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The Application of Pontianak Liang Tea Calamansi-Flavored Kombucha as Masking Agent on Goat Milk Ice Cream: Consumer Preferences Evaluations

Davin Goneril, Yohana Sutiknyawati Kusuma Dewi, Sholahuddin, Felix Aurelius, Sophie Nathania*

Tanjungpura University, Indonesia

*Correspondence: E-mail: davingoneril@gmail.com

ABSTRACT

The diversification of goat milk processing may provide strong support for the development of agricultural and gastronomy tourism sector in Indonesia. One of the most popular dairy frozen desserts, such as ice cream, has been developed using goat milk. However, its natural goaty flavor makes the product less acceptable to consumers. This research aims to utilize Indonesian local herbal beverages, such as Pontianak Liang Tea (PLT), in a fermented version using a kombucha inoculum with the addition of calamansi juice as a strong sensory-profile masking agent. The research consisted of processing goat milk ice cream with 6 levels of PLT calamansi-flavored Kombucha concentration (0–25%). The processed ice cream was evaluated with a sensory hedonic test with 35 semi-trained panelists. The study results showed that there is a significant effect of kombucha additions on ice cream acceptance across all sensory attributes (aroma, taste, color, texture, melting properties, and overall acceptance). The directly proportional increases in likeness with increased kombucha addition (peaking at 15%), indicating its successful role as a masking agent, supported the presence of kombucha organic acids and bioactive compounds. Furthermore, the evaluation of physicochemical and sensory profiles can be explored.

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1. INTRODUCTION

Goat milk has gained acceptance and popularity in the current global society due to hunger and socio-economic challenges, especially in developing countries. Goat milk has good nutritional value, with lower allergenicity, and is much more financially friendly for developing sustainable husbandry compared to bovine milk (Idamokoro, 2023). In Southeast and East Asia, milk consumption has gradually increased. However, due to the low consumption of milk-based products in the 20th century, Southeast and East Asian people mostly developed lactose intolerance (Prasad, 2017). Replacing bovine milk with goat milk has been done in various Asian countries (Ameer et al., 2026), which is a safer choice for lactose-intolerant people, due to smaller lactose content and undigested remnants (Kibre et al., 2020). In Asian countries such as Indonesia, various issues affect dairy goat product consumption.

In Indonesia, dairy goat livestock development as sustainable farming has been favoured compared to bovine livestock, due to its lower cost for smallholder farm ventures and production, widespread husbandry, and environmental adaptability (Liang & Paengkoum, 2019; Sumarmono, 2022). However, small dairy goat populations and narrow production have affected the unsuccessful compliance with the high demand for goat milk (Sembiring et al., 2022). These impacted to low consumption of goat milk due to the expensive selling price (Benjamin et al., 2019), unfamiliarity (Zulkifli et al., 2023), and limited access (Wantasen et al., 2025). Diversification of goat milk products can be an interesting solution by creating market demand according to local consumer characteristics (Divarathne et al., 2025; Hautbout et al., 2025). Therefore, processing local goat milk into diverse food products has high potential in Indonesia, such as ice cream.

Ice cream is one of the most favoured frozen desserts across the globe, which was approximately produced and sold in 2023 around 15 billion litres and 75 billion US$ (Goff et al., 2025). In Indonesia, ice cream has been exported and imported around 17 million and 3 million kg throughout 2025 (BPS, 2026a, 2026b). Among the bovine milk alternatives in ice cream processing, goat milk provides a creamier and softer texture with proper melting. However, the goaty flavor makes consumers dislike the product (Aloğlu et al., 2018; Kalit et al., 2023; Suhendri et al., 2024). Supplementing a masking agent can be a strategy to improve the product's acceptability (Adamkiewicz & Szeleszczuk, 2023; Bartkiene et al., 2018). Herbs or spices seem suitable as a masking agent in goat milk ice cream due to their rich bioactive and volatile organic compounds (Alosily et al., 2023; Riyansa & Syarif, 2023). Therefore, utilizing Indonesian traditional herbal beverages has potential for local gastronomy empowerment, such as using Pontianak Liang Tea (PLT).

PLT is a traditional West Kalimantan herbal tea originated by the Teochew and Hakka Chinese ethnic groups, made from Chinese foldwing leaf and boat lily leaf (Murdijati-Gardjito et al., 2024). The currently developed PLT has been incorporated with West Kalimantan herbs and spices, such as wild oregano, fragrant pandan leaf, aloe vera frond skin, and sappanwood bark (Dewi et al., 2022). These herbal plants contain plentiful volatile organic compounds and are commonly used as flavoring agents to mask off-odors (Migone et al., 2024; Estiasih et al., 2025). However, PLT supplementation in ice cream products tends to have a weak aroma release (Dewanti, 2023). Utilizing developed PLT derivative products with stronger sensory profiles can be an interesting approach, such as using PLT calamansi-flavored kombucha. PLT calamansi-flavored kombucha is a fermented PLT and calamansi citrus juice using a symbiotic culture of bacteria and yeast (SCOBY), which is usually used for kombucha fermentation. The developed fermented beverages add citrus sourness and aroma to form a unique flavor, which results in preferences from the panelists for the overall liking of the products (Dewi et

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al., 2026). Kombucha fermentation also increases sourness through the production of organic acids from lactic acid bacteria and acetic acid fermentation (Nyhan et al., 2022; Kitwetcharoen et al., 2023; Su et al., 2023).

