

The Effect of Arabica and Robusta Coffee Blends on Caffeine Content, Acidity and Organoleptic Properties of Instant Coffee

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Abstract

One of the types of coffee in Indonesia that can be processed into instant coffee is gayo coffee. This research was conducted to find out the quality of instant coffee brewed in a mixture of arabica and robusta Gayo coffee. The method used in this research is a complete randomized design method (RAL) consisting of five treatments of a mixture of arabica coffee and robusta Gayo by making observations on acidity levels (pH), caffeine levels, and organoleptics of instant coffee brewing. The results showed that the mixed instant coffee types of Arabica and Robusta Gayo from each formulation produced different levels of acidity with a pH value of 5.55 – 6.43 and a different caffeine concentration with a value of 2.79% - 3.27% and qualified the quality requirements of the 2014 Indonesian National Standard (SNI) with a caffeine concentration value above a minimum of 2.5%. The brewing taste favored by the panelists was Gayo instant coffee, a mixture of 50% Arabica: 50% Robusta with a mild sour and bitter taste, a pH value of 5.94, and a caffeine content of 3.19%. The color and aroma of the coffee brewing favored by the panelists was Gayo instant coffee, a mixture of 70% arabica: 30% robusta with the quality of the brewing color of dark chocolate, the aroma of a little spice, the pH value of 5.55, and the caffeine content of 2.79%.

Keywords— Arabica, Robusta, Blend, Instant Coffee Brew

Introduction

Coffee is a refreshing beverage ingredient that has relatively large industrial potential based on the increasing value of world coffee consumption (Sunarharum *et al.*, 2019). *The International Coffee Organization* (ICO), estimates that coffee consumption in the world in 2020 to 2021 will be 9,997.68 tons with an annual average increase of 1.1% since 2017 (ICO, 2021). The coffee that is often traded and found on the market today is ground coffee and instant coffee (Pastiniasih, 2012). In the current era of globalization and modernization, many consumers choose instant coffee because instant coffee products are practical and do not leave any dregs when brewed, making it easier and faster to enjoy. Based on the increase in market interest in instant coffee products, this must be followed by increased innovation and quality of instant coffee products. Improving the quality of instant coffee can be done by mixing different types of coffee. Mixing different types of coffee will have an impact on the quality produced because each type of coffee has different advantages and disadvantages.



Literature Review

There are currently two types of coffee that are widely planted and cultivated in the world, namely Arabica coffee and Robusta coffee. According to Rendon et al (2014) arabica coffee has a taste and *flavor* that consumers prefer more than robusta coffee, causing the commercial value of arabica coffee to be high. According to Panggabean (2019), Arabica coffee contains organic acids, which makes the coffee taste distinctive. Robusta coffee has twice the caffeine content compared to Arabica coffee so the brewed coffee tastes more bitter. However, Robusta coffee has a higher yield than Arabica coffee so that the raw material costs for making instant coffee are cheaper. (Panggabean, 2019; Pastiniasih, 2012).

One type of coffee in Indonesia that can be processed into instant coffee is Gayo coffee. According to Saputri *et al* (2020), the chemical characteristics of Arabica and Robusta Gayo coffee beans are known to have relatively high consumer preferences. Dry Arabica Gayo coffee has chemical characteristics of coffee beans with a pH value of 5.2 – 5.8, total dissolved solids 9.39-17.6%, total organic acids 0.68-3.65%, total amino acids 11.04 -14.95%. Meanwhile, dry Gayo Robusta coffee has chemical characteristics of coffee beans with a pH value of 4.60-5.40, total dissolved solids of 10.56-17.23%, total organic acids of 2.74-3.96%, and total amino acids of 11 .09-17.54%. Currently, research on processing instant coffee mixed with Arabica and Robusta using Gayo coffee in brewed form has never been found. Therefore, this research must be carried out to determine the quality of brewing instant coffee from a variety of Arabica and Robusta Gayo coffee mixtures.

Research Method

Time and place of research

This research was carried out in March-May 2021 in the *research and development laboratory* PT Aman Food Industri Bogor, Process Laboratory of the Bogor Agro Industry Center, and Kopi Cap Gajah *Roastery* Jakarta.

