

Sensory Profiling and Consumer Preference of Local Bogor Coffee Brands Using CATA (Check-All-That-Apply) Method

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ABSTRACT

Coffee has complex sensory characteristics, such as aroma, flavor, texture, color, and aftertaste. While various local coffee products are available in Bogor, studies on sensory attributes and consumer preferences are limited. This study aimed to evaluate the sensory profiles and preference levels of four local Bogor coffee brands using the CATA method. The samples consisted of commercially available local Bogor coffee products, including robusta-based coffee and an arabica-robusta blend produced by local roasters. A total of 29 sensory attributes were identified through focus group discussions (FGDs) with eight trained panelists and evaluated by 50 general consumers. Hedonic testing was also conducted and analyzed using preference mapping. The results showed that earthy, floral, chocolate, and spicy sensory attributes tended to increase consumer preference, while smoky aroma and rubbery and burned flavors decreased it. Ideal coffee attributes include brown color, fruity flavor, chocolate and spicy aromas, light body, and sour aftertaste. Samples 669 and 614 showed the highest preference cluster (60–80%), while 471 and 628 achieved the lowest (20–40%). These findings demonstrate the importance of sensory attributes in influencing consumer preferences and can serve as a guide for local Bogor coffee producers.

1. INTRODUCTION

Coffee is one of the most popular beverages globally and has extensive trade, including in Indonesia (BPS, 2024). As a major plantation commodity, coffee has high economic value and is a source of livelihood for millions of farmers. Indonesia ranks fourth in the world's coffee production after Brazil, Vietnam, and Colombia, with a planted area of 1.24 million hectares and production of approximately 717.9 thousand tons (ICO, 2023). Domestic consumption continues to grow, driven by the increasing coffee-drinking trend among young people, especially in major cities (Sunarhum *et al.*, 2019).

Bogor has great potential for producing Arabica and Robusta coffee due to its favorable agroclimatic conditions. Its proximity to Jakarta is also an advantage in terms of distribution and marketing (Sari, 2023). Several local coffee brands have grown in Bogor, but they face competition from national and international products. To remain competitive, it is important for local producers to highlight product quality, innovation, and differentiation, one way being through an understanding of sensory attributes (Anderson *et al.*, 2023).

The sensory attributes of coffee include elements such as aroma, flavor, aftertaste, body, and color, which are influenced by the type of coffee, origin, post-harvest processing, and bean ripeness level (Terán, 2024). Common sensory characteristics include acidity, bitterness, sweetness, complexity, and floral aroma (Sunarhum *et al.*, 2019). For producers, mapping sensory attributes is important for aligning products with consumer preferences (Bi *et al.*, 2020).

Various methods can be used for sensory evaluation. Quantitative Descriptive Analysis (QDA) and Rate-All-That-Apply (RATA) are commonly used descriptive methods that require trained or highly trained panelists to evaluate sensory attributes and often involve rating the intensity of each attribute. These methods generally require extensive panelist training, longer evaluation time, and more complex data analysis. In contrast, the Check-All-That-Apply (CATA) method is simpler and can be performed by semi-trained panelists or general consumers because panelists only select attributes that they perceive without rating their intensity (Adawiyah *et al.*, 2019). Compared with QDA and RATA, CATA is more efficient in terms of time, training requirements, and ease of implementation, making it particularly suitable for studies involving multiple samples and relatively large numbers of panelists (Kim *et al.*, 2023; da Silva *et al.*, 2025; Geffroy *et al.*, 2024). Therefore, the CATA method was selected in this study to obtain descriptive sensory information from panelists in a more practical and efficient manner (Gunawan *et al.*, 2024).

Several previous studies have applied CATA to instant coffee products (Hunaefi & Marusiva, 2022), fruit tea (Kurniawan *et al.*, 2024a), and 2-in-1 coffee (Kurniawan *et al.*, 2024b). However, similar studies focusing on local Bogor coffee are still very limited. Previous research on Bogor coffee has primarily focused on physicochemical characteristics and chemical composition (Atikah *et al.*, 2023), while studies investigating its sensory profile and consumer-driven sensory analysis remain scarce. Although several studies have evaluated the chemical composition of Bogor coffee, studies investigating the sensory profile and consumer-driven preference mapping remain scarce. Understanding how specific sensory attributes influence consumer preference is essential for improving the competitiveness of local coffee brands. Therefore, research that evaluates the sensory attributes and consumer perception of local Bogor coffee using the CATA approach is needed to provide a more comprehensive understanding of its sensory characteristic.

2. MATERIALS AND METHODS

2.1. Materials and Tools

This research used four commercial local coffee products produced by different coffee manufacturers located in the Bogor area, Indonesia. The samples were purchased directly from the respective factories and were coded as 669, 614, 471, and 628 to ensure blind sensory evaluation by the panelists. Based on information available on product packaging and previous literature, samples 628, 471, and 669 were made from robusta coffee beans (Atikah *et al.*, 2023), while sample 614 consisted of a blend of arabica and robusta coffee (Fauzi, 2023). All samples were commercial ground coffee products packaged in their original retail packaging. Information regarding roasting level and grind size was not available on the product packaging, as these details are part of each manufacturer's proprietary production process. As supporting materials, mineral water and plain biscuits were used to neutralize the flavor between tastings. The equipment used includes 2 oz paper cups, spoons, thermometers, measuring cups, coffee heaters and brewers, coffee pots, sticker labels, trays, stationery, and questionnaires.

