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Sensory Profile and Consumer Preference Analysis of Robusta and Arabica Coffee with Ginger and Lemongrass Addition

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A B S T R A C T

Consumer-based sensory profile assessment of the use of spices in coffee beverages is necessary to determine consumer acceptance. This study aims to describe the sensory profile and analyse the relationship between the sensory profile and consumer preferences for robusta and arabica ground coffee with the addition of ginger and lemongrass at various concentrations. The sensory profile was determined using the rate-all-that-apply (RATA) method, resulting in 22 attributes covering the sensory attributes of robusta and arabica coffee with the addition of ginger and lemongrass, namely sweet aroma, sour aroma, bitter aroma, roasted aroma, nutty aroma, cocoa aroma, spicy aroma, sour taste, bitter taste, roasted taste, burnt taste, nutty flavor, cocoa flavor, gingery flavor, lemongrass flavor, mouthfeel body, mouthfeel rough, mouthfeel mouth drying, mouthfeel burnt, aftertaste bitter, aftertaste sour, and aftertaste spicy. The panellists' preference mapping showed that 60%–80% of panellists had above-average preference scores for sample K1 625, a robusta coffee treatment with the addition of 5% ginger and 5% lemongrass, with a dominant bitter aroma.

Contribution to Sustainable Development Goals (SDGs):
SDG 2: Zero hunger
SDG 8: Decent work and economic growth
SDG 9: Industry, innovation, and infrastructure

1. INTRODUCTION

1.1. Research Background

Coffee is one of the most widely consumed products in the public due to its distinctive aroma and taste. Robusta and arabica coffee varieties have different aroma and taste characteristics. Robusta coffee has a more bitter taste, a distinctive sweet aroma, and a coarser texture than Arabica coffee [1]. Arabica coffee has a slightly sour taste, a strong aroma, and a more balanced flavor [2]. The differences in characteristics between these two coffee species mean that coffee consumers have different preferences when choosing coffee products.

Spiced coffee is a beverage made by combining coffee and spice powders. Research on the use of spices in coffee beverages is needed to determine acceptable formulations, serving as a reference for developing spiced coffee beverage products. [3].

Methods for determining consumer preferences for coffee sensory profiles include sensory evaluation [4]. Consumer-based sensory evaluation using the rate-all-that-apply (RATA) method can be used to assess a product's sensory profile and the intensity of specific attributes [5]. RATA sensory profile assessment is followed by a hedonic test to determine consumer acceptance or preference for a product [8]. Consumer preferences are one reason why consumers choose products they like, which can be influenced by various factors [9]. Sensory profile can be one of the factors that influence consumer preference for a product [10].

Rate-all-that-apply (RATA) is one of the sensory evaluation methods that can be used in product development. This method provides information on sensory attributes along with the intensity levels perceived by panelists. Another sensory evaluation method commonly used in product development is

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Just-About-Right (JAR). In this method, intensity is assessed based on the product's ideal level (too weak, just about right, too strong), making it more suitable for product optimization [6]. The use of the RATA method is appropriate for detecting various sensory attributes that may potentially appear in a developed product [7].

1.2. Literature Review

1.2.1. Coffee

Robusta coffee (*Coffea canephora*) is coffee species originates from lowland areas in Africa. Robusta coffee plants are commonly found in humid tropical areas at an altitude of 250 m – 1500 m above sea level. In general, robusta coffee has a bitter taste, a distinctive sweet aroma, varied bean colors, and a coarser texture than arabica coffee [1].

Arabica coffee (*Coffea arabica*) is a coffee plant originates from the forests of the highlands around Ethiopia and South Sudan. Robusta coffee plants generally grow in highlands at an altitude of between 1300 and 2000 m above sea level [11].

The flavor components in Arabica coffee beans are more complex than those in Robusta. Green arabica coffee beans have a higher sucrose content than robusta. This sucrose content affects the acidity of the coffee brew. Arabica coffee brew has nutty, sweet, floral, fruity, and fermented flavor characteristics [12].

1.2.2. Spiced Coffee

Spiced coffee is a beverage product made from a mixture of coffee powder and spice powder. Increased competition and consumer demand are among the reasons why there are now many types of coffee with added spices [13; 14]. Spiced coffee is made by grinding coffee and spices separately before mixing them together. The spiced coffee processing begins with the preparation of raw materials, namely roasting coffee beans. The roasted coffee beans are then ground with a grinder to obtain coffee powder. The spices are cleaned first to remove any unused parts. After that, the spices are dried and ground. The coffee powder and spice powder are then mixed in a specific formulation to obtain a homogeneous mixture [15].

1.2.3. Ginger

Ginger (*Zingiber officinale*) has a plant height of 0.5–0.7 m, round roots, green stems that are flat and round in shape, leaves with pointed tips, and each stem consists of 15–26 leaves. Ginger plants have straight rhizomes with a yellowish-white color. The flesh of ginger rhizomes is yellow to grayish-yellow [16].

Ginger contains gingerol, zingerone, shogaol, and essential oils that act as antioxidants. Gingerol is an active compound in fresh ginger that gives ginger its spicy taste. Zingeron is a phenolic compound that gives ginger its spicy, hot, bitter taste and distinctive aroma. Shogaol is a phenolic compound that gives ginger its spicy taste and has antioxidant effects [17].

1.2.4. Lemongrass

Lemongrass (*Cymbopogon citratus*) is a plant with grassy stems that grow in clusters and are green in color, growing upright. Lemongrass has ribbon-shaped leaves with pointed tips. The edges of the leaves are smooth with a hairy surface that is green in color [18].

Lemongrass has a distinctive and strong lemon aroma, making it widely used as an aromatic ingredient in food. Several compounds contained in lemongrass have antioxidant properties, such as citronellal, stronelol, geraniol, and limonene [19]. Lemongrass contains essential oils with high citral content, giving it a strong lemon aroma [20].

1.2.5. Rate-all-that-apply (RATA)

Rate-all-that-apply (RATA) is a consumer-based method for determining sensory profiles. The use of RATA in sensory evaluation can provide an intensity value for a sensory attribute, making the evaluation more complete and comprehensive [5]. RATA consists of two stages: the first is to determine the presence of a sensory attribute in the product, and the second is to assess the intensity of the sensory attribute [21]. The determination of sensory attributes for products to be used in the RATA test is carried out through focus group discussions (FGD) [22].