Supplementing PLT-calamansi flavored kombucha masking agent with herbal and strong acidic flavors in goat milk ice cream may be an interesting approach to utilize and promote local gastronomy. Applying unpopular traditional beverages as flavors for ice cream processing may promote exposure to traditional beverages with high acceptance levels for younger-generation consumers (Pinandoyo et al., 2021). Alternatively, utilizing local goat milk for novel-based food development enhances regional local community gastronomy tourism by attracting tourists and supporting local entrepreneurs (Yuniastuti et al., 2024). Combining traditional foods and local resources for food development may boost community economic and cultural values as a tourism product through cultural heritage preservation and transformation to modern popular foods (Fitriani et al., 2023; Maulana et al., 2026). However, the development and processing of ice creams incorporated with herbal tea kombucha and goat milk were still limited. Therefore, this study aims to evaluate the application of locally based gastronomy kombucha, such as PLT calamansi-flavored kombucha, as a masking agent to improve goat milk ice cream acceptability by the sensory hedonic test.

2. LITERATURE REVIEW

2.1. Goat Milk and Ice Cream Processing

Goats (*Capra bircus*) are small ruminants that have been domesticated for 100 centuries for dairy production in Mesopotamia, which is currently spread throughout the world and able to adapt to each country's environment (Turkmen, 2017; Lund & Ahmad, 2020). As well as other dairy milks, goat milk is a source of fat, protein, amino acids, sugar, minerals, and vitamins (Park, 2017). The produced milk is considered an excellent bovine milk alternative. Goat milk fat mainly consists of short-chain fatty acids (SCFA) and medium-chain fatty acids (MCFA) that can be readily absorbed into the intestine. Goat milk is dominated by β-casein and has a lower content of lactose in goat milk. Therefore, goat milk can be rapidly and easily digested with fewer lactose-intolerance symptoms (Yadav et al., 2016). The lack of α_{s1}-casein in goat milk makes it safer for patients with bovine milk allergy (Aalst et al., 2024)**.** According to Mishra et al. (2026), goat milk can also provide several functional properties, such as antioxidant, anti-inflammatory, etc. The nutritional values of goat milk are shown in Table 1.

Table 1. Nutritional Values of Various Dairy Milks

Criteria	Goat Milk	Cow Milk	Sheep Milk	Human Milk
Fat (g/100 g)[1]	4.25	3.70	7.90	3.75
Protein (g/100 g)[1]	3.52	3.50	5.23	1.63
Lactose (g/100 g)[1]	4.27	4.90	4.81	6.98
Ash (g/100 g)[1]	0.86	0.70	0.90	0.21
Calories (kcal/100 ml)[2]	70	69	105	68
Saturated fatty acid (g/100 g)[3]	2.67	2.08	4.06	2.01
Butyric acid (g/100 g)[3]	0.13	0.11	0.20	ND
Caproic acid (g/100 g)[3]	0.09	0.06	0.14	ND
Caprylic acid (g/100 g)[3]	0.10	0.04	0.14	ND
Capric acid (g/100 g)[3]	0.26	0.08	0.40	0.06
Casein (g/100 ml)[3]	2.11	2.70	4.24	0.40
α_{s1}-Casein (% total casein)[3]	5.60	38.00	1.48	NP
α_{s2}-Casein (% total casein)[3]	19.20	12.00	5.60	NP
β-Casein (% total casein)[3]	54.80	36.00	17.53	60.00–70.00

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Source: Lambrini et al. (2020)[1]; Pereira & Vicenta (2017)[2]; Turkmen (2017)[3]
Notes: Not determined (ND); Not present (NP)

Goat milk processing into new innovative products may create interest in customers (Miller & Lu, 2019). Besides, fresh goat milk is considered perishable due to its high nutrient and moisture content (Chughtai et al., 2021; Razali et al., 2021). Thus, processing using freezing technology, such as processing into ice cream (Nayik et al., 2021; Sarica & Coşkun, 2022). According to Goff et al. (2025), ice cream is an aerated frozen dessert consisting of dairy milk, non-dairy or dairy fats, milk proteins, sweetener, stabilizer, emulsifier, and flavoring agent. Ice cream production is carried out through stirring or mix blending, pasteurization, homogenization, aging, freeze-whipping, packaging, and storing. The unique texture of Ice cream was achieved by the formation of complex phases consisting of sols, solute, foam, and emulsion. As stated by Homayouni-Rad (2024), most formulas of the ice cream are composed of 55–64% water from milk, 10–16% milk fat, 9–12% milk solids-non-fat, 12–16% sweetener, and 0.2–0.5% stabilizer and emulsifier. The application of goat milk results in a softer and smoother texture due to its smaller fat globules. However, the ice cream was mostly disliked due to its fast melting rate and pronounced goaty flavor (Nayik et al., 2022; Kalit et al., 2023; Akshit et al., 2024).

