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Formulation Of A Natural *Mouth Spray* Containing Clove Flower Extract (*Syzygium aromaticum*) And Peppermint Leaf Essential Oil (*Mentha piperita* L.) As A Mouth Freshener

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ABSTRACT

Halitosis is an oral health problem that can reduce quality of life and self-confidence. The use of natural mouth sprays offers a promising alternative for maintaining oral freshness. Clove flower extract (Syzygium aromaticum) contains eugenol, which has antibacterial properties, while peppermint essential oil (Mentha piperita L.) contains menthol, which provides a refreshing sensation. This study aimed to formulate a mouth spray combining clove flower extract and peppermint essential oil and to evaluate its physical quality, stability, and panelist acceptance. This experimental study used four formulations: Blank Formulation (F0), Formulation 1 (F1), Formulation 2 (F2), and Formulation 3 (F3). The evaluation included organoleptic testing, pH measurement, spray pattern analysis, spray weight measurement, stability testing using a cycling test, and hedonic testing involving 31 panelists. Hedonic data were analyzed using the Friedman test, followed by pairwise Wilcoxon Signed-Rank tests with Bonferroni correction, while physical parameters were analyzed descriptively using mean ± standard deviation (SD). The results showed that all formulations met the evaluated physical quality parameters, with pH values ranging from 6.53 to 7.43. During the cycling test, the organoleptic properties remained unchanged, although a decrease in pH was observed, while the pH values remained within the acceptable range. The hedonic test revealed significant differences in panelists' acceptance among specific formulation pairs, with Formula 1 showing the highest mean acceptance scores across the six sensory parameters. Based on the study results, the combination of clove flower extract and peppermint essential oil was successfully formulated into a mouth spray with good physical quality and stability and has the potential to be developed as a natural mouth freshener.

Keyword: *mouth spray; Syzygium aromaticum; Mentha piperita L.; hedonic.*

Introduction

Oral health is closely related to general health and contributes to overall well-being and quality of life (PAULSON et al., 2025). Oral health disorders remain a public health issue in many countries, with the number of people affected estimated at 3.5 billion worldwide (WHO, 2022). In Indonesia, dental and oral diseases also remain a health issue requiring attention due to their relatively high prevalence (Kementerian Kesehatan RI, 2017). Various oral diseases, such as dental caries, periodontal disease, and halitosis, not only cause physical symptoms but also impact the psychological and social well-being of those affected (Kementerian Kesehatan RI, 2018). One of the most common oral health problems is halitosis, or bad breath. Halitosis is a condition characterized by an unpleasant odor resulting

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from the formation of volatile sulfur compounds (VSCs) produced by anaerobic bacteria in the oral cavity (Alshehri, 2016). Approximately 90% of halitosis cases originate in the oral cavity and are associated with plaque accumulation, poor oral hygiene, and periodontal disease (Akaji et al., 2014). About 90% of halitosis cases originate in the oral cavity and can be triggered by various factors, such as poor oral hygiene, plaque buildup, the use of dentures, reduced saliva secretion (xerostomia), smoking, consumption of strongly flavored foods, or certain medical conditions (Ketut et al., 2017). These conditions not only affect oral health but also have psychological and social implications, as they can reduce self-confidence and the quality of life of those affected (Akaji et al., 2014).

Various oral refreshers, such as mouthwash and mouth spray, have been developed to help treat halitosis. Mouth spray has the advantage of being more practical to use, easy to carry, and capable of providing a quick refreshing effect. However, most commercial products still contain synthetic ingredients such as chlorhexidine, preservatives, and artificial colors. Continuous use of synthetic ingredients has the potential to cause side effects, such as oral mucosal irritation, changes in taste sensation, and disruption of the oral microbiota balance (Thapa et al., 2016). Therefore, the development of natural-based oral fresheners is a promising alternative.

Cloves possess a distinctive aromatic scent associated with their essential oil content. Cloves are a traditional medicinal plant with antibacterial, anti-inflammatory, and antioxidant effects. (Huda et al., 2018) reported the antibacterial activity of clove flower extract against Staphylococcus aureus. Clove flower extract (*Syzygium aromaticum*) contains eugenol, which exhibits antibacterial, anti-inflammatory, and antioxidant activity. Eugenol has been reported to inhibit the growth of bacteria that cause oral diseases, such as Streptococcus mutans and Porphyromonas gingivalis (Elbestawy et al., 2023; Maggini et al., 2024). Previous evidence has indicated that clove and other essential oils may have potential in reducing intra-oral halitosis, supporting their potential use as active ingredients in oral care formulations (Dubar et al., 2023).

