

Panelists' Preference Levels for Herbal Drinks Based on Nutmeg Leaves and Skin (*Myristica fragrans*)

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This research aims to determine the best formulation of herbal tea based on nutmeg leaves and nutmeg fruit peels based on sensory quality. The parameters observed include color, taste, aroma, texture, and overall acceptance. The design used is a completely randomized block design with three replications. The treatments consist of five formulations, namely 100% nutmeg leaves, 75% nutmeg leaves and 25% nutmeg skin, 50% nutmeg leaves and 50% nutmeg skin, 25% nutmeg leaves and 75% nutmeg skin, and 100% nutmeg skin. Data were obtained thru a hedonic test by 25 panelists using a scale of 1 to 5, and then analyzed descriptively based on the average value. The research results show that the formulation of 25% nutmeg leaves and 75% nutmeg skin yields the highest values in several parameters, namely color 4.32, taste 4.21, texture 4.07, and overall acceptance 4.29. Meanwhile, the highest aroma is found in the formulation of 75% nutmeg leaves and 25% nutmeg skin with a value of 4.01. In general, the combination of nutmeg leaves and nutmeg skin provides better sensory quality compared to the use of single ingredients. The formulation of 25% nutmeg leaves and 75% nutmeg skin is the best formulation.

Keywords: Herbal Drinks, Nutmeg Leaves, Nutmeg Skin, Sensory Test, Preference

INTRODUCTION

Introduction One of the significant nutmeg-producing regions in Indonesia is Lampung Province. Lampung is known as one of the largest nutmeg producers in Indonesia, especially in the Tanggamus and West Lampung regions. Nutmeg from this region has very good quality and has been exported to various countries. Nutmeg from Lampung, both in seed and skin form, is used in various processed products, including herbal drinks, due to its distinctive volatile compounds, such as myristicin and eugenol. Therefore, Lampung Province plays an important role in the development of herbal drinks based on nutmeg skin and leaves. Research on the sensory quality of this beverage based on local raw materials will provide further insights into the potential of the product in both local and international markets. Herbal drinks based on spices have been widely recognized in traditional medicine and are now evolving into commercial products processed to support health. The skin and leaves of nutmeg contain volatile compounds that give a distinctive taste and aroma. These volatile compounds can influence consumer preferences for herbal drink products. Previous research has shown that components such as myristicin and eugenol found in the skin of nutmeg fruit play an important role in providing a distinctive aroma to nutmeg-based herbal beverage products (Hartari et al., 2023). In developing herbal drinks based on nutmeg leaves and fruit skins, sensory testing becomes an important stage in determining consumer acceptance. The sensory characteristics that are generally tested include taste, aroma, color, and texture, all of which play an important role in determining product quality. Several studies show that differences in processing treatments such as cooking time, drying, or fermentation can alter the intensity of the resulting taste and aroma, which in turn affects consumer preferences. Therefore, systematic and structured sensory analysis can provide valuable insights in developing products that are more market-accepted.

The use of trained panelists in hedonic tests allows for the objective measurement of preferences toward various sensory attributes (Utomo et al., 2023). The level of consumer preference for spice-based herbal drinks, particularly nutmeg, highly depends on sensory factors that can be influenced by processing methods and ingredient composition. Research on herbal tea based on nutmeg skin shows that although there are variations in the intensity of taste and aroma, products prepared with proper processing techniques, such as non-excessive drying, can produce beverages with better sensory quality. Therefore, it is important to identify the optimal processing methods to enhance the sensory quality of nutmeg-based herbal beverages (Hartari et al., 2025). In addition to providing health benefits, nutmeg-based herbal drinks from Lampung have the potential to enhance market appeal thru superior sensory quality. Research on processed products from this nutmeg-producing region will greatly contribute to a deeper understanding of how sensory aspects, such as taste and aroma, can be enhanced. Proper processing and appropriate technology will produce high-quality products that not only have health benefits but are also favored by consumers due to their distinctive aroma and taste (Hair et al., 2024).