2.2. Pontianak Liang Tea

Chinese herbal tea, or liáng chá (凉茶), is an ancient traditional Chinese beverage made by decocting non-tea (*Camellia sinensis*) plant parts, such as leaves, seeds, fruits, flowers, barks, and roots. The practice has been conducted for over 2000 years and was commonly practiced in Southern China regions. Consumption of liang cha was meant to balance yin and yang or regulate heat in the human body, and for health-improving purposes (Li et al., 2016; Chao et al., 2022). There are several liang cha practices done in the Ling-nan area (South China regions), including Guangdong, Guangxi, etc. In Guangdong, the purpose of liang cha consumption is a response to the harsh climate, especially in summer, with scorching hot and highly humid weather (Jiang, 2023). Chinese people in Guangdong migrated from Guangdong in the early 20th century to West Kalimantan, which is dominated by Teochew and Hakka ethnics (Atmaja & Fachrurazi, 2018), which is estimated to have lived around and assimilated into West Kalimantan society in the early 7th century. Thus, those ethnics influencing West Kalimantan's gastronomic diversity. Most of the culinary cuisines were still authentic, with certain ingredient usage (Chee-Beng, 2011; Molodysky, 2019). The practice of liang cha was also preserved in Indonesia, purposely consumed as part of ancestral teaching to cope with the tropical hot and humid climate similar to the mainland (Kuah, 2021). One of the traditional liang cha still consumed in West Kalimantan is PLT.

PLT is the Hakka and Teochew liang cha style, made with decocting Chinese foldwing leaf (*Dicliptera chinensis*), which is easily found by riversides, roadside, and wild yards. Traditionally, PLT was combined with other herb leaves such as boat lily (*Tradescantia spathacea*), purple leaves (*Graptophyllum pictum*), Javanese grapes (*Vitis japonica*), Asiatic pennywort (*Centella asiatica*), and mint (*Mentha cordifolia*). PLT is generally sold and consumed as a side drink for health purposes or a thirst quencher (Billy et al., 2024; Murdijati-Gardjito et al., 2024). The currently developed PLT formula by Dewi et al. (2022), consisted of Chinese foldwing leaf and boat lily leaf, which were mixed with West Kalimantan herbs and spices as a substitute for less available ingredients, such as wild oregano or cat whisker leaf (*Origanum vulgare*), fragrant pandan leaf (*Pandanus amaryllifolius*), aloe vera frond skin (*Aloe vera* var. *chinensis*), and sappanwood bark (*Caesalpinia sappan*). As part of local gastronomy, enhancing traditional beverages and adding flavor to various food products may be a strategic

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way to improve the popularity and utilization of natural West Kalimantan herbal resources.

2.3. Kombucha and Development with Pontianak Liang Tea and Calamansi

PLT has been processed into various products, such as kombucha. Kombucha is a functional fermented tea beverage produced using SCOBY, which consists of acetic acid bacteria, lactic acid bacteria, and yeast. Kombucha fermentation is mostly done for 14 days with an additional sugar substrate, which produces the fermented broth and pellicle. The fermented broth may produce specific flavor characteristics, live probiotics, and bioactive compounds (Su et al., 2023). The formation of organic acids makes the kombucha sensory profile described with a strong sour taste and sharp aroma. During fermentation, the yeasts (*Saccharomyces* and *Zygosaccharomyces*) may produce ethanol, which dominates in the early fermentation days. The produced ethanol can be used by acetic acid bacteria (*Acetobacter*) as a substrate for the formation of acetic acid. The present sugar can also be oxidized by acetic acid bacteria (*Komagataeibacter*) and lactic acid bacteria (*Lactobacillus*), producing gluconic or glucuronic acid and lactic acid (Kitwetcharoen et al., 2023). In terms of processing herbal kombucha, utilizing PLT as the fermenting medium has been done to improve functional properties and create a new sensory profile. However, the production of organic acid was not optimized. Incorporating calamansi orange (*Citrus microcarpa*) juice as a carbon source and acidifier may improve the PLT fermentation. The combined kombucha tends to produce greater organic acid formation with higher antioxidant activity compared to the original formula. The product has sensory properties with moderate citrusy acidity and aroma, a slight soda sensation, and is moderately liked (Dewi et al., 2026).

