Effect of blend percentage and roasting degree on sensory quality of arabica-robusta coffee blend

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Abstract. Coffee is one of the most famous commodities in the world. There are two types of coffee cultivated in Aceh, especially in Gayo Highland, namely Arabica coffee (C. arabica) and Robusta coffee (C. canephora). Arabica coffee can grow well in the farm with altitudes between 900-1,700 m above sea level [1], while Robusta coffee generally grow well at farm altitude ranging from 400-700 m above sea level [2]. The higher the farm altitude, usually, the better the Arabica coffee taste will be [3].

Blending is a process of combining different types of coffee into one mixture. One of the most common coffee blending is a combination of Robusta and Arabica coffee. Although, each type of coffee has different characteristics in terms of shape, flavour, and aroma, however, in general, Arabica coffee has a better flavour quality than Robusta coffee [4]. Thus, if the two types of these coffee are combined it is likely to produce a better flavour quality.

Arabica coffee possesses a little bit sour taste with a stronger aroma and balanced flavour. Meanwhile, Robusta coffee has a bitter taste character with a weaker aroma, but its body (thickness in the mouth) and total dissolved solid are very good. Therefore, Arabica coffee is commonly used in the

1. Introduction

Coffee (Coffea sp) is one of the most well-known agricultural commodities in the world. There are two types of coffee cultivated in Aceh, especially in Gayo Highland, namely Arabica coffee (c. arabica) and Robusta coffee (c. canephora). Arabica coffee can grow well in the farm with altitudes between 900-1,700 m above sea level [1], while Robusta coffee generally grow well at farm altitude ranging from 400-700 m above sea level [2]. The higher the farm altitude, usually, the better the Arabica coffee taste will be [3].

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blend to improve the flavour and aroma of Robusta coffee brew as demanded by consumers [5]. Coffee drinkers often mix Robusta and Arabica coffee to produce a better taste. However, the blend ratio varies widely among users, so that there is no blend composition that can be used as a reference to produce a good quality coffee blend. [6] reported that, in general, consumers prefer to have robusta-arabica coffee blends compared to that of pure robusta. Consumer consideration on Robusta and Arabica coffee blends include taste, aroma, color, and overall.

In addition to blending, roasting is also one of the determinants for the formation of distinctive flavors of roasted coffee beans. Roasting, which involved high temperature, marked significant chemical and physical changes in coffee bean. The degree of roasting associates closely with sensory quality attributes of the coffee brew. In general, the degree of roasting can be divided into three groups namely light roast, medium roast, and dark roast [7].

The objectives of this study are to determine the effect of roasting and composition of Arabica in Robusta coffee blend to cup quality and taste characteristic. This research is expected to provide information on the composition of Arabica to Robusta coffee in accordance to consumer preferences. The information could be used to improve flavor quality of robusta coffee which in turn could improve its value.

2. Materials and Methods
This research used factorial randomized block design (RBD) with 2 factors. The first factor was percentage of Arabica coffee (P) namely P1 = 0%, P2 = 10%, P3 = 20% and P4 = 30%. The second factor was degree of roasting (T) namely T1 = light, T2 = medium and T3 = dark roasting. Each treatment was replicated 2 times to produce 24 units of experiment. The data was analysed by using ANOVA (Analysis of variance). If factors showed significant effect on a parameter, a further LSD (least square difference) test was carried out. The research was conducted in one of Coffee Companies Laboratory in Bener Meriah and in Laboratory of Food Analysis and Agricultural Products, Faculty of Agriculture, Syiah Kuala University, Banda Aceh.

2.1. Materials and Tools
Materials used in this study were Arabica coffee beans (Tim-tim cultivar) and robusta coffee beans obtained from farmers in Bintang District, Central Aceh. Other materials are buffer solutions for pH 4 and 7, unsalted crackers, and aquades. Laboratory instruments used in this study were pH meters, hand refractometers, analytical scales, roasters, percolators, filter paper, grinders, glassware, measuring cylinders, jars, cup test and other supporting tools.

2.2. Research Procedure
This study was divided into three stages which were preparation of roasted beans, preparation of samples that is blended based on treatments, and parameters analysis. The roasting process of Arabica and Robusta coffee was conducted separately. The beans, as much as 2 kg each, were roasted at 195 °C for 9 minutes, (to obtain light roast), 12 minutes (to obtain medium roast) and 14 minutes (to obtain dark roast). Furthermore, roasted bean was grind using a coffee grinder to obtain about 30 mesh in coffee powder particle size. The samples were prepared by blending Robusta and Arabica coffee powders according to treatments, with a total weight of 50 gr. The percentage of Arabica coffee powder in the mixture is 0%, 10%, 20% and 30%. The coffee brewing process was carried out by pouring 150 ml hot water into a cup containing 8.25 gr of coffee powder. Then, sensory evaluation was performed by three cuppers who held Q-grader certificate recognized by international buyers. The sensory evaluation used the descriptive method based on Specialty Coffee Association of America [8]. This assessment is needed to describe the characteristics of coffee products. Aims of this test are to describe coffee brew by several criteria based on coffee quality standards. The assessment is divided into several stages, namely sniffing, slurping and swallowing [8]. Parameters observed in the analysis included total dissolved solid [9], pH [10], and organoleptic tests (descriptive test) [11].
3. Results and discussion

3.1. pH value

The pH of coffee brew is ranged from 4.95 to 5.50 with an average of 5.16. The results of analysis of variance show that percentage of Arabica coffee has a significant effect (P≤0.05) on acidity of coffee brew. Meanwhile, the degree of roasting has a very significant effect (P≤0.01) on the pH (acidity level) of coffee brew. Figure 1 shows the effect of percentage of Arabica coffee on the pH of the coffee blend.

