



## Sensory Profiling of Brewed Robusta Cascara Tea Flavored with Clove and Cinnamon Based on the Rate-All-That-Apply (RATA) Method

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### ABSTRACT

*Cascara is a residual product of coffee cherry processing, has the potential to be utilized as a brewed beverage with a distinctive taste and aroma; however, its sensory characteristics are sometimes less favored by panelists. To enhance its sensory quality and mask undesirable flavors, the addition of cloves and cinnamon was employed. This study aimed to describe and determine the sensory attributes of cascara beverages with the addition of cloves and cinnamon using the Rate-All-That-Apply (RATA) method. Prior to the RATA assessment, total phenol content and color analyses were conducted across various concentration levels. The RATA test involved 70 panelists who evaluated 14 sensory attributes. Principal Component Analysis (PCA) results indicated that sample P1 (100% Cascara) was associated with a bitter aroma; sample P2 (90% Cascara:5% Cinnamon:5% Clove) was characterized by a bitter taste and aftertaste, sweet aroma, watery mouthfeel, and lingering sensation; sample P3 (80% Cascara: 10% Cinnamon: 10% Clove) exhibited a spicy taste, aroma, and aftertaste, along with a distinctive spice aroma; whereas samples P4 (70% Cascara: 15% Cinnamon: 15% Clove) and P5 (60% Cascara: 20% Cinnamon: 20% Clove) were associated with a yellowish color and high brightness levels. These findings suggest that the incorporation of additional ingredients may further enhance consumer acceptance and overall sensory appeal.*

## 1. INTRODUCTION

Indonesia is one of the world's top four coffee producers, with Arabica (*Coffea arabica*) and Robusta (*Coffea canephora*) being the most commonly cultivated and consumed varieties. Its tropical climate provides ideal conditions for coffee cultivation. Robusta dominates national production, with an average yield of 543,741 tons, exceeding that of Arabica (BPS, 2024). Robusta is more widely planted due to its greater adaptability and resistance to pests, making it easier to cultivate across various regions in Indonesia. While Robusta beans are typically used for beverages and food products such as cookies, the outer skin of the coffee cherry is often discarded as waste. Coffee fruit skin waste can be used to make Cascara, a drink made from coffee skins. Cascara drinks tend to taste like tea, as they lack any coffee flavor. Cascara is a processed coffee skin product that involves sorting, washing, peeling, and drying the coffee skins. Cascara not only offers a unique flavor profile but also provides health benefits due to its natural antioxidant content (Hidayat *et al.*, 2024; Setiyono *et al.*, 2023).

Brewed Robusta cascara offers health benefits and has been widely studied. It generally exhibits fruity flavors and aromas such as strawberry, rose, cherry, mango, and tobacco (Puspaningrum & Sumadewi, 2019). However, Murlida *et al.* (2021) reported that cascara may also present astringent, sour, and unsweet tastes. Therefore some ingredients with strong distinctive flavor can be added to improve sensory profiles of the brewed cascara tea. Cinnamon is

recognized for its sweet taste and strong aromatic profile, while cloves provide a distinctive aroma with a sharp, slightly spicy flavor, both of which are commonly used and accepted by consumers. Supporting this, Pratiwi *et al.* (2024) investigated herbal tea formulations containing mangosteen pericarp, cinnamon, and cloves, and found that cinnamon enhanced the taste and aroma particularly by complementing the sour notes of mangosteen and was generally preferred by panelists, whereas cloves were less favored due to their strong spicy and slightly bitter taste. These findings suggest that the addition of cinnamon and cloves may significantly influence the sensory profile of cascara brews; therefore, this study aims to conduct sensory attribute profiling to evaluate their effects.

Sensory attribute profiling was conducted using descriptive sensory analysis, a method recognized for its accuracy, detail, and reliability in identifying product characteristics as perceived by consumers. One effective technique employed in this study was Rate-All-That-Apply (RATA) method, which collects data on aroma, flavor, taste, and aftertaste, along with the intensity of each attribute (Adawiyah *et al.*, 2020). Thus, RATA method provides a more detailed sensory profile of the cascara beverages. When combined with a hedonic rating test, the RATA method enhances the evaluation process while minimizing potential bias. The procedure typically begins with a Focus Group Discussion (FGD) involving selected panelists to determine relevant sensory attributes. Following this, panelists assess the samples using both the RATA method and a hedonic test. The resulting data are then analyzed using Principal Component Analysis (PCA) with XLSTAT software. To date, no studies have specifically examined the sensory attributes of cascara beverages with the addition of cloves and cinnamon. Thus, this study aims to evaluate the sensory characteristics of cascara drinks enhanced with these spices through structured panelist assessment.