3. METHODS

3.1. Materials

The natural resources were collected in Pontianak City (West Kalimantan). PLT herb ingredients (Chinese foldwing leaves, boat lily leaves, oregano leaves, fragrant pandan leaves, and aloe vera frond skin) and calamansi orange were purchased from Flamboyan traditional market, while the spice ingredient (sappanwood bark) was purchased from a traditional herbal medicine store in Gadjah Mada Street. Raw goat milk was collected from local dairy Sapera goat husbandry (Tazayyad Farm, Pal 5 Sub-district). Black tea kombucha starter (Herbeeluxe), dried black tea bags (Teh Sosro), sucrose (GulaVit), whipped cream (Anchor, 35% fat content), skimmed goat milk powder (Ausnutria Dairy Ingredients), β-cyclodextrin (Kimia Jaya), gelatine powder (Beorganik), and sunflower liquid lecithin (NOW Foods) were purchased from an online shop.

3.2. Pontianak Liang Tea Calamansi-Flavored Kombucha Processing

Processing of PLT was conducted according to Fannia et al. (2024). All ingredients were washed in flowing clean water and drained. The herbal materials were dried in the cabinet dryer at 60℃ until the ingredients were easily shattered (moisture content ≤ 8%). The dried ingredients were pulverized in a blender and sifted through an analysis sieve (80 mesh). The dried powder of each ingredient was weighed and packed in a tea bag. The dried herbal tea formula consisted of 1 g Chinese foldwing leaf, 0.75 g boat lily leaf, 0.2 g sappanwood bark, 0.2 g oregano leaf, 0.2 g fragrant pandan leaf, and 0.2 g aloe vera frond skin. An infusion of one tea bag (2.55 g dried ingredients) was made in 400 mL boiling water at 100℃ for 20 min. The infusion then cooled for further processing.

Kombucha consortium rejuvenations were done according to Sutthiphatkul et al. (2022)

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with modification. Sweet black tea infusion was made by boiling dried black tea (1 g/L) and sucrose (10 g/L) for 15 min. The sweetened black tea solution was immediately poured into a sterilized glass jar and cooled to room temperature. The solution was inoculated with SCOBY from commercial kombucha, consisting of 30 g of pellicle and 100 mL of fermented kombucha broth. The fermentation jar was covered with fabric, followed by fermentation for 14 days in a dark room. The fermented broth was collected as the kombucha inoculum.

PLT calamansi-flavored kombucha production consists of two main processes, which are calamansi juice pasteurization and kombucha fermentation. Calamansi oranges were harvested at maturity around 94–101 days, as shown by their bright yellow-orange colored juice vesicles and plump-sized fruit (Rosillo-Magno & Mapalo, 2020). The fruit was washed thoroughly in running water until the skin surface became shiny, then the fruit was drained and air-dried. Calamansi were sliced into two cross sections, followed by squeezing and straining to obtain the fine juice. Calamansi juice was pasteurized at 80℃ for 3.5 min. The juice was cooled to room temperature and was ready to be processed for kombucha production. All ingredients were mixed in a sterilized glass jar, consisting of 128 g PLT infusion, 16 g calamansi juice, 16 g sucrose, and 16 g rejuvenated kombucha starter broth. The medium was covered with a fabric lid and placed in a dark room, then fermented for 14 days at room temperature. The herbal kombucha was harvested for its fermented broth and stored in the freezer before further processing (Dewi et al., 2026).

3.3. Ice Cream Processing

Goat milk ice cream was produced according to Alosily et al. (2023) with modifications from Simatupang et al. (2024), Pangestu et al. (2019), and Goff et al. (2025). Ice cream processing consisted of milk pasteurization and ice cream making. The milk pasteurization process was conducted using the High Temperature Short Time (HTST) method. Raw goat milk was pasteurized at 75℃ for 15 s. Pasteurized goat milk was packed and stored in the freezer until the next process. Ice cream making proceeded through ingredient mixing, pasteurization, homogenization, aging, freeze-whipping (flavoring), packaging, and storage. The liquid ingredients (goat milk and whipped cream) were combined and heated to 60℃, followed by immediate incorporation of dry ingredients (sucrose, skimmed goat milk powder, β-cyclodextrin, gelatin, and sunflower liquid lecithin). The ingredients were mixed using a hand mixer until no lumps remained. The mixture was pasteurized, then homogenized using a magnetic stirrer at 85℃ for 15 min. After pasteurization, the mixture was cooled and re-homogenized with a hand mixer, then poured into a container and immediately cooled at 4℃ for 8 h. The aged ice cream mixture and PLT calamansi-flavored kombucha were poured into a batch-type ice cream freezer (GEA ICE-1530) and freeze-whipped for 30 min. The kombucha was added at 6 levels, from 0-25%. The produced ice cream was packaged in a container and freeze-stored at -18℃. The following formulas and processing of the produced ice cream were shown in Table 2 and Figure 1.