2.2. Focus Group Discussion (FGD)

The sensory attributes used in this study were developed through a Focus Group Discussion (FGD) involving eight experienced baristas who regularly conduct coffee preparation and cupping activities. The participants also participate in periodic coffee flavor calibration training conducted approximately every six months to maintain consistency in sensory perception. This activity was conducted after the sensory evaluation training to compile a list of sensory attributes (aroma, taste, body, and aftertaste) used in the consumer CATA questionnaire (Kurniawan *et al.*, 2024b). The FGD session lasted approximately 2–3 hours. During the session, participants evaluated the coffee samples and referred to the coffee flavor wheel as a guideline to identify potential sensory descriptors (SCAA, 2015). An initial list of attributes was generated, and through group discussion, the attributes were refined by selecting those that were clearly perceivable and relevant across the four coffee samples. As a result, 23 sensory attributes were selected and used in the CATA questionnaire for the consumer sensory evaluation.

2.3. Consumer Panelist Selection

This study involved 50 consumer panelists who were selected through a screening questionnaire designed to collect background information, including gender, age, and frequency of local Bogor coffee consumption. Referring to SNI

2346:2015, the minimum number of panelists for hedonic testing is 30 individuals. In this study, 50 panelists were selected from approximately 70–100 potential participants who met the predefined criteria, including being 15–65 years old, consuming coffee at least twice a week, having basic knowledge of coffee, being in good health, and having no olfactory or taste disorders. The panelists consisted of 68% male and 32% female participants. Panelists were recruited using a convenience sampling approach at two coffee shops located in Bogor and Sukabumi. Recruitment was conducted at different time periods (morning, afternoon, and evening) over two days to minimize sampling bias and capture a broader range of regular coffee consumers. Sensory evaluation was conducted at the coffee shop locations using the CATA method

2.4. Preparation of Brewed Coffee Samples

Each sample was brewed at a ratio of 1:18 (coffee:water) (SCAA, 2015) and served in 2 oz paper cups (60 mL capacity) with a 40 mL serving volume and labeled with a random three-digit code (Kurniawan *et al.*, 2024b). The coffee was stirred gently and allowed to stand for 5 minutes to let the grounds settle (Sunarhum *et al.*, 2019), enabling panelists to evaluate the liquid without interference from particles. All samples were presented at a temperature of 40–45 °C. A small serving volume was used because the CATA method only requires panelists to identify perceived attributes, while also helping reduce sensory fatigue during multiple sample evaluations (Barahona *et al.*, 2020). Mineral water and plain biscuits were provided as palate cleansers between samples.

Sensory Analysis - The sensory evaluation was conducted in two stages. In the first stage, panelists completed a questionnaire to indicate their ideal sensory attributes of coffee using a Check-All-That-Apply (CATA) format before the coffee samples were served. In the second stage, the coffee samples were presented one at a time in a randomized order. Panelists first visually evaluated the color and smelled the aroma, then tasted and aftertaste samples to assess the flavor. During this process, they checked all sensory attributes perceived in each sample on the CATA questionnaire (Kurniawan *et al.*, 2024b). After completing the attribute evaluation, panelists assessed their overall liking of each sample using a six-point hedonic scale: 1 (strongly dislike), 2 (dislike), 3 (somewhat dislike), 4 (somewhat like), 5 (like), and 6 (strongly like) (Uy-uyon *et al.*, 2025). The liking data were subsequently used for preference mapping analysis.

2.5. Data Analysis

Data analysis was performed using XLSTAT software version 2025 with the CATA Analysis and Preference Mapping features, producing the main outputs of Cochran's Q Test, Correspondence Analysis (CA), Principal Coordinate Analysis (PCoA), Penalty Analysis, and Preference Mapping. The data were entered in a vertical format including attributes, products, evaluators, and preference data. Statistical significance was determined at a significance level of $\alpha = 0.05$. Attribute was validated using Cochran's Q test and Sheskin's Critical Difference. In Correspondence Analysis (CA), the Chi-Square distance method was applied, and the F1 and F2 axes were used as the basis for visualization.

3. RESULTS AND DISCUSSION

3.1. Sensory Attributes of Coffee

The sensory attributes of the local Bogor brand coffee products obtained from the FGD can be seen in Table 1. There are 10 aroma attributes, 13 flavor attributes, 2 body attributes, 2 color attribute, and 3 aftertaste attributes. The attributes were categorized into aroma, flavor, body, color, and aftertaste based on the coffee flavor wheel to distinguish sensory perceptions occurring at different stages of evaluation.