LITERATURE REVIEW

Nutmeg

Nutmeg (*Myristica fragrans*) is a spice that is widely known in Indonesia, with various health benefits it provides. Nutmeg contains bioactive compounds such as myristicin, eugenol, and safrole, which are known to have antioxidant, anti-inflammatory, and antimicrobial properties. In addition, nutmeg is also used in the herbal beverage industry due to its ability to enhance flavor and aroma, thereby giving a unique characteristic to the processed products. In the making of herbal drinks, all the seeds, skin, and leaves of

nutmeg contribute differently to the sensory quality of the final product, and therefore, the selection of the right part of the plant greatly affects the quality of the produced product. The use of nutmeg in herbal drinks not only provides health benefits but also enriches the flavor and aroma produced. Nutmeg has a distinctive aroma and a warm, slightly spicy taste, making it suitable as a base ingredient in various beverage products, such as herbal tea or beverage extracts. Several studies have identified that the use of nutmeg in herbal beverages can enhance consumer acceptance, especially when used in a balanced composition with other herbal ingredients. More in-depth research on the use of nutmeg, whether in extract form or as whole spices, can aid in the development of more diverse herbal beverage products that are more widely accepted in the global market (Rajan & Cherian, 2026).

Nutmeg Skin

Nutmeg skin, although often considered waste in nutmeg fruit processing, actually contains volatile compounds that are very important in providing flavor and aroma characteristics in herbal beverage products. Nutmeg skin contains compounds such as myristicin and eugenol, which provide a distinctive aroma known to be strong and warm. Nutmeg peel extract is also a natural flavor enhancer that is often used in the making of drinks with spices. Therefore, the utilization of nutmeg husk as a raw material in herbal beverage products is not only beneficial in reducing waste but can also enhance the economic value of the products. In addition to volatile compounds, nutmeg skin also contains a number of other active compounds that have health benefits, such as antioxidant and antimicrobial properties. Research shows that the use of nutmeg skin in herbal drinks not only provides benefits in terms of taste and aroma but also enhances the health properties of the product. Properly processed nutmeg skin can retain volatile compounds that positively contribute to the sensory quality of herbal drinks. Therefore, further research on optimal processing techniques for nutmeg skin is crucial to produce herbal beverage products with superior sensory profiles and maximum health benefits (Ashokkumar, 2026; Trifan et al., 2023).

Nutmeg Leaves

Nutmeg leaves (*Myristica fragrans*), although not as popular as its seeds, have great potential in the production of high-value herbal beverages. Nutmeg leaves contain active compounds such as myristicin, eugenol, and terpenoids, which are also found in its seeds and skin, playing a role in providing a distinctive taste and aroma. Compounds in nutmeg leaves are known to have health benefits, such as anti-inflammatory and antimicrobial properties, which can enhance the therapeutic efficacy of herbal drinks based on nutmeg leaves. Further research on the bioactive components in nutmeg leaves will open up opportunities to introduce more innovative herbal products to the market. Nutmeg leaves also offer flexibility in processing techniques to produce optimal products. Several studies show that nutmeg leaves can be used in the form of infusions or extracts to provide an additional refreshing aroma and a lighter taste compared to its seeds or skin. In the preparation of herbal drinks, nutmeg leaves not only provide health benefits but also offer a variation in terms of a more subtle taste and aroma. Proper processing of nutmeg leaves, such as drying and correct extraction, can maximize the active compound content within them. Therefore, the development of nutmeg leaf-based products has significant potential to be marketed as a healthy and refreshing herbal drink alternative for consumers seeking variety in spice-based products (Shyu et al., 2025).

Sensory Properties

Sensory or organoleptic properties, such as taste, aroma, color, and texture, play a key role in determining consumer acceptance of herbal beverage products. In herbal drinks based on *Myristica fragrans* (nutmeg), the components contained in the seeds, skin, and leaves of nutmeg significantly contribute to the sensory characteristics of the final