Mint leaves are classified as a medicinal plant and belong to the Lamiaceae family. Essential oil from mint (peppermint) can be extracted from all parts of the plant, particularly from plants that have begun to flower. Mint leaf essential oil contains the compounds menthol, menthone, methyl acetate, isomenthone, linalool, and lominen (Sústriková dan Šalamon, 2018). Phytochemical compounds found in mint leaves include terpenoids, steroids, phenols, flavonoids, alkaloids, and tannins. (Singh et al., 2015) reported that peppermint leaf essential oil exhibits strong antimicrobial and antioxidant properties. Peppermint essential oil (*Mentha piperita* L.) contains menthol and other volatile compounds that provide a refreshing sensation and demonstrate antimicrobial activity against bacteria causing halitosis

(Abdelrahman et al., 2024). Furthermore, the use of mint oil has also been reported to reduce the abundance of certain bacteria associated with halitosis and periodontal disease, thereby potentially supporting oral health and providing a greater sense of freshness. A study by (Pangesti et al., 2018) demonstrated that essential oils are effective in alleviating halitosis.

The combination of clove flower extract and peppermint essential oil has been reported to have potential as a natural active ingredient in mouth fresheners because it provides antibacterial effects while enhancing the sensation of freshness (Mudia Alti, 2023). Although the antibacterial activity of both clove flower extract and peppermint essential oil has been widely reported, research combining these two ingredients in a mouth spray formulation with a comprehensive evaluation of physical quality, stability, and panelist acceptance remains limited. Therefore, this study aims to formulate a mouth spray combining clove flower extract and peppermint essential oil, evaluate the physical quality and stability of the formulation, and determine panelist acceptance through hedonic testing.

Method

This study is a true experimental study aimed at formulating a mouth spray containing clove flower extract (*Syzygium aromaticum*) and peppermint essential oil (*Mentha piperita* L.), as well as evaluating the physical quality, stability, and panelists' acceptance of the resulting formulation. The study was conducted at the Laboratory of the Faculty of Pharmacy, University of 17 Agustus 1945, Jakarta, from February 2026 to June 2026. This study, which involved panelists, received ethical approval from the Health Research Ethics Committee (200/KEPK-UTA45JKT/EC/EXP/3/2026).

Preparation of Clove Extract and Peppermint Essential Oil

Clove flower extract was obtained through maceration using 70% ethanol at a ratio of crude drug to solvent of 1:10 (w/v) for 72 hours, then concentrated using a rotary evaporator until a thick extract was obtained (Lestari & Sari, 2021). Peppermint essential oil was obtained using the hydrodistillation method with a Clevenger apparatus for 3 hours in accordance with the procedures of the Indonesian Herbal Pharmacopoeia (Moghtader, 2013).

Formulation of Mouth Spray

The mouth spray formula is a modification of the mouthwash formula developed by (Mudia Alti, 2023). The mouth spray formulations were prepared using clove flower extract (*Syzygium aromaticum*) and peppermint essential oil (*Mentha piperita*) as the active ingredients. The total concentration of clove flower extract and peppermint essential oil was maintained at 1% in F1–F3, with varying

ratios of 0.25%:0.75%, 0.50%:0.50%, and 0.75%:0.25%, respectively. All formulations contained glycerin, propylene glycol, potassium sorbate, Tween 80, sodium hydroxide or citric acid as a pH regulator, and distilled water to a final volume of 100 mL.

Evaluation of Mouth Spray

The formulations were evaluated for organoleptic characteristics, pH, spray pattern, and physical stability using a cycling test method over six cycles at temperatures of 4°C and 40°C. Panelist acceptance was assessed through a hedonic test involving 31 panelists using a five-point hedonic scale that included evaluations of color, scent, taste, freshness, aftertaste, and comfort of use.

Statistical Analysis

The data were analyzed using IBM SPSS Statistics version 25. Normality was assessed using the Shapiro–Wilk test. Since the data were not normally distributed, the analysis continued using the Friedman test to determine differences among the formulas. For significant Friedman test results, pairwise comparisons were performed using the Wilcoxon Signed-Rank test with Bonferroni correction. Six pairwise comparisons were performed among the four formulations (F0–F1, F0–F2, F0–F3, F1–F2, F1–F3, and F2–F3), resulting in an adjusted significance level of $p < 0.0083$ (0.05/6).

