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Assessing The Effects Of Black Pepper (Piper Nigrum) Aromatherapy On Cigarette Consumption: A Double-Blind Randomized Controlled Trial

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ABSTRACT

Introduction: The global use of tobacco is becoming increasingly concerning. Nicotine addiction management now explores innovative options like aromatherapy. Black pepper (Piper nigrum) essential oil shows potential as an aid in smoking cessation.

Objective: This study aimed to evaluate the effects of black pepper aromatherapy on cigarette consumption and nicotine dependence.

Methods: Conducted as a double-blind randomized clinical trial at the Class II A Kerobokan Correctional Institution Clinic from July to September 2024, the study included smokers aged 12 years and older. Participants were randomly assigned to receive aromatherapy with either black pepper essential oil or plain water, with 30 participants per group. Weekly cigarette usage was self-reported, and nicotine dependence was measured using the Fagerström Test for Nicotine Dependence (FTND). SPSS version 25.0 was used for data analysis.

Results: At baseline, both groups were comparable in age, FTND scores, and cigarette consumption. Over four weeks, the black pepper group showed a significantly greater reduction in daily cigarette consumption, particularly in Week 4 ($p = 0.002$), compared to controls. Repeated measures ANOVA indicated a significant decrease in the black pepper group ($F = 80.022$, $p < 0.001$), with progressive reductions each week. FTND scores also significantly declined, with greater reductions in the black pepper group (mean difference = -1.300, $p = 0.004$). No serious adverse effects were reported.

Conclusion: Black pepper aromatherapy may aid in reducing cigarette use and nicotine dependence, supporting its potential as an adjunct in smoking cessation.

Keywords: black pepper, aromatherapy, smoking cessation, nicotine addiction

INTRODUCTION

The use of tobacco among teenagers globally and in Indonesia is becoming increasingly concerning. Data indicates that out of all smokers worldwide, 25 million are aged 13-15 years. WHO reports that approximately 6.4 million smokers are in Southeast Asia, the highest in the world, with Indonesia being the largest contributor. In Indonesia, teenage smoking rates have reached 19.2%.[1,2]

The 2018 Basic Health Research (Riskesdas) survey by the Indonesian Ministry of Health shows that the prevalence of smoking among teenagers aged 10-18 increased from 7.2% in 2013 to 9.1% in 2018, far from the 2019 target of 5.4%.[3] A 2023 study by Megatsari et al. found that 38.3% of young male smokers were active smokers, and 67% had a smoking history, with 39.1% smoking at least 2 cigarettes per day. High smoking rates in Bali and Indonesia demand serious attention from all parties.[4]

Nicotine addiction contributes significantly to high smoking rates. Nicotine influences the dopamine system, stimulating reward and learning processes, which lead to addiction.[5] Nicotine binds to neuronal nicotinic acetylcholine receptors (nAChRs), causing several neuronal adaptations due to chronic exposure, leading to withdrawal symptoms when nicotine is absent.[6,7]

Various strategies exist for managing addiction, including behavioural counseling, pharmacological therapy, and electronic cigarettes (e-cigs). Pharmacological options like varenicline, bupropion, and cytisine, collectively

known as Nicotine Replacement Therapy (NRT), are available.[8]Behavioural therapy enhances the success rates of smoking cessation when combined with pharmacotherapy. Full substitution therapy poses challenges for chronic smokers, leading to the theory of Harm Reduction and Product Replacement. E-cigs are effective as standalone or combined strategies with nicotine patches, showing no serious short-term side effects. Among alternative tobacco products, e-cigs receive significant attention for their potential to aid smoking cessation.[9]
Herbal ingredients in aromatherapy, such as Black Pepper, show potential for addiction management. Black Pepper reduces withdrawal symptoms, with significant reductions in anxiety-related somatic symptoms compared to control groups. The active component piperine offers various health benefits, supporting disease risk reduction in chronic smokers. A study found Black Pepper and angelica in aromatherapy reduced nicotine cravings, with Black Pepper providing more craving reduction and angelica extending time before the next tobacco use.[10,11]
To explore effective, minimally harmful addiction management options, this study aims to assess the impact of Black Pepper Plant Extract (Piper nigrum) in aromatherapy for e-cig and conventional cigarette users. This research offers new addiction management options through interdisciplinary collaboration and legal policy analysis in Indonesia. The goal is to understand the effect of Black Pepper Plant Extract in aromatherapy as a Nicotine Reduction Program in Addiction Management.