Materials and tools

Material Which used in study This is seed Gayo Arabica coffee with ripe fruit that is processed wetly then dried to a moisture content of 12%, beans Robusta Gayo coffee with ripe fruit that is processed wetly then dried to a moisture content of 12%, and water . Tools that used are *roasting machine*, *grinder* (JX 600) , *water boiler* (Krischef) , *spray dryer* (GEA Niro Mobile minor) , analytical balance (Radwag AS220/C/2), digital scale (AND GF-10K), thermometer (Alla France) , pH meter (HANNA HI8424), High Performance Liquid Chromatography (HPLC), stainless filters, cloth filters and laboratory glassware.

Research method

The method used in this study is a randomized design method complete (CRD) consisting of five mixed treatments of Gayo Arabica and Robusta coffee with arabica : robusta ratio 70%:30% (7A3R), 60%:40% (6A4R), 50%:50%(5A5R), 40%:60% (4A6R), and 30%:70% (3A7R). If the calculated F is greater than or equal to the F table then proceed with the *Duncan's New Multiple Range Test* (DMRT) with a significance level of $\alpha = 5\%$.

Research procedure

Making ground coffee coffee (Punamayanti *et al*, 2017)

The production of Arabica and Robusta ground coffee begins with the roasting process. The temperature of the roasting machine is set first until it reaches a roasting temperature of 235°C. Arabica and Robusta coffee beans are each put into the roaster machine and roasted for

14 minutes (Purnamayanti *et al*, 2017). After the roasting process is complete, the roaster is turned off and the coffee is poured into a container to be cooled. The cooled coffee beans are then each ground to *fine powder* (average particle size 20-40 μ m) (Deotale *et al*, 2020). After the grinding process, ground coffee is mixed according to the ratio of treatment variations.

Making instant coffee and brewing it (Pastiniasih, 2012 modified)

Each coffee powder was extracted with a ratio of coffee powder : water (1:8) w/v using hot water at a temperature of $93^{\circ}\text{C} \pm 3^{\circ}\text{C}$ for 1.5 hours and left to cool (Pastiniasih, 2012). The coffee that has been extracted is then separated between the extract and the dregs by pouring the extract liquid through two stages of filtering, namely with a cloth filter and a *stainless steel filter*. The extraction results were dried using a *spray dryer* at an *inlet temperature* of 180°C and an *outlet temperature* of 90°C . Making instant coffee brew is done by dissolving mixed instant coffee powder using hot water with a ratio of instant coffee powder and water (1:120) w/v. The same treatment was applied to all instant coffee grounds with various mix ratios.

Results and Discussion

Value of degree of acidity (pH)

The pH value of brewed coffee is formed from the acid content in the coffee beans and the way the coffee is processed. The average pH value of a mixture of Arabica and Robusta Gayo coffee can be seen in the table.

Table 1. Average values for the degree of acidity (pH) of instant coffee brews

Coffee type ratio (%)	Average pH
Arabica (A) : Robusta (R)	
70 : 30 (7A3R)	5.55 ± 0.01^a
60 : 40 (6A3R)	5.72 ± 0.03^b
50 : 50 (5A5R)	5.94 ± 0.18^c
40 : 60 (4A6R)	6.22 ± 0.01^d
30 : 70 (3A7R)	6.43 ± 0.02^e

Description: The same letters in behind the average value shows no difference from the DMRT test .

The results of the variance analysis showed that the mixture of Arabica and Robusta coffee in each treatment statistically had a significant effect on the pH value in all instant coffee brewing treatments. A mixture of 70% arabica: 30% robusta produces the lowest pH value with a value of 5.55 and a mixture of 30% arabica: 70% robusta produces the highest pH value with a value of 6.43. This proves that the higher the concentration of Arabica coffee, the lower or more acidic the pH value will be in the instant coffee brew mixture. It is suspected that the acid content contained in Gayo Arabica coffee is more than Gayo Robusta coffee. According to Panggabean (2019), the acidity level of coffee is caused by different carboxylic acid levels in the two types of coffee with an average of 1.7% for Arabica. and robusta 1.6%.

The results of this study are different from the results of research by Saputri *et al* (2021) which stated that the pH of Gayo Arabica coffee was between 5.2 - 5.8, higher than the pH of

Javanese Arabica coffee between 4.9 - 5.3 and the pH of Gayo Robusta coffee between 4.60-5.40 less than the pH of the Java Robusta coffee sample which ranges from 5.01-6.12. However, the results of this research are supported by literature according to Bicho *et al* (2013) and Lee *et al* (2017) using coffee beans from Brazil, India and Korea, stating that the pH of Arabica coffee beans is lower with pH values ranging from 4.60 – 5.60 and Robusta coffee beans with a pH value ranging from 5.30 – 6.10 and according to Suwarmini *et al* (2017) using Arabica and Balinese robusta coffee, stated that the pH of Arabica coffee ranges between 4.09 – 5.03 and the pH of Robusta coffee ranges between 5.44 – 5.50. According to Gumulya and Helmi (2017), Gayo coffee has an acidity level that is not too high compared to types of coffee from other regions.