The physical parameters, including pH, spray pattern diameter, and spray weight, were analyzed descriptively and presented as mean ± standard deviation (SD). No inferential statistical tests were applied to these physical parameters.

Result and Discussion

Physical Characteristics of Mouth Spray

1.1 Organoleptic Evaluation

The results of the organoleptic evaluation showed that all mouth spray formulations were liquid and had a distinctive peppermint scent combined with a clove scent. Differences in organoleptic characteristics were primarily evident in the color of the preparations. Formula F0 appears clear because it does not contain clove flower extract, whereas F1, F2, and F3 exhibit a yellowish-brown color with increasing intensity as the concentration of clove flower extract increases. During stability testing using the cycling test method, no changes in color, scent, or form were observed in any of the formulations, indicating that the preparations possess good organoleptic stability. These results suggest that the developed formulations are capable of maintaining their physical characteristics during storage under varying temperature conditions.

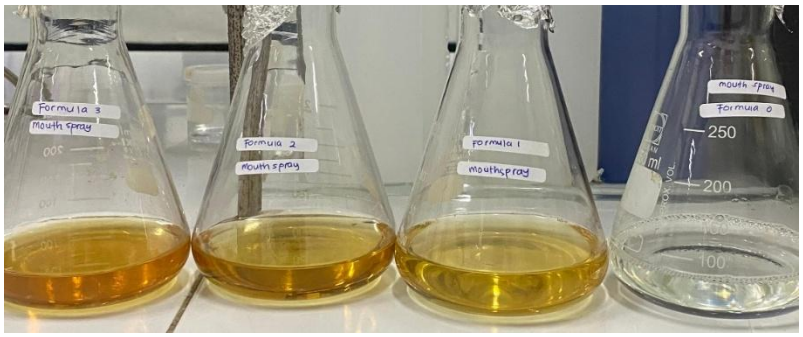


Figure 1. Formula F0, F1, F2, F3

Table 1. Organoleptic Evaluation Result

Formula	Color	Scent	Taste
Blanko	Clear	Odorless	Sweet glycerin
Formula 1	Bright yellow	The distinctive freshness of mint and a hint of aromatic cloves	Tends to be peppery with a hint of mint, slightly bitter with a hint of clove
Formula 2	Golden yellow	The distinctive freshness of mint and aromatic cloves	Fresh and slightly sweet, slightly bitter with a hint of clove
Formula 3	Brownish yellow or amber	Aromatic cloves and a hint of the distinctive freshness of mint	Tends to be bitter, slightly peppery with a hint of mint

1.2 pH Evaluation

The pH values of all formulations fall within the range of 6.53–7.43, which is within the physiological pH range of saliva and makes them safe for use in the oral cavity. This mouth spray formulation meets the requirements because the pH obtained falls within the physiological pH range of human saliva, which is 5.8–7.5, making the resulting mouth spray formulation safe for use (Kubala et al., 2018). The study results indicate that an increase in the concentration of clove flower extract causes a decrease in the formulation's pH value. This decrease is believed to be influenced by the content of phenolic compounds, particularly eugenol, as well as other acidic components present in the clove flower extract. Nevertheless, all formulations still meet the pH requirements for oral use and are therefore not expected to cause irritation to the oral mucosa.

Table 2. pH Evaluation Result

Formula	Result	Mean ± SD
Blanko	7.43	7.43 ± 0.006
	7.43	
	7.42	
Formula 1	7.14	7.15 ± 0.012
	7.14	
	7.16	
Formula 2	6.78	6.77 ± 0.012
	6.76	
	6.78	
Formula 3	6.54	6.53 ± 0.006
	6.53	
	6.53	

1.3 Spray Pattern and Spray Weight Evaluation

The spray pattern is one of the key factors in evaluating the quality of the sprayer used, and it is influenced by the characteristics of the formulation, particularly the viscosity of the preparation (Anung Anindhita et al., 2020). All

formulations produced an imperfectly round spray pattern, indicating a relatively even distribution of the formulation. The diameter of the spray pattern is influenced by the physical characteristics of the formulation, such as viscosity and surface tension. Based on the mean values, F2 produced the largest spray pattern diameter (3.37 ± 0.15), while F1 showed the smallest diameter (3.13 ± 0.06). Additionally, the spray weight varied among the formulations, with mean values ranging from 0.0487 ± 0.0046 g to 0.0637 ± 0.0065 g. These differences indicate variation in the spray volume produced by the pump system. Consistency in spray weight is essential to ensure uniform dosing with each use.