Table 2. Goat Milk Ice Cream Formula

Ingredients	Formula (% w/w)					
	k_0	k_1	k_2	k_3	k_4	k_5
Goat milk	54.3					
Whipped cream (35% fat)	25.0					
Sucrose	14.0					
Skimmed goat milk powder	5.2					
β-cyclodextrin	1.0					
Gelatin	0.3					

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Ingredients	Formula (% w/w)					
	k_0	k_1	k_2	k_3	k_4	k_5
Sunflower liquid lecithin	0.2					
Total	100					
PLT calamansi-flavored kombucha	0	5	10	15	20	25
Grand total	100	105	110	115	120	125

Source: Alosily et al. (2023) with modification

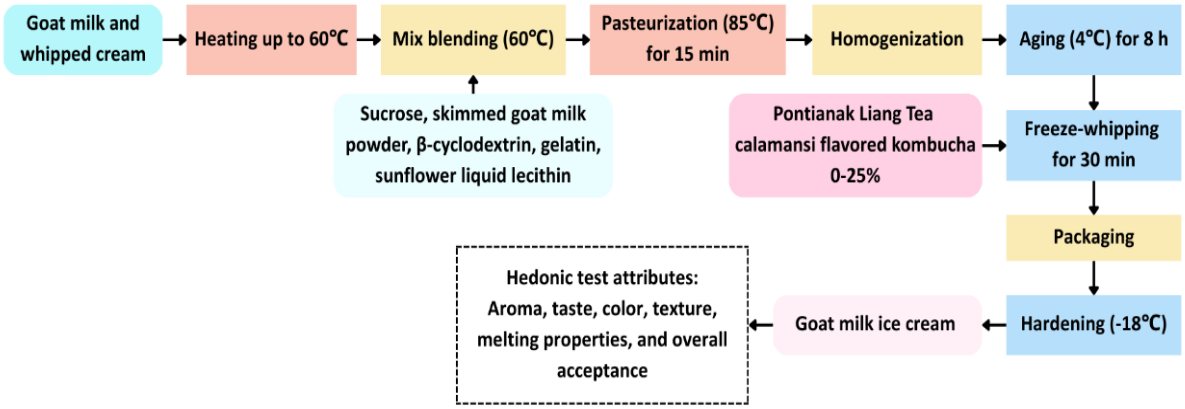


Figure 1. Goat Milk Ice Cream Processing Method
Source: Alosily et al. (2023) with modification

3.4. Hedonic Test

Hedonic sensory analysis was conducted according to Michelle et al. (2022) with modification from Civille et al. (2024). The affective or hedonic test measured the various sensory attributes of the food product and showed its acceptability from the consumer's perspective. The measured likeness sensory attributes consisted of aroma, taste, color, texture, melting properties, and overall acceptance. Assessment of the likeness degree was evaluated using a 5-point hedonic scale of the perception of likeness (Table 3). The sensory evaluation was done by selecting 35 semi-trained panelists, according to Febriana et al. (2024) with adjustments. The inclusion criteria for semi-trained panelists were volunteers, around 19–25 years old, physically healthy with no sensory impairments or smoking history, enrolled as a Food Technology student or alumni, having received hedonic test training or taken a Sensory Evaluation course, and being familiar with goat milk and kombucha. Ice cream (20 g) was served frozen inside a small cup, and each sample was labelled with three random digits, then given to panelists for blind tasting.

Table 3. Hedonic Scale

Criteria	Scale
Strongly dislike	1
Dislike	2
Moderately like	3
Like	4
Strongly like	5

Source: Civille et al. (2024)

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3.5. Statistical Analysis

The hedonic test results were displayed as the mean with standard deviation. The obtained data were analysed through Kruskal-Wallis's non-parametric test to find the significant effect ($p \leq 0.05$). The attributes that proved its significance effect were continued all pairwise comparisons with a Bonferroni correction post-hoc test to determine significant differences between treatments ($\alpha = 0.05$). Data analysis was conducted using IBM SPSS Statistics 26.0 (SPSS Inc., U.S.).

4. RESULTS AND DISCUSSION

4.1. Panelist and Sensory Evaluations

The number of panelists that have participated in sensory hedonic evaluations was 35 participants, aged around 19–25 years, and had been in higher education. The majority of the panelists were female (85.71%), lived in a private house (62.86%), Malays ethnicity (40.00%), had an income < 1.000.000 IDR (85.71%), and were non-workers (77.14%). As for the ice cream purchasing preference, most of the panelists consumed ice cream twice to thrice a month (68.57%) and purchased it at convenience stores (68.57%). The participants' demographic characteristics were shown in Table 4. All the panelists were considered semi-trained panelists. According to Yadav et al. (2024), a semi-trained panelist is a communicative and discriminative panel acquainted with certain food characteristics without receiving formal sensory training. Semi-trained panelists had the ability to differentiate and convey their own opinions. Utilizing semi-trained panelists may provide some advantages, such as bridging the gap between consumer preferences and analytical precision (Singh et al., 2025). The hedonic scores of the produced goat milk ice cream are shown in Table 5. The addition of PLT calamansi-flavored kombucha at various levels of concentration to goat milk ice cream was found to have a significant effect ($p \leq 0.05$) on all sensory attributes preference.