FGD aims to find terms that can explain sensory attributes to untrained panelists [5]. The ideal number of FGD participants is 7–11 people so that each participant can express their opinion [23]. FGD can involve 8 people who represent consumers and have a general understanding of sensory attributes [5]. In another study, 9 panelists were involved in determining the sensory attributes to be used in the RATA test [22].

Sensory evaluation using the RATA method allows panelists to rate the intensity of a product's sensory attributes. The 3-point intensity rating scale consists of 1 "low," 2 "medium," and 3 "high," while the 5-point intensity rating scale ranges from 1 'low' to 5 "very high" [21]. RATA test is followed by a hedonic test to determine consumer preference for a product [8]. The level of liking or hedonic scale consists of responses such as very like, like, somewhat like, somewhat dislike, dislike, or very dislike, which are expressed in numbers [24].

1.3. Research Objective

This study aims to describe the sensory profile of robusta and arabica ground coffee with the addition of ginger and lemongrass and to examine the relationship between sensory profile and consumer preference.

2. MATERIALS AND METHODS

2.1. Materials

The ingredients used in this study to make product samples were robusta and arabica coffee powder (medium roast, medium grind), ginger, and lemongrass. The ingredients used for sensory evaluation were six formulations of robusta and arabica coffee samples added with ginger and lemongrass, mineral water, and crackers to neutralize the taste buds.

2.2. Research Procedure

2.2.1. Coffee Processing

Fresh ginger and lemongrass were washed to remove any dirt. The ingredients were thinly sliced and placed on a tray. The spice pieces were dried in a cabinet dryer at 60°C for 6 hours. The dried ingredients were ground using a blender and then sifted using a 60 mesh sieve. The ground spices were mixed with Arabica coffee according to the following formulas:

K1 625: 90% robusta coffee with 5% ginger and 5% lemongrass

K2 342: 80% robusta coffee with 10% ginger and 10% lemongrass
K3 217: 70% robusta coffee with 15% ginger and 15% lemongrass
K4 483: 90% arabica coffee with 5% ginger and 5% lemongrass
K5 175: 80% arabica coffee with 10% ginger and 10% lemongrass
K6 539: 70% arabica coffee with 15% ginger and 15% lemongrass

2.2.2. Sample Preparation

A total of 10g of spiced coffee powder was brewed with 150 mL of hot water at a temperature of 90°C. The brewed coffee was poured into serving glasses labeled ±15 mL. The six coffee samples were served to the panelists simultaneously, along with mineral water and crackers to neutralize the palate.

2.2.3. Focus Group Discussion (FGD)

A Focus Group Discussion (FGD) was conducted to determine the sensory attributes for the RATA questionnaire, including aroma, taste, mouthfeel, and aftertaste. The FGD participants were 9 panellists who were qualified as baristas or frequent coffee drinkers (5-7 times per week). In the first session, each panellist was asked to observe and taste the samples presented. The second session involved a discussion to determine the sensory attributes for each parameter.

2.2.4. Rate-all-that-apply and hedonic testing

This study involved 100 panelists from the food technology study program at the Universitas Pembangunan Nasional "Veteran" Jawa Timur with the criteria of being in good health and having consumed coffee. The panelists were asked to consume the samples and write down their assessments of the sensory attributes (aroma, taste, mouthfeel, aftertaste) and hedonic scores (overall) on the questionnaire. The RATA attribute assessment used a 6-point rating scale (0 for none; 1–5 for low to high). The hedonic assessment questionnaire for the overall parameter had a liking rating scale of 1–6 (strongly dislike–strongly like).

2.3. Data Analysis

Validity and reliability tests were conducted on the RATA questionnaire resulting from the FGD involving 20 panelists The data were analyzed using IBM SPSS Statistics 25. Validity test was conducted to determine the suitability of the questionnaire used. If the r-value > r-table, then the research instrument was declared valid. Reliability test was conducted to measure the consistency of the questionnaire. The significance level used was 0.6. If the Cronbach's alpha value was > the significance level, the instrument was declared reliable.

The sensory attribute intensity data from the RATA test was visualized in a spider chart using Microsoft Excel 2019. The RATA and hedonic intensity data were analyzed using the Kruskal Wallis test. If a p-value ≤ 0.05 was obtained, the test was continued with the Dunn post hoc test.

The correlation between sensory attributes and consumer preference was analyzed using Partial Least Squares Regression (PLSR) to determine the attributes that most influence product quality. The correlation between sensory attributes and products was illustrated using a Principal Component Analysis (PCA) biplot graph. Preference mapping analysis was conducted to determine consumer preferences through overlay contour plots with PCA results presented in different colors to illustrate above-average preference values. PLSR, PCA, and preference mapping analysis were performed using XLSTAT 2025.

3. RESULT AND DISCUSSION

3.1. Sensory Profiles Analysis

3.1.1. Focus Group Discussion (FGD) Results

Focus Group Discussion (FGD) was conducted as a preliminary step to identify and define the sensory attributes of the coffee samples, which were subsequently used to develop the Rate-All-That-Apply (RATA) questionnaire [5]. A total of 23 sensory attributes were identified by the panelists (**Table 1)**. These attributes were further subjected to validity and reliability test prior to their inclusion in the RATA questionnaire.

Table 1. Sensory attributes identified through FGD

No	Attribute	Definition
1	Sweet aroma	Aroma associated with sucrose or honey
2	Sour aroma	Aroma associated with the presence of acids
3	Bitter aroma	Aroma associated with caffeine
4	Roasted aroma	Aroma associated with something roasted
5	Nutty aroma	Aroma associated with nuts
6	Cocoa aroma	Aroma associated with cocoa beans or cocoa powder
7	Spicy aroma	Aroma associated with spices
8	Sour taste	Taste associated with the presence of acids
9	Bitter taste	Taste associated with caffeine
10	Roasted taste	Taste associated with something roasted
11	Burnt taste	Taste associated with something burnt
12	Nutty taste	Taste associated with nuts
13	Cocoa taste	Taste associated with cocoa beans or cocoa powder
14	Gingery taste	Taste associated with ginger
15	Lemongrass flavor	Taste associated with lemongrass
16	Mouthfeel body	A strong and full sensation between the tongue and palate
17	Mouthfeel rough	A thick and turbid sensation felt in the oral cavity
18	Mouthfeel mouth drying	A dry sensation in the mouth
19	Mouthfeel gritty	A sensation like large, undissolved particles
20	Mouthfeel burnt	A burning sensation that remains on the tongue
21	Aftertaste bitter	A bitter sensation that remains in the mouth after swallowing
22	Aftertaste sour	An acidic sensation that remains in the mouth after swallowing
23	Aftertaste spicy	A spicy sensation that remains in the mouth after swallowing

3.1.2. Validity and Reliability Results

Validity and reliability tests were conducted prior to distributing the RATA questionnaire to ensure that the instrument was suitable for use. The validity test aimed to assess the accuracy of the questionnaire in measuring sensory attributes [25]. The test

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was conducted on 20 panelists representing consumers. Validity was analyzed using Pearson product moment correlation between attribute scores and total scores at a significance level of 0.05. An attribute was declared valid if the r-value > r-table. The correlation values results ranged from 0.10 to 0.86. One attribute, namely gritty mouthfeel (r < 0.44), was declared invalid and removed from the questionnaire.

