

Organoleptic Properties and Storage Stability of Herbal Drink Formulations Containing Lemongrass, Ginger, Karamunting Fruit, and Stingless Bee Honey

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Abstract

Optimizing sensory acceptance and stability is essential for the development of instant herbal beverages based on local plant resources. This study evaluated three formulations (F1, F2, and F3) of an instant herbal drink composed of lemongrass, ginger, karamunting fruit, and stingless bee honey, with progressively increasing honey proportions. Organoleptic acceptance of aroma, taste, color, and texture was assessed by 25 untrained panelists using a 7-point hedonic scale and interpreted through comparative radar chart analysis. Physical characteristics, including pH and dissolution time, as well as short-term stability under room temperature ($\pm 30\text{--}31^\circ\text{C}$) and refrigerated conditions ($\pm 4^\circ\text{C}$) over seven days, were also evaluated. Among the tested formulations, F3 consistently demonstrated the highest sensory acceptance, particularly for taste (hedonic score ≈ 6), followed by F2, while F1 showed the lowest acceptance. All formulations exhibited slightly acidic pH values (5.8–6.7) and rapid dissolution times (10–11 s). Stability testing indicated that all formulations deteriorated rapidly at room temperature, whereas refrigerated storage effectively preserved the sensory quality of F2 and F3 for up to seven days. These findings identify F3 as the most promising formulation for further development as an instant functional herbal beverage, while highlighting the importance of formulation optimization and storage conditions for product stability.

Keywords: beverage; ginger; karamunting; honey; stability

1. INTRODUCTION

Herbal beverages derived from plant-based ingredients have long been used to support health due to their bioactive compounds, including antioxidants, flavonoids, and polyphenols. Herbal medicines are known to enhance immunity, prevent disease, and accelerate recovery (Septiana et al., 2017). However, liquid herbal preparations are generally perishable because of their high water content, which limits shelf life and reduces practicality for modern consumers. To address these limitations, herbal ingredients can be processed into instant powdered beverages with low moisture content (3–5%), improved stability, and preserved functional properties (Husnani & Zulfitri, 2022).

Instant powdered drinks offer advantages such as ease of preparation, portability, and extended shelf life. Nevertheless, previous studies have primarily focused on single-ingredient or limited-combination formulations, leaving the stability behavior and sensory performance of more complex multi-component herbal powders insufficiently explored (Husnani & Ningsih, 2023).

Lemongrass (*Cymbopogon citratus*) and ginger (*Zingiber officinale*) are widely consumed spices in Indonesia and are commonly used in traditional herbal beverages. Lemongrass contains essential oils rich in citral with antimicrobial and anti-inflammatory activities (Yanti et al., 2022), while ginger contains gingerol and shogaol, which function as antioxidants and immune system modulators (Akram et al., 2014; Ghasemzadeh et al., 2018). Although these spices are frequently studied individually or in liquid herbal products, their combined application in instant powdered beverage formulations with extended stability has received limited scientific attention.

Karamunting fruit (*Melastoma malabathricum*), a wild plant commonly found in Kalimantan, represents an underutilized local resource. Despite often being classified as a weed, karamunting fruit contains anthocyanins, flavonoids, and polyphenols with strong antioxidant activity (Aurelia et al., 2023; Marwati et al., 2020; Setiawan et al., 2018). Previous studies have explored its use in syrup or extract forms; however, these products exhibit short shelf life and limited practicality (Jaya, 2024). Its development as an ingredient in instant powdered herbal beverages, particularly in combination with spices, has not been widely reported.

Another promising functional ingredient is stingless bee honey (*Trigona* sp.), also known as kelulut honey. Kelulut honey from Kalimantan has high antioxidant potential and provides a distinctive sweet-sour flavor profile (Batistuta et al., 2021; Kustiawan et al., 2023; Marini et al., 2022). Studies on community-based beekeeping initiatives have demonstrated the economic and functional potential of kelulut honey for product diversification. However, its application as a natural sweetener and functional component in instant powdered herbal drink formulations remains largely unexplored.