The sensory attributes of coffee are influenced by various compounds present in coffee. Sweetness in coffee brews is formed due to the presence of sugar or simple carbohydrates, namely sucrose and fructose (Partelli *et al.*, 2014), while the sweet aroma is produced by volatile compounds such as furan and furanones (Liu *et al.*, 2024). Acidity is formed due to the presence of volatile acetic acid and non-volatile compounds such as citric acid, malic acid, formic acid, lactic acid (Rune *et al.*, 2024), and also butyric, acetic and other high carboxylic acids (Mardhatilah & Faizah, 2025). In the roasted attribute, the contributing volatile compounds are furfural, 2-(methoxymethyl)-furan, 2-thiophenemethanol, 2-ethyl-6-methylpyrazine (Yulianti *et al.*, 2024). In addition to producing the roasted attribute, 2-

furfurylthiol can also produce the coffee aroma attribute. Spicy attributes the aroma is formed due to the presence of several volatile compounds, 2-methoxy-3-(2-methylpropyl)-pyrazine, 6-Methyl-3,5-heptadiene-2-one, 2-methoxyphenol (Yulianti *et al.*, 2024). The non-volatile compounds that contribute to the bitter taste attribute are caffeine, quinine, trigonelline, and nicotinic acid (Yan & Tong, 2022). The brown color attribute of coffee is due to the presence of caramelan compounds and melanoidins (Portillo & Arévalo, 2022).

Table 1. Sensory attributes of local Bogor coffee brand products based on FGD

Category	Attribut	Description
Aroma	Acidity	Acid aroma sensation
	Roasted	Roasted aroma sensation
	Fruity	Fruity aroma sensation
	Smoky	Smoky aroma
	Woody	Similar to old wood or bamboo aroma
	Earthy	Wet earth or wood aroma
	Rubbery	Rubber or tire-like aroma
	Nutty	Nutty aroma
	Spicy	Spicy aroma
	Chocolate	Chocolate aroma
Taste	Bitter	Bitter taste
	Sweetness	Sweet saste
Flavor	Acidity	Acid flavor sensation
	Burned	Burned flavor sensation
	Woody	Similar to wood flavor
	Earthy	Similar to wet earth flavor
	Fruity	Fruity flavor sensation
	Chocolate	Chocolate flavor sensation
	Astringent	Astringet flavor
	Spicy	Similar to spicy flavor
	Floral	Floral flavor sensation
	Nutty	Nutty flavor sensation
	Rubbery	Robber or tire-like flavor
Body	Watery	Light sensation like mineral water
	Thickness	Thick or viscous sensation in the mouth
Colour	Brown	Typical coffee brown color
	Black	Black color
Aftertaste	Bitter	Bitter aftertaste
	Acid	Sour aftertaste throughout the mouth
	Astringency	Astringent aftertaste

3.2. Sensory Profile of Coffee

According to Meyners *et al.* (2013), an attribute is considered significantly different if the p -value is <0.05 , and not significant if the p -value is >0.05 . Since the Cochran Q test does not indicate which specific samples are different, further analysis using Multiple Pairwise Comparisons with Critical Difference (Sheskin) is required. The results of the Cochran Q Test can be seen in Table 2. The test results show that all attributes exhibit significant differences at a 5% confidence level between each sample, except for the earthy aroma, acidity taste, bitter taste, and brown color attributes, as indicated by the p -values of all four attributes, which are all above the significance threshold (Table 2). This means there is no significant difference of the four attributes among samples. This finding is supported by the results of multiple comparison test (Marascuilo's method) with the critical difference approach (Sheskin).

Based on the Cochran's Q test, the attribute of brown color did not significantly differ among the four coffee samples ($p > 0.05$). Although brown color appeared evenly across all samples, this attribute did not distinguish product characteristics. This color is formed due to the Maillard reaction during the roasting process, which transforms coffee beans into dark brown (Geng, 2024). This finding aligns with the research by Nurazizah *et al.* (2021), where not all sensory attributes in CATA are discriminatory, making Cochran's Q test important for identifying significant attributes.

Table 2. Results of Cochran's Q test and Sheskin at 5% for sensory attributes of four local Bogor coffee brands

