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Organoleptic Test of Nutmeg Pulp Residue Tea (*Myristica fragrans* Houtt) As a Nutriceutical

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Abstract
Nutmeg (*Myristica fragrans* Houtt) is a native Indonesian spice, and its pulp is often discarded as waste after juice production. However, the residue still contains essential oils and active compounds such as flavonoids, phenols, and myristicin, which may benefit human health. This study aims to evaluate the potential of nutmeg pulp residue as a nutraceutical herbal tea through organoleptic testing, assessing aroma, taste, clarity, and color. The research employed a completely randomized design with three replications. Organoleptic and hedonic tests were carried out on 25 panelists using Friedman and Wilcoxon tests. Results showed that tea clarity scored highest in preference (3.72), followed by aroma (2.28), taste (2.18), and color (1.82). The nutmeg pulp tea was generally acceptable, although improvements in color and flavor intensity are needed. This innovation offers an ecological and economic solution for waste utilization, with potential for rural product diversification and health benefits.

INTRODUCTION

Tea is a type of beverage commonly consumed either cold with ice or in warm to hot conditions. It is one of the most widely consumed drinks in Indonesia due to its affordable price and refreshing taste (Maufrais *et al.,* 2018). Tea can be divided into two categories: herbal and non-herbal Non-herbal teas are further divided into three categories: black tea, green tea, and oolong tea (Zhang *et al.,* 2018; Poswal *et al.,* 2019).

Nutmeg (Myristica fragrans Houtt) is a native Indonesian plant originating from the Banda Islands of Maluku (Sasikumar, 2021; Kusuma *et al.,* 2023). Nutmeg seed fat is processed in the Banda Islands of Maluku, and this process is now carried out in Europe, where the product is traded as volatile oil of nutmeg for the manufacture of perfumes, soaps, sugar processing, and food. In Europe and the Middle East, nutmeg is processed into powder for cooking (Jordan, 2016).

Nutmeg pulp can be processed into pickles, preserves, marmalade, syrup, and nutmeg jam (Vuković *et al.,* 2022). Utilization of nutmeg pulp is limited to processing it into preserves and nutmeg juice, necessitating product development through diversification into primary products and also into processed products (Arnelia *et al.,* 2024).

Nutmeg juice production generates a substantial amount of unused residue, which is typically discarded as waste. Producing nutmeg juice requires approximately 40 kg of nutmeg

pulp every two weeks (Kaplale *et al.,* 2022; Gujar, 2023), resulting in about 20 kg of residual pulp. This pulp still possesses a strong aroma and is believed to contain numerous active compounds, making it a potential raw material for nutraceutical beverages.

Nutraceuticals are foods or drinks (or parts of them) that offer medical or health benefits (Kumar & Kumar, 2015). One of the health benefits of nutmeg pulp is its ability to alleviate sleep disorders and insomnia due to its myristicin content. Other active compounds found in nutmeg, such as flavonoids (Barman *et al.,* 2021; Malik *et al.,* 2022; Sultan *et al.,* 2023), phenols, terpineol, and essential oils, serve as antioxidants in food, medicine, and cosmetics. Nutmeg is also a source of important minerals like magnesium and calcium (Dhaslin *et al.,* 2019), which help reduce nervous tension and stimulate serotonin release, promoting a sense of relaxation or sedation.

The idea of utilizing nutmeg pulp residue to produce herbal tea represents a novel health innovation. Herbal tea is popular among the public due to its affordability, long shelf-life, quick preparation, and ease of use. The nutmeg pulp tea material is obtained from nutmeg pulp or nutmeg pulp in making nutmeg syrup or juice, but people do not yet know the technology for making nutmeg tea (Suryaneta *et al.,* 2023; Putra *et al.,* 2024; Anripa & Lone, 2024)

Ecologically, using nutmeg waste could help to cope with the environmental disposal issues related to nutmeg pulp. Educational outreach on environmental awareness could also motivate communities to utilize nutmeg pulp waste. Economically, diversified products such as nutmeg tea could provide new income opportunities for communities, as it has the potential to be marketed more widely. Rural-based processing industries are expected to drive regional economic growth by increasing employment, income, and overall community welfare (Plummer *et al.,* 2018).

This study aims to determine the organoleptic properties of nutmeg tea, including taste, color, and aroma. The long-term goal is to diversify nutmeg into a nutriceutical beverage, specifically nutmeg tea, which is beneficial for health.

RESEARCH METHODS

Research Time and Location

This study was conducted in June 2022 at the Basic Biology and Basic Chemistry Laboratory, Faculty of Mathematics and Natural Sciences, Pattimura University, Ambon.