## 2. MATERIALS AND METHOD

### 2.1. Research Materials

The materials used in this study included dried Robusta coffee husks (cascara) sourced from local farmers in Pasuruan, East Java, as well as cloves, cinnamon, and hot water. These ingredients were combined in varying formulation concentrations to produce differences in sensory characteristics. The chemicals utilized for analytical purposes comprised distilled water, gallic acid, Folin–Ciocalteu reagent 0.4 mL, and sodium carbonate ( $\text{Na}_2\text{CO}_3$ ) 4.2 mL. The equipment employed in the study included a blender for processing ingredients, digital scales, stopwatch, writing tools, and tea bags for the brewing process. Additional tools used were small cups, prepared sensory evaluation questionnaires, the XLSTAT and SPSS software for data analysis, as well as laboratory instruments such as a UV–VIS spectrophotometer 760 nm ( $\lambda_{\text{max}}$ ), vortex mixer, micropipettes, test tubes, cuvettes, and volumetric flasks.

### 2.2. Design of Experiment

The research methodology was carried out in several sequential stages, beginning with the preparation of the brewed samples, followed by total phenol analysis and color measurement. Focus Group Discussion (FGD) was then held to identify relevant sensory attributes, which were later evaluated through the Rate-All-That-Apply (RATA) test involving the selected panelists. The final stage involved statistical data analysis to interpret the results. The product formulations tested included five variations: P1 (100% cascara: 0% cinnamon: 0% cloves), P2 (90% cascara: 5% cinnamon: 5% cloves), P3 (80% cascara: 10% cinnamon: 10% cloves), P4 (70% cascara: 15% cinnamon: 15% cloves), and P5 (60% cascara: 20% cinnamon: 20% cloves), all of which were prepared using the same brewing procedure to ensure consistency across samples.

### 2.3. Making Cascara with the Addition of Cinnamon and Cloves

The preparation process began with the selection of cascara, cloves, and cinnamon to ensure optimal final product results. The selected ingredients were then ground using a blender for approximately 2 minutes until a fine consistency was achieved. This refining process aimed to facilitate uniform extraction during the brewing stage. The ground materials were subsequently sieved using a 10-mesh sieve to obtain a consistent particle size across all samples. After sieving, the cascara, clove, and cinnamon powders were mixed in accordance with the specified formulation ratios. The blended mixture was then placed into tea bags, which were brewed using 200 mL of hot water for 2 minutes. Once the brewing process was completed, the brewed cascara was ready for sensory evaluation and consumption.

## 2.4. Total Phenol Analysis

The total phenolic content of the brew was determined using a modified method based on (Almey *et al.*, 2010), the sample was first extracted with 5 mL of 85% methanol in a test tube, vortexed until homogeneous, and centrifuged at 3000 rpm for 15 minutes. The resulting supernatant was filtered, and the filtrate was diluted to a final volume of 5 mL. A 0.4 mL aliquot of the filtrate was then mixed with 0.4 mL of Folin–Ciocalteu reagent, vortexed, and allowed to stand for 6 minutes. Subsequently, 4.2 mL of 5% sodium carbonate ( $\text{Na}_2\text{CO}_3$ ) solution was added, and the mixture was homogenized and incubated at room temperature for 90 minutes. After incubation, the absorbance was measured at a wavelength of 760 nm ( $\lambda_{\text{max}}$ ) using a UV-Vis spectrophotometer. A calibration curve was prepared using gallic acid dissolved in 85% methanol at concentrations ranging from 0 to 100 mg/L. The total phenolic content was calculated based on the linear regression equation derived from the gallic acid standard curve and expressed as milligrams of gallic acid equivalents per liter (mg GAE/L).

