NurseLine Journal, November 2025, Volume 10(2): 105-111
Author: Titin Andri Wihastuti, Mayu Rahmayanti, Kumboyono Kumboyono
DOI: 10.19184/nlj.v10i2.53708
p-ISSN 2540-7937 | e-ISSN 2541-464X

INNOVATION IN HOLISTIC HEALTH PROMOTION FOR SMOKERS: DEVELOPMENT OF A LEMONGRASS (Cymbopogon citratus) ESSENTIAL OIL HERBAL INHALER

Titin Andri Wihastuti[1], Mayu Rahmayanti[2], Kumboyono Kumboyono[3]*
[1]*Department of Basic Nursing Science, Faculty of Health Sciences, Universitas Brawijaya, Malang, Indonesia*
[2]*Department of Pharmaceutical Science, Faculty of Medicine and Health Sciences, Universitas Islam Negeri Maulana Malik Ibrahim, Malang, Indonesia*
[3]*Department of Community Health Nursing, Faculty of Health Sciences, Universitas Brawijaya, Malang, Indonesia*

ABSTRACT

Background: Community nurses play a collaborative role in developing holistic complementary therapies for smoking cessation. Lemongrass (Cymbopogon citratus) essential oil, known for its anxiolytic properties, was formulated into a herbal inhaler as a candidate Nicotine Replacement Therapy (NRT) to complement psychological and behavioral interventions for smokers. **Objective:** This study aimed to evaluate smokers' acceptance of the lemongrass-based herbal inhaler as a potential NRT. **Methods:** Three inhaler formulations were developed, with lemongrass essential oil as the active ingredient. Stability testing was tested among 90 participants over a 4-week storage period, assessing homogeneity and power of Hydrogen (pH) levels. **Results:** Results indicated no significant differences in homogeneity or pH across the storage period, with p-values at week 0, 1, 2, 3, and 4 being 0.716, 0.754, 0.771, 0.710, and 0.674, respectively ($p > 0.05$). **Conclusion:** The findings demonstrate that the lemongrass essential oil herbal inhaler exhibits favorable physical stability and is well-accepted by smokers as a smoking cessation therapy.

Keywords: Cymbopogon citratus; Health promotion; Holistic care; Nicotine replacement therapy; Smoking cessation;

Corresponding author:
Name: Kumboyono Kumboyono
Affiliation: Department of Community Health Nursing, Faculty of Health Sciences, Universitas Brawijaya, Malang, Indonesia
email address: abu_hilmi.fk@ub.ac.id

Submitted:
08-06-2025
Revised:
13-10-2025
Accepted:
28-10-2025

BACKGROUND

Smoking cessation remains a global public health priority (Pipe et al., 2022), demanding interventions that address both physiological nicotine dependence and psychological withdrawal symptoms, such as anxiety and cognitive impairment (Abdelkader et al., 2024; Ghasemipour et al., 2021). Conventional Nicotine Replacement Therapy (NRT), including patches, gums, and inhalers, reduces cravings by delivering controlled nicotine doses but faces challenges such as mucosal irritation and low long-term adherence (Alshehri, 2024). These limitations highlight the need for non-nicotine alternatives that synergistically target physical and psychological withdrawal mechanisms.

Lemongrass (Cymbopogon citratus) essential oil emerges as a promising candidate due to its anxiolytic properties mediated via gama-aminobutyric acid type A (GABA) receptor modulation, which alleviates anxiety-a key relapse trigger (Hisaki et al., 2024). This mechanism aligns with the neurobiological interplay between GABA and nicotinic acetylcholine receptors (nAChRs), both implicated in nicotine addiction (Kumboyono et al., 2024; Wills et al., 2022). By targeting stress reduction and neurochemical pathways, lemongrass oil could complement NRT strategies while minimizing side effects.

Nasal inhalers offer a dual therapeutic route: pharmacological (systemic absorption) and psychological (olfactory stimulation). Olfactory stimuli directly activate brain regions linked to craving, such as the amygdala and orbitofrontal cortex, enhancing intervention efficacy (Lender et al., 2023). For example, beta-citronellol, a bioactive compound in lemongrass, may disrupt nicotine reward circuits while inducing calming effects through aroma (de Sousa et al., 2024). This aligns with holistic health promotion, emphasizing non-invasive, multisensory therapies.