![Figure 1. Effect of Arabica coffee percentage on the pH of coffee brew (number followed by similar alphabet shows no significant difference)](image)

The pH tends to decrease as percentage of Arabica coffee increased. This occurs because Arabica coffee has a lower pH compared to Robusta coffee. The result is in accordance to the finding of [12] who reported that pH average of Arabica coffee is lower than that of Robusta. [13] explains that the acidity of ground Arabica coffee ranges from 5 to 6.1. Meanwhile according to [4] pH value of pure Arabica coffee brew around 5, while the pH of Robusta coffee is between 5.40-5.50. [14] stated that the composition of Robusta and Arabica in coffee blend has a significant influence on the pH value of instant coffee. A mixture of robusta and arabica by ratio 80:20, 70:30 and 60:40 have a lower pH value compared to pure Robusta, due to a lower pH value of pure Arabica coffee. [3] reported that the level of acidity of arabica coffee is influenced by coffee varieties and the altitude of the farm. Tim-tim variety of Arabica coffee grown on farm at around 1200 m above sea level, has a pH value of 5.02.

The acidity level of coffee brew decreases as degree of roasting increases toward a darker level, because darker roast tended to promote the release of more acidic substances from coffee beans. As stated by [4], coffee beans naturally contain volatile compounds such as aldehydes, furfuals, ketones, alcohols, esters, formic acid and acetic acid which have volatile properties. [7] also stated that roasting has caused changes in physical and chemical properties in coffee beans. The pH of coffee brew increased as roasting degree get darker.

Coffee contains acid compounds contributed to the formation of aroma and flavors that can influence quality of coffee drink. Coffee brew with high acidity can release a stronger aroma and flavor due to its acidic compounds such as formic acid, acetic acid, malic acid, citric acid and phosphoric acid, all of which are volatile. Most of compounds providing good and pleasant coffee aroma are produced during roasting [15].
3.2. Total Dissolved Solids
The results showed that the total dissolved solids of brewing coffee ranged from 3.50 to 4.00 °Brix with an average of 3.76 °Brix. The treatment had no significant effect on the total dissolved solids in brewed coffee. Sugar is a major component in measuring total dissolved solids. In addition to glucose, dissolved solids in brewed coffee consist of other simple sugars and pectin [4].

3.3. Organoleptic Test
The results of cup test (total scores) in this study are ranged from 75.75 to 81.88 with an average of 79.30. Analysis of variance showed that percentage of Arabica coffee and roasting degree have a very significant influence (P≤0.01) on the taste of coffee brew. Figure 3 shows the effect of Arabica coffee composition and the roasting degree on coffee brew. As composition of Arabica coffee in the blend increases, the total cup test score, also tends to increase. The composition of 10% Arabica coffee has the lowest total cup test score (77.58), while the highest cup test score (80.71) is obtained from coffee blend with 30% Arabica coffee. Differences in total cup test score are influenced by properties and organic compounds contained in each coffee. This statement is also supported by [5] who explains that Arabica coffee has a better flavour quality than that of Robusta coffee. [16] reported that the more Arabica coffee is added into the blend, the better the aroma of the coffee blend.

In terms of economic consideration and to reduce the cost, the best composition producing acceptable cup test score is 20% of Arabica coffee in the blend. [17] reported that total cup test score of Robusta coffee is ranging from 49 to 76. Meanwhile, [18] states that generally gayoArabica coffee had a minimum score of 80. [3] mentioned that total cup test of gayo Arabica coffee is ranging from 80.02±2.09 to 85.48±0.42 with the average of 83.31. The results of total cup test scores of coffee brew obtained from this study have reached the intended target, which is ≥ 80.
Figure 3. Effect of Arabica coffee percentage on the total cup scores of coffee blend (number followed by similar alphabet shows no significant difference).

Figure 4. Effect of degree of roasting on total cup test score of coffee brew (number followed by similar alphabet shows no significant difference).

In general, the darker the degree of coffee roasting, the lower the total cup score of the coffee brew. Coffee with light roasting produced a total cup score of 79.84 which is not statistically different from total cup score of medium roasting which is 80.72. Accordingly, the total cup score of coffee with dark roast decreases significantly to 77.34. [4] states that the dark roast will scorch the chemical compounds present in coffee beans. This indicates that roasting at the dark level will damage some of the chemical compounds responsible for forming the taste and aroma of coffee brew. Medium roasting provide coffee brew with the highest total cup score (80.72).

