> | 0.89<sup>a</sup> | 0.96<sup>a</sup> | 1.06<sup>a</sup> |
| Acid               | 0.31<sup>b</sup> | 0.32<sup>b</sup> | 0.43<sup>ab</sup> | 0.16<sup>b</sup> | 0.37<sup>ab</sup> | 0.69<sup>a</sup> |
| Scorched           | 1.32<sup>c</sup> | 0.94<sup>d</sup> | 0.68<sup>d</sup> | 2.42<sup>a</sup> | 2.01<sup>b</sup> | 1.58<sup>c</sup> |
| Cocoa              | 0.22<sup>b</sup> | 0.23<sup>b</sup> | 0.62<sup>a</sup> | 0.16<sup>b</sup> | 0.05<sup>b</sup> | 0.27<sup>b</sup> |
| Sweet              | 0.15<sup>bc</sup> | 0.07<sup>bc</sup> | 0.18<sup>ab</sup> | 0.02<sup>c</sup> | 0.02<sup>c</sup> | 0.29<sup>a</sup> |
| Nutty              | 0.00<sup>b</sup> | 0.31<sup>a</sup> | 0.36<sup>a</sup> | 0.18<sup>ab</sup> | 0.39<sup>a</sup> | 0.27<sup>a</sup> |
| Aftertaste         |             |             |             |          |          |          |
| Bitter             | 2.28<sup>bc</sup> | 1.94<sup>c</sup> | 1.81<sup>d</sup> | 2.39<sup>a</sup> | 2.25<sup>bc</sup> | 1.93<sup>cd</sup> |
| Acid               | 0.49<sup>a</sup> | 0.47<sup>a</sup> | 0.07<sup>b</sup> | 0.39<sup>a</sup> | 0.62<sup>a</sup> | 0.56<sup>a</sup> |
| Sweet              | 0.17<sup>ab</sup> | 0.07<sup>b</sup> | 0.24<sup>e</sup> | 0.07<sup>b</sup> | 0.07<sup>b</sup> | 0.18<sup>ab</sup> |

Note: different notation at the same row means significantly different at 95% confidence level

Compounds contribute to the smoky flavor are mostly phenolic compounds, 4-ethyl-2-methoxyphenol compounds [8, 10]. Crude mouthfeel is caused by the granules of coffee powder which have not been completely dissolved in brewed coffee [11]. Roasting process in the coffee beans
experiences a Maillard reaction that produces a melanoidin compound that gives a brownish color to coffee [5].

The differences of dominant sensory attributes in Ijo coffee and Dampit coffee might be attributed to their particle size, in which particle size of Ijo coffee is smaller than Dampit coffee. Thus, it may improve the effectiveness of extraction and the breakdown of higher coffee cell structures [12]. Therefore the release CO2 together with volatile compounds is also more effective.

When brewed at 75°C brewing temperature, Ijo coffee was found to have ash aroma, sour taste, greasy mouthfeel, sharp acid flavor, ash flavor, woody flavor, nutty flavor and acid aftertaste. The greasy mouthfeel may be attributed to the fact that lipid fraction in coffee is the largest constituent in coffee beans [5]. The roasting of the coffee beans will cause the migration of the lipid fraction to the surface of the seed. The lipid fraction will be extracted with a cup of coffee and affect the mouthfeel.

The sour taste in coffee is caused by the acid content present in the coffee that is from the carboxylic acid group such as formic acid, acetate acid, citric acid, lactic acid, malate acid and quinat acid. These acids are formed in the process of fermentation and roasting, which gives the level of sour taste in coffee so that produces a pleasant effect for coffee drinkers [11]. Ijo coffee 75°C tends to have a higher acid attribute intensity compared to other coffees. This is because Ijo coffee has characteristics such as Arabica coffee in general that is higher acidity than robusta coffee [13]. The bean flavor attributes are produced from sugar and coffee components (especially pyrazine) that are mostly produced when roasting takes place [2].

Ijo Coffee with 100°C brewing temperature has sensory characteristics such as acid flavor, sweet flavor, woody flavor and mouthfeel thick. Acid flavor is one of the attributes caused by the presence of volatile organic acid components in coffee beans such as acetic acid, butanoic acid, hexanoic acid, and octanoic acid [8]. In Ijo coffee also found sweet flavor, sweet flavor in coffee is influenced by the presence of oligosaccharides as a result of hydrolysis during roasting and ketone, oxazole and furan compounds [14].

The thick mouthfeel or concentrated coffee is described by the high content of protein and coffee fiber [15]. According to [16] coffee texture associated with the density and viscosity in coffee is often called the body. Body sensation is caused by the presence of lipid compounds and dissolved polysaccharides in steeping coffee.

Dampit coffee with 50°C brewing temperature has sensory characteristics of roasty aroma, roasty flavor and acid aftertaste. The roasty aroma in coffee is due to the chemical content of the caffeine and other coffee-making compounds such as acetone, furfural, formic acid and acetic acid [7]. Dampit coffee with 75°C has nutty aroma as its sensory characteristic. This nutty aroma caused by pyrazines component in coffee.

While in Dampit coffee with brewing temperature 100°C has sensory characteristics of cocoa aroma, sweet taste, cocoa flavor and sweet aftertaste. Coffee with medium roasting profile produces a sweet aroma, cocoa and nutty with higher intensity than coffee with dark roasting profile. Sweet taste in Ijo coffee is due to the polysaccharide contained in the coffee [5].

The intensity of cocoa notes and high sweetness in Dampit coffee 100°C is thought to be caused by the coffee used is Robusta coffee where it has cocoa and sweet characteristic. In addition, the higher temperature of brewing might also be contributed to profound cocoa notes. It was reported that the release of aroma compounds will increase with increasing brewing temperatures [6]. Water temperature was one that affects the quality of the final result of coffee brewing. Because hot water can extract many chemical compounds. Some volatile substances were responsible for aroma and contributed to the taste of a cup of coffee [17].

4. Conclusion

The difference in brewing temperature has an influence on the caffeine content both in Dampit and Ijo coffee. Coffee with low brewing temperature tends to contain high amounts of caffeine. While brewed coffee with high temperature contains low caffeine. Brewed coffee with low temperature has sensory characteristics such as burnt, smokey and roasty aroma. While brewed coffee with high temperature
has sensory characteristic of sweet flavor and sweet aroma. It is also important to note that bitter taste tends to be constantly rated along with different brewing temperature. Meanwhile, bitter aftertaste tends to decrease as the increase of brewing temperature

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