METHODS

Study Design and Participants

This study is a double-blind randomized clinical trial involving volunteers in a smoking cessation program conducted at the Class II A Kerobokan Correctional Institution Clinic. The intervention group received aromatherapy using Black Pepper Plant Extract (Piper nigrum) essential oil, while the control group received aromatherapy using plain water. To ensure blinding, both the participants and the researchers conducting assessments were unaware of group assignments. The intervention lasted for one month, with weekly face-to-face follow-ups and a final reassessment at the study's end
The study was conducted from July 2024 to September 2024, incorporating elements of psychiatry, agricultural technology, and legal studies. The accessible population comprised smokers registered in the smoking cessation program from January to August 2024. Inclusion criteria were smokers aged 12 years and older who were willing to use aromatherapy. Exclusion criteria included refusal to participate, severe mental disorders, addiction to other substances, and allergies to Black Pepper. Participants who discontinued aromatherapy before the study concluded were considered dropouts, though none of the participants dropped out of the study.

Measurements

Baseline characteristics were assessed for both the intervention and control groups. This included participants' age, FTND (Fagerström Test for Nicotine Dependence) scores, and cigarette consumption at the start of the study (week 1). Data was normally distributed according to the Shapiro-Wilk test, with no significant differences between the two groups in terms of age, baseline FTND scores, or initial cigarette consumption ($p > 0.05$).
Weekly assessments of cigarette usage were conducted using self-reported smoking diaries, where participants recorded the number of cigarettes smoked each day. This method allowed for continuous monitoring of smoking behaviour, providing insight into changes over the intervention period. FTND was administered by trained personnel during face-to-face meetings at the beginning and end of the study to measure changes in nicotine dependence.
Additionally, side effects related to the use of Black Pepper essential oil were documented throughout the intervention period. Participants were encouraged to report any adverse effects they experienced, allowing for a comprehensive evaluation of the intervention's safety.

Research Permit and Ethical Clearance

The research received a permit from the Bali Regional Office of the Ministry of Law and Human Rights of the Republic of Indonesia with the permit number W20.HH.04.04-9181. The study also received ethical approval from the Research Ethics Committee of the Faculty of Medicine, Udayana University, with the approval number 1944/UN14.2.2.VII.14/LT/2024, dated August 5, 2024. The study protocol number is 2024.002.1.0897. Written informed consent was obtained from all participants prior to enrollment. Participation was voluntary, and participants could withdraw from the study at any time without penalty.

Analysis

Data were analyzed using SPSS version 25.0. Univariate analysis was performed to describe sample characteristics, while bivariate analysis using the independent sample t-test assessed differences in smoking degree and nicotine dependence between the intervention and control groups. Additionally, repeated measures ANOVA was applied to evaluate the effect of the intervention on weekly nicotine use over the 4 weeks,

adjusting for relevant baseline variables such as age, FTND score, and cigarette consumption. No participants were lost to follow-up, so the final analysis included all 60 participants, with no missing data. A p-value of <0.05 was considered statistically significant.

RESULT

The study began with the assessment of 97 participants for eligibility. Of these, 37 were excluded from the trial, with 30 participants excluded due to drug addiction and 7 participants excluded due to severe mental disorders. This left 60 participants who were then randomized into two groups. The intervention group consisted of 30 participants who received black pepper aromatherapy, while the control group also included 30 participants but received aromatherapy without black pepper. Throughout the follow-up period, no participants in either group discontinued the study or were lost to follow-up. At the conclusion of the study, the analysis was conducted with all 30 participants in both the intervention and control groups, ensuring complete data for both groups (Figure 1).