From a scientific perspective, combining lemongrass, ginger, karamunting fruit, and stingless bee honey is expected to generate complementary and synergistic effects, as lemongrass and ginger contribute antimicrobial, anti-inflammatory, and immunomodulatory activities; karamunting fruit provides anthocyanin-rich antioxidant capacity; and kelulut honey enhances both antioxidant potential and sensory acceptance (Livana et al., 2016; E. Misran et

al., 2025; Suwandi & Kustiawan, 2024). To date, no studies have comprehensively evaluated the physical stability and organoleptic characteristics of an instant herbal drink powder formulated from these four ingredients, as previous research has largely focused on simpler formulations without addressing spice–fruit–honey interactions during storage. Therefore, this study aims to evaluate the organoleptic properties and physical stability of an instant herbal drink powder formulated from lemongrass, ginger, karamunting fruit, and stingless bee honey, including pH, dissolution behavior, and changes in color, aroma, taste, and texture under room and refrigerated storage conditions. This research introduces a novel multi-component formulation that integrates underutilized local fruit with traditional spices and kelulut honey, contributing scientific evidence for the development of a practical, stable, and functional beverage based on Indonesia’s biodiversity (Manurung & Simanjuntak, 2019; Utami et al., 2022).

2. METHOD

2.1 Research Materials

The materials used in this study consisted of fresh lemongrass (3 kg), ginger rhizomes (2 kg), karamunting fruit (*Melastoma malabathricum*) (1 kg), stingless bee honey (*Trigona* sp.) (115 mL), and hot water (180 mL), which was used in the preparation of each formulation. All plant materials were obtained from local sources in East Kalimantan and processed immediately to minimize quality degradation.

2.2 Extraction and Formulation

Three formulations were prepared, differing in honey content (Table 1).

Table 1. Composition of formulations (per 19 g serving)

Ingredient	F1	F2	F3
Lemongrass	6.30	5.42	4.75
Ginger	3.16	2.71	2.37
Karamunting fruit	6.30	5.42	5.42
Kelulut honey	3.26	5.42	7.13

2.3 Organoleptic Test

Organoleptic evaluation was conducted using a hedonic sensory test in accordance with general sensory evaluation principles (ISO 11136; SNI 01-2346). A total of 25 untrained panelists assessed the aroma, color, and taste of the herbal beverage formulations using a 7-point hedonic scale (1 = dislike very much, 2 = dislike moderately, 3 = dislike slightly, 4 =

neutral, 5 = like slightly, 6 = like moderately, 7 = like very much). Panelists were adults aged 18–45 years, in good health, non-smokers, and without known sensory impairments or food allergies related to the test ingredients. Individuals with prior sensory evaluation training, respiratory or oral health issues, or hypersensitivity to herbal products were excluded. Participation was voluntary, and informed consent was obtained prior to testing. Each formulation was evaluated once per panelist during a single evaluation session. Samples were coded with random three-digit numbers and presented in a randomized order to minimize bias. Panelists were instructed to rinse their mouths with drinking water between samples to prevent carry-over effects.

2.4 Stability Test

The stability test was designed as a short-term (preliminary) stability evaluation, which is commonly applied for instant powdered beverage formulations to identify early physical changes prior to long-term or accelerated testing. This approach is consistent with recommendations in the literature for preliminary stability screening of herbal drink powders (Husnani & Ningsih, 2023). Each formulation was stored for seven days under two storage conditions: room temperature ($\pm 30\text{--}31\text{ }^{\circ}\text{C}$) and refrigerated temperature ($\pm 4\text{ }^{\circ}\text{C}$). Samples were stored uncovered to allow observation of potential environmental effects on physical stability. Physical parameters were observed daily by visual inspection, including changes in aroma, sedimentation, and texture.

2.5 Data Analysis

All experimental measurements were conducted in triplicate ($n = 3$) and are presented as mean $\pm$ standard deviation (SD) in tables and figures. For continuous physical parameters (pH and dissolution time), data were subjected to one-way analysis of variance (ANOVA) at a significance level of $\alpha = 0.05$ to explore differences among formulations. When ANOVA assumptions were not fully met due to limited replication, results were interpreted cautiously as exploratory. For organoleptic data, which are ordinal in nature, differences among formulations were evaluated using the Kruskal–Wallis test ($\alpha = 0.05$). Descriptive statistics were also used to summarize hedonic score distributions. Overall, statistical outcomes were complemented with descriptive interpretation and comparison with relevant literature, as this study was designed as a preliminary formulation and stability evaluation rather than a confirmatory hypothesis-testing study.