## 2.5. Color Test Analysis ( $L^*$ , $a^*$ , $b^*$ )

Color analysis was conducted to evaluate the visual characteristics of the beverages using a Konica Minolta CR-10 Color Reader, with modifications adapted from a previously published method (Nadhifah *et al.*, 2021), which operates based on the CIELAB color system ( $L^*$ ,  $a^*$ ,  $b^*$ ). The  $L^*$  value represents the lightness level, ranging from black (0) to white (100), while the  $a^*$  value indicates the red-green axis, with positive values indicating red and negative values indicating green. The  $b^*$  value corresponds to the yellow-blue axis, with positive values indicating yellow and negative values indicating blue. The color measurement was performed by placing the sample on a white background, followed by three repeated measurements for each sample to ensure accuracy. The obtained  $L^*$ ,  $a^*$ , and  $b^*$  values were then used to calculate the hue angle ( $^\circ\text{hue}$ ) and chroma ( $C^*$ ) to further characterize the color attributes of the brew.

## 2.6. Brown Index Analysis

The results of the color test ( $L^*$ ,  $a^*$ ,  $b^*$ ) will be used to find the brown index. The brown index will determine which sample has the highest brown color. The formula used is obtained from the journal (Shimizu *et al.*, 2021).

$$\text{Browning Index} = \frac{100 \times (x - 0.31)}{0.172} \quad (1)$$

$$x = \frac{\alpha^* + 1.75 \times L^*}{5.645 \times L^* + \alpha^* - 0.3012 \times b^*} \quad (2)$$

## 2.7. Rate-All-That-Apply (RATA) Testing and Hedonic Testing

The Rate-All-That-Apply (RATA) method was preceded by a Focus Group Discussion (FGD) to identify the relevant sensory attributes of the brewed cascara samples. The FGD involved 10 panelists selected from food technology students, with the main criterion being frequent consumption of coffee and tea, panelists who are allowed to participate must be in good health and not have allergies to product or coffee and spices. Based on the outcomes of the FGD, a list of attributes was compiled for use in the RATA evaluation. Subsequently, the RATA and hedonic tests were conducted with 70 semi-trained panelists.

In this sensory evaluation, panelists were given sufficient time to assess the cascara brewed beverage with the addition of cloves and cinnamon. The sensory evaluation employed the Rate-All-That-Apply (RATA) method, in which panelists checked all sensory attributes they perceived as present in the sample and rated their intensity. The intensity scale ranged from "0" (not perceived), "1" (very weak), "2" (weak), "3" (moderate), "4" (strong), to "5" (very strong) (Meyners *et al.*, 2016). Following the RATA assessment, panelists completed a hedonic test to evaluate their level of liking for each sample without making direct comparisons between them. The hedonic scale ranged from "1" (very dislike), "2" (dislike), "3" (neutral), "4" (like), to "5" (very like) (Triandini & Wangiyana, 2022).

## 2.8. Data Analysis

The results of total phenol content and color measurements ( $L^*$ ,  $a^*$ ,  $b^*$ ) were analyzed using Analysis of Variance (ANOVA), followed by Duncan's Multiple Range Test (DMRT) at a 5% significance level, utilizing SPSS software,

each product was tested in triplicate. Sensory profiling data, obtained through the Rate-All-That-Apply (RATA) method, were analyzed using the non-parametric Kruskal–Wallis test, followed by Dunn's post hoc test at the same significance level to identify significant differences in attribute intensities among the samples. Additionally, Principal Component Analysis (PCA) biplot graphs and preference mapping were conducted using XLSTAT software to visualize sample differentiation and consumer preference patterns, providing a comprehensive interpretation of sensory and analytical data.

Table 1. Results of the attributes selected from Focus Group Discussion (FGD)

Sensory aspect	Attribute	Description
Aroma	Sweet	The sweet aroma associated with a sweet taste comes from cinnamon, because of cinnamaldehyde.
	Bitter	Aroma associated with bitter taste
	Spicy	The aroma is associated spicy sensation in the mouth.
	Herbs and Spices	Aroma associated with spices
Flavor	Bitter	Taste associated with bitter taste
	Spicy	The spicy taste comes from the addition of cloves and cinnamon, due to the eugenol content.
	Herbs and Spices	Flavors associated with spices
Mouthfeel	Watery	Watery and runny sensation in the mouth cavity
	Longevity	Long-lasting taste sensation in the mouth
	Spicy	Hot sensation of consuming and burning while consuming
Aftertaste	Bitter	Bitter taste sensation that remains in the mouth
Color	Yellow	The sample color looks yellowish
	Brown	The sample color looks brown
	Brightness	The sample color looks bright

### 3. RESULTS AND DISCUSSION

#### 3.1. Total Phenols and Color Test ( $L$ , $a$ , $b$ ) in Cascara Brew with the Addition of Cinnamon and Cloves

In this study, the brewed samples were analyzed for total phenolic content, accompanied by color measurements using the CIE  $L^*a^*b^*$  color space system to support and complement the phenolic data. The results of this analysis are presented in Table 2.