Despite lemongrass's potential, existing research focuses on formulations like nanogels, overlooking inhaler-based delivery (Sindhu et al., 2022). Developing stable inhalers requires optimizing physicochemical parameters pH to ensure efficacy and user acceptability (Hickey & Stewart, 2022). This study evaluates the physical stability of a lemongrass oil inhaler in homogeneity and power of Hydrogen (pH) over a 4-week storage period among smokers. Findings will advance holistic NRT development, integrating pharmacological and sensory strategies to empower patient-centered care.

METHODS

This study employs a repeated measures design to evaluate the physical stability (homogeneity and pH) of an herbal inhaler formulation containing Lemongrass (Cymbopogon citratus) essential oil as a potential Nicotine Replacement Therapy (NRT). Three formulations with varying lemongrass oil concentrations were developed: Formula 1 (10%), Formula 2 (15%), and Formula 3 (20%), to assess the impact of composition on stability and user preference.

Participants were selected through stringent inclusion and exclusion criteria to ensure result validity and subject safety. Inclusion criteria comprised: active smokers aged above 18 years, smoking daily at least one year, no history of allergies to inhaler components (lemongrass essential oil, menthol), and absence of respiratory/nasal disorders (e.g., allergic rhinitis, nasal polyps). Exclusion criteria included: use of NRT or smoking cessation medications within the past 3 months (to avoid intervention interference), history of severe psychiatric disorders (major depression, schizophrenia), and pregnancy or breastfeeding. A purposive sampling method was applied to recruit participants from urban smoking communities. Awareness Campaign through digital posters and direct counseling at healthcare facilities identified potential candidates. Screening for candidates who underwent basic health checks and allergy testing: 90 smokers met the eligibility criteria. All participants provided informed consent detailing the study's purpose, procedures, risks, and benefits, adhering to biomedical ethics guidelines (Balkhy, 2024). Confidentiality and the right to withdraw were assured.

The inhaler formulation comprises lemongrass (Cymbopogon citratus) essential oil and menthol as its primary components. The manufacturing equipment employed in the preparation process included an analytical precision balance (Ohaus NV212), a dropper, a porcelain crucible, a mortar and pestle, and inhaler packaging units. The inhaler was prepared by homogenizing menthol via grinding, followed by gradual addition of lemongrass oil under continuous mixing. The homogeneous mixture was packed into inhaler devices.

Stability was assessed under room temperature storage (30±2°C) for a four-week period, with weekly monitoring of pH (using a calibrated pH meter; acceptable range: 4-7) and homogeneity (Li et al., 2023). Homo-

geneity was evaluated visually by participants for changes in odor, color, texture, and phase separation. A one-way ANOVA was performed to analyze pH variations across Formulas 1, 2, and 3.

Ethical approval for this research was granted by the Institutional Review Board (IRB) of the Health Polytechnic under the Ministry of Health, Malang, Indonesia (Approval No: DP.04.03/F.XXI.31/01104/2024). Written informed consent was acquired from all participants prior to their involvement, and all procedures strictly adhered to the ethical guidelines outlined in the Declaration of Helsinki and its subsequent revisions.

RESULTS

The smokers who participated in the lemongrass (Cymbopogon citratus) essential oil inhaler homogeneity test have the characteristics listed in Table 1.

Participants were engaged in this study to evaluate the homogeneity of lemongrass (Cymbopogon citratus) essential oil inhaler formulations. The inhaler formulation utilizes lemongrass (Cymbopogon citratus) essential oil as the primary active ingredient, combined with menthol. Homogeneity was evaluated by assessing visual and olfactory parameters (color, odor, physical form, and phase uniformity) of the formulations over a 4-week storage period (Table 2). Results demonstrated that all formulations (F1: 10%, F2: 15%, F3: 20%) retained stable physical characteristics, with no observable changes in color, odor, texture, or homogeneity throughout the study (Table 2).

Chemical stability, meanwhile, was assessed through weekly monitoring of the formulations' pH values over a 4-week storage period. Observational data revealed that all formulations maintained average pH levels within a narrow range of 5.33-5.57 (Figure 1), aligning with the safety criteria for liquid preparations (pH 4-7). Statistical analysis via one-way ANOVA confirmed no significant differences in pH values across the storage weeks ($p>0.05$), indicating stable pH profiles for all formulations (Figure 1).