Table 2. Validity test result

Attribute		Pearson Correlation	Description
Aroma	Sweet	0.53	Valid
	Sour	0.76	Valid
	Bitter	0.56	Valid
	Roasted	0.71	Valid
	Nutty	0.63	Valid
	Cocoa	0.86	Valid
	Spicy	0.45	Valid
Flavor	Sour	0.68	Valid
	Bitter	0.60	Valid
	Roasted	0.67	Valid
	Burnt	0.58	Valid
	Nutty	0.76	Valid
	Cocoa	0.73	Valid
	Gingery	0.76	Valid
	Lemongrass flavor	0.68	Valid
Mouthfeel	Body	0.80	Valid
	Rough	0.80	Valid
	Mouth drying	0.65	Valid
	Gritty	0.10	Not valid
	Burnt	0.62	Valid
Aftertaste	Bitter	0.57	Valid
	Sour	0.69	Valid
	Spicy	0.82	Valid

Reliability test was conducted to assess the consistency of the questionnaire [26]. This test was carried out by comparing the Cronbach's Alpha coefficient value with the significance level, whereby if the Cronbach's Alpha value was > 0.6, the variable was declared reliable.

Table 3. Reliability test result

Variable	Alpha Cronbach	Standard Alpha	Description
Aroma	0.77	0.60	Reliable
Flavor	0.82	0.60	Reliable
Mouthfeel	0.61	0.60	Reliable
Aftertaste	0.50	0.60	Not reliable

Attributes of aroma, taste, and mouthfeel showed Cronbach's Alpha values ≥ 0.60, indicating good reliability. In contrast, aftertaste had a Cronbach's Alpha of 0.498 (< 0.60), indicating low reliability. However, the aftertaste variable was retained in the RATA questionnaire because all its items were valid. Cronbach's Alpha is influenced by the number of items and may be underestimated when fewer than 10 items are used, reliability was further evaluated using the mean inter-item correlation with acceptable range 0.2–0.4 [27]. The aftertaste variable showed a mean inter-item correlation of 0.26, supporting its retention in the questionnaire.

3.1.3. Sensory Profile Visualization

The sensory profiles of robusta and arabica coffee with added ginger and lemongrass were evaluated using the Rate-All-That-Apply (RATA). Panelists rated the intensity of aroma, taste, mouthfeel, and aftertaste attributes for each sample. The mean intensity values were presented in a spider chart (**Figure 1**).

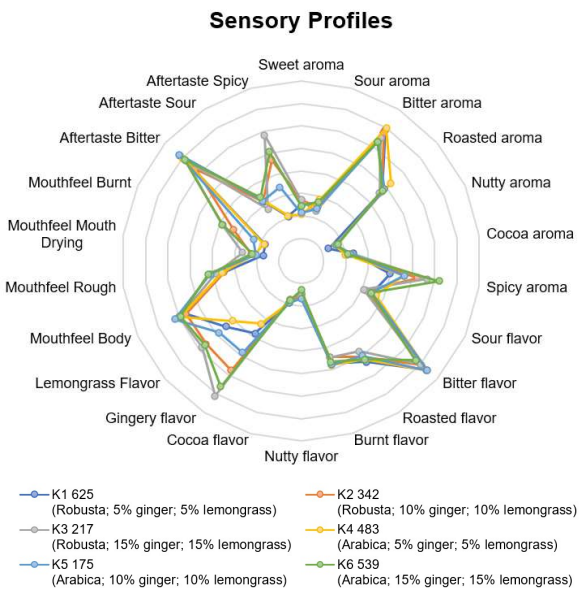

Figure 1. Sensory profiles spider chart

The samples showed relatively similar intensity patterns, with notable differences in spicy aroma, gingery and lemongrass flavors, burnt mouthfeel, and spicy aftertaste. Sample K3 217 showed the highest sweet aroma, gingery and lemongrass flavors, mouth-drying sensation, and spicy aftertaste. Sample K4 483 had the highest sour, bitter, roasted aroma, as well as sour and burnt taste. Sample K6 539 exhibited the highest nutty and spicy aroma, and rough and burnt mouthfeel. Sample K1 625 was highest in cocoa aroma and roasted and cocoa taste. Sample K5 175 showed the highest nutty and cocoa taste, body mouthfeel, and bitter aftertaste.

Table 4. Intensity of aroma attributes of coffee with ginger and lemongrass addition

Attribute	Sample					
	K1 625	K2 342	K3 217	K4 483	K5 175	K6 539
Sweet aroma	1.24	1.35	1.36	1.03	1.07	1.22
Sour aroma	1.36	1.26	1.15	1.42	1.21	1.37
Bitter aroma	3.45	3.38	3.26	3.50	3.14	3.15
Roasted aroma	2.37	2.39	2.30	2.64	2.44	2.39
Nutty aroma	0.66	0.86	0.85	0.83	0.85	0.89
Cocoa aroma	1.17	1.02	1.14	0.99	1.10	1.05
Spicy aroma	1.99	2.61	2.83	2.30	2.31	3.10

The sweet aroma attribute exhibited low intensity (1.03–1.36). In robusta coffee, sweet aroma is considered a positive sensory characteristic and an indicator of quality, often described as honey, caramel, or molasses-like [28]. Sweet aroma is associated with sugars such as glucose, fructose, and sucrose, as well as Maillard reactions between sugars and amino acids during roasting, which produce caramel-like notes [29]. However, pungent compounds in ginger, such as gingerol and shogaol, may mask the perception of sweetness in coffee [30].