Table 2. Results of total phenol analysis and color test ( $L^*$ ,  $a^*$ ,  $b^*$ )

Sample	Total Phenol (mg GAE/g)	$L^*$	$a^*$	$b^*$	Brown Index
P1	5.29 ± 0.12 <sup>a</sup>	25.17 ± 0.17 <sup>a</sup>	7.96 ± 0.61 <sup>a</sup>	32.42 ± 0.75 <sup>a</sup>	396.51
P2	15.24 ± 0.26 <sup>b</sup>	26.00 ± 0.28 <sup>b</sup>	7.92 ± 1.31 <sup>a</sup>	33.37 ± 0.33 <sup>a</sup>	392.44
P3	18.70 ± 0.29 <sup>c</sup>	25.15 ± 0.39 <sup>a</sup>	6.63 ± 1.50 <sup>a</sup>	32.85 ± 0.81 <sup>a</sup>	412.20
P4	26.55 ± 0.23 <sup>d</sup>	25.76 ± 0.47 <sup>ab</sup>	8.04 ± 1.59 <sup>a</sup>	33.45 ± 0.50 <sup>a</sup>	405.23
P5	30.92 ± 0.38 <sup>e</sup>	27.11 ± 0.37 <sup>c</sup>	7.77 ± 0.45 <sup>a</sup>	35.48 ± 0.25 <sup>b</sup>	414.53

Note: The average values in rows followed by different letters indicate significant differences ( $p < 0.05$ ),  $L^*$  (Light-Dark),  $a^*$  (Red-Green), and  $b^*$  (Yellow-Blue)

The total phenol contents sample were significantly different ( $p < 0.05$ ), the lowest total phenol content was observed in sample P1 (100% cascara), which aligns with the findings of [Febriyanto \*et al.\* \(2021\)](#), who reported a total phenol content of 5.62 mg GAE/g in sun-dried cascara products. The phenolic content of cascara is significantly influenced by its drying process. In contrast, the highest total phenol content was recorded in sample P5 (60% cascara: 20% cloves: 20% cinnamon) at 30.92 mg GAE/g, attributed to the relatively high concentration of added spices. This finding is consistent with studies by [Andriyani \*et al.\* \(2024\)](#), who observed an increase in total phenols to 18.251 mg GAE/g after adding 5% cinnamon to moringa leaf tea, and [Bikheet \*et al.\* \(2025\)](#), who reported a total phenol content of 58.70 mg GAE/g following the addition of 1% cloves to beverage products. These results suggest that the total

phenol content increases proportionally with higher concentrations of cloves and cinnamon, due to the abundance of phenolic compounds in these spices. Research of Ryadha *et al.* (2021) confirmed that cinnamon and cloves are rich sources of phenolic compounds, while cascara itself also contains phenols, as reported by (Wibisono *et al.*, 2024). Furthermore, the phenol content in cascara is affected by preparation methods such as drying, brewing time, and extraction technique, with sun-drying specifically shown to enhance phenolic levels (Prasetyo & Winardi, 2024).

The results of the  $L^*$  (lightness) and  $b^*$  (yellow-blue) color analysis, as well as the calculated Brown Index, showed that the highest values were observed in sample P5 (414.53). This finding aligns with the study by Suseno *et al.* (2023), who investigated the blending of black tea with cinnamon and reported an  $L^*$  value of 33.00 and  $b^*$  value of 38.25 upon the addition of cinnamon. However, in the present study, the presence of clove may have influenced the observed color variations. According to Islam *et al.* (2020), the production of clove tea resulted in an  $L^*$  value of 33.32 and  $b^*$  value of 15.52, indicating a noticeable impact on color parameters. These variations in color can be attributed to the presence of tannin and flavonoids compounds, as all three ingredients black tea, cinnamon, and clove contain tannins that contribute to yellow to brown coloration (Rizqiani & Haryanto, 2022) and the highest  $a^*$  (red-green) color value was observed in sample P4, which recorded a value of 8.04. This sample contained a relatively high concentration of cascara as the main ingredient (70%), with clove and cinnamon each contributing 15%. For instance, Islam *et al.* (2020) reported an  $a^*$  value of 12.35 in a study utilizing clove spices, while Suseno *et al.* (2023) recorded an  $a^*$  value of 26.75 in a formulation combining black tea with cinnamon. The lower  $a^*$  value in the present study may be attributed to the influence of anthocyanin compounds, which contribute to reddish hues (Priska *et al.*, 2018).