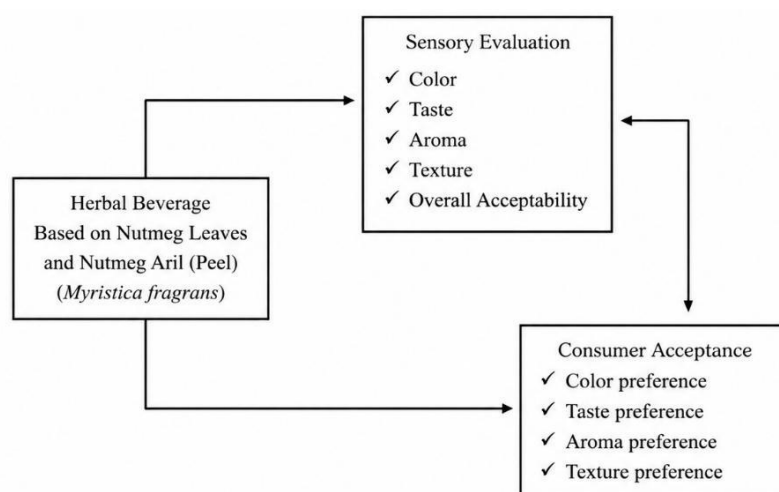
product. Volatile compounds such as myristicin and eugenol contained in nutmeg play a major role in producing a distinctive aroma, which affects how consumers perceive and evaluate the product. Hedonic sensory tests reveal that a strong aroma and balanced taste are very important for the acceptance of nutmeg-based herbal beverage products. In addition, the texture of the drink also plays an important role in sensory quality, especially in thicker herbal drinks or those containing spice extracts. Beside aroma and taste, the color of herbal drinks also affects consumers' perception of product quality. Well-processed nutmeg-based herbal drinks, such as those subjected to proper drying or extraction, produce an attractive and consistent color, which can enhance the sensory appeal of the product (Rumata et al., 2023).

Research Hypothesis

The sensory components of nutmeg leaves and fruit skins affect the quality and acceptance of herbal beverage products.

Conceptual Framework

The conceptual framework can be seen in Figure 1.



RESEARCH METHOD

This research was conducted at the Analysis Laboratory and Food Laboratory of Politeknik Negeri Lampung from February to May 2026. The equipment used in this research includes a dehydrator, analytical balance, oven, blender, steamer, drying equipment, as well as sensory testing tools such as evaluation sheets and pH testing equipment. The main materials used in this study are nutmeg leaves and fruit skins obtained from farmers in Tanggamus Regency, Lampung Province, as well as additional materials such as water, sugar, and natural preservatives. This study uses a Completely Randomized Block Design (CRBD) with three replications. The factor examined in this study is the proportion of nutmeg leaves and nutmeg fruit skin used in the preparation of herbal drinks, which consists of five formulation levels: 100% nutmeg leaves, 75% nutmeg leaves and 25% nutmeg skin, 50% nutmeg leaves and 50% nutmeg skin, 25% nutmeg leaves and 75% nutmeg skin, and 100% nutmeg skin. The data obtained from this study were then analyzed using descriptive statistics to determine the average test results obtained. After the herbal drink was produced, a sensory test was conducted to assess the color, aroma, taste, texture, and overall acceptance of the resulting product. The sensory test was conducted using a hedonic test, where a panel of 30 people was asked to evaluate their level of liking or disliking for the tested product. The evaluation was carried out using a 1-5 scale, which includes: very dislike (1), dislike (2), somewhat

like (3), like (4), and very like (5). This hedonic scale is used to measure consumer acceptance of the herbal drink based on nutmeg leaves and fruit peels, as well as to determine sensory differences between the tested formulations.

RESULTS

Herbal drinks based on nutmeg leaves and peels produced from five different treatments were tested for acceptance thru hedonic sensory analysis by 25 panelists. The testing includes color, aroma, taste, texture, and overall acceptance. The average data from the sensory tests can be seen in Table 1, and the tabulation of the sensory test results is presented in Table 2.

Table 1. Average Data of Sensory Test Results

Parameters	Repitition	100% Nutmeg Leaves	75% Nutmeg Leaves 25% Nutmeg Skin	50% Nutmeg Leaves 50% Nutmeg Skin	25% Nutmeg Leaves 75% Nutmeg Skin	100% Nutmeg Skin
Color	1	3.08	3.23	3.80	4.24	3.36
	2	4.03	4.11	3.90	4.23	3.91
	3	3.33	4.03	3.30	4.50	3.20
	Average	3.48	3.79	3.67	4.32	3.49
Taste	1	3.14	3.62	3.88	4.00	3.23
	2	4.23	4.02	3.69	4.28	3.22
	3	3.02	3.41	3.49	4.33	3.01
	Average	3.47	3.67	3.69	4.21	3.16
Aroma	1	3.45	3.71	3.90	3.83	3.24
	2	4.00	4.03	3.88	3.92	3.45
	3	3.12	4.29	3.08	3.97	3.57
	Average	3.52	4.01	3.69	3.92	3.42
Texture	1	3.73	3.82	3.51	4.40	3.45
	2	4.14	4.11	3.09	3.94	3.57
	3	3.47	3.56	3.97	3.88	3.12
	Average	3.78	3.83	3.52	4.07	3.38
Overall acceptance	1	3.36	4.04	3.60	4.20	3.59
	2	3.24	3.86	3.92	4.54	3.50
	3	3.20	4.12	3.92	4.12	3.40
	Average	3.27	4.01	3.81	4.29	3.50