The sour aroma attribute also showed low intensity (1.15–1.42), with the highest value observed in sample K4 483 and the lowest in K3 217. Sour aroma in coffee is primarily derived from organic acids, including citric, malic, acetic, and tartaric acids [31]. The high citral content in lemongrass essential oil

contributes a strong lemon-like aroma [20], which likely enhances fresh sour notes.

Bitter aroma presented the highest intensity among attributes (3.14–3.50). Bitterness in coffee is mainly attributed to caffeine and chlorogenic acids [29]. Higher concentrations of ginger and lemongrass reduced bitter aroma intensity, possibly due to the masking effect of gingerol [30]. The presence of citral and neral in lemongrass may suppress bitterness perception [32].

Roasted aroma ranged from low to moderate intensity (2.30–2.64). Roasting at high temperatures induces chemical transformations that generate coffee aroma compounds without necessarily producing burnt notes [33; 27]. Previous findings also reported roasted as a dominant detectable attribute in coffee [28].

Nutty aroma showed the low intensity (0.66–0.89) as well as cocoa aroma (0.99–1.17). Nutty and cocoa notes are commonly associated with pyrazine compounds formed during roasting [29].

Spicy aroma ranged from low to moderate intensity (1.99–3.10). Spicy aroma was attributed to the addition of ginger and lemongrass, particularly due to gingerol and shogaol compounds that contribute characteristic spicy notes [30].

Table 5. Intensity of flavor attributes of coffee with ginger and lemongrass addition

Attribute	Sample					
	K1 625	K2 342	K3 217	K4 483	K5 175	K6 539
Sour flavor	1.72	1.59	1.52	1.82	1.71	1.70
Bitter flavor	3.69	3.53	3.50	3.71	3.71	3.36
Roasted flavor	2.66	2.52	2.38	2.59	2.50	2.60
Burnt flavor	2.37	2.22	2,23	2.41	2.40	2.33
Nutty flavor	0.73	0.77	0.72	0.82	0.83	0.64
Cocoa flavor	0.97	0.89	0.89	0.95	0.97	0.91
Gingery flavor	1.91	2.89	3.56	1.65	2.42	3.32
Lemongrass flavor	2.22	2.81	2.92	2.03	2.43	2.84

Sour taste showed low intensity (1.52–1.82). The highest sour intensity was observed in sample K4 483 (90% arabica with 5% ginger and 5% lemongrass), while the lowest was found in K3 217 (70% robusta with 15% ginger and 15% lemongrass). Sourness in coffee is mainly associated with organic acids such as citric, malic, acetic, and tartaric acids [31]. Arabica coffee generally exhibits higher acidity due to its greater organic acid content compared to robusta [2]. Increasing concentrations of ginger and lemongrass reduced sour perception, likely due to the pungent sensation of ginger and the citral content of lemongrass, which masked acidity.

Bitter taste showed moderate to moderately high intensity (3.36–3.71), higher than other taste attributes. Bitterness in coffee is primarily attributed to caffeine and chlorogenic acids [29]. Ginger bioactive compounds may also contribute mild bitter and pungent sensations [34].

Roasted taste ranged from low to moderate intensity (2.38–2.66). This attribute was formed during high-temperature roasting, which induces chemical transformations responsible for characteristic coffee flavor [29]. Higher spice concentrations slightly reduced roasted perception, possibly due to the dominance of spice notes.

Burnt taste was categorized as low (2.22–2.41) and is typically associated with excessive roasting, producing sharp bitterness [33]. This attribute is often considered as a roasting defect [28]. Higher spice levels slightly decreased burnt perception, likely due to the fresh aroma of lemongrass and the pungency of ginger masking burnt notes [35; 32].

Nutty (0.64–0.83) and cocoa (0.89–0.97) tastes were very low in intensity. Nutty and cocoa flavor are associated with pyrazine compounds, particularly 2,5-dimethylpyrazine which formed during roasting [29; 31]. Higher spice concentrations reduced nutty perception, likely due to masking effects.

Gingery taste ranged from low to moderately high intensity (1.65–3.56), increasing with higher ginger and lemongrass addition. The highest intensity was observed at 15% ginger and 15% lemongrass addition in both robusta and arabica. Ginger's characteristic pungent and warm sensation is attributed to zingerone and related compounds [17].

Lemongrass flavor ranged from low to moderate intensity (2.03–2.92). This flavor increased with higher lemongrass concentration. The highest intensity was found in samples with 15% ginger and lemongrass addition. Lemongrass flavor is influenced by citronellal, citronellol, geraniol, and limonene compounds [19].

Table 6. Intensity of mouthfeel attributes of coffee with ginger and lemongrass addition

Attribute	Sample					
	K1 625	K2 342	K3 217	K4 483	K5 175	K6 539
Mouthfeel body	2.83	2.83	2.99	2.97	3.10	2.96
Mouthfeel rough	1.74	1.74	1.92	1.78	2.04	2.10
Mouthfeel mouth drying	0.86	1.13	1.32	1.04	1.02	**1.10**
Mouthfeel burnt	0.88	1.66	1.93	0.91	1.17	1.94

Body is a key mouthfeel attribute in coffee, characterized by a full and rounded sensation in the oral cavity. The body attribute showed moderate intensity (2.83–3.10). During roasting, lipids migrate to the bean surface and are extracted during brewing, forming crema and contributing to coffee body [29].

Rough mouthfeel exhibited low intensity (1.74–2.10). It is described as a coarse or grainy sensation caused by fine particles or non-homogeneous liquids [31]. In this study, the perception of roughness was likely associated with coffee sediment or residual ginger and lemongrass particles.

Mouth drying showed very low intensity (0.86–1.32). This drying or astringent sensation is related to coffee acids [31]. Mouth drying also results from interactions between phenolic compounds or tannins and salivary proteins, reducing oral lubrication [36].Burnt mouthfeel ranged from very low to low intensity (0.88–1.94). This sensation may be influenced by ginger compounds such as zingerone and shogaol, as well as lemongrass essential oils, which produce warm or slightly burn sensations during consumption [17; 12].