Sensory attributes	<i>p</i> -values	Sample Code			
		471	614	628	669
Acidity Aroma	<0.0001	0.320 (a)	0.880 (b)	0.700 (b)	0.680 (b)
Roasted Aroma	0.00054	0.680 (ab)	0.640 (ab)	0.460 (a)	0.860 (b)
Fruity Aroma	0.00239	0.180 (a)	0.420 (ab)	0.520 (b)	0.440 (b)
Smoky Aroma	<0.0001	0.520 (ab)	0.700 (bc)	0.400 (a)	0.780 (c)
Woody Aroma	<0.0001	0.520 (a)	0.740 (ab)	1 (c)	0.760 (b)
Earthy Aroma	0.44251	0.480 (a)	0.540 (a)	0.600 (a)	0.620 (a)
Rubbery Aroma	0.00185	0.220 (a)	0.520 (b)	0.320 (ab)	0.540 (b)
Nutty Aroma	0.01673	0.160 (a)	0.160 (a)	0.160 (a)	0.360 (a)
Spicy Aroma	<0.0001	0.760 (b)	0.340 (a)	0.600 (b)	0.540 (ab)
Chocolate Aroma	0.02131	0.460 (ab)	0.520 (ab)	0.660 (b)	0.360 (a)
Acidity taste	0.11944	0.420 (a)	0.540 (a)	0.500 (a)	0.660 (a)
Burned flavor	<0.0001	0.140 (a)	0.860 (c)	0.420 (b)	0.680 (bc)
Woody flavor	<0.0001	0.880 (bc)	0.660 (ab)	0.920 (c)	0.500 (a)
Earthy flavor	0.01579	0.760 (b)	0.620 (ab)	0.580 (ab)	0.460 (a)
Bitter taste	0.41158	0.680 (a)	0.680 (a)	0.540 (a)	0.660 (a)
Fruity flavor	<0.0001	0.460 (b)	0.060 (a)	0.320 (b)	0.400 (b)
Chocolate flavor	0.01075	0.560 (ab)	0.320 (a)	0.580 (ab)	0.620 (b)
Asterigent flavor	0.00577	0.460 (ab)	0.600 (b)	0.240 (a)	0.420 (ab)
Spicy flavor	<0.0001	0.780 (b)	0.740 (b)	0.820 (b)	0.440 (a)
Floral flavor	0.00016	0.580 (b)	0.200 (a)	0.300 (a)	0.360 (ab)
Nutty flavor	0.06987	0.080 (a)	0.280 (a)	0.140 (a)	0.200 (a)
Rubbery flavor	<0.0001	0.100 (a)	0.560 (c)	0.300 (ab)	0.380 (bc)
Watery	<0.0001	0.760 (b)	0.380 (a)	0.460 (a)	0.320 (a)
Thickness	<0.0001	0.380 (a)	0.800 (c)	0.520 (ab)	0.660 (bc)
Brown Color	0.26425	0.480 (a)	0.340 (a)	0.500 (a)	0.420 (a)
Black color	<0.0001	0.620 (ab)	0.700 (bc)	0.420 (a)	0.900 (c)
Aftertaste bitter	0.00012	0.620 (ab)	0.800 (b)	0.380 (a)	0.700 (b)
Aftertaste acid	<0.0001	0.460 (bc)	0.220 (a)	0.660 (c)	0.300 (ab)
Aftertaste astrigent	<0.0001	0.160 (a)	0.600 (c)	0.340 (ab)	0.540 (bc)

Note: Attributes and *p*-values written in bold are not significantly different at the 5% test level. The same letters indicate that there is no significant difference between samples at the 5% significance level ($\alpha = 0.05$)

The highest acidity aroma was observed in sample 471, indicating a relatively fresher aromatic profile compared to the other samples. This characteristic may be associated with the presence of acidic compounds such as citric and malic acids, which are known to contribute to fresh acidity notes in coffee. Previous studies have reported that light roasting conditions tend to preserve these acidic compounds and enhance acidity-related aromas in coffee (Pamungkas *et al.*, 2021). The most dominant roasted aroma was observed in samples 471 and 614, indicating a stronger roasted character compared to the other samples. This aroma may be associated with volatile compounds such as acetic acid and furfural that are commonly formed during the roasting process. Previous studies have reported that more intensive roasting conditions can promote the formation of these volatile compounds, contributing to a stronger roasted aroma in coffee (Pamungkas *et al.*, 2021).

The four local coffee brands from Bogor use different types of coffee; samples 628, 471, and 669 are based on robusta (Atikah *et al.*, 2023), while sample 614 is a blend of arabica and robusta (Fauzi, 2023). The fruity aroma was more prominent in samples 628 and 669 due to the formation of ester and volatile alcohol compounds during the light to medium roasting process, which plays a significant role in producing a fruity aroma, as explained by Saputri *et al.* (2020) that roasting temperature and duration affect the fruity aroma. The roasted and smoky aroma is more pronounced in pure robusta like samples 471 and 669, which is due to the high content of phenols and pyrazines, compounds characteristic of the robusta roasting process. This is supported by Wang *et al.* (2021) who state that robusta tends to produce a stronger roasted and smoky aroma due to a greater number of aroma precursors. Meanwhile, sample 628, although also based on robusta, had a lower aroma, likely due to a lighter roasting level. Sample 614, as a mixture, retained its aroma due to the dominance of robusta (Atikah *et al.*, 2023).

The strong woody aroma in sample 628 is due to the use of robusta beans from Bogor and Sumatra, which are rich in phenols and pyrazines compounds, and the medium roasting process that preserves this aroma (Kivançlı & Elmacı, 2016). The earthy and rubbery attributes were more pronounced in samples 471 and 614. These sensory characteristics may be associated with the presence of compounds such as butan-1,3-diol and butan-2,3-diol, which have been reported to contribute to earthy and rubbery notes in coffee as described by Bertrand *et al.* (2012). In terms of body, sample 614 had a thicker texture due to its higher fat and phenolic content, while sample 471 tended to be watery. The bitter aftertaste was more dominant in samples 614 and 669 because both contained a high proportion of robusta, which is naturally rich in caffeine and bitter compounds. In sample 614, despite being a coffee blend, a relatively stronger bitter taste was perceived compared to the other samples. This characteristic may be associated with the presence of bitter compounds formed during the roasting process, such as phenylindanes resulting from the degradation of chlorogenic acids. Previous studies have reported that coffee composition, particularly the proportion of robusta beans, and roasting conditions can influence the formation of bitter compounds such as caffeoyl- and feruloylquinides (Frank *et al.*, 2006).