Research Design

Organoleptic test research uses a response testing method to the color, aroma, clarity, and taste of nutmeg pulp tea on the respondent. The nutmeg pulp tea material is obtained from nutmeg pulp or nutmeg pulp in making syrup. The organoleptic test of nutmeg pulp tea used 25 respondents from Batu Merah village or nutmeg juice, aged 17 to 40 years. Previous research has not shown the use of nutmeg as tea; therefore, there needs to be innovation in making nutmeg tea.

Research Procedures

Preparation of Nutmeg Pulp Residue

The nutmeg pulp was washed with clean water, then peeled and split to separate the seed, aril, and skin. The pulp was subsequently cut into pieces measuring 0.2–0.3 cm and immersed in boiling water for 20 minutes. Drying was carried out using an oven at 60 °C for three days until dried nutmeg pulp was obtained. The dried material was then ground using a crusher and sieved with a 60-mesh screen to obtain a uniform particle size.

Preparation of Nutmeg Pulp Residue Tea

The preparation of nutmeg pulp residue tea began with the dried nutmeg pulp residue that had been ground and sieved. The residue was weighed according to the formulation requirements and then placed into filter paper tea bags or food-grade tea bags. Each tea bag was filled with a uniform amount of residue to ensure consistent quality. After the packaging process was completed, the tea bags were sealed and stored in an airtight container to maintain dryness and prevent contamination. The prepared nutmeg pulp residue tea can be brewed using hot water to produce a herbal beverage with a distinctive aroma and potential nutraceutical benefits.

Organoleptic Test of Nutmeg Tea

Organoleptic tests were conducted by observing shape, color, smell, and taste. The test lasted for three weeks using varying compositions of ginger rhizome additions and storage temperatures (room temperature and cold). The evaluated attributes included color, aroma, clarity, and taste, and observations were conducted weekly.

Hedonic Test

The hedonic test involved panelists providing their personal preferences for the product being evaluated. This test, also known as the preference test, was conducted using a 5-point scale ranging from 1 (very dislike) to 5 (very like), with attributes tested including color, aroma, and taste (Ministry of Health RI, 2020). The panelists' preference level was recorded numerically: 1 (very dislike), 2 (dislike), 3 (neutral), 4 (like), and 5 (very like) (Muchiri *et al*., 2022).

Panelists were treated as grouped data due to assumed heterogeneity. The ranking process involved the following steps: 1) arranging observation values from smallest to largest for each panelist; 2) assigning ranks from 1 to n; 3) for tied values, assigning average ranks; 4) repeating for all panelists (Wangiyana & Triandini, 2022)

Data Analysis

Organoleptic test results were analyzed using the non-parametric Friedman test at a 5% significance level. If significant differences were found, the Mann-Whitney test was conducted as a post-hoc analysis. All data were processed using SPSS 25.0 for Windows.

RESULTS AND DISCUSSION

This study involved 25 respondents from Batu Merah village. The level of community preference for nutmeg pulp tea (*Myristica fragrans* Houtt) as a nutraceutical is presented in Table 1.

Table 1. Average preference rankings by respondents from Batu Merah village toward nutmeg pulp tea (*Myristica fragrans* Houtt) as a nutraceutical.

Sensory Attribute	Average Rank
Color	1.82
Aroma	2.18
Taste	2.28
Clarity	3.72

The Friedman test produced a significance value of 0.000, which is less than 0.05. This indicates a significant difference among the sensory attributes. At least one of the variables, aroma, taste, color, or clarity, differed significantly in preference. The bar chart below illustrates the mean ranks: the lower the bar, the more preferred the attribute.