Source: Primary data processed, Researcher (2026)

Table 2. Tabulation of Sensory Test Results Data

Formulation	Color	Taste	Aroma	Texture	Overall acceptance
100% Nutmeg Leaves	3.48	3.47	3.52	3.78	3.27
75% Nutmeg Leaves 25% Nutmeg Skin	3.79	3.67	4.01	3.83	4.01
50% Nutmeg Leaves 50% Nutmeg Skin	3.67	3.69	3.69	3.52	3.81
25% Nutmeg Leaves 75% Nutmeg Skin	4.32	4.21	3.92	4.07	4.29
100% Nutmeg Skin	3.49	3.16	3.42	3.38	3.50

Source: Primary data processed, Researcher (2026)

DISCUSSION

Color

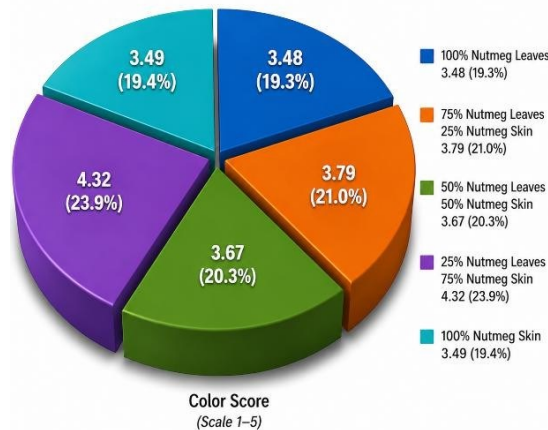
The color assessment results show that the difference in formulations of nutmeg leaves and nutmeg skin affects the color acceptance level of the product. The color values range from 3.48 to 4.32. The formulation with 25% nutmeg leaves and 75% nutmeg skin received the highest score, which is 4.32. This value indicates that this combination produces the most preferred color among the panelists compared to other formulations. The increase in the proportion of nutmeg skin tends to enhance the color value up to the formulation of 75% nutmeg skin. This is evident from the color value in the 100% nutmeg leaf formulation, which is 3.48, then increases to 3.79 in the 75% nutmeg leaf and 25% nutmeg skin formulation. The color value slightly decreases in the 50% nutmeg leaf and 50% nutmeg skin formulation, which is 3.67. However, the value clearly increases again in the 25% nutmeg leaf and 75% nutmeg skin formulation. The 100% nutmeg skin formulation received a score of 3.49. This score is almost the same as the 100% nutmeg leaf formulation, which is 3.48. These results indicate that using a single ingredient fully does not yield the most attractive color. The best color actually emerges from the combination of nutmeg leaves and nutmeg skin in the right proportions. In general, the formulation of 25% nutmeg leaves and 75% nutmeg skin is the best formulation based on color parameters. This combination is suspected to produce a more visually appealing color balance. The product color in this formulation is likely to appear stronger, more distinctive, and more easily accepted by the panelists. Conversely, the formulation of 100% nutmeg leaves and 100% nutmeg skin has a lower color acceptance level, making it less optimal if used as a single formulation. Thus, a higher proportion of nutmeg skin, when still combined with nutmeg leaves, can enhance the color quality of the product (Palijama, 2024).

This result indicates that the formulation of materials plays an important role in determining the visual appeal of the product. This indicates that the mixture of nutmeg leaves and nutmeg skin produces a better color balance and is more appealing to the panelists, considering the contribution of both ingredients that result in a brighter color than the dominant nutmeg skin. Overall, these results show that nutmeg leaves contribute more to the bright and vibrant color in herbal drinks, while nutmeg skin tends to give a darker and possibly more intense color. Therefore, a formulation that combines both ingredients could produce a product with a more attractive color that is well-received by consumers. To enhance consumer acceptance of the color of nutmeg-based herbal drinks, it is important to find a balance between these two ingredients in the product formulation. In addition, the selection of appropriate processing techniques, such

as not excessively drying nutmeg leaves or more careful processing of nutmeg skin, can

affect the desired color outcome (Alfiani et al., 2024; Spence, 2024). The average color scores in the sensory test of herbal drinks based on nutmeg leaves and fruit skins are presented in Figure 2.