Table 7. Intensity of aftertaste attributes of coffee with ginger and lemongrass addition

Attribute	Sample					
	K1 625	K2 342	K3 217	K4 483	K5 175	K6 539
Aftertaste bitter	3.57	3.12	3.40	3.50	3.61	3.44
Aftertaste sour	1.56	1.57	1.37	1.61	1.58	1.68
Aftertaste spicy	1.03	2.34	2.91	1.05	1.71	2.53

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Bitter aftertaste showed moderate to moderately high intensity (3.12–3.61). This lingering bitterness is mainly attributed to caffeine and chlorogenic acids in coffee [29]. Gingerol and shogaol in ginger and phenolic compounds in lemongrass may also contribute to mild residual bitterness [37].

Sour aftertaste ranged from very low to low intensity (1.37–1.68). It is associated with organic acids naturally present in coffee. The highest intensity was observed in sample K6 539 arabica sample likely due to the higher organic acid content of arabica compared to robusta [2]. The slight increase may also be influenced by citral in lemongrass, which imparts a mild acidic sensation [20].

Spicy aftertaste ranged from very low to moderate intensity (1.03–2.91). It is resulted from ginger and lemongrass addition which produce warming sensations. Ginger contains zingerone and shogaol responsible for pungency and higher shogaol content in powdered ginger may enhance spicy aftertaste perception [17; 28].

3.1.4. Determination of Different Sensory Profiles

The intensity data of sensory attributes obtained from the RATA test were analyzed using the nonparametric Kruskal–Wallis test to determine significant differences among attributes.

Table 8. P-value of sensory attributes of coffee with ginger and lemongrass addition.

Attribute		*p-value*
Aroma	*Sweet*	0.53
	Sour	0.65
	Bitter	0.19
	Roasted	0.74
	Nutty	0.82
	Cocoa	0.93
	Spicy	**0.00**
Flavor	*Sour*	0.85
	Bitter	0.45
	Roasted	0.84
	Burnt	0.94
	Nutty	0.77
	Cocoa	0.99
	Gingery	**0.00**
	Lemongrass	**0.00**
Mouthfeel	*Body*	0.81
	Rough	0.40
	Mouth drying	0.34
	Burnt	**0.00**
Aftertaste	*Bitter*	0.19
	Sour	0.75
	Spicy	**0.00**

Attributes with p-values < 0.05 were spicy aroma, gingery taste, lemongrass flavor, burnt mouthfeel, and spicy aftertaste, indicating significant differences among treatments. Other attributes showed no significant differences. Significant attributes were further analyzed using Dunn's post hoc test.

Gingery taste and lemongrass flavor differed significantly among samples. The highest gingery intensity was observed in K3 217 (70% robusta with 15% ginger and 15% lemongrass), followed by K6 539 (70% arabica with 15% ginger and 15% lemongrass). The lowest gingrey intesity was found in K4 483 (90% arabica with 5% ginger and 5% lemongrass). A similar result was observed for lemongrass flavor, with the highest intensity in K3 217 and K6 539, and the lowest in K4 483. Burnt mouthfeel also differed significantly, with the highest intensity in K6 539 and K3 217, both were at 15% ginger and 15% lemongrass addition. The lowest burnt mouthfeel was found in K1 625 and K4 483 at 5% ginger and 5% lemongrass addition. Spicy aftertaste showed significant differences, with the highest intensity in K3 217 and K6 539, categorized as moderate. The lowest was observed in K1 625 and K4 483 with 5% ginger and 5% lemongrass addition. Overall, higher ginger and lemongrass concentrations consistently increased spicy-related sensory attributes.

Table 9. Significantly different sensory attribute intensities

Attribute	Sample					
	K1 625	**K2 342**	**K3 217**	**K4 483**	**K5 175**	**K6 539**
Aroma *spicy*	1.99^{a}	2.61^{abc}	2.83^{bc}	2.30^{ab}	2.31^{ab}	3.10^{c}
Rasa *gingery*	1.91^{ab}	2.89^{cd}	3.56^{d}	1.65^{a}	2.42^{bc}	3.32^{d}
Rasa *lemongrass flavor*	2.22^{ab}	2.81^{b}	2.92^{b}	2.03^{a}	2.43^{ab}	2.84^{b}
Mouthfeel burnt	0.88^{a}	1.66^{bc}	1.93^{c}	0.91^{a}	1.17^{ab}	1.94^{c}
Aftertaste spicy	1.03^{a}	2.34^{bc}	2.91^{c}	1.05^{a}	1.71^{ab}	2.53^{c}

3.2. Consumer Preference Analysis

Consumer preference was evaluated using a hedonic test on the overall attribute. Hedonic data were analyzed using the Kruskal-Wallis test in XLSTAT 2025. The overall hedonic p-value was 0.004, indicating significant differences among samples. Therefore, Dunn's post hoc test was conducted to determine pairwise differences.

Table 10. Hedonic scores of coffee ginger and lemongrass addition

Attribute	Sample					
	K1 625	**K2 342**	**K3 217**	**K4 483**	**K5 175**	**K6 539**
Overall	3.42^{b}	3.01^{ab}	3.10^{ab}	3.21^{ab}	2.98^{ab}	2.78^{a}

The mean overall hedonic scores of coffee supplemented with ginger and lemongrass ranged from 2.78 to 3.42, indicating slight dislike among panelists. Based on Table 13, samples K1 625, K2 342, K3 217, K4 483, and K5 175 did not differ significantly, whereas K1 625 differed significantly from K6 539. The highest overall liking score was observed in K1 625 (90% robusta with 5% ginger and 5% lemongrass), while the lowest was found in K6 539 (70% arabica with 15% ginger and 15% lemongrass).

The higher acceptance of K1 625 may be attributed to the use of robusta coffee with a lower spice concentration, consistent with findings that robusta based spiced coffee is generally preferred over arabica [13]. Increasing spices concentration reduced overall liking. Spice addition above 5% decreases overall sensory acceptance [38].

3.3. Correlation between Sensory Profiles and Consumer Preferences

3.3.1. Partial Least Squares Regression (PLSR)

Partial Least Squares Regression (PLSR) was conducted to evaluate the relationship between sensory attributes and consumer overall liking of coffee supplemented with ginger and lemongrass. The model was developed using RATA intensity data as X variables and overall hedonic scores as the Y variable. The PLSR results showed an R^2Y of 0.948, indicating that 94.8% of the variation in consumer acceptance was explained by the

sensory attributes. The Q^2 value of 0.683 suggests good predictive ability and model reliability for further interpretation.