Caffeine

Caffeine is a secondary metabolite compound belonging to a class of heterocyclic alkaloid compounds derived from methylxanthine which has a bitter taste. The average caffeine value of Gayo Arabica and Robusta coffee mixtures can be seen in the table.

Table 2. Average Caffeine percentage of instant coffee brewing

Coffee type ratio (%)	Average Caffeine (%)
Arabica (A) : Robusta (R)	
70 : 30 (7A3R)	2.79 ± 0.03 ^a
60 : 40 (6A3R)	3.01 ± 0.01 ^b
50 : 50 (5A5R)	3.19 ± 0.01 ^c
40 : 60 (4A6R)	3.23 ± 0.02 ^{cd}
30 : 70 (3A7R)	3.27 ± 0.07 ^d

Description: The same letters in behind the average value shows no difference from the DMRT test

The results of variance analysis show that the comparison treatments of Arabica and Robusta Gayo coffee 70%:30%, 60%:40% and 50%:50% are significantly different from each other, the comparison between Arabica and Robusta 50%:50%, 40%:60% is not mutually exclusive. Significantly different, and the ratios of arabica: robusta 40%:60% and 30%:70% were not significantly different from each other with the highest caffeine value in the 30% arabica: 70% robusta treatment and the lowest caffeine value in the 70% arabica treatment. This shows that the higher the concentration of Robusta Gayo coffee, the higher the percentage of caffeine content in the instant coffee mixture.

The results of this study are reinforced by Panggabean (2019) which states that the levels caffeine average type arabica which is approx 1.2% whereas the robusta type is around 2.2% and Sunarharum *et al* (2019) stated that the caffeine content of robusta type coffee is almost double the caffeine content of arabica type coffee. In addition, the results of this research show that the average percentage of caffeine concentration in each treatment meets the quality standards for instant coffee according to the Indonesian National Standard (SNI) with a minimum limit of 2.5%.

Organoleptics of Brewing Coffee

The organoleptic test used in this research is the hedonic (liking) *scoring method* for instant coffee brewing involving PT employees. Aman Food Industry consisting of 20 untrained panelists taken randomly and 5 trained non-expert panelists from the *Quality Control department*.

The tested sample was served warm. Assessment is done by seeing the color, tasting the taste, and smelling the aroma of instant coffee brewing.

Color

The color of the coffee brew is produced from the process of roasting the coffee beans. The average panelist preference level for the color of instant coffee brewing can be seen in the table.

Table 3. Color assessment of instant coffee brewing

Coffee type ratio (%)	The average level of preference of panelists for color
Arabica (A) : Robusta (R)	
70 : 30 (7A3R)	3.56 ± 0.65 ^a
60 : 40 (6A3R)	3.52 ± 0.65 ^a
50 : 50 (5A5R)	3.44 ± 0.50 ^a
40 : 60 (4A6R)	3.40 ± 0.64 ^a
30 : 70 (3A7R)	3.44 ± 0.82 ^a

Description: The same letters in behind the average value shows no difference from the DMRT test

The results of the analysis of variance showed that the mixed treatment of Arabica and Robusta coffee did not show a significant difference in the color of the mixed instant coffee brew. This is because the process of making mixed instant coffee does not add fillers or fillers *and* the temperature used does not vary between each treatment. To find out the differences between each treatment, an analysis was carried out based on the value of the level of liking for the color that can be seen in the picture.