Figure 2. Average Color Score in Sensory Test of Herbal Drinks Based on Nutmeg Leaves and Skin

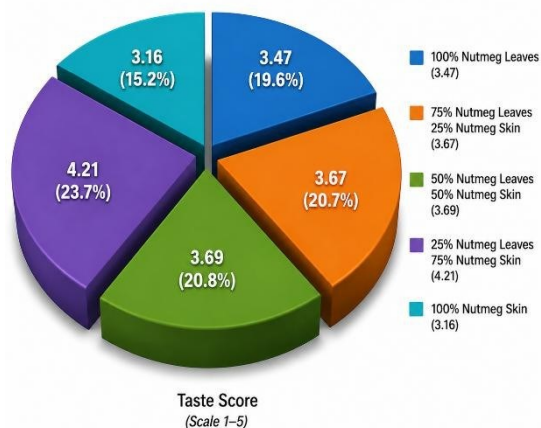


Source: Data Processed by Researcher (2026)

Taste

Based on the assessment results, the formulation of 25% nutmeg leaves and 75% nutmeg skin received the highest taste score. This formulation indicates that a higher proportion of nutmeg skin provides the most preferred taste by the panelists. The average taste scores in the sensory test based on nutmeg leaves and skins are presented in Figure 3.

Figure 3. Average Taste Score in Sensory Test of Herbal Drinks Based on Nutmeg Leaves and Skin



Source: Data Processed by Researcher (2026)

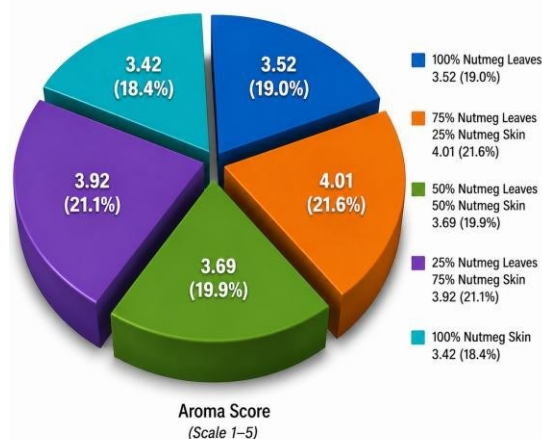
Other formulations, such as 75% nutmeg leaves and 25% nutmeg skin, received a score of 3.79, while 50% nutmeg leaves and 50% nutmeg skin received a score of 3.67. The formulations of 100% nutmeg leaves and 100% nutmeg skin had low scores, 3.48 and 3.49 respectively. This indicates that the use of a single ingredient does not produce an optimal flavor. Theoretically, the difference in taste acceptance can be explained by the chemical composition and bioactive compounds of each ingredient. Mace leaves contain aromatic compounds, essential oils, and flavonoids that impart a bitter taste and herbal aroma. Mace skin contains essential oils, lignans, and polyphenols that provide a sweet,

warm, and complex flavor. The combination of the two allows for the interaction of flavor compounds, so the bitterness of mace leaves can be balanced by the sweetness and warm aroma of mace skin. This phenomenon aligns with the theory of flavor synergy in food science, which states that the combination of ingredients with different chemical profiles can enhance sensory acceptance thru a balance of taste and aroma. Therefore, the formulation of 25% nutmeg leaves and 75% nutmeg skin produces the most optimal flavor because it creates a balance between the herbal aroma and the warm/sweet taste of the nutmeg skin, making it more accepted by the panelists (Kardas et al., 2024).