Table 4. Panelist Demographic Profile (n = 35)

Information	Total (%)
Gender	
• Female	30 (85.71%)
• Male	5 (14.29%)
Residence	
• House	22 (62.86%)
• Boarding house	13 (37.14%)
Ethnicity	
• Malays	14 (40.00%)
• Chinese	9 (25.71%)
• Javanese	9 (25.71%)
• Dayak	2 (5.71%)
• Batak	1 (2.86%)
Income	
• < 1.000.000 IDR	30 (85.71%)
• 1.000.000–3.000.000 IDR	3 (8.57%)
• 3.000.000–5.000.000 IDR	1 (2.86%)
• > 10.000.000 IDR	1 (2.86%)
Occupation	
• Non-worker	27 (77.14%)
• Worker	8 (22.86%)
Ice cream eating frequencies	

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Information	Total (%)
• 2–3 times per month	24 (68.57%)
• Once per month	7 (20.00%)
• Seldom (< once per year)	2 (5.71%)
• < Thrice per month, but > twice per year	2 (5.71%)
Purchasing an ice cream store	
• Convenience store	24 (68.57%)
• Supermarket	11 (31.43%)

Source: Research Data (2026)

Table 5. Hedonic Score of the Goat Milk Ice Cream

Kombucha (%)	Aroma*	Taste*	Color*	Texture*	Melting Properties*	Overall Acceptance*
0	2.77 ± 0.81^{a}	2.97 ± 0.95^{a}	2.57 ± 0.74^{a}	3.23 ± 0.84^{a}	3.14 ± 1.00^{a}	3.09 ± 0.98^{a}
5	3.31 ± 0.83^{ab}	3.57 ± 0.78^{ab}	2.97 ± 0.86^{ab}	3.71 ± 0.67^{ab}	3.20 ± 0.76^{ab}	3.71 ± 0.79^{b}
10	3.40 ± 0.81^{ab}	3.63 ± 0.84^{ab}	3.11 ± 0.80^{ab}	3.74 ± 0.82^{ab}	3.34 ± 0.76^{ab}	3.77 ± 0.77^{b}
15	3.69 ± 1.05^{b}	3.91 ± 0.98^{b}	3.40 ± 0.98^{b}	3.91 ± 0.74^{b}	3.80 ± 0.99^{b}	4.14 ± 0.81^{b}
20	3.37 ± 0.88^{ab}	3.54 ± 0.95^{ab}	3.49 ± 0.85^{b}	3.57 ± 0.98^{ab}	3.43 ± 0.95^{ab}	3.77 ± 0.77^{b}
25	3.20 ± 0.83^{ab}	3.34 ± 1.11^{ab}	3.17 ± 0.82^{ab}	3.37 ± 0.97^{ab}	3.20 ± 0.90^{ab}	3.63 ± 0.88^{ab}
p-value	0.004	0.003	0.000	0.009	0.026	0.000

Source: Research Data (2026)

Note: The data are displayed as mean ± standard deviation; The attribute shown to has significant effect by the Kruskal-Wallis test with p-value ≤ 0.05 (*); The significant difference is displayed alphabetically beside the hedonic score value with α = 0.05 ($^{a, b}$)

4.2. Aroma

The aroma preferences of the produced goat milk ice cream showed a range of likeness around 2.77–3.69. The analysis showed a significant difference between the control and 15% addition of the kombucha. The highest hedonic score was achieved at 15% addition of the kombucha, which was perceived as close to "like", while the lowest hedonic score was obtained at the control treatment, being perceived as close to "moderately like". Panelists were reported to experience an unpleasant, robust aroma at the control, similar to a barnyard-like aroma, and higher kombucha concentration (20–25%) was described to had slight overwhelming and sharp aroma.

According to Fitrotin et al. (2024), a strong goaty aroma in ice cream will make the perception lower, especially in aroma attributes. A similar study by Alosily et al. (2023), also reported lower aroma acceptance in goat milk ice cream without being added with β-cyclodextrin and essential oils. According to Yang et al. (2015), increasing fat content in skimmed goat milk induces strong odor perception, which is caused by the presence of MCFAs such as caproic and capric acid. Caproic acid aroma is mostly described with a robust sweaty smell similar to blue cheese, while capric acid aroma is described as bitter, musty, rancid, and slightly fruity. However, there is a chance that the freeze-stored goat milk-based products may experience autoxidation or hydrolytic rancidity, which may produce rancid volatile compounds (McGhee et al., 2015; Lee, 2020). Additional flavoring agents, such as vanilla and fruit flavor, were found to effectively mask the goaty aroma and improve acceptance (Riyansa & Syarif, 2023; Akshit et al., 2024).

4.3. Taste

The taste preferences of the produced goat milk ice cream showed a range of likeness around 2.97–3.91. The analysis showed a significant difference between the control and 15%

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addition of the kombucha. The highest hedonic score was achieved at 15% addition of the kombucha, which was perceived as close to "like", while the lowest hedonic score was obtained at the control treatment, being perceived as close to "moderately like". Panelists reported detecting unpleasant taste at the control and the highest kombucha concentration (25%), which were respectively described with distinct gamey taste with slight bitterness, and strong sourness, followed by slightly herbal-bitterness and astringency. However, the feedback was positively unique flavor combination of herbal, citrusy-tangy, and milky taste.