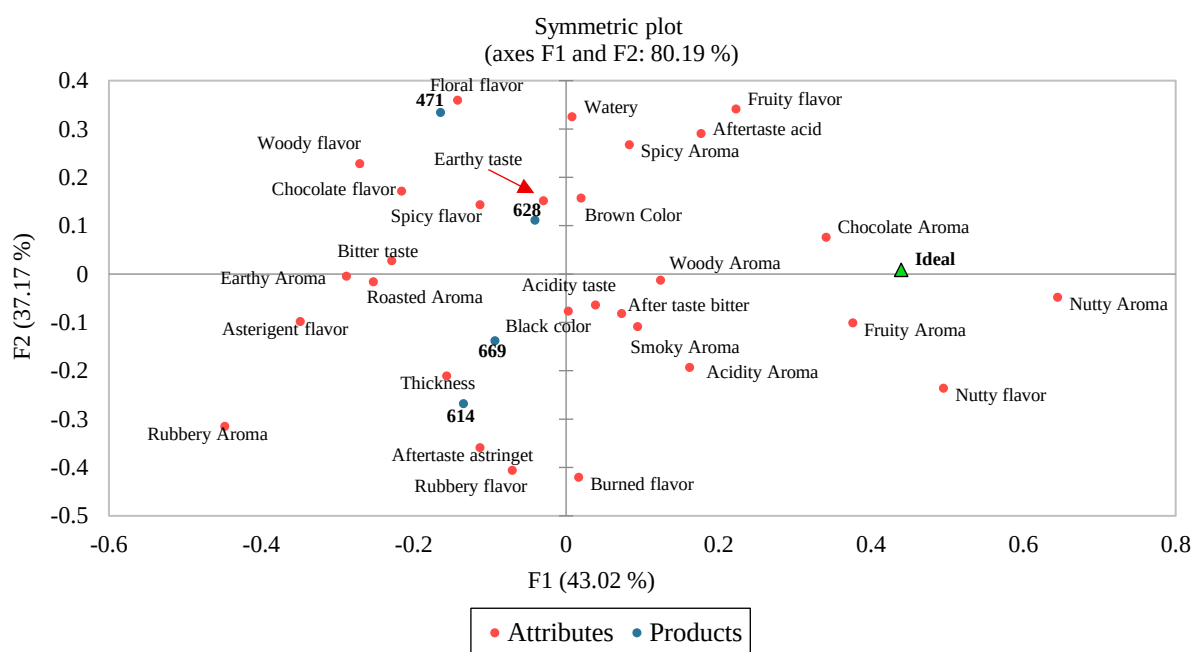


Figure 1. PCA Biplot of sensory atributs for local Bogor coffee brand products and ideal sensory attributes

Figure 1 presents a biplot graph showing the principal components (PCs), where the F1 and F2 axis represent the two main components used in this visualization. The combination of these two components is able to explain a total data variance of 80.19%, indicating that the data has a fairly good level of diversity. According to [Mattjik & Sumertajaya \(2011\)](#), a principal component is considered suitable if it can explain 70-90% of the total variance.

An attribute is considered ideal when its position is closest to the ideal product point on the biplot map (Drake *et al.*, 2023). Based on the Correspondence Analysis (CA) results presented in Figure 4, the attributes located closest to the ideal product point include chocolate color, fruity taste, spicy aroma, chocolate aroma, watery body, and acidity aftertaste. These attributes therefore represent the sensory characteristics perceived as ideal by panelists for local Bogor coffee products. These findings are consistent with previous studies on coffee sensory profiles. Kurniawan *et al.* (2024), in their study on Arabica coffee of the Sigagar Utang variety from Bogor using QDA, identified fruity aroma, chocolate notes, and acidity aftertaste as important sensory attributes. Similarly, Nurazizah *et al.* (2021) reported that acidity, spicy aroma, and a light or watery mouthfeel were key attributes influencing panelist preference in black coffee with the addition of black pepper. In addition, Kurniawan *et al.* (2024) also identified brown color as one of the preferred attributes in 2-in-1 coffee products.

Analysis shows that no sample of local Bogor coffee has a sensory profile identical to the ideal product, and none are even in the same quadrant as the ideal point. According to [Hunaefi & Farhan \(2021\)](#), a product can be categorized as ideal when it lies in the same quadrant as the ideal point on the biplot. Therefore, the results indicate that the sensory profiles of the evaluated coffees do not fully match the ideal attributes expected by consumers. The product with code 471 shows a dominance of floral taste attributes, but its position is furthest from the ideal point, indicating that this attribute is less suitable for the preferences of local Bogor coffee consumers. Meanwhile, product 628 has earthy flavor attributes, and products 614 and 669 tend to be closer to body thickness attributes.