### 3.2. Sensory Profiling of Brew Tea Using the RATA Method

Data obtained from the Focus Group Discussion (FGD) revealed  $p$ -values for 14 sensory attributes (Table 3), which were analyzed using the RATA (Rate-All-That-Apply) method. Sample P1 exhibited the highest scores for both bitter aroma and mouthfeel longevity. The pronounced bitter aroma is attributed to the presence of tannin compounds, as noted by Hutasoit *et al.* (2021). According to Puspaningrum & Sumadewi (2019), the drying time and temperature during processing significantly influence the quality of cascara, including its flavor and aromatic profile. Furthermore, the high mouthfeel longevity in sample P1 indicates a persistent sensation remaining in the oral cavity after consumption, which may be associated with the concentration of specific bioactive compounds.

Table 3. The intensity of sensory attribute values of brewed tea and the respected  $p$ -value

No	Sensory Attributes	$p$ -value	Sample				
			100% CS	90%CS:5%KM: 5%CG	80%CS:10%K M:10%CG	70%CS:15%K M:15%CG	60%CS:20%K M:20%CG
1	Bitter	0.694	1.78 <sup>a</sup>	1.65 <sup>a</sup>	1.85 <sup>a</sup>	1.88 <sup>a</sup>	1.54 <sup>a</sup>
2	Sweet	0.869	1.50 <sup>a</sup>	1.57 <sup>a</sup>	1.37 <sup>a</sup>	1.32 <sup>a</sup>	1.32 <sup>a</sup>
3	Herbs & Spices	0.001	2.61 <sup>a</sup>	3.81 <sup>b</sup>	3.72 <sup>b</sup>	3.80 <sup>b</sup>	3.64 <sup>b</sup>
4	Spicy	0.001	0.97 <sup>a</sup>	2.12 <sup>b</sup>	2.02 <sup>b</sup>	1.94 <sup>b</sup>	1.94 <sup>b</sup>
<b>Flavor</b>							
5	Bitter	0.168	1.94 <sup>a</sup>	3.10 <sup>a</sup>	2.68 <sup>a</sup>	2.51 <sup>a</sup>	2.61 <sup>a</sup>
6	Herbs & Spices	0.003	2.91 <sup>a</sup>	3.74 <sup>b</sup>	3.61 <sup>b</sup>	3.42 <sup>ab</sup>	3.38 <sup>ab</sup>
7	Spicy	0.001	1.15 <sup>a</sup>	1.95 <sup>b</sup>	1.88 <sup>b</sup>	1.50 <sup>ab</sup>	1.90 <sup>b</sup>
<b>Mouthfeel</b>							
8	Longevity	0.203	3.14 <sup>a</sup>	3.24 <sup>a</sup>	3.14 <sup>a</sup>	2.98 <sup>a</sup>	3.01 <sup>a</sup>
9	Watery	0.853	2.94 <sup>a</sup>	2.92 <sup>a</sup>	2.82 <sup>a</sup>	2.75 <sup>a</sup>	2.88 <sup>a</sup>
10	Spicy	0.014	0.98 <sup>a</sup>	1.70 <sup>b</sup>	1.67 <sup>b</sup>	1.40 <sup>ab</sup>	1.57 <sup>ab</sup>
<b>Aftertaste</b>							
11	Bitter	0.127	3.14 <sup>a</sup>	3.24 <sup>a</sup>	3.14 <sup>a</sup>	2.98 <sup>a</sup>	3.01 <sup>a</sup>
<b>Color</b>							
12	Yellow	0.001	1.47 <sup>a</sup>	1.48 <sup>b</sup>	2.12 <sup>ab</sup>	2.14 <sup>ab</sup>	2.72 <sup>b</sup>
13	Brown	0.001	3.77 <sup>c</sup>	3.87 <sup>c</sup>	3.34 <sup>bc</sup>	3.11 <sup>ab</sup>	2.58 <sup>a</sup>
14	Brightness	0.000	1.92 <sup>a</sup>	1.82 <sup>a</sup>	2.22 <sup>ab</sup>	2.58 <sup>b</sup>	2.64 <sup>b</sup>