Aroma

Based on the average scores, treatments 2 has the highest value, which is 4.01, indicating that the aroma in the formulation represented by this treatments is the most preferred by the panelists. This high score signifies a strong, distinctive, and balanced herbal tea aroma between nutmeg leaves and nutmeg skin. Treatments 4 also has a relatively high average, 3.91, indicating a pleasant aroma, although slightly lower than treatments 2. Treatments 1 and treatments 3 have medium averages, 3.52 and 3.62 respectively. This indicates that the herbal aroma from the leaves and nutmeg skin is present, but not as strong or balanced as in treatments 2 and treatments 4. Treatments 5 has the lowest average, 3.42, indicating that the aroma of this formulation is less prominent or less preferred. The average aroma scores in the sensory test of herbal drinks based on nutmeg leaves and fruit skins are presented in Figure 4.

Figure 4. Average Aroma Score in Sensory Test of Herbal Drinks Based on Nutmeg Leaves and Skin



Source: Data Processed by Researcher (2026)

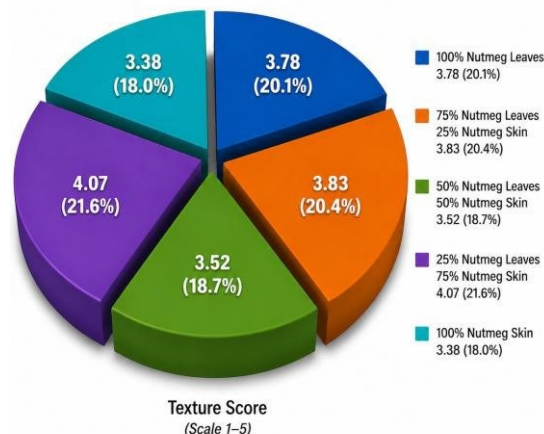
Theoretically, this difference in aroma can be explained by the volatile compound content in the leaves and skin of the nutmeg. Nutmeg leaves contain aromatic compounds and essential oils that give a fresh herbal aroma, while nutmeg skin is rich in essential oils and polyphenols that produce a warm and sweet aroma. The combination of both allows for the interaction of aromatic compounds, creating a more complex balance of herbal and warm aromas. The formulation represented in treatments 2 shows the optimal proportion of nutmeg leaves and skin for the aroma of herbal tea. This formulation produces the most accepted aroma by the panelists, while the treatments with a lower average indicates a formulation that needs to be adjusted to improve the aroma. The stronger aroma of nutmeg skin might overpower the milder aroma of nutmeg leaves, thereby reducing the sensory appeal of the drink (Aini et al., 2024).

Texture

Based on the texture value data, the formulation of 25% nutmeg leaves and 75% nutmeg skin received the highest score, which is 4.07. This indicates that a higher proportion of nutmeg skin provides the most preferred texture of herbal tea among the panelists. This formulation likely has a more balanced and comfortable chewiness or brew thickness on the palate. Other formulations such as 75% mace leaves and 25% mace skin received a score of 3.83, while 100% mace leaves received a score of 3.78. The formulation of 50% mace leaves and 50% mace skin had a score of 3.52, while 100% mace skin had the lowest score of 3.38. This pattern shows that using a proportion of nutmeg leaves that is too high or too low does not produce an optimal texture. Theoretically, this difference in texture can be explained by the fiber composition and the soluble solid content in the leaves and nutmeg skin. Nutmeg leaves tend to contain fine fibers that can make the brew feel lighter, while nutmeg skin contains coarser fibers and solid compounds that can add thickness and texture sensation. A combination of 25% nutmeg leaves and 75% nutmeg skin produces a balance between light and dense, resulting in the texture most accepted by the panelists. The formulation of 25% nutmeg leaves and 75% nutmeg bark shows optimal texture for herbal tea, while other formulations with extreme proportions of leaves or bark are less preferred. This data serves as the basis for determining the ideal composition of ingredients in the development of herbal tea based on nutmeg leaves and bark. A smoother and softer texture in herbal drinks based on nutmeg leaves can provide a more enjoyable drinking experience and be more accepted by consumers (Rosyidah et al., 2024). The average texture score in the sensory test of herbal drinks based on nutmeg leaves and fruit peels is presented in Figure 5.