Since none of the evaluated samples were positioned close to the ideal product point, the sensory profile of each coffee was further interpreted based on the proximity between the sample points and the sensory attribute points, as well as their position within the same quadrant of the biplot. Attributes located closer to a product indicate a stronger association with the sensory characteristics perceived in that sample. Sample 471, positioned in the upper-left quadrant, is associated with attributes such as floral flavor, woody flavor, chocolate flavor, spicy flavor, and earthy taste, indicating that these attributes contribute to the sensory profile of this coffee. Sample 628 is located near attributes including earthy taste, spicy aroma, brown color, and watery body, suggesting that these characteristics describe the overall perception of this product. Meanwhile, sample 669 is positioned near attributes such as roasted aroma, bitter taste, black color, and thickness, indicating a profile dominated by roasted and strong taste characteristics. Sample 614, located in the lower-left quadrant, is associated with attributes including thickness, astringent aftertaste, rubbery flavor, and rubbery aroma, suggesting a heavier body and more persistent aftertaste perception compared to the other samples. Overall, the distribution of samples and attributes in the biplot supports the results of the Cochran's Q and Sheskin tests, which indicated significant differences in several sensory attributes among the evaluated local Bogor coffee products.

Based on the PCoA graph analysis in Figure 2, the attributes that contribute most to consumer preference are earthy aroma, spicy taste, floral taste, and chocolate aroma. This finding is consistent with [\(Mahmud et al., 2020\)](#) research, which states that sensory attributes such as earthy aroma, chocolate aroma, spicy flavor, and floral flavor have an influence on consumer preference. While, the attributes furthest from the point of liking are rubbery, smoky, and burnt. This indicates that consumer panelists tend to dislike coffee flavor profiles dominated by those attributes. If an

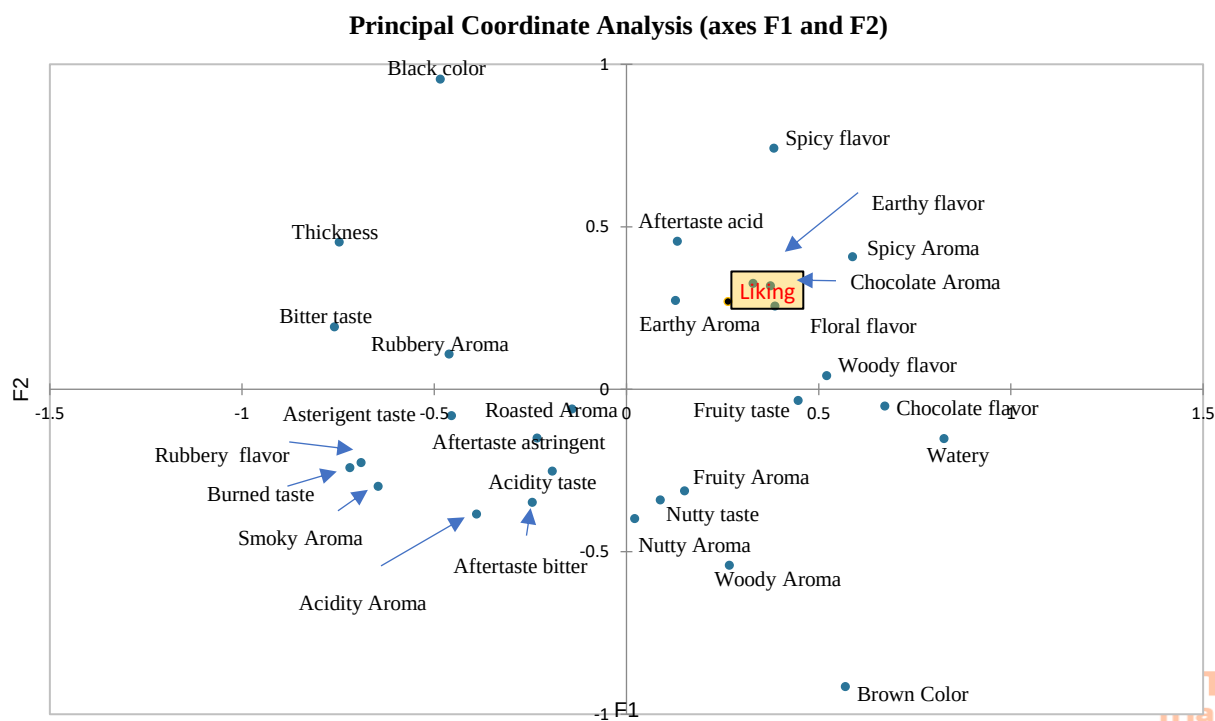


Figure 2. PCoA graphic analysis of sensory attributes and liking

attribute is in the same area as the liking point, then that attribute has a positive correlation with consumer liking levels (Kim *et al.*, 2016). Attributes located close to the liking point on the graph are considered to have a positive correlation with consumer liking levels (Selvaraj *et al.*, 2023).

According to Yang & Lee (2020), penalty analysis is used as a basis for product development to identify sensory attributes that influence overall consumer acceptance. In XLSTAT, the penalty analysis results are classified into five categories: must have, nice to have, does not influence, does not harm, and must not have. An attribute is categorized as must have when three criteria are met: the conditional probability $P(\text{No} | \text{Yes})$ exceeds 20%, the mean drop value is positive, and the p-value is lower than 0.05, indicating a significant reduction in liking when the attribute is absent (Meyners *et al.*, 2013). These parameters indicate that the absence of the attribute significantly decreases consumer liking, making it an important attribute for the ideal product.