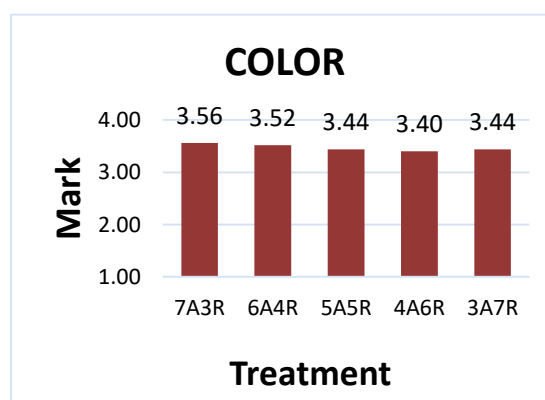


Figure 1. Panelists' preference for the color of instant coffee brewing

The results of the panelists' assessment showed that the color of the brew produced from each treatment received a score greater than 3 with a range of neutral to favorable. The color of the brew for each treatment was dark brown and visually there was no significant difference, although the assessment results showed that the highest favorability value was in the 70% Arabica: 30% Robusta mixture treatment. The color of the instant coffee brew is thought to be influenced by the juice content of each coffee which has a dark brown color when dried. The dark brown color is produced from the initial processing of instant coffee, namely the coffee bean

roasting process. This is reinforced by literature according to Mulato (2002) and Sunarharum *et al* (2019) which states that in the roasting process physical and chemical changes occur in coffee beans such as reactions *maillard* between sour amino And carbohydrates to produce a brown compound called melanoidin and the caramelization reaction of sugar which produces a brown color.

Flavor

The taste of coffee brew is produced by non-volatile compounds and is formed during the coffee processing process. The average level of panelists' preference for the taste of instant coffee brewing can be seen in the table.

Instant coffee brewing taste rating table

Coffee type ratio (%)	The average level of preference of the panelists for the taste
Arabica (A) : Robusta (R)	
70 : 30 (7A3R)	2.84 ± 1.10 ^a
60 : 40 (6A3R)	3.04 ± 0.97 ^a
50 : 50 (5A5R)	3.24 ± 1.09 ^a
40 : 60 (4A6R)	2.88 ± 0.97 ^a
30 : 70 (3A7R)	2.72 ± 1.13 ^a

Description: Same letters in behind the average value shows no difference from the DMRT test

The results of the analysis of variance showed that the mixed treatment of Arabica and Robusta coffee did not show a real difference in the taste of the mixed instant coffee brew. This is because the average panelists used are untrained panelists so they do not have a high enough sensitivity to the specific taste of instant coffee brewing. To find out the differences in generally preferred taste in each treatment, an analysis was carried out based on the value of the level of liking for the taste which can be seen in the picture.

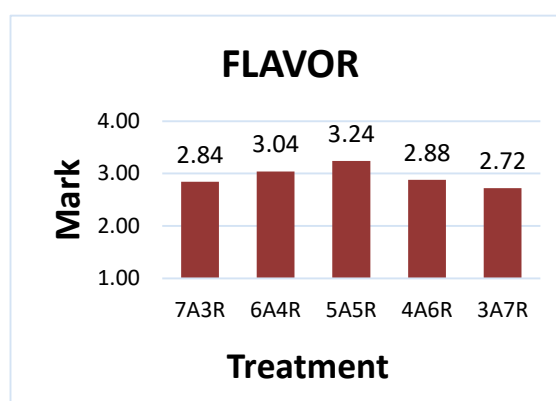


Figure 2. Panelists' preference for the taste of instant coffee

The panelist assessment results show that the higher the concentration of Arabica coffee and the higher the concentration of Robusta coffee, the panelists' preference for the taste of instant coffee will decrease. The assessment results showed that the panelists liked the instant coffee mixture the most in a ratio of 50% Arabica: 50% Robusta with a quite significant difference compared to other instant coffee mixtures with a liking value of 3.24. The ratio of mixed coffee

50% arabica: 50% robusta produces a mild and balanced sour and bitter taste. This is because the Arabica and Robusta coffees used are each processed wet and have the same formulation percentage.

The results of this research are supported by literature according to Panggabean (2019) which states that the bitter taste in brewed instant coffee is produced from caffeine compounds with an average of around 1.2% for the Arabica type and around 2.2% for the Robusta type, while the sour taste comes from carboxylic acid with the average type of arabica 1.7% and robusta 1.6%. Apart from that, according to Sunarharum *et al* (2019), Purwanto (2016), and the Agricultural Research and Development Agency (2019) stated that wet processing produces a softer, milder taste character, a thin body, with *low* acidity and strengthened yields. pH analysis with an average value of 5.94 (low acidity) and caffeine value with an average of 3.19% which can be compared to the 2014 Indonesian National Standard with a minimum limit of 2.5% and literature according to Clarke and Macrae, 1985 with an average value of 4.5% – 5.1%, so it can be concluded that the concentration of caffeine produced is relatively low so that the resulting taste is not too bitter.