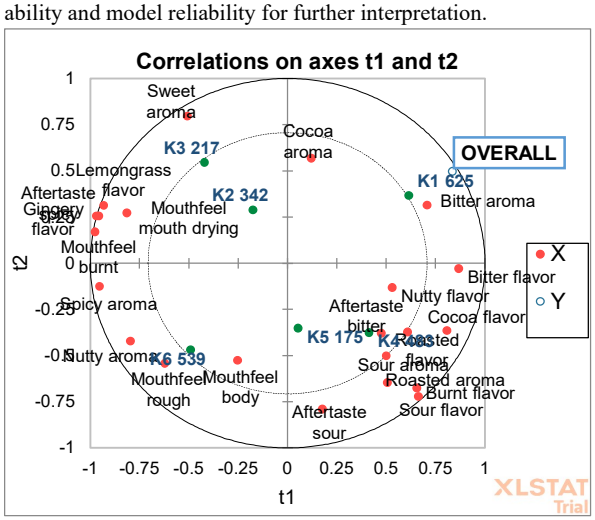

Figure 2. Correlation circle of sensory attributes in relation to overall acceptance.

Based on **Figure 2**, the samples are distributed into four quadrants according to their relationship with specific sensory attributes and overall acceptance. Sample K1 625 is located in the same quadrant as the overall attribute, indicating a positive correlation. The dominant attributes in this quadrant are cocoa aroma and bitter aroma, suggesting that panelists preferred coffee characterized by these notes.

Samples K2 342 and K3 217 are positioned in the upper-left quadrant, distant from the overall attribute. Attributes in this area include sweet aroma, spicy taste, lemongrass flavor, gingery taste, mouth drying, burnt mouthfeel, and spicy aftertaste, indicating limited contribution to overall liking. Sample K6 539 is located in the lower-left quadrant, opposite to the overall attribute, reflecting lower acceptance. Associated attributes include spicy aroma, nutty aroma, rough mouthfeel, and body.

Samples K5 175 and K6 539 are positioned in the lower-right quadrant, also opposite to overall acceptance. These samples are associated with sour aftertaste, sour taste, burnt taste, roasted aroma, sour aroma, bitter aftertaste, roasted taste, cocoa taste, nutty taste, and bitter taste, which were negatively related to consumer preference.

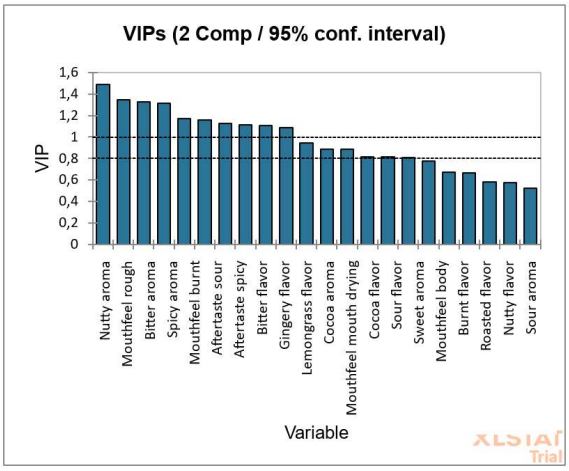

Figure 3. Variable Importance in Projection (VIP) plot

Based on the Variable Importance in Projection (VIP) plot in **Figure 3**, the key attributes significantly influencing panelists' overall liking can be identified. Attributes with VIP values ≥ 1.0 are considered to have a significant contribution to the overall preference model [39]. Ten attributes showed VIP values above 1.0 and were influential in determining overall liking. These attributes include nutty aroma, rough mouthfeel, bitter aroma, spicy aroma, burnt mouthfeel, sour aftertaste, spicy aftertaste, bitter taste, gingery taste, and lemongrass flavor.

3.3.2. Principal Component Analysis (PCA)

Principal Component Analysis (PCA) was performed to examine the correlation among sensory attributes and samples based on their positions within quadrants. The PCA plot illustrates positive and negative correlations, where attributes located close to each other indicate positive correlation, while those positioned far apart or opposite indicate negative correlation. The PCA biplot of robusta and arabica coffee supplemented with ginger and lemongrass is presented in **Figure 4**.

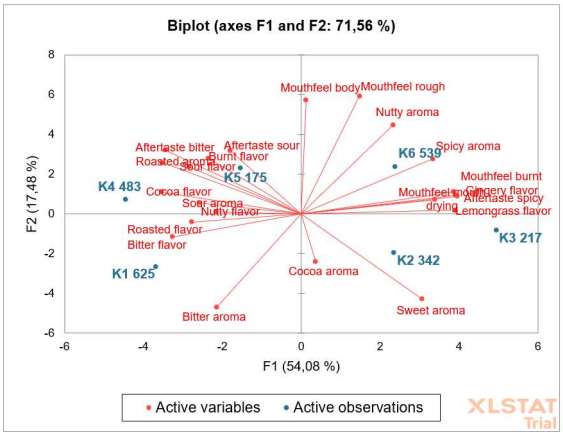

Figure 4. PCA plot of coffee with ginger and lemongrass addition

The PCA biplot of coffee supplemented with ginger and lemongrass explained 71.56% of the total variance (F1 and F2). Both sensory attributes and the six samples were distributed across four quadrants, indicating distinct sensory profiles. Quadrant I contained sample K6 539 which associated with lemongrass flavor, gingery taste, burnt mouthfeel, mouth drying, roughness, body, spicy aroma, nutty aroma, and spicy aftertaste. Quadrant II included K4 483 and K5 175, characterized by nutty, cocoa, sour, and burnt tastes, sour and roasted aromas, and bitter and sour aftertastes. Quadrant III contained K1 625, associated with roasted and bitter tastes and bitter aroma. Quadrant IV included K2 342 and K3 217, associated with cocoa and sweet aroma.

3.4. Recommendations for Product Development

Preference mapping was conducted to examine the relationship between sensory attributes and panelists' preferences. This analysis generates a mean liking map represented by color gradients: red indicates the highest preference level (80–100%), followed by yellow (60–80%), green (40–60%), light blue (20–40%), and dark blue (0–20%) [5].

Color mapping was obtained through cluster analysis using Agglomerative Hierarchical Clustering (AHC) based on overall hedonic scores and PCA results [40]. The preference map is

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presented as the PCA biplot was overlaid onto the contour plot which show in **Figure 5**.