As shown in Table 3, no attributes were classified as must have for the analyzed local Bogor coffee products. Although several attributes such as earthy flavor, spicy aroma, watery body, and chocolate aroma showed $P(\text{No} | \text{Yes})$ values above 20%, their p-values exceeded the 5% significance threshold, indicating that the reduction in consumer liking was not statistically significant. Therefore, these attributes cannot be categorized as significant must-have attributes. The absence of attributes in this category suggests that the sensory characteristics perceived as ideal by panelists were already represented in the tested products.

Table 3. Summary of penalty analysis results

Must have	Nice to have	Does not influence	Does not harm	Must not have
	Woody flavor	Fruity aroma	Roasted aroma	Rubbery aroma
		Woody aroma	Earthy aroma	Rubbery flavor
		Spicy aroma	Bitter taste	
		Chocolate aroma	Chocolate flavor	
		Acidity taste	Astringent flavor	
		Burned flavor	Floral flavor	
		Earthy flavor	Nutty flavor	
		Watery	Thickness	
		Black color	Brown color	
		Aftertaste bitter	Aftertaste astringent	
		Aftertaste acid		

Several attributes, including brown color, black color, floral flavor, spicy flavor, chocolate flavor, astringent flavor, earthy flavor, bitter taste, roasted aroma, and woody flavor, showed positive mean drop values, indicating that their presence tends to increase consumer liking. These attributes can therefore be considered as nice-to-have attributes that positively contribute to the sensory acceptance of the product.

In addition to must-have and nice-to-have categories, penalty analysis also identifies attributes classified as does not influence and does not harm. Attributes categorized as does not influence indicate that their presence or absence does not significantly affect consumer liking, suggesting that these attributes are not critical determinants of product preference. Meanwhile, attributes classified as does not harm do not significantly increase consumer liking but also do not negatively affect overall acceptance when present in the product (Meyners *et al.*, 2013). These categories indicate that certain sensory attributes may exist in the product without substantially influencing consumer evaluation and therefore are not considered essential in defining the ideal sensory profile.

In contrast, two attributes were identified as must-not-have, namely rubbery aroma and rubbery flavor, which negatively affected consumer acceptance. In coffee sensory evaluation, rubbery notes are considered defects because they mask desirable flavors such as sweetness or fruity notes and are often associated with processing issues such as poor fermentation or excessive roasting (SCAA, 2015). Therefore, controlling raw bean quality and optimizing roasting conditions are essential to prevent the formation of such undesirable attributes. Proper process control combined with flavor optimization can help develop robusta coffee products that maintain their local identity while achieving higher consumer acceptance.