2.6 Ethical Considerations

This study adheres to ethical guidelines for research involving human participants and has been approved by the Research Ethics Committee of Muhammadiyah University of Surakarta (UMS) (Approval Number: 5667/A.1/KEPK-FKUMS/IV/2025). Participation was voluntary, and all panelists provided written informed consent via a Google form.

3. RESULTS AND DISCUSSION

3.1 Organoleptic Acceptance (Hedonic Evaluation)

The organoleptic acceptance of the three herbal drink formulations (F1, F2, and F3) was evaluated using a hedonic test covering aroma, taste, color, and texture. The overall sensory profiles of the formulations are illustrated in a radar (spider) chart (Figure 1), which provides a comparative visualization of panelist preferences across attributes. Based on the spider chart, formulation F3 consistently exhibited the highest relative scores, particularly for taste, indicating the highest level of overall acceptance among the tested formulations.

The superior taste acceptance of F3 is closely associated with the higher proportion of stingless bee honey, which enhanced sweetness and effectively masked the pungency of ginger as well as the natural acidity of karamunting fruit. Honey contains glucose and fructose that not only contribute sweetness but also modulate flavor perception through taste–taste interactions, reducing the perception of bitterness and sourness. Similar improvements in sensory acceptance have been reported in ginger-based beverages formulated with natural sweeteners (Suseno et al., 2025).

Aroma, color, and texture attributes showed the same general trend ($F3 > F2 > F1$) in the radar chart, indicating that the formulation ratio applied in F3 produced a more balanced sensory profile. These results suggest that the combined use of lemongrass, ginger, karamunting fruit, and kelulut honey in appropriate proportions plays a critical role in achieving optimal organoleptic acceptance.

The radar chart (Figure 1) indicates that aroma acceptance was highest in F3. This may be explained by the synergistic interaction between volatile compounds from lemongrass, particularly citral and geraniol, and essential oil components from ginger. These compounds generate a fresh citrus–spicy aroma that is generally more acceptable when balanced by sweetness, as previously reported for ginger-based beverages (Ghasemzadeh et al., 2018). In

formulations with lower honey content, the essential oil aroma tended to be perceived as overly intense, which reduced panelist preference.

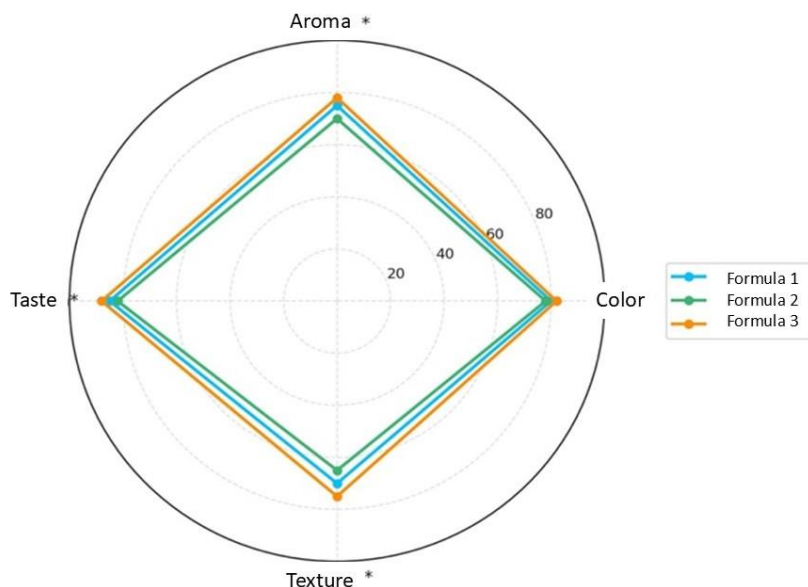


Figure 1. Radar chart of hedonic sensory attributes (aroma, taste, texture, and color) of herbal drink formulations F1, F2, and F3.