DISCUSSION

The herbal inhaler formulation integrates pharmacological and psychological mechanisms to function as a holistic Nicotine Replacement Therapy (NRT). Lemongrass oil contains bioactive compounds such as citral and beta-citronellol, which bind to GABA receptors in the central nervous system, alleviating anxiety symptoms during nicotine withdrawal (Hartley & McLachlan, 2022). This mechanism directly targets psychological triggers of relapse in smokers. Psychologically, the aroma of lemongrass stimulates olfactory pathways, activating the amygdala and orbitofrontal cortex-brain regions involved in emotional regulation and smoking cravings (Sattayakhom et al., 2023).

This formulation mimics the sensory stimulation of smoking, reducing nicotine cravings without nicotine exposure. The inhaler combines the active ingredient (lemongrass oil) with a synergistic excipient (menthol). The inhaler combines the active ingredient (lemongrass oil) with a synergistic excipient (menthol) Lemongrass oil was selected for its proven anxiolytic properties in preclinical models, while menthol enhances inhalation comfort by providing a cooling effect and stabilizing the essential oil's volatility (Ashaq et al., 2024; Rojek et al., 2022). The combination ensures pharmacological efficacy and user-friendly design, which may improve treatment adherence.

Homogeneity testing over a four-week under ambient storage conditions confirmed that all formulations (F1-F3) remained homogeneous, with no phase separation, color changes, or precipitation. This stability was achieved through a stepwise formulation process: menthol was ground to homogeneity before adding lemongrass oil, ensuring consistent single-phase formation. This stability was achieved through a stepwise formulation process: menthol was ground to homogeneity before adding lemongrass oil, ensuring consistent single-phase formation. These findings align with a study on lemongrass oil-based aromatherapy balms, which reported similar 4-week homogeneity (Hsouna et al., 2023). Homogeneity is critical for dose consistency and therapeutic efficacy, particularly in inhalable formulations requiring precise active ingredient delivery. Homogeneity is critical for dose consistency and therapeutic efficacy, particularly in inhalable formulations requiring precise active ingredient delivery.

Figure 1 demonstrates that pH of lemongrass oil across formulations in normal range based on safety criteria for liquid preparation. Air-tight packaging minimized oxidation risks, preventing pH degradation (Alam & Sharma, 2023). The stable pH of lemongrass oil (neutral range) helps prevent nasal mucosal irritation associated

Table 1. Distribution of participant characteristics

Characteristic	Frequency (f)	Percentage (%)
Age (years)		
Mean ± SD	36.2 ± 10.5	-
Gender		
Male	63	70.0
Female	27	30.0
Smoking Duration		
Mean ± SD	12.4 ± 7.8 years	-
Cigarette Type		
Kretek (clove cigarette)	45	50.0
Filtered cigarettes	27	30.0
E-cigarettes	9	10.0
Others (cigar, pipe)	9	10.0
Nicotine Dependence (FTND)		
Low (score 0–3)	18	20.0
Moderate (score 4–6)	45	50.0
High (score 7–10)	27	30.0
Motivation to Quit (MTSS)		
Low (score 1–4)	18	20.0
Moderate (score 5–6)	36	40.0
High (score 7)	36	40.0

Table 2. Stability data of lemongrass oil inhaler formulations

Storage Period	Formula 1			Formula 2			Formula 3		
	R1	R2	R3	R1	R2	R3	R1	R2	R3
Week 0	Form: Liquid Color: Clear yellowish Odor: Strong lemongrass, weak menthol Homogeneity: Homogeneous			Form: Liquid Color: Clear yellowish Odor: Strong lemongrass, weak menthol Homogeneity: Homogeneous			Form: Liquid Color: Clear yellowish Odor: Strong lemongrass, weak menthol Homogeneity: Homogeneous		
Week 1	No changes observed.			No changes observed.			No changes observed.		
Week 2	No changes observed.			No changes observed.			No changes observed.		
Week 3	No changes observed.			No changes observed.			No changes observed.		
Week 4	No changes observed.			No changes observed.			No changes observed.		

with pH instability (Nguyen et al., 2024). A pH below 4 may cause irritation, while a pH above 7 risks impairing nasal cilia function, which is vital for foreign particle clearance (Katare et al., 2024). The formulation's neutral pH ensures mucosal tolerance, reducing side effects like dryness or inflammation commonly seen in conventional nicotine-based NRTs (Angellotti et al., 2022). Furthermore, it can be seen from the figure 1 that Formula 3 (20% lemongrass oil) had the highest pH among other formulations. It may suggest that the higher oil concentration potentially reduces smoking cravings via olfactory receptor stimulation. Higher lemongrass oil concentrations in F3 increase volatile compounds (e.g., citral, ?-citronellol), which activate olfactory receptors in the nasal