Table 3. Spray Pattern and Spray Weight Evaluation Result

Formula	**Spray Pattern**	**Diameter (cm)** **Mean ± SD**	**Weight (gram)** **Mean ± SD**
Blanko	Imperfectly round	3.23 ± 0.06	0.0587 ± 0.0053
F1	Imperfectly round	3.13 ± 0.06	0.0487 ± 0.0046
F2	Imperfectly round	3.37 ± 0.15	0.0637 ± 0.0065
F3	Imperfectly round	3.27 ± 0.06	0.0549 ± 0.0046

1.4 Stability Evaluation

The results of the cycling test showed that the organoleptic properties of all formulations remained unchanged after six cycles of alternating storage at low and high temperatures. However, a decrease in pH was observed in all formulations after the sixth cycle, while the pH values remained within the acceptable range. The unchanged organoleptic properties indicate that the mouth spray formulations exhibited good physical stability during the cycling test, although a decrease in pH was observed. These findings indicate that the combination of active ingredients and excipients was able to maintain the organoleptic properties of the formulations

despite fluctuations in storage temperature. The formulation can remain stable for 2–6 months if it remains stable after undergoing 6 cycles (Farid, 2021).

Table 4. Stability Evaluation Result



Figure 2. Results of the 6th Cycle Stability Test

Observation of the 6th cycle					
Formula	**Color**	**Scent**	**Taste**	**Initial pH (Mean±SD)**	**pH Cycle 6 (Mean±SD)**
F0	Unchanged	Unchanged	Unchanged	7.43 ± 0.0057	7.13 ± 0.01
F1	Unchanged	Unchanged	Unchanged	7.15± 0.0115	6.97 ± 0.0115
F2	Unchanged	Unchanged	Unchanged	6.77 ± 0.0115	6.61 ± 0.0058
F3	Unchanged	Unchanged	Unchanged	6.53 ± 0.0058	6.40 ± 0.0058

1.5 Hedonic Evaluation

The results of the hedonic test conducted on 31 panelists showed that the panelists' levels of preference differed for each mouth spray formula containing clove flower extract (*Syzygium aromaticum*) and peppermint essential oil (*Mentha piperita* L.). Evaluations were conducted on six parameters: color, scent, taste, freshness, aftertaste, and comfort of use. Overall, Formula F1 showed the highest mean acceptance scores across all six hedonic parameters, namely color, scent, taste, freshness, aftertaste, and comfort of use. However, pairwise comparisons showed that statistically significant differences were observed only for specific formulation pairs, as presented in Table 6.

Table 5. Hedonic Evaluation Result

No	Parameter	Formula			
		Mean ± SD			
		F0	F1	F2	F3
1	Color	4,03 ± 0,8750	4,42 ± 0,7648	4,00 ± 0,8563	3,52 ± 0,9957
2	Scent	3,35 ± 0,9146	4,26 ± 0,8932	4,06 ± 0,7718	3,93 ± 0,9286
3	Taste	2,77 ± 1,3591	4,00 ± 0,9309	3,84 ± 1,0984	3,61 ± 0,9549
4	Freshness	2,82 ± 1,1081	4,29 ± 0,7391	4,03 ± 0,7520	3,61 ± 0,9892
5	Aftertaste	2,77 ± 1,1750	3,71 ± 0,8244	3,45 ± 1,0276	3,29 ± 0,938
6	Comfort of use	3,42 ± 1,1768	4,13 ± 0,7634	4,10 ± 0,9075	3,83 ± 0,898

Statistical analysis using the Friedman test showed that there were significant differences in all hedonic parameters, including color ($p<0.001$), scent ($p<0.001$), taste ($p<0.001$), freshness ($p<0.001$), aftertaste ($p < 0.001$), and comfort of use ($p = 0.002$). Therefore, a Wilcoxon test with Bonferroni correction was conducted to identify pairs of formulas with significant differences.