Figure 5. Average Texture Score in Sensory Test of Herbal Drinks Based on Nutmeg Leaves and Skin

Source: Data Processed by Researcher (2026)

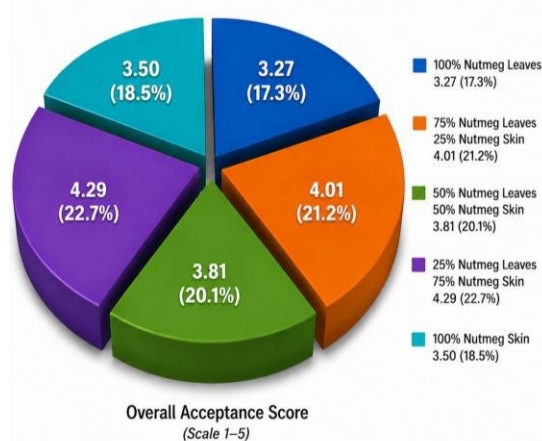


Overall Acceptance

Based on the graph and average values, treatments 4 has the highest value, which is 4.29. This indicates that the formulation represented by this treatments produces the most preferred herbal tea texture among the panelists. This formulation likely has a balanced brew between thickness and smoothness, providing a comfortable drinking sensation. Treatments 2 also has a high average, 4.01, indicating a texture that is quite liked, while treatments 3 has an average of 3.81, showing a moderate texture. Treatments 5 has an average of 3.50 and treatments 1 has the lowest average, 3.27, indicating a less optimal texture according to the panelists' assessment. Theoretically, this difference in texture can be explained by the fiber and solid compound content in the leaves and nutmeg skin. Nutmeg leaves tend to produce a lighter brew, while nutmeg skin provides a denser and more textured sensation due to its higher fiber and dissolved solid content. The right combination of proportions allows for a balance between light

and dense, resulting in a texture that is accepted by the panelists. formulation in treatments 4, which likely has a higher proportion of nutmeg compared to leaves, produces an optimal texture. Other formulations with extreme proportions of leaves or nutmeg show less preferred texture, so adjustments are needed to achieve the best texture quality in leaf and nutmeg-based herbal tea. This could be due to the harmonious combination of taste, aroma, color, and texture produced by the fresher and more natural nutmeg leaves (Aisyah et al., 2025; Puspasari et al., 2024). Formulations with a mixture of nutmeg leaves and nutmeg skin still manage to maintain a better level of acceptance compared to 100% nutmeg skin, although there is a decrease compared to drinks that are predominantly nutmeg leaves (Ervin & Marvell, 2023; Fidyasari et al., 2024; Nurmalasari et al., 2025). The average overall acceptance score in the sensory test of herbal drinks based on nutmeg leaves and skin is presented in Figure 6.

Figure 6. Average Overall Acceptance Score in Sensory Test of Herbal Drinks Based on Nutmeg Leaves and Skin



Source: Data Processed by Researcher (2026)

CONCLUSION

The formulation of 25% nutmeg leaves and 75% nutmeg skin stand out in almost all parameters. The highest values were observed in taste (4.32), texture (4.07), and aroma (4.01–4.29 depending on the column), indicating that this combination provides the most balanced sensory impression and is well-received by the panelists. The color also tends to be more appealing compared to formulations with a single proportion of either nutmeg leaves or nutmeg skin. Extreme formulations, such as 100% nutmeg leaves or 100% nutmeg bark, have lower values on most parameters, indicating that using a single ingredient does not produce optimal herbal tea quality. Theoretically, the success of the formulation with 25% nutmeg leaves and 75% nutmeg skin can be explained by the balance of chemical compounds: nutmeg leaves contribute herbal aroma and a light taste, while nutmeg skin adds warmth, complex aroma, and a denser texture. This combination produces a more harmonious drinking sensation and is well-received by the panelists. In addition to providing the best performance in sensory aspects, the formulation of 25% nutmeg leaves and 75% nutmeg skin also show consistency in the characteristics of herbal tea. The average values of all parameters support that this formulation is stable and does not cause fluctuations in taste, aroma, or texture that disrupt the drinking experience. This is important in product development, as sensory consistency becomes a key factor in consumer acceptance. From a product development perspective, this formulation also offers flexibility in presentation and processing. A higher nutmeg peel content can increase the dissolved solids content,

provide a more attractive brew color, and support a stronger aroma without overshadowing the flavor character of the nutmeg leaves. This combination allows producers to create a sensory-balanced herbal tea that is also visually appealing, thereby enhancing market appeal and the likelihood of higher consumer satisfaction

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DECLARATION OF CONFLICTING INTERESTS

The authors have declared no potential conflicts of interest concerning the study, authorship, and/or publication of this article.

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