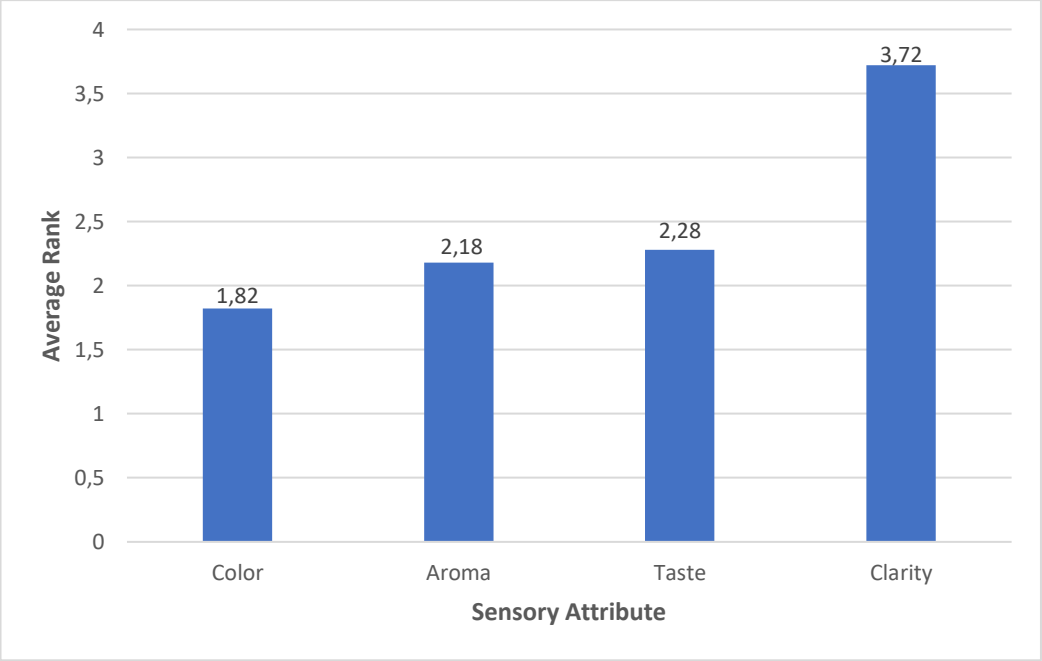

Figure 1. Preference rankings by respondents from Batu Merah village for nutmeg pulp tea (*Myristica fragrans* Houtt).

The preference ranking from most to least liked was clarity, aroma, taste, and color, as presented in Table 2.

Table 2. Friedman and the Mann-Whitney test results for pairwise comparisons among sensory attributes

Attribute Pair	Δ Mean Rank	Potential Significance
Color - Aroma	0.36	Possibly not significant
Color - Taste	0.46	Possibly not significant
Color - Clarity	1.90	Most likely significant
Aroma - Taste	0.10	Not significant
Aroma - Clarity	1.54	Likely significant
Taste - Clarity	1.44	Likely significant

Herbal tea is a brewed product derived from various plant parts, including leaves, stems, flowers, and fruits. Unlike traditional tea (*Camellia sinensis*), herbal tea is made from a wide range of plants, giving it unique characteristics. One of the main appeals of herbal tea is its health-promoting properties (Yang *et al.,* 2023). Recent developments include forest-based herbal teas, made from woody or shrubby forest plants, often harvested from pristine environments (Chamberlain *et al.* 2019).

Nutmeg is a forest plant mainly used for its seeds (Naeem *et al.,* 2016). However, due to limited technology, the pulp is often discarded. While mostly processed into syrup, juice, or candied nutmeg, the leftover pulp still contains bioactive compounds suitable for health-promoting products.

The data analysis supports the potential of nutmeg pulp tea as a healthy beverage. Organoleptic results ranked clarity as the most preferred attribute, followed by aroma and taste, with color being the least favored. The high clarity rating is due to optimal filtration and coarsely ground pulp, which results in a clear infusion. Particle size and tea bag quality also influence clarity. Larger particles may retain aroma and flavor, but poor filtration reduces clarity.

Nutmeg consists of pulp, seeds, and mace. Whole nutmeg seeds contain fat (30-55%) and solids (45-60%). Nutmeg seeds are ground into nutmeg powder, which contains essential oil (5-15%), fixed oil or butter (24-45%), and oleoresin (Khanam *et al.,* 2023). Nutmeg pulp, comprising 77.8% of the fruit, contains essential oils with monoterpene hydrocarbons (α-pinene, β-pinene), monoterpene acids, and aromatic ethers such as myristicin and safrole. The aroma, although reduced by prior syrup production, was still distinguishable and well-received. Enhancing the aroma could involve adding mace or whole nutmeg (Periasamy *et al.,* 2016). Taste received moderately good scores. Loss of flavor was likely due to prior syrup production. Moreover, raw nutmeg has an astringent taste due to tannins, which were reduced during juice extraction and drying.

Color plays a crucial role in food appeal. Visually, nutmeg pulp tea varies in color, ranging from colorless to pale yellow. Organoleptic test results show that color has the lowest value, as the pulp of the nutmeg fruit does not emit color, making nutmeg tea colorless. Enhancing its color with natural additives such as sappanwood extract can increase consumer acceptance. Sappanwood is rich in phenolics and enhances antioxidant activity, making it a functional additive (Arsiningtyas, 2021). In conclusion, nutmeg pulp tea was generally well-accepted. However, improvements in aroma, taste, and especially color are recommended. The product holds significant potential as a novel nutraceutical beverage.

CONCLUSION

Nutmeg pulp tea was well received, particularly for its clarity, followed by aroma and taste. Color received the lowest preference score, indicating the need for further refinement.

DECLARATIONS

Author Contributions

C. D. U. B and D. E. S designed and conducted the study, analyzed the data, and wrote the manuscript.

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Ethical Statement

This research has carried out ethical procedures for the use of living subjects in accordance with applicable provisions.

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