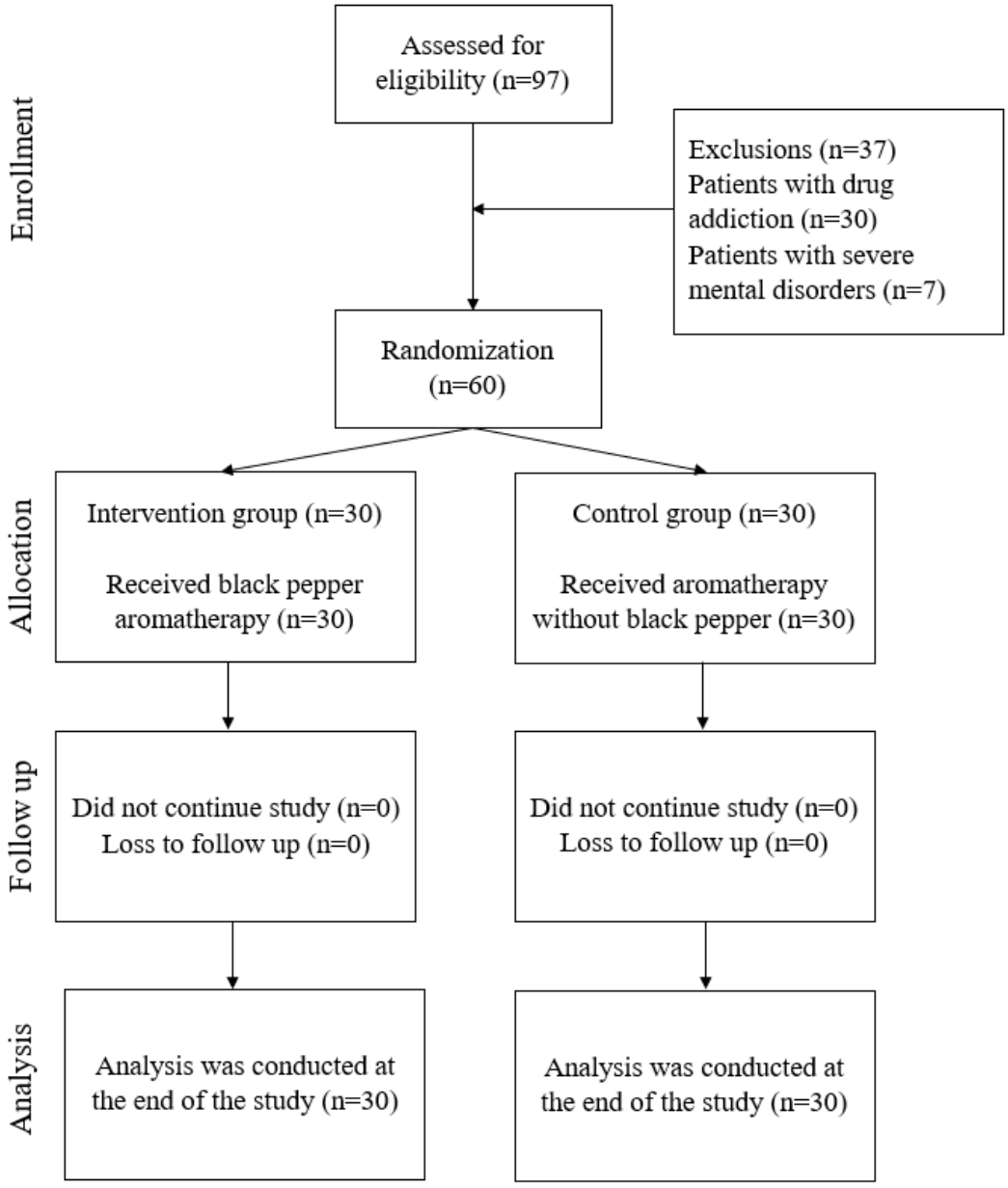

Figure 1. Consort flowchart

Baseline Characteristics

At baseline, there were no significant differences between the intervention group (aromatherapy with Black Pepper) and the control group (aromatherapy with plain water) in terms of age, nicotine dependence (FTND

score), or initial cigarette consumption during the first week. The data were normally distributed, as confirmed by the Shapiro-Wilk test ($p > 0.05$). The data in table 1 indicate that the groups were comparable at baseline with no statistically significant differences in any of the measured variables (using an independent t-test).

Table 1. Baseline Characteristic between Groups

Variable	Aromatherapy Black Pepper (Mean ± SD)	Aromatherapy Control (Mean ± SD)	pvalue	95% CI
Age (years)	39.87 (±7.22)	42.53 (±7.73)	0.173	(-6.53 – 1.20)
FTND Pre Score	6.37 (±1.47)	6.17 (±1.53)	0.608	(-0.57 – 0.97)
Cigarette Quantity Week 1	10.00 (±3.99)	9.37 (±3.75)	0.529	(-1.37 – 2.63)

Note: Mean ± SD: Mean and Standard Deviation for baseline variable, **p value:** Significance level from the independent t-test, $p < 0.05$, **95% CI:** 95% Confidence Interval of the mean difference between groups.