Taste acceptance appeared to be strongly influenced by honey concentration. In addition to providing sweetness, reducing sugars in honey are known to suppress sour taste perception, thereby improving palatability in formulations containing acidic polyphenols from karamunting fruit. This masking effect explains the consistently higher taste preference observed for F3 compared with F1 and F2.

Color preference was also highest in F3, likely due to the presence of anthocyanin pigments from karamunting fruit that impart a natural reddish–purple hue. Anthocyanins are known to enhance visual appeal in herbal beverages and are often associated with antioxidant-rich products, which positively influences consumer perception (Ismandari, 2022). Texture evaluation indicated that all formulations dissolved smoothly; however, F3 showed slightly better acceptance, possibly due to improved wettability related to the hygroscopic nature of sugars present in honey.

3.2 pH Values

The pH values of the formulations ranged from 5.8 to 6.7, indicating slightly acidic conditions that remain acceptable for herbal beverages (Table 2).

Table 2. pH of formulations	
Formulation	pH $\pm$ SD
F1	5.8 $\pm$ 0.00
F2	6.7 $\pm$ 0.00
F3	6.5 $\pm$ 0.00

The observed differences in pH are likely influenced by organic acids present in stingless bee honey as well as phenolic compounds from karamunting fruit. Similar pH ranges have been reported in honey-based herbal drink formulations (Kek et al., 2017). The absence of variation among replicates (SD = 0.00) indicates good formulation reproducibility.

3.3 Dissolution Time

All formulations exhibited rapid dissolution, within 10–11 seconds (Table 3), which is substantially faster than many commercial instant beverages and well below the Indonesian standard requirement (SNI) of less than 5 minutes.

Table 3. Dissolution time	
Formulation	Time (s) $\pm$ SD
F1	10.45 $\pm$ 0.09
F2	10.47 $\pm$ 0.03
F3	10.52 $\pm$ 0.07

This rapid dissolution can be attributed to low moisture content, fine particle size, and the presence of honey sugars, which enhance powder wettability and dispersion in water. The low standard deviation values indicate consistent physical performance across replicates.

3.4 Stability During Storage (0–7 Days)

Stability observations during storage are summarized in Table 4. At room temperature (± 30 – 31°C), noticeable deterioration began on day 2, characterized by aroma changes and sediment formation, progressing to clear signs of fermentation by day 7.

Table 4. Stability observations (0–7 days)

Day Room Temperature ($\pm 30\text{--}31^\circ\text{C}$)		Refrigeration ($\pm 4^\circ\text{C}$)
0	Fresh aroma, clear, no sediment	Fresh aroma, clear, no sediment
1	Slight decrease in aroma, still acceptable	Aroma stable, clear
2	Aroma change (slightly sour), beginning sediment	Aroma stable, no sediment
3	Noticeable aroma deterioration, visible sediment	Aroma still fresh, solution clear
5	Fermented aroma, increased sediment	Slight aroma decrease, still acceptable
7	Strong deterioration, heavy sediment, less acceptable	Aroma acceptable, minimal sediment, relatively stable

This behavior can be mechanistically explained by the high reducing sugar content of stingless bee honey, which serves as a readily fermentable substrate for microorganisms under warm conditions (Misran et al., 2025).

In contrast, samples stored under refrigeration ($\pm 4^\circ\text{C}$) remained relatively stable, with only minor aroma changes and minimal sedimentation observed after day 5. Lower temperatures inhibit microbial growth and enzymatic activity, thereby slowing fermentation and preserving sensory quality. These findings emphasize that while honey improves organoleptic properties, appropriate storage conditions are essential to maintain the stability of honey-containing herbal powder formulations.

The organoleptic evaluation demonstrated that formulation F3 consistently achieved the highest mean hedonic scores for aroma, taste, color, and texture, indicating stronger consumer acceptance than F1 and F2. This finding aligns with literature showing that the addition of sweeteners can enhance overall sensory acceptance in functional beverages by modulating taste perception and masking undesirable bitter or sour sensations from bioactive compounds (Ertan et al., 2018). In particular, reducing sugars in honey (glucose and fructose) play a crucial role in enhancing sweetness intensity and suppressing bitterness and acidity, which improves overall palatability. Reducing sugars have been shown to influence flavor perception and interact with phenolics, leading to enhanced sweetness and preference in complex beverage matrices (Ng et al., 2023).