Note: The average value followed by a different letter indicates a significant difference between columns ( $p < 0.05$ ), scale criteria: 1 (low), 2 (rather low), 3 (medium), 4 (rather high), 5 (high), CS (Cascara), KM (Cinnamon), CG (Cloves)

Sample P2 demonstrated the highest values in several significantly different sensory attributes, including the aroma and taste of Herbs and Spices, spicy taste, spicy mouthfeel, and brownish color. Although attributes such as bitter aroma, sweet taste, mouthfeel longevity, and bitter aftertaste did not differ significantly among samples, P2 still recorded relatively higher values. The distinctive herbal aroma of cascara tea aligns with findings by [Rosdiana \*et al.\* \(2024\)](#) identified cascara as having a characteristic herbal tea profile. This is supported by [DePaula \*et al.\*, \(2022\)](#), who reported that volatile compounds particularly aldehydes and esters contribute to its herbal aroma. The enhanced spicy characteristics in P2 are attributed to the addition of cinnamon and cloves. Cinnamon contributes a sweet and spicy aroma due to cinnamaldehyde ([Andriyani \*et al.\*, 2024](#); [Kaka \*et al.\*, 2023](#); [Rahmawati \*et al.\*, 2024](#)), while cloves provide a strong, warm, and sharp aroma due to their eugenol content ([Pribatiwi \*et al.\*, 2024](#)). The spicy aftertaste is further intensified by these compounds, as supported by [Sarvika \*et al.\* \(2024\)](#), who found that increasing cinnamon concentrations (0–2.5 g) enhances a fresh, spicy-sweet aftertaste. This elevated spicy aftertaste contributes directly to the perception of a spicy mouthfeel. Additionally, the brownish color observed in P2 is influenced by anthocyanins and the oxidation of tannins found in both cinnamon and cloves during the brewing process ([Zai \*et al.\*, 2023](#)).

The color attributes observed in the brewed samples are influenced by the presence and transformation of bioactive compounds during the brewing process. Sample P5 exhibited the highest brightness and yellowness compared to other samples, which can be attributed to the presence of specific polyphenolic compounds such as eugenol, commonly found in cinnamon and cloves. According to [Anggrayni & Nasution \(2021\)](#), eugenol is typically clear to pale in color, contributing to the light appearance of the infusion. Additionally, cascara combined with cinnamon and cloves contain tannin compounds that dissolve during processing, thereby enhancing the yellowish to brownish-yellow color attributes. Furthermore, flavonoid compounds are known to contribute to the yellowish hue, as they generally produce an orange coloration, as noted by [Hastuti \(2024\)](#). These combined chemical constituents play a significant role in the visual characteristics of the final brewed product.

### 3.3. Principal Component Analysis (PCA)

The Principal Component Analysis (PCA) is to explain as much of the variance in the original dataset as possible using a reduced number of principal components, also referred to as factors and PCA also helps in attribute mapping and differentiating among samples. PCA is a statistical technique used to simplify complex datasets by linearly transforming the original variables into a new coordinate system, where the largest variance lies along the first principal component, the second largest variance along the second component, and so on. This transformation allows for more efficient data interpretation and visualization while minimizing information loss.