Table 6. Pairwise Wilcoxon Signed-Rank Test Results with Bonferroni Correction

Parameter	Significant pairwise comparisons
Color	F1-F3; F2-F3
Scent	F0-F1; F0-F2
Taste	F0-F1; F0-F2; F0-F3
Freshness	F0-F1; F0-F2; F0-F3; F1-F3
Aftertaste	F0-F1; F0-F2
Comfort of use	F0-F2

Note: Significant pairwise differences are based on Bonferroni correction.

For the color parameter, Formula F1 received the highest likability rating because it produced a more appealing light yellow color compared to the other formulas. Formula F1 showed the highest mean acceptance score (4.42 ± 0.76). Pairwise analysis showed significant differences between F1 and F3 and between F2 and F3, while the other pairwise comparisons were not statistically significant after Bonferroni correction.

In terms of scent, Formula F1 also received the highest likability score because it achieved a balance between the distinctive scent of cloves and the fresh sensation of peppermint. Formula F1 showed the highest mean acceptance score for scent (4.26 ± 0.89). Significant differences were observed between F1 and F0 and between F2 and F0, whereas the other pairwise comparisons were not significant after Bonferroni correction.

For the taste parameter, Formula F1 was preferred because it produced a relatively balanced taste between sweetness, freshness, and the slight spiciness characteristic of cloves. The higher concentration of clove flower extract in Formulas F2 and F3 increased the intensity of the spicy and slightly bitter taste due to the eugenol content, thereby lowering the panelists' acceptance level. Formula F1 showed the highest mean acceptance score for taste (4.00 ± 0.93). Pairwise analysis showed significant differences between F1 and F0, F2 and F0, and F3 and F0. However, no significant differences were observed among F1, F2, and F3 after Bonferroni correction.

Regarding the freshness parameter, Formula F1 provided the most preferred sensation of freshness. This sensation stemmed from the menthol content in peppermint essential oil, which produced a cooling effect in the oral cavity. The reduced concentration of peppermint essential oil in Formulas F2 and F3 is believed

to have resulted in a less pronounced sensation of freshness. Formula F1 showed the highest mean acceptance score for freshness (4.29 ± 0.74). Significant differences were observed between F1 and F0, F2 and F0, F3 and F0, and F3 and F1. In contrast, the comparisons between F1 and F2 and between F2 and F3 were not statistically significant after Bonferroni correction.

Evaluation of the aftertaste showed that Formula F1 provided the most acceptable aftertaste because it did not leave an excessive spicy or bitter taste after use. In contrast, Formula F3 produced a stronger aftertaste due to the high concentration of clove flower extract. Formula F1 showed the highest mean acceptance score for aftertaste (3.71 ± 0.82). Significant differences were observed between F1 and F0 and between F2 and F0, whereas the other pairwise comparisons were not statistically significant after Bonferroni correction.

In terms of comfort of use, Formula F1 received the highest score because it offered the most balanced combination of color, scent, taste, freshness, and aftertaste, making it more comfortable to use than the other formulas. Formula F1 showed the highest mean acceptance score for comfort of use (4.13 ± 0.76). However, pairwise analysis showed a significant difference only between F2 and F0, while the other formulation pairs were not statistically significant after Bonferroni correction. Overall, the pairwise Wilcoxon analysis showed that not all formulation pairs differed significantly, indicating that the observed differences in panelists' acceptance were associated with variations in the clove flower extract–peppermint essential oil ratio.

Conclusion

Clove flower extract (*Syzygium aromaticum*) and peppermint essential oil (*Mentha piperita* L.) were successfully formulated into a natural mouth-freshening spray. All formulations met the evaluated physical quality parameters, including organoleptic properties, pH, and spray characteristics. During the cycling test, the organoleptic properties remained unchanged, although a decrease in pH was observed, while the pH values remained within the acceptable range. Variations in the ratios of clove flower extract and peppermint essential oil affected the sensory characteristics and panelists' acceptance of the formulations. Based on hedonic testing, Formula 1 showed the highest mean acceptance scores across the six sensory parameters, namely color, scent, taste, freshness, aftertaste, and comfort of use. Thus, the combination of clove flower extract and peppermint essential oil has the potential to be developed as a natural mouth-freshening spray.

Suggestion

Further research is needed to evaluate the antibacterial activity against bacteria that cause halitosis and to test the clinical effectiveness of the formulation in humans.

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