Aroma

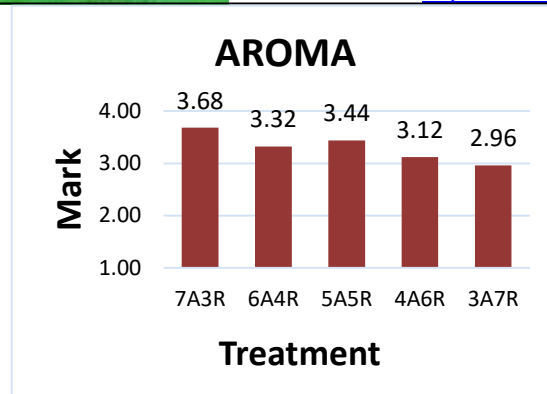
The aroma of brewed coffee is produced by volatile compounds that easily evaporate due to the interaction between the ingredients and heat during the roasting process and are formed during the coffee processing process. The average level of panelists' liking for the aroma of instant coffee brewing can be seen in the table.

Table of aroma assessment of instant coffee brewing

Coffee type ratio (%)	Average level of panelists' liking for taste
Arabica (A) : Robusta (R)	
70 : 30 (7A3R)	3.68 ± 0.85 ^a
60 : 40 (6A3R)	3.32 ± 0.85 ^a
50 : 50 (5A5R)	3.44 ± 0.76 ^a
40 : 60 (4A6R)	3.12 ± 0.66 ^a
30 : 70 (3A7R)	2.96 ± 1.01 ^a

Description: Same letters in behind the mean value shows no different from the DMRT test

The results of the analysis of variance showed that the mixed treatment of Arabica and Robusta coffee did not show a significant difference in the aroma of mixed instant coffee brewing. This is because the panelists used on average are untrained panelists so they do not have a high enough sensitivity to the specific aroma of brewed instant coffee. To see the differences in the generally preferred aroma in each treatment, an analysis was carried out based on the graphic value of the level of preference for the aroma which can be seen in the picture.



Picture of the panelists' preference for the aroma of instant coffee.

The results of the panelists' assessment showed that brewing instant coffee in each treatment produced a slight aroma of spice (spice) with the ratio of Arabica: Robusta Gayo 70%: 30% having the highest favorability value and the ratio Arabica: Robusta Gayo 30%: 70% having the lowest favorability value. . It can be concluded that the lower the percentage of Robusta coffee, the panelist's assessment of the aroma of coffee will decrease. It is suspected that Arabica coffee has a tastier *flavor or volatile compound and is preferred by panelists and is supported by Rendon et al (2014) and Suwarmini et al (2017) who state that flavor Arabica coffee as a whole is preferred by consumers over Robusta coffee. The aroma of spices in brewed coffee is thought to come from phenolic compounds Which formed during roasting coffee beans. This assumption is strengthened by the literature according to Gumulya and Helmi (2017) who state that Gayo coffee has an earthy aroma and fragrant spices and according to Panggabean (2019) and Sunarharum et al (2019) who state that the components phenolic aromatics are formed during roasting Andm give characteristics general like spice (spicy phenolics) , like smoke (smoky), and burning. Compounds included in this class are: guaiakol, 4-ethylguaiacol, 4-viniliguaiacol. According to Nijssen (1996) in Sunarharum et al (2019), volatile compounds in coffee come from various kinds of coffee bean precursors and chemical reactions during the coffee processing process. According to Sunarharum et al (2019), the groups of volatile compounds that contribute most to the formation of coffee aroma are furans, thiols, pyrazines, furanones and phenolic compounds.*

Conclusion

1. Instant coffee mixed with Gayo Arabica and Robusta types from each formulation produces a different level of acidity with a pH value of 5.55 – 6.43 and a different concentration of caffeine with a value of 2.79% - 3.27% and meets the quality requirements of the National Standard Indonesia (SNI) in 2014 with a caffeine concentration value above a minimum of 2.5%.
2. The brewing flavor that the panelists liked was Gayo instant coffee, a mixture of 50% arabica: 50% robusta with a mild sour and bitter taste, a pH value of 5.94, and a caffeine content of 3.19%.
3. The color and aroma of the brew that the panelists liked was Gayo instant coffee, a mixture of 70% arabica: 30% robusta with a dark brown brew color quality, a slight spice aroma, a pH value of 5.55, and a caffeine content of 2.79%.

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