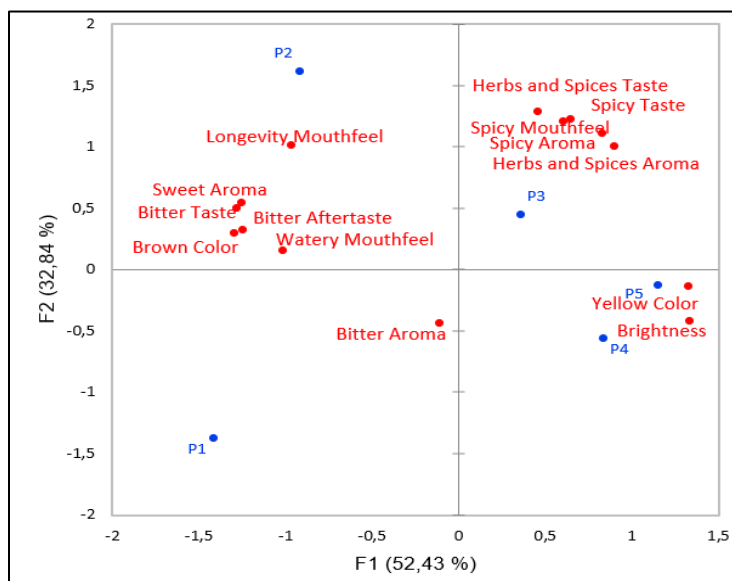


Figure 2. Results of Principal Component Analysis (PCA) of brewed cascara tea

The Figure 2 illustrates the sensory attributes associated with each sample. Sample P3 is characterized by a strong spicy aroma and taste, a pronounced Herbs and Spices profile, and a spicy mouthfeel. Sample P2 demonstrates the highest number of associated attributes, including bitter taste, sweet aroma, watery mouthfeel, mouthfeel longevity, bitter aftertaste, and brown color. In contrast, sample P1 is associated with only one attribute within its quadrant—namely, a bitter aroma. Lastly, samples P4 and P5 are grouped within the same quadrant, both associated with yellowish color and high brightness.

### 3.4. Preference Mapping Sensory Attributes

The purpose of Preference Mapping is to determine the sensory attributes related to panelist preferences for cascara brewed products with the addition of cinnamon and cloves. Preference Mapping is obtained from cluster analysis using the Agglomerative Hierarchical Clustering (AHC) method and principal component analysis using Principal Component Analysis (PCA) (Ayuningtyas *et al.*, 2019). The red area has an interpretation value of 80-100% of consumers giving a preference value above average or high, then the yellow area has an interpretation value of 60-80%, the green area has an interpretation value of 40-60%, the light blue area has an interpretation value of 20-40% and the dark blue area has an interpretation value of 0-20%. The following are the results of the preference mapping at Figure 3.

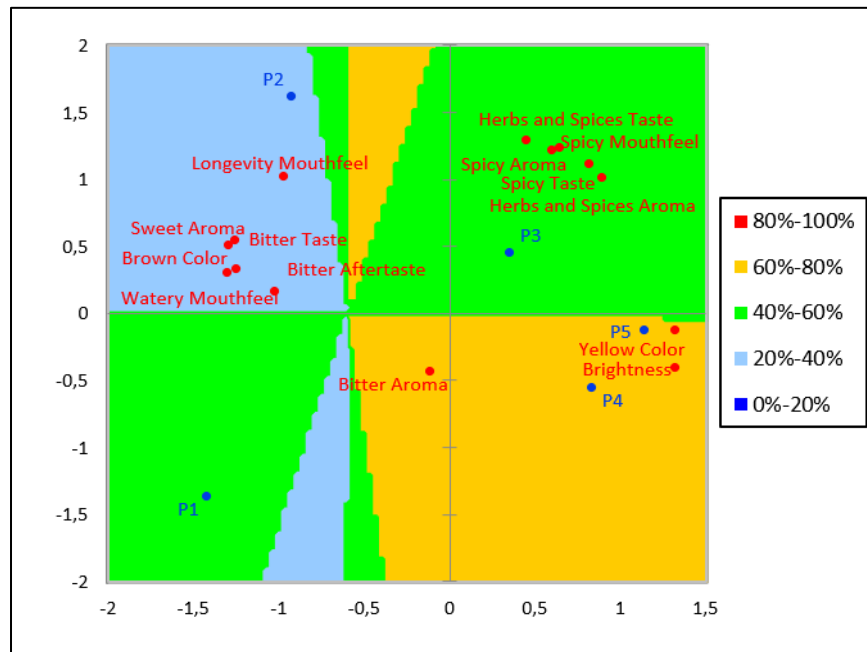


Figure 3. Preference mapping of sensory attributes of brewed cascara tea with cinnamon and cloves

First, there is sample P2 which is located or found in light blue, then this sample has an average preference of 20%-40%. The attributes contained in that area are the mouthfeel longevity and bitter taste attributes, sweet aroma, bitter aftertaste, watery mouthfeel and brown color have the lowest value. Then there is a P3 sample that has quite a lot of attributes but P3 has a value above P2 which is located in the green area (40-60%), and the bound attributes are the aroma of herbs and spices, spicy aroma, spicy taste, spicy mouthfeel has a medium value, then there is the taste of herbs and spices. According to Prayoga (2024) the brewed products formed by cascara tea result in a fruity aroma. However, adding cinnamon and cloves can improve the taste and aroma, such as research by Rukmelia *et al.* (2023) that adding cinnamon and cloves can provide a distinctive aroma and taste of these spices, but in this Figure 3 sample P2 was rated lower in overall preference compared to sample P3. This discrepancy may be attributed to the lower concentrations of cinnamon and clove additives present in sample P2.