The improved aroma acceptance in F3 may be explained by the interaction between volatile compounds in lemongrass (citral and geraniol) and ginger (zingiberene) with the honey

matrix. Increased viscosity due to sugars can slow the release of volatile aroma compounds, resulting in a smoother sensory profile that is generally preferred by consumers, a phenomenon supported by sensory research on honey sweetened beverages.

Color preference was also higher in F3, likely due to the stable contribution of anthocyanins from karamunting fruit. Anthocyanins are natural pigments that confer red–purple hues and are more stable under mildly acidic conditions, while their color expression is affected by pH, temperature, and interactions with co-pigments or sugars. Studies have shown that sugars, including honey, can influence anthocyanin stability and color intensity through copigmentation effects, though the specific outcome depends on the type of anthocyanin and storage conditions. For example, honey has been reported to either enhance or reduce anthocyanin stability depending on the matrix and storage, with some research demonstrating higher anthocyanin and color density in honey-sweetened nectars compared to sucrose or maltose syrup (Ertan et al., 2018). Additionally, anthocyanin stability is pH-sensitive, and mildly acidic environments tend to favor the more pigmented flavylium cation form, contributing to more appealing colors in beverages such as herbal drinks (Song et al., 2022).

Stability observations showed that at room temperature, formulations deteriorated faster, with noticeable sour aroma changes and sediment formation by day 2. This instability can be mechanistically linked to the high reducing sugar content of honey, which serves as an easily fermentable substrate for microorganisms, accelerating fermentation and organic acid production under warm conditions. Similar behavior is observed in honey-rich fermentates where increased sugar levels promote microbial activity and Brix-dependent physicochemical changes. Refrigeration slowed these processes, likely due to reduced microbial metabolism and enzyme activity at lower temperatures, thereby extending sensory acceptability.

These sensory and stability trends are consistent with other research on functional beverages, where achieving a balance between bioactive compound content and acceptable sensory properties remains a challenge. Many functional fruit-herbal beverages require sweeteners to balance inherent bitterness or acidity from polyphenols, and consumer studies often report a preference for formulations that achieve this balance without compromising perceived health benefits (Socha et al., 2021).

In summary, the enhanced sensory acceptance of F3 appears to result from the combined effects of reducing sugars in honey modulating taste and aroma, moderately acidic pH stabilizing anthocyanin color, and the balanced interplay of volatile compounds from herbal

ingredients. The trade-off between sensory quality and storage stability at higher temperatures underscores the need for optimization strategies such as improved preservation or co-pigmentation stabilizers to extend shelf life while maintaining desirable sensory attributes.

4. CONCLUSION

This study confirms that an instant herbal drink formulated from lemongrass, ginger, karamunting fruit, and stingless bee honey can achieve acceptable sensory quality and physical stability, with formulation F3 showing the best overall performance. Sensory evaluation visualized through a radar chart indicated that F3 consistently obtained the highest relative acceptance, particularly for taste (≈ 6 on a 7-point hedonic scale), reflecting a strong “like very much” response compared with F1 and F2. All formulations exhibited slightly acidic pH values ranging from 5.8 to 6.7 and rapid dissolution times of 10–11 s, meeting the requirements for instant beverage products. Stability testing demonstrated that samples stored at room temperature (± 30 – 31°C) began to deteriorate as early as day 2, whereas refrigerated storage ($\pm 4^\circ\text{C}$) maintained acceptable aroma, color, and texture for up to 7 days, highlighting the role of honey’s reducing sugars in promoting fermentation under warm conditions. These findings indicate that formulation F3 is the most promising candidate for product development as a functional instant herbal beverage, with practical implications including the need for refrigerated storage, improved packaging, or additional stabilization strategies to enable wider commercialization.

5. ACKNOWLEDGMENT

The authors would like to thank Universitas Muhammadiyah Kalimantan Timur for the facility. We also thank to Rendri Arista Avimaro for provided stingless bee honey.

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