Furthermore, determination of coffee quality also requires descriptive test to describe the characteristics of coffee products. Figure 5, 6 and 7 show the cup quality of coffee blend with various percentage of Arabica coffee (P) and degree of roasting (T).

The highest score on fragrance, flavour and aftertaste parameters are obtained in coffee with 10% composition of Arabica and with medium roasting degree (P2T2). While the lowest fragrance scores is obtained from coffee with 0% Arabica coffee composition and medium roasting degree (P1T2). In assessing this criterion, panellist must pay attention to the aroma and taste from the very beginning starting form preparation until slurping the brew. As mentioned by [19], fragrance of coffee
characterized by its origin, though it is not considered as the main one, because coffee quality is influenced by numerous factors and holistic coffee processing practice [20].

![Figure 5](image1.png)

**Figure 5.** Cupping score of each attributes of coffee blend with light roasting (T1), with 0% (P1), 10% (P2), 20% (P3), and 30% (P4) composition of Arabica coffee;

![Figure 6](image2.png)

**Figure 6.** Cupping score of coffee blend with medium roasting (T2), with 0% (P1), 10% (P2), 20% (P3), and 30% (P4) composition of Arabica coffee;

![Figure 7](image3.png)

**Figure 7.** Cupping score of coffee blend with dark roasting (T3), with 0% (P1), 10% (P2), 20% (P3), and 30% (P4) composition of Arabica coffee;

For acidity, the highest score was obtained in coffee blend with 20% Arabica coffee composition and light roasting degree (P3T1), and in coffee blend with 20% Arabica coffee composition with dark roasting degree (P4T3). Meanwhile the lowest acidity score was obtained from 0% Arabica coffee composition with dark roasting degree (P1T3). For body parameter, higher score is obtained from Arabica coffee with 0%, 10%, 20%, and 30% composition with dark roasting degrees (P1T3, P2T3, P3T3 and P4T3). While the lowest body score is obtained from light roasting degrees (P1T1, P2T1, P3T1 and P4T1).

For balance parameter, the highest score is obtained from 10% composition of Arabica coffee with a light roasting degree (P2T3). While the lowest balance score is obtained from 20% Arabica coffee
blend with a light roasting degree (P3T1). For parameter overall, the highest score is obtained from 0% and 10% composition of Arabica coffee with a medium roasting degree (P1T2 and P2T2). While the lowest overall score is obtained from 0% and 10% composition of Arabica coffee with dark roasting degrees (P1T3 and P2T3).

From all samples, three best total score are obtained from 20% composition of Arabica coffee with light roasting degree (P3T1 treatment), from 30% composition of Arabica coffee with medium roasting degree (P4T2), and from 30% composition of Arabica coffee with dark roasting degree (P4T3), with scores of 81.88, 81.63 and 79.75, respectively. In addition to the cup score, the panellists also described flavour characteristics of the coffee brew as shown in Table 1.

| Coffee samples | Flavor Characteristic |
|----------------|----------------------|
| P1T1           | Nutty, floraly, astrigency, roasted peanut, fine robusta, sweet, boring |
| P1T2           | Nutty, floraly, fine robusta, sweet, salty |
| P1T3           | Nutty, floraly, bitter, dark chocolaty, fine robusta |
| P2T1           | Nutty, floraly, bitter, milky, astrigency, tea like, Bit sweet, , salty |
| P2T2           | Nutty, herby, spicy, gardenpeas, sweet, sweet robusta |
| P2T3           | Herby, bitter, astrigency, sweet, dark chocolaty |
| P3T1           | Nutty, floraly, gardenpeas, sweet, balanced tabacco |
| P3T2           | Nutty, floraly, herby, spicy, chocolaty, melon, soft milky |
| P3T3           | Herby, Bitter, milky, sweet, dark chocolaty, insect |
| P4T1           | Nutty, gardenpeas, milk powder, sweet, fruity, greenish, weak aroma, chocolaty, caramelly, watery |
| P4T2           | Herby, Astringency, spicy, sweet, fruity |
| P4T3           | Herby, milky, sweet butternut, dark chocolaty, |

In general, there are similarity in flavour characteristic of each coffee blend with different Arabica composition and degree of roasting. Flavour characteristics that are unique to this brew include nutty, florally, spicy, herby, garden peas, milky, and bitter. This specific flavour characteristic also depicts location of farm origin.

4. Conclusions and suggestions
The composition of Arabica coffee in Robusta coffee blend, has a significant effect on pH, has a very significant effect on organoleptic test and has no significant effect on the total dissolved solids. The roasting degree has a very significant effect on pH and organoleptic attributes and does not have any significant effect on total dissolved solids. The interaction between the two factors do not have any significant effect on the pH value, total dissolved solids and organoleptic test. As composition of Arabica coffee increase, the level of coffee brew acidity tends to increase. The blend with 20% Arabica coffee and medium roasting degree produces coffee brew with the best total cup score. Further research is needed in regard to the composition of other Arabica coffee varieties to Robusta coffee blend.

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