The goat milk ice cream taste is highly correlated with its emitted aroma perception, especially the goaty flavor (Alosily et al., 2023). The gamey taste may be influenced by caproic acid. However, covering up those tastes with citrus refreshing and sour flavor, including its tangy taste, may improve the taste acceptance in goat milk-based products (Desfi et al., 2024). The detection of bitter taste influenced by protein breakdown, resulting in increased free bitter biopeptides in goat milk, such as leucine, isoleucine, tyrosine, and phenylalanine (Zhang & Jia, 2024). This result is also highly relevant to complex flavor compounds in PLT calamansi-flavored kombucha. The slightly bitter and astringent taste may come from PLT-extracted polyphenols such as flavonoids, tannins, and phenolic compounds (Dewi et al., 2022). Organic acids from PLT kombucha fermentation and calamansi juice may influencing increasing of sourness (Dewi et al., 2026). However, Simatupang et al. (2024) stated that increasing calamansi juice sourness in goat milk ice cream which decrease taste preference. The research found that the decreasing likeness at higher concentrations of kombucha did not significantly differ, which may indicate various panelists' preferences on sourness levels.

4.4. Color

The color preferences of the produced goat milk ice cream showed a range of likeness around 2.57–3.49. The analysis showed a significant difference between the control and 15–20% addition of the kombucha. The highest hedonic score was achieved at 20% addition of the kombucha, which was perceived as close to "like", while the lowest hedonic score was obtained at the control treatment, being perceived close to "moderately like". The evaluation reported that panelists perceived the goat milk ice cream with the highest concentration of kombucha to be unappetizing due to its dull appearance.

The control ice creams tend to have a whitish appearance. Sari et al. (2025) stated that goat milk was perceived as the whitest in color compared to other dairy milks. However, the goat milk ice cream white index did not significantly differ, but was significantly lighter compared with other dairy milk ice creams (Ürkek et al., 2022). Therefore, it is suspected to impact the hedonic score. The addition of a natural pigment component with yellow to purple color in ice cream may improve its color affection (Wijaya et al., 2021). PLT is described as having a combination of orange-brownish and purplish (Fannia et al., 2024), which is suspected to be contributed by polyphenols from the Chinese foldwing leaf (Murdijati-Gardjito et al., 2024), rheonin or anthocyanins from the boat lily leaf (García-Varela et al., 2015), and brazilin or brazilein from sappanwood (Vij et al., 2023). According by Dewi et al. (2026), PLT calamansi juice kombucha have appearance with yellowish appearance due to the calamansi juice. Calamansi juice is found to have abundant carotenoids, which produce a yellow-orangish color (Oe et al., 2024). In fermentation, the increasing acidity levels may impact color shifting, especially brazilin color change into a yellowish color (Ngamwonglumlert et al., 2020). However, a previous study by Simatupang et al. (2024), were shown to have no significant effects with the addition of calamansi juice 0–12.5% in goat milk ice cream, which is suspected by insignificant color change. This may be relevant to the results in the highest kombucha addition in ice cream, with a slight color change to brown-yellowish in line with dull

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appearance perception.

4.5. Texture

The texture preferences of the produced goat milk ice cream showed a range of likeness around 3.23–3.91. The analysis showed a significant difference between the control and 15% addition of the kombucha. The highest hedonic score was achieved at 15% addition of the kombucha, which was perceived as close to "like", while the lowest hedonic score was obtained at the control treatment, being perceived as "moderately like". Some panelists reported liking the soft and smooth texture in the control, but a lot of panelists liked their ice cream to have a thicker consistency and slight bites in ice cream with a 15% addition of kombucha.

Goat milk ice cream tends to have a smoother and softer texture due to its small fat globules (Carvalho et al., 2022; Akshit et al., 2024), while using gelatin also maintains the soft texture (Ayudiarti et al., 2020). Simatupang et al. (2024) showed that increasing the addition of calamansi juice in goat milk ice cream may increase textural effects, which was suspected to produce a coarse texture due to developing large ice crystals impacted by decreasing fat and increasing free-bound water composition. However, instead of larger ice crystal formation, producing ice cream with the addition of plant extract with high organic acid and phenolic acid may cause protein denaturation and aggregation. Thus, the consistency will be thicker due to an increase in viscosity (Pangastuti et al., 2025). The thicker consistency may influence the perception of a more stable body in the ice cream, which led to a higher score of textural affection.

4.6. Melting Properties

The melting properties preferences of the produced goat milk ice cream showed a range of likeness around 3.14–3.80. The analysis showed a significant difference between the control and 15% addition of kombucha. Most of the panelists were quite disappointed with the rapid melting rate of the produced ice creams. However, ice cream with the addition of 15% kombucha was somewhat perceived to be slightly resistant to melting. Therefore, the highest hedonic score was achieved at 15% addition of the kombucha, which was perceived as close to "like", while the lowest hedonic score was obtained at the control treatment, being perceived as close to "moderately like".