Smoking Reduction Over Time

Smoking behaviour was tracked over four weeks, and weekly mean cigarette consumption was compared between the intervention group (aromatherapy with Black Pepper) and the control group (aromatherapy with plain water) using independent sample t-tests. Table 2 presents the average number of cigarettes smoked in Week 2, Week 3, and Week 4 for both groups.

Table 2. Mean Daily Cigarette Consumption (± SD) After Intervention

Variable	Aromatherapy Black Pepper (Mean ± SD)	Aromatherapy Control (Mean ± SD)	P Value	95% CI
Week 2	8.42 (±3.70)	8.87 (±4.07)	0.644	(-2.47 – 1.54)
Week 3	7.10 (±3.09)	8.57 (±3.56)	0.094	(-3.19 – 0.26)
Week 4	5.77 (±2.16)t	8.17 (±3.46)	0.002*	(-3.89 – 0.91)

Note: Mean ± SD: Mean daily cigarette consumption and Standard Deviation, **pvalue:** Significance level from independent t test, $p < 0.05$,,**95% CI:** 95% Confidence Interval of the mean difference between groups,**(*):** Indicate statistically significant differences ($p < 0.05$)

As shown in Table 2, there was no significant difference in the number of cigarettes smoked between the two groups in Week 2 ($p = 0.644$) and Week 3 ($p = 0.094$). However, in Week 4, the intervention group showed a statistically significant reduction in daily cigarette consumption compared to the control group ($p = 0.002$), with a mean difference of -3.89 to -0.91 cigarettes. A significant difference in cigarette consumption between the groups was observed in Week 4 ($t(58) = -2.40$, $p = 0.002$, 95% CI: -3.89 to -0.91), indicating that participants in the Black Pepper aromatherapy group smoked significantly fewer cigarettes than those in the control group. The use of Black Pepper aromatherapy was particularly effective in the later stages of the intervention (Week 4), leading to a greater reduction in daily smoking compared to the control group receiving plain water aromatherapy.

In the Black Pepper aromatherapy group, a significant reduction in cigarette consumption was observed over time, with an F-value of 80.022 and a p-value of 0.000, indicating a statistically significant decrease in smoking behaviour across the 4 weeks. In comparison, the control group, which received plain water aromatherapy, also showed a reduction in cigarette consumption, though to a lesser extent, with an F-value of 11.983 and a p-value of 0.000. While both groups demonstrated reductions in smoking behaviour, the effect was more pronounced in the Black Pepper group as shown in Table 3.

Table 3. Analysis of Repeated Measure Annova and Post-Hoc Comparisons

Variable	Test	Mean Difference	SE	F	p value
Aromatherapy Black Pepper	Repeated Measures Annova	-	-	80.022	0.000
Post Hoc	Week 1 vs Week 2	1.600*	0.163	-	0.000
	Week 1 vs Week 3	2.900*	0.273	-	0.000
	Week 1 vs Week 4	4.233*	0.420	-	0.000
	Week 2 vs Week 3	1.300*	0.180	-	0.000
	Week 2 vs Week 4	2.633*	0.351	-	0.000
	Week 3 vs Week 4	1.333*	0.241	-	0.000
Aromatherapy Plain Water	Repeated Measures Annova	-	-	11.983	0.000
Post Hoc	Week 1 vs Week 2	0.500	0.234	-	0.245

	Week 1 vs Week 3	0.800*	0.246	-	0.018
	Week 1 vs Week 4	1.200*	0.206	-	0.000
	Week 2 vs Week 3	0.300	0.180	-	0.642
	Week 2 vs Week 4	0.700*	0.210	-	0.014
	Week 3 vs Week 4	0.400	0.149	-	0.070

Note: SE: Standard Error, **F**: F-statistic from the ANOVA test, **p value**: Significance level $p < 0.05$, **Post Hoc**: Pairwise comparisons between weeks to assess the specific timing of changes in cigarette consumption, **Repeated Measures ANOVA**: Assesses the effect of time on cigarette consumption within each group, **(*):**Indicate statistically significant differences ($p < 0.05$)

Post-hoc Bonferroni tests were conducted to identify specific weekly comparisons where significant differences occurred. In the Black Pepper aromatherapy group, significant reductions in cigarette consumption were observed across all weekly comparisons. The mean difference between Week 1 and Week 2 was 1.600 (p=0.000), between Week 1 and Week 3 was 2.900 (p=0.000), and between Week 1 and Week 4 was 4.233 (p=0.000), indicating a progressive and substantial reduction over time. Further, significant reductions were noted between Week 2 and Week 3 (mean difference = 1.300, p=0.000) and between Week 2 and Week 4 (mean difference = 2.633, p=0.000). Even the comparison between Week 3 and Week 4 showed a significant reduction (mean difference = 1.333, p=0.000). These findings suggest that Black Pepper aromatherapy consistently and significantly reduced cigarette consumption within each 1-week duration, with cumulative effects observed throughout the intervention.