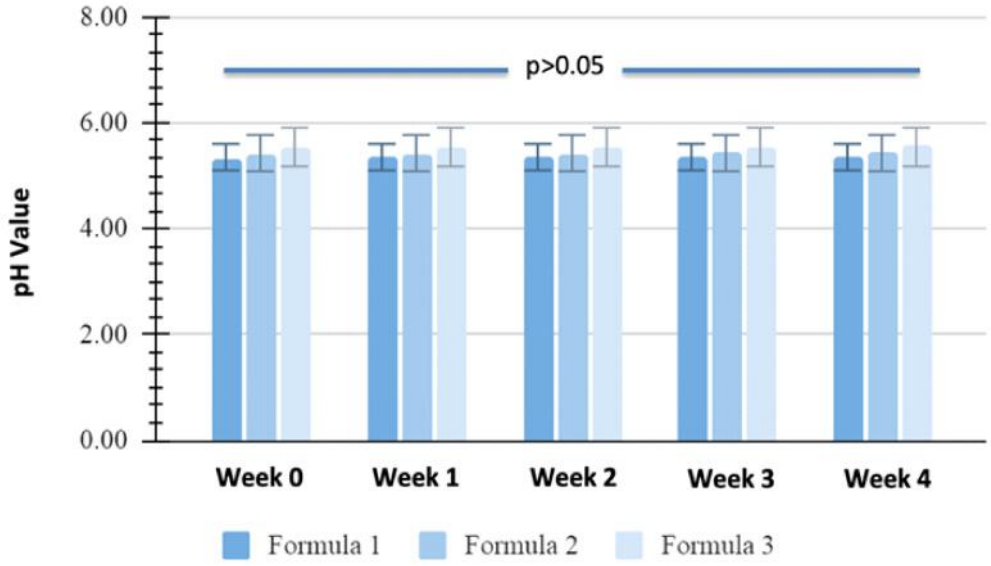

Figure 1. pH stability profile of lemongrass oil inhaler formulations

epithelium (Hartley & McLachlan, 2022). This stimulation triggers neural pathways to the amygdala and orbitofrontal cortex, modulating negative emotions like anxiety that drive relapse (Hand et al., 2024).

Menthol enhances user compliance by inducing a cooling sensation via TRPM8 receptor activation in the nasal mucosa, reducing irritation (Kokki & Kokki, 2022). The dual mechanism-olfactory the dual mechanism-olfactorystimulation from lemongrass and menthol's cooling effect-creates a sensory distraction therapy. The strong lemongrass aroma mimics smoking's sensory experience, substituting behavioral cues, while menthol's physical comfort minimizes inhalation discomfort.

Implications for Community Health Nursing

This innovation holds considerable promise for community translation, positioning the inhaler as a viable complementary strategy to augment smoking cessation efforts. Community nurses play a pivotal role in integrating evidence-based complementary therapies into holistic smoking cessation programs. They can educate the public on the benefits of lemongrass inhalers as non-nicotine NRTs, emphasizing their dual mechanisms: anxiety reduction and behavioral substitution through aroma stimulation. Education can be delivered via group workshops, social media, or individual counseling as part of tobacco harm reduction initiatives. Nurses may also advocate for community-based anti-smoking policies promoting herbal inhalers to enhance quit rates. Combining pharmacological and behavioral therapies holistically is expected to reduce relapse rates among smokers.

CONCLUSION

Based on the study findings, the lemongrass (Cymbopogon citratus) essential oil inhaler formulation demonstrates robust physical stability and is favored by smokers as a smoking cessation therapy. Its novelty lies in integrating pharmacological and psychological mechanisms, positioning it as a promising holistic Nicotine Replacement Therapy (NRT) candidate. However, further clinical validation is required to optimize its therapeutic potential and confirm efficacy in community settings.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the Faculty of Health Sciences, Universitas Brawijaya, for its financial support and extend sincere appreciation to all participants for their invaluable cooperation in this research.

Conflict of Interest

The authors affirm that no financial or personal conflicts of interest influenced the conduct of this research.

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