According to Homayouni-Rad (2024), the common preferences for ice cream melting rate were starting to melt at room temperature around 10–15 min. The panelist feedback might indicate that the ice cream melting properties were faster than those of commercial ice cream. This is highly relevant to the disadvantages of goat milk ice cream, such as having a rapid melting rate due to its softer body and smaller coalescence degree (Carvalho et al., 2022; Akshit et al., 2024). However, the melting rate was highly correlated with the texture, especially with the viscosity of the ice cream. Ice cream with a thicker texture might significantly increase the melting resistance due to closure from each molecular microstructure and slower-flowing movements (Pangastuti et al., 2025). Thus, this might explain the correlation between the acceptance behavior of textural and melting properties.

4.7. Overall Acceptance

The overall acceptance of produced goat milk ice cream showed a range of product likeness around 3.09–4.14. The highest hedonic score was achieved at 15% addition of the kombucha, which was perceived as close to "like", while the lowest hedonic score was obtained at the control treatment, being perceived as close to "moderately like". The analysis

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showed a significant difference between the control and the 5–20% addition of the kombucha. According to panelist comments, some panelists liked the produced goat milk ice cream with the addition of the herbal kombucha, and even described it as "delicious". However, several panelists perceived overall acceptance of the control goat milk ice cream to be considered basic. The result was suspected to be hugely influenced mostly by flavor and textural acceptance aspects, rather than appearance aspects (Akshit et al., 2024).

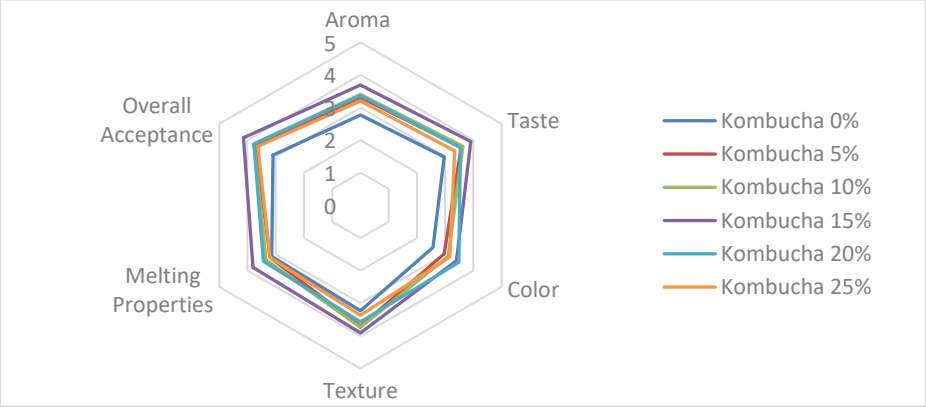


Figure 2. Goat Milk Ice Cream Consumer Preference
Source: Research Data (2026)

4.8. Consumer Preference and Implementation Strategy on Gastronomy Tourism

The sensory hedonic evaluations of the produced goat milk ice cream (Figure 2) were shown to have significantly higher scores with a 15% addition of PLT calamansi-flavored kombucha compared to the control sample, which indicates its strong enough sensory profile to mask the goaty flavor and improve its textural properties. Therefore, 15% addition of the kombucha in goat milk ice cream is the most acceptable product based on consumer preferences. As a gastronomy tourism product, the produced ice cream can be implemented as a signature novel fusion food in West Kalimantan through marketing with local culinary businesses supported by local agroindustry. Fusion cuisine sold in restaurants has been a younger generations tourist destination (Türker & Süzer, 2022). While utilizing local agroindustry as a supplier for traditional food culinary businesses increases economic value and availability (Setyowati et al., 2023). Moreover, exposing in foods festivals can also increase tourist understanding of regional gastronomy products (Gündüz et al., 2024). Thus, this strategy may create sustainable local gastronomy tourism and agroindustry in West Kalimantan.

5. CONCLUSION

The study concludes that the addition of PLT calamansi-flavored kombucha can effectively improve consumer sensory acceptance as a masking agent. Therefore, the innovative approach of developing goat milk ice cream with traditional beverage flavors may show the potential of utilizing local-based resources. All treatments were found to be higher in terms of hedonic score compared to control samples. Goat milk ice cream with a 15% addition of PLT calamansi-flavored kombucha was chosen as the best treatment. The sensory acceptance was described as "moderately like" for the aroma, taste, color, texture, and melting properties attributes, while the overall acceptance reached "like" acceptance levels. The produced ice cream can be a gastronomy tourism product to preserve and promote the community gastronomy heritage of West Kalimantan. Furthermore, the study suggests evaluating the physicochemical properties and functional properties to achieve its development as a

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functional food with proper standardization and sensory profiling.

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