In the control group, post-hoc Bonferroni analysis revealed fewer significant differences between weekly comparisons. Notable reductions were observed between Week 1 and Week 3 (mean difference = 0.800, p=0.018) and between Week 1 and Week 4 (mean difference = 1.200, p=0.000). Smaller reductions were also observed between Week 2 and Week 4 (mean difference = 0.700, p=0.014). In the control group, significant reductions in cigarette consumption only became evident after 2 weeks, whereas in the Black Pepper group, the intervention showed a measurable effect as early as the first week. This highlights that Black Pepper aromatherapy led to faster and more pronounced changes in smoking behaviour compared to the more gradual and limited impact observed with plain water aromatherapy.

Nicotine Dependence Reduction: FTND Score Changes in Each Group

The results of paired t-tests comparing FTND scores before and after treatment for both the intervention and control groups are shown in Table 4. In the intervention group, the mean FTND score decreased by 3.667 after the treatment, with a standard deviation of 1.493. The standard error of the mean was 0.273, and the 95% confidence interval ranged from 3.109 to 4.224. The t-value was 13.449 with 29 degrees of freedom, and the p-value was less than 0.001 ($p = 0.000$), indicating a statistically significant reduction in FTND scores after treatment.

In the control group, the mean difference in FTND scores before and after the control condition was 2.367, with a standard deviation of 1.847. The standard error of the mean was 0.337, and the 95% confidence interval ranged from 1.677 to 3.056. The t-value was 7.017 with 29 degrees of freedom, and the p-value was less than 0.001 ($p = 0.000$), indicating a significant reduction in FTND scores in the control group as well. Overall, both groups experienced significant reductions in FTND scores, but the intervention group showed a larger decrease compared to the control group, suggesting the intervention had a stronger effect.

Table 4. Paired t-test for FTND Score Changes in Each Groups

Variable	Pre-Test Mean (±SD)	Post-Test Mean (±SD)	Mean Difference	p value	CI 95%
FTND Score Control	6.17 (±1.53)	3.80 (±1.86)	2.37 (±1.85)	0.000	1.677 – 3.056
FTND Score Black Pepper	6.37 (±1.47)	2.70 (±1.46)	3.67 (±1.49)	0.000	3.109 – 4.224

Note: Mean ± SD: Mean FTND score and Standard Deviation, **FTND:** Fagerström Test for Nicotine Dependence, **p value:** Significance level from the paired t-test, $p < 0.05$, **95% CI:** 95% Confidence Interval of the mean difference between groups.

Nicotine Dependence Reduction: FTND Score Changes between Groups

The independent samples t-test (Table 5) compared the differences in Fagerström Test for Nicotine Dependence (FTND) scores between the Black Pepper aromatherapy group and the control group. Levene's test showed no violation of the assumption of equal variances ($F = 1.806$, $p = 0.184$), and the Shapiro-Wilk test confirmed normal data distribution ($p > 0.05$).

The t-test revealed a significant difference in FTND score changes between the groups (t(58) = -2.998, p = 0.004), with the Black Pepper group showing a greater reduction in nicotine dependence (mean difference = -1.300). The 95% confidence interval (-2.168 to -0.431) further supported the significance. These results indicate that Black Pepper aromatherapy was more effective in reducing nicotine dependence compared to the control group.

Table 5. Independent t-test for FTND Score Changes Between Groups

Variable	dF	t	Mean Difference	p Value	95% CI
FTND Score Changes Between Groups	58	-2.998	-1.300	0.004*	-2.168 – -0,432

Note: FTND Score Changes: Changes in scores on the Fagerström Test for Nicotine Dependence (FTND) between two groups (intervention and control), **dF: (Degrees of Freedom):** The degrees of freedom for the t-test (58), **t:** (t-statistic) The calculated t-value, **Mean Difference:**The average difference in FTND score changes between the two groups, **FTND:** Fagerström Test for Nicotine Dependence, **p value:** Significance level from the independent t-test, $p < 0.05$, **95% CI:** 95% Confidence Interval of the mean difference between groups.