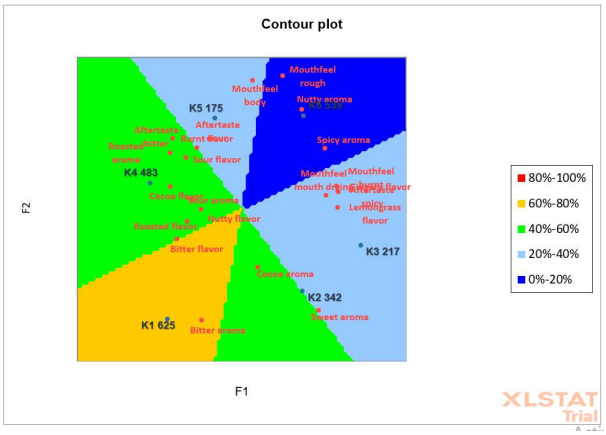

Figure 5. Preference mapping and contour plot of panelists' liking and sensory attributes of coffee with ginger and lemongrass addition

The contour plot shows the distribution of samples and attributes driving preference. Sample K1 625 was located in the yellow region and showed the highest acceptance 60–80% among panelists. K4 483 was in the green region indicated moderate liking. Samples K2 342, K3 217, and K5 175 were in the light blue region. Sample K6 539 was in the dark blue region, indicating the lowest acceptance. These results confirm that robusta with 5% spice addition was the most preferred, whereas higher spice concentrations reduced acceptance, consistent with previous studies [13; 36].

The overlay analysis showed that K1 625 was associated with a bitter aroma that positively influenced liking. Moderate acceptance of K4 483 was linked to cocoa, roasted, nutty, sour, and bitter attributes, reflecting the natural acidity of arabica [2]. Samples with 10–15% spices were characterized by dominant spice-related notes, gingery, lemongrass, spicy, burnt mouthfeel, contributing to lower preference. Overall, the highest acceptance formulation is 90% robusta coffee with 5% ginger and 5% lemongrass. Higher ginger and lemongrass concentration should be reduced to maintain a balanced coffee and spice profile to improve consumer acceptance.

4. CONCLUSION

RATA analysis of robusta and arabica coffee with added ginger and lemongrass identified 22 sensory attributes, with five showing significant differences: spicy aroma, gingery taste, lemongrass flavor, burnt mouthfeel, and spicy aftertaste. Attributes influencing panelists' preference included nutty aroma, rough mouthfeel, bitter and spicy aroma, burnt mouthfeel, sour and spicy aftertaste, bitter taste, gingery taste, and lemongrass flavor. Sample K1 625 (90% robusta with 5% ginger and 5% lemongrass) showed the highest consumer preference (60–80%), with bitter aroma identified as a key positive attribute to be maintained.

REFERENCE

[1] Sulistyaningtyas, A. R. Pentingnya Pengolahan Basah (Wet Processing) Buah Kopi Robusta (Coffea robusta Lindl.ex.de.Will) untuk Menurunkan Resiko Kecacatan Biji Hijau Saat Coffee Grading. Prosiding Seminar Nasional Publikasi Hasil-Hasil Penelitian dan Pengabdian Masyarakat, 90–94. 2017.

[2] Abubakar, Y., Gemasih, T., Muzaifa, M., Hasni, D., & Sulaiman, M. I. Effect of blend percentage and roasting degree on sensory quality of arabica-robusta coffee blend. *IOP Conference Series: Earth and Environmental Science*, *425*(1), 1–8. 2020.

[3] Anggia M., Wijayanti R., & Ariyetti A. Analisis sensori terhadap minuman kopi celup rempah yang disukai panelis. *Gontor Agrotech Science Journal,* 8(3), 138–146. 2022.

[4] Belgis, M., Zhafirah Arifin, T., Prameswari, D., Taruna, I., Choiron, M., Witono, Y., & Dwi Masahid, A. Sensory Profile on Robusta Coffee by *Rate-all-that-apply* (RATA). *Pelita Perkebunan, 39*(1), 32–42. 2023.

[5] Adawiyah, D. R., Tjiptoputri, O. M., & Lince, L. Profil Sensori Sediaan Pemanis dengan Metode *Rate-all-that-apply* (RATA). *Jurnal Mutu Pangan : Indonesian Journal of Food Quality*, *7*(1), 38–45. 2020.

[6] Li, B., Hayes, J. E., & Ziegler, G. R. Just-About-Right and ideal scaling provide similar insights into the influence of sensory attributes on liking. *Food quality and preference*, *37*, 71–78. 2014.

[7] Van Stokkom, V., Benguedda, S., Pelgrim, E., & Nijmeijer, M. Exploring sensory profiling with rate-all-that-apply in comparison to check-all-that-apply with and without just-about-right in product development. *Applied Food Research*, 2025.

[8] Meilgard M.C., Civile G.V., & Carr BT. Sensory Evaluation Techniques. Fourth Edition. CRC Press. 2016.

[9] Nadja, R. A., & Halimah, A. S. *Preferensi konsumen terhadap pangan*. Penerbit Nem. 2023.

[10] Bi, K., Zhang, D., Song, Z., Qiu, T., & Huang, Y. A PLSR Model for Consumer Preference Prediction of Yoghurt from Sensory Attributes Profiles. In *Computer Aided Chemical Engineering* (Vol. 46, pp. 1477–1482). Elsevier. 2019.

[11] Herrera, J. C., & Lambot, C. The Coffee Tree-Genetic Diversity and Origin. In B. Folmer (Ed.), The Craft and Science of Coffee (pp. 1–16). Academic Press. 2017.

[12] Seninde, D. R., & Chambers, E. Coffee flavor: A review. *Beverages, 6*(3), 44. 2020.

[13] Priyanto, D.A.M., Antonius A.H., & Dwiloka B. Perbedaan sifat fisikokimia dan organoleptik produk kopi rempah dari kopi arabika (Coffea arabica) dan kopi robusta (Coffea robusta). *Jurnal Aplikasi Teknologi Pangan, 11*(4), 179–184. 2022.

[14] Hamdi, M., Murlida, E., & Yusriana. Pengaruh derajat sangrai biji kopi arabika (*Coffea arabica*) dengan bubuk serai dapur (*Cymbopogon citratus*) terhadap sifat kimia dan sensori kopi celup. *Jurnal Teknologi dan Industri Pertanian Indonesia*, 17(1), 64–70. 2025.

[15] Fatmawati, & Muhammad, M. Feasibility analysis of spice coffee processing business in home industries in Tabahawa Village, Ternate City. *Agrikan: Jurnal Agribisnis Perikanan*, *13*(2), 344–351. 2020.