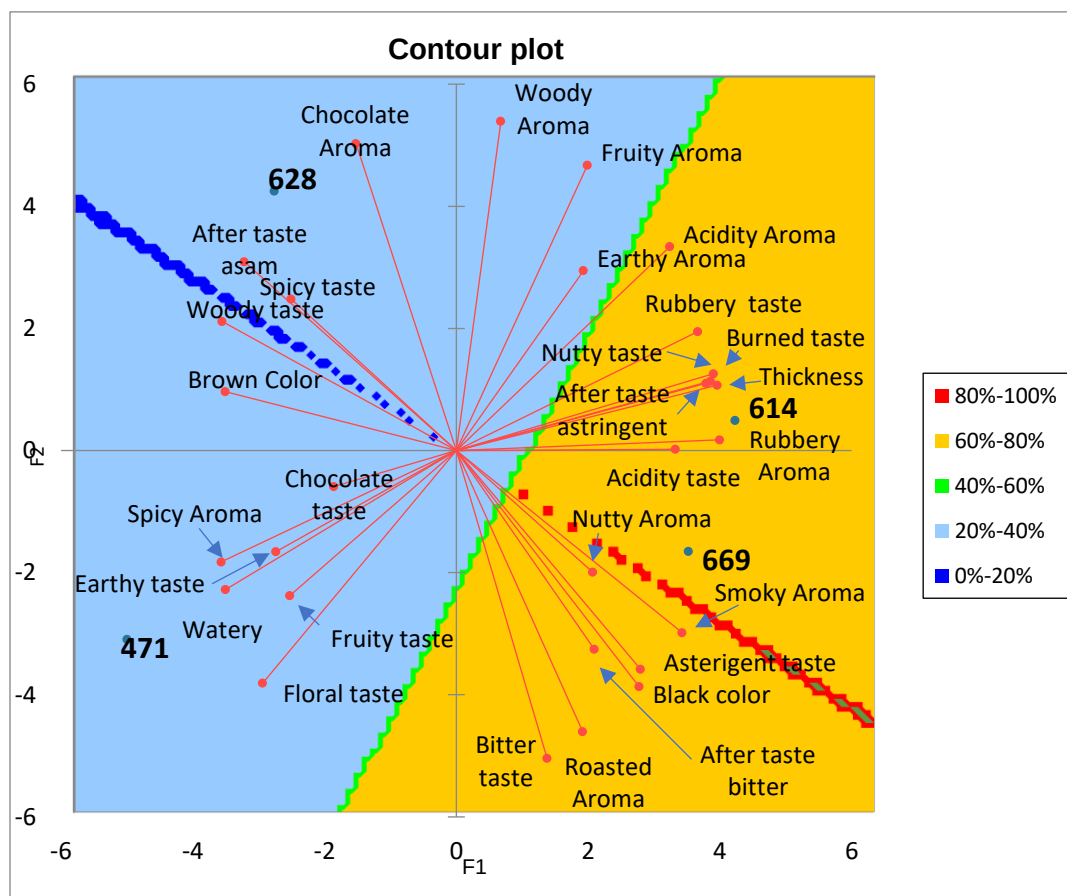


Figure 3. Preference mapping of local Bogor coffee brand products

3.3. Preference Map

Preference maps were analyzed using the preference mapping method available in XLSTAT 2025 software, resulting in a contour plot as a visualization (Figure 3). This plot illustrates the number of clusters with product preference levels exceeding the average value. The preference level of each cluster is shown as a percentage (%) and is represented by different colors according to its percentage value.

Based on the preference mapping results visualized in the contour plot, the samples can be statistically ranked from the highest to the lowest level of consumer liking as 669, 614, 628, and 471. Sample 669 is associated with several attributes located near higher preference regions, such as thickness, bitterness, and smoky aroma, indicating relatively strong sensory intensity. However, its central point is positioned in the yellow region (60–80%) rather than the optimum preferences area, suggesting that higher attribute intensity does not always correspond to higher consumer liking, particularly when the flavor profile becomes too dominant or unbalanced (Lawless & Heymann, 2010).

Sample 614 is also located in the yellow region (60–80%) and appears to have a more balanced sensory profile, which may contribute to its relatively high acceptance among panelists. According to Meilgaard *et al.* (2007), products with balanced sensory attributes tend to achieve stable consumer preference. Meanwhile, samples 628 and 471 are positioned in the light-blue region (20–40%), indicating lower preference levels compared with the other samples. Overall, the results suggest that coffee samples characterized by stronger body and roasted flavor attributes tend to occupy higher preference regions. Preference mapping therefore provides a visualization of how consumer liking is distributed in relation to sensory attributes in the sensory space (Varela & Ares, 2012).

These findings are consistent with the results of the penalty analysis and PCA. Attributes associated with higher preference regions, such as body, roasted aroma, and nutty flavor, were also identified as positive attributes

contributing to consumer acceptance. Conversely, attributes such as rubbery aroma, rubbery flavor, watery body, and weak aftertaste were positioned in lower preference regions, indicating that these characteristics should be minimized in product development. The use of the CATA method allows the identification of both positive and negative sensory attributes that influence consumer perception, providing useful guidance for improving product quality and aligning the sensory profile with consumer preferences.

4. CONCLUSION

Based Based on the results of the FGD and sensory analysis of four local Bogor coffee samples, 29 main sensory attributes were identified, including aroma (acidity, roasted, fruity, smoky, woody, earthy, rubbery, nutty, spicy, chocolate), flavor/taste (acidity, burned, woody, earthy, bitter, fruity, chocolate, astringent, spicy, floral, nutty, rubbery), body (watery, thickness), color (brown, black), and aftertaste (bitter, sour, astringent). Each sample exhibited distinct characteristics: sample 471 was dominated by acidity and fruity aromas; sample 614 stood out for its roasted, bitter, and thick qualities; sample 669 had the darkest brew color and a high bitter aftertaste; while sample 628 excelled in acidity and floral aftertaste. The panelists chose the ideal attributes as brown color, fruity flavor, chocolate and spicy aroma, watery sensation, and aftertaste acid. Correspondence analysis shows that no sample perfectly matches the ideal point, although samples 669 and 614 are closest to consumer preferences. Preference mapping shows that samples 669 and 614 have the highest preference levels (yellow zone 40–80%), while samples 471 and 628 have lower preferences (light blue zone 20–40%). These findings indicate that local coffee producers in Bogor should emphasize sensory attributes such as fruity flavor, chocolate aroma, spicy notes, moderate acidity, and brown brew color, which were identified as ideal characteristics by consumers. At the same time, attributes associated with lower consumer preference, including rubbery aroma, smoky notes, and excessively bitter taste, should be minimized through improved processing control and raw bean quality management. The use of sensory approaches such as CATA combined with multivariate analysis can help identify both positive and negative attributes, providing practical guidance for developing local Bogor coffee products that better align with consumer preferences.

AUTHOR CONTRIBUTION STATEMENT

Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
MFK	✓			✓				✓				✓		✓
SNR		✓	✓		✓	✓			✓		✓			
TAL		✓		✓				✓				✓		
C: Conceptualization			Fo: Formal Analysis			O: Writing - Original Draft			Fu: Funding Acquisition					
M: Methodology			I: Investigation			E: Writing - Review & Editing			P: Project Administration					
So: Software			D: Data Curation			Vi: Visualization								
Va: Validation			R: Resources			Su: Supervision								

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