Furthermore, in sample P1 (40%-60%) there is only one attribute in it with a high value, namely a bitter aroma, this attribute is included in the yellow area. There are several studies that explain that cascara can provide a taste that is not liked by consumers, one of which is in the study of [Fadhillah \*et al.\* \(2023\)](#), this happened in this study where cascara gives a bitter taste so that it can affect the aroma. The processing process can have an effect on the aroma, such as research from [Muzaifa \*et al.\* \(2020\)](#) that during the processing of cascara brewing, it is best to reduce the size first, because it can affect the extracted chemical components, and samples P4 and P5 had intensity values of 60%-80% in the yellow quadrant. These samples exhibited brightness and yellowish color attributes, suggesting the addition of cinnamon and cloves could improve the color. These differences in quadrants are due to panelists' individual preferences for responding with their human senses, which can lead to different results and preferred or perceived attributes ([Ismanto, 2022](#)).

### 3.5. Level of Preference for Brewed Products

The panelists preference level was processed using the Kruskal-Wallis test to determine the highest value for each preference of the cascara brew sample with the addition of cinnamon and cloves at Table 4. Based on the Kruskal-Wallis test, the preference scores ranged from 2.38 to 2.94. The lowest preference score was recorded for sample P2 (2.38), while the highest was observed in sample P5 (2.94). The higher preference for P5 may be attributed to its higher concentration of cinnamon and cloves, which positively influenced the sensory characteristics. In contrast, the lower score for P2 is likely due to the dominance of 90% cascara, which resulted in a less favorable sensory profile. According to [Murlida \*et al.\* \(2024\)](#), the use of 90% cascara yields low preference scores, and the addition of only 5% cinnamon and cloves is insufficient to significantly enhance flavor. Conversely, the inclusion of higher concentrations of cinnamon and cloves has been shown to improve taste perception. For example, [Arisanti & Mutsyahidan \(2018\)](#) reported that lemongrass herbal tea containing 50% cinnamon achieved high preference ratings, while [Utami \*et al.\* \(2010\)](#) found that the addition of 0.6% cloves increased sensory acceptance. These findings suggest that cinnamon and cloves positively influence preference levels; however, excessive use may also negatively impact overall flavor quality.

Table 4. Preference Values for Sample

Sample	Preference Values
100% Cascara : 0% Cinnamon : 0% Clove	2.58 <sup>a</sup>
90% Cascara : 5% Cinnamon :5% Clove	2.38 <sup>a</sup>
80% Cascara :10% Cinnamon :10% Clove	2.58 <sup>ab</sup>
70% Cascara :15% Cinnamon :15% Clove	2.82 <sup>b</sup>
60% Cascara : 20% Cinnamon :20% Clove	2.94 <sup>b</sup>

Note: The average value followed by a different letter indicates a significant difference between columns ( $p < 0.05$ ), scale criteria: 1 (low), 2 (rather low), 3 (moderate), 4 (rather high), 5 (high).

## 4. CONCLUSION AND SUGGESTION

The conclusion obtained is that the highest phenol and  $L^*$  and  $b^*$  colors are found in sample P5, for the  $a^*$  color is found in sample P4. The PCA results show that P2 is the sample that is most bound to its attributes by six attributes, namely bitter taste and aftertaste, watery and longevity mouthfeel then sweet aroma, brown color then P2 is the least preferred sample and in sample P1 is the sample that is bound to the fewest attributes but the attribute has a high value, namely bitter aroma, then the results of Preference Mapping P4 and P5 are the samples that have the highest intensity value and are the most preferred samples.

Based on the findings of this study, it is recommended that future product development incorporates additional ingredients to enhance consumer acceptance. This suggestion is supported by the results of the preference mapping, which indicated that most of the dominant sensory attributes were less preferred by panelists. Enhancing the formulation with complementary ingredients may help improve the overall sensory appeal and align the product more closely with consumer preferences.

## AUTHOR CONTRIBUTION STATEMENT

Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
FFD	✓	✓		✓	✓	✓		✓	✓	✓	✓			
RAA	✓	✓		✓						✓		✓		
HM	✓	✓								✓		✓		
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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