[16] Aryanti, I., Bayu, E. S., & Kardhinata, E. H. Identifikasi karakteristik morfologis dan hubungan kekerabatan pada tanaman jahe (Zingiber officinale Rosc.) di Desa Dolok Saribu Kabupaten Simalungun. *Jurnal Agroekoteknologi Universitas Sumatera Utara*, *3*(3), 2015.

[17] Octaviana, A. C., & Sandrasari, D. A. Identifikasi komponen bioaktif minuman bubuk kopi jahe merah menggunakan gas chromatography-mass spectrometry. *Jurnal Teknologi Pangan dan Kesehatan*, *6*(1), 12–21. 2024.

[18] Utami, D. N., Rosanti, D., & Kartika, T. Karakteristik Morfologi Jenis-Jenis Tanaman Obat Di Kelurahan Prabujaya Kecamatan Prabumulih Timur Kota Prabumulih. *Indobiosains*, 56–65. 2023.

[19] Khaerunnisa, Mahendradatta, M., & Asfar, M. Characteristics of simplicia ginger (Zingiber officinale) and lemongrass (Cymbopogon citratus) powder by different drying method. In *IOP Conference Series: Earth and Environmental Science*, 807(2). IOP Publishing. 2021.

[20] Febriani, R., Rohaeti, E., & Wahyuni, W. T. Aktivitas antibakteri dan toksisitas minyak serai dapur (Cymbopogon citratus) dengan perlakuan pemekatan pada suhu berbeda. *Analit:Analytical and Environmental Chemistry*, 6(02), 168–179. 2021.

[21] Meyners, M., Jaeger, S. R., & Ares, G. On the analysis of *Rate-all-that-apply* (RATA) data. *Food Quality and Preference, 49,* 1–10. 2016.

[22] Munarko, H., Jariyah, J., & Kurnianto, M. A. Profiling Atribut Sensori Kukis Nastar Menggunakan Metode *Rate-all-that-apply* (RATA). *Gorontalo Agriculture Technology Journal, 6*(2), 55. 2023.

[23] Indrizal, E. Diskusi kelompok terarah. *Jurnal Antropologi: Isu-Isu Sosial Budaya*, *16*(1), 75–82. 2014.

[24] Tarwendah, I. P. Jurnal review: Studi komparasi atribut sensoris dan kesadaran merek produk pangan. *Jurnal Pangan Dan Agroindustri, 5*(2), 66–73. 2017.

[25] Utami, Y. Uji Validitas dan Uji Reliabilitas Instrument Penilaian Kinerja Dosen. *Jurnal Sains Dan Teknologi*, *4*(2), 21-24. 2023.

[26] Darma, B. Statistika penelitian menggunakan SPSS (Uji validitas, uji reliabilitas, regresi linier sederhana, regresi linier berganda, uji t, uji F, R2). Guepedia. 2021.

[27] Pallant, J. SPSS Survival Manual 6th Edition: A Step By Step Guide to Data Analysis Using IBM SPSS. Open University Press. 2016.

[28] Carvalho, F. M., Alves, E. A., Artêncio, M. M., Cassago, A. L., & Pereira, L. L. Development of a flavour wheel for Coffea canephora using rate-all-that-apply. *Scientific Reports*, *15*(1), 1–19. 2025

[29] Sunarhanum, W. B., Williams, D. J., & Smyth, H. E. Complexity of coffee flavor: A compositional and sensory perspective. *Food Research International*, 62, 315–325. 2014.

[30] Asyik, N., Herdiansyah, D., & Sadimantara, M. S. Study on The Addition of Red Ginger (Zingiber officinale Var. Rubrum) and Black Rice (Oryza sativa L. Indica) to The Organoleptic Evaluation and Physical-Chemical Properties of Robusta Coffee (Coffea canephora) from Southeast Sulawesi. *Jurnal Penelitian Pendidikan IPA*, *11*(7), 280–287. 2025.

[31] Williams, S. D., de Andrade, D., & Liu, L. Coffee is more than flavor, the creation of a coffee character wheel. *Journal of sensory studies*, *38*(6), 1–13. 2023.

[32] Karaituma, D. M., Mburu, M., & Ronoh, A. K. Effect of lemongrass powder substitution on the physicochemical, nutritional, and sensory properties of chicory-based functional beverage. *Applied Food Research*. 2025.

[33] Chambers IV, E., Sanchez, K., Phan, U. X., Miller, R., Civille, G. V., & Di Donfrancesco, B. Development of a "living" lexicon for descriptive sensory analysis of brewed coffee. *Journal of sensory studies*, *31*(6), 465-480. 2016.

[34] Sharifi-Rad, M. Ginger and its bioactive compounds. *International Journal of Molecular Sciences*, 18(1), 38. 2017.

[35] Orrego-Lagarón, N. Chemical composition of Cymbopogon citratus. *Journal of Food Science and Technology*. 2016.

[36] Ayseli, M. T., Ayseli, Y. I., Florkowski, W. J., & Opara, U. L. Phenolics and their interactions with food proteins: Mechanisms and implications for sensory perception. *Food Research International*, 123, 205–216. 2019.

[37] Bhumiratana, N., Adhikari, K., & Chambers, E. The development of an emotion lexicon for coffee and its association with sensory attributes. *Foods*, 8(4), 130. 2019.

[38] El-Anany, A. M., Althwab, S. A., Ali, R. F., Ali, R. F., & Mousa, H. Potential antioxidant and lipid peroxidation inhibition of coffee mixed with lemongrass (Cymbopogon citrates) leaves. *Nutrition & Food Science*, *51*(8), 1194-1206. 2021.

[39] Akarachantachote, N., Chadcham, S., & Saithanu, K. Variable importance index based on the partial least squares and boxplot cutoff threshold for variable selection. *International Journal of Data Analysis Techniques and Strategies*, *9*(1), 34–45. 2017.

[40] Ayuningtyas, F., Restuhadi, F., & Kurnia, D. (. Analisis Pemetaan Penilaian Responden Terhadap Atribut Video Penyuluhan Komoditas Cabai Di Desa Titian Resak Kecamatan Seberida Kabupaten Indragiri Hulu. *SEPA: Jurnal Sosial Ekonomi Pertanian dan Agribisnis*, *16*(1), 11–19. 2019.

 https://doi.org/10.29165/ajarcde.v10i1.919