Adverse Effects

Throughout the study, participants in the Black Pepper group were monitored for side effects related to the use of essential oil. No serious adverse effects were reported, and the intervention was generally well-tolerated by participants.

DISCUSSION

In this study, aromatherapy using black pepper was compared to a placebo (just water without aromatherapy) in individuals addicted to nicotine. Results showed a decrease in the number of cigarettes smoked in the black pepper group compared to the placebo group by the fourth week. A significant reduction was noted in the treatment group in the first week compared to the control group, which saw significant changes in the third week.

While existing tobacco cessation treatments like varenicline, nicotine replacement therapy, and clinician advice work for many, there's a need for novel treatments. New methods that lessen tobacco withdrawal symptoms can help more patients move into early remission. Black pepper has shown various beneficial effects, such as antimicrobial and anti-inflammatory properties, mainly in lab studies. However, in humans, black pepper has been investigated as a potential tobacco withdrawal treatment, with two small trials showing promising results. A 2013 study found participants experienced greater reductions in nicotine cravings after inhaling vaporized black pepper essential oil compared to angelica essential oil.[12,13]

In 2022, a case report detailed an individual using black pepper in condiment form to combat tobacco withdrawal, which was somewhat effective without leading to compulsive use. However, this method did not result in long-term tobacco abstinence. The patient reported that black pepper smoke produced sensations similar to tobacco, reinforcing the stimulating effects of cigarette puffing.[14] A 2020 study looked into the respiratory sensations and sensory-related cues associated with e-cigarette use among people who couldn't quit smoking traditional cigarettes using conventional medications but succeeded with e-cigarettes. It found that 91% of participants believed these sensations helped them stop smoking combustible tobacco cigarettes.[15]

The significant reduction in nicotine dependence, as measured by the Fagerström Test for Nicotine Dependence (FTND), aligns with earlier studies that have highlighted the benefits of black pepper in managing addiction. For example, research by Ashokkumar et al. (2021) demonstrated that piperine, a major alkaloid in black pepper, modulates neurotransmitter pathways, particularly dopamine, which is heavily involved in the addiction cycle. This effect could explain why participants in the black pepper group experienced both a decrease in cigarette consumption and nicotine dependence. Additionally, the results corroborate findings from previous studies examining the role of herbal ingredients in reducing nicotine cravings. For instance, a study involving black pepper and angelica oil found that black pepper provided more effective craving reduction. Our study similarly observed that black pepper aromatherapy leads to faster reductions in smoking behaviour compared to the control group.[16,17]

The efficacy of black pepper aromatherapy can be attributed to its ability to stimulate sensory receptors in the respiratory tract. Research has suggested that the inhalation of volatile compounds from black pepper can mimic the sensations associated with smoking, such as the feeling of warmth in the throat and chest. This could provide a placebo-like effect, helping to reduce the urge to smoke. Additionally, piperine's impact on dopamine receptors may reduce the intensity of nicotine cravings by modulating the brain's reward system.[18-21]

Despite the widespread application of the tool in the clinical and research area, the psychometric qualities of the questionnaire are still questionable. From this systematic review of various scientific papers published between 2000 and 2019, it can be seen that the FTND scores have found a weaker correlation with other smoking

questionnaires with moderate internal consistency. Similarly, a recent study from India based on the FTND among smokers with poly-drug abuse concluded that FTND had low internal consistency and reliability and suggested a two-factor structure of FTND based assessment.[12]

One strength of this study is the double-blind randomized controlled trial (RCT) design, which minimizes bias and increases the reliability of the findings. The use of weekly face-to-face follow-ups also allowed for accurate tracking of smoking behaviour and nicotine dependence over time. However, this study has several limitations. The relatively small sample size (n=60) may limit the generalizability of the findings, and future studies with larger sample sizes are needed to confirm these results. Additionally, while participants were smokers from a correctional facility, their unique environment may not fully represent the broader population of smokers, which could affect the external validity of the study.

Another limitation is the reliance on self-reported cigarette consumption, which is subject to recall bias. Although self-reporting is a common method in smoking cessation studies, objective measures, such as biochemical verification of smoking status (e.g., cotinine levels), would strengthen the study's conclusions.

Given the promising results observed in this study, future research should explore the long-term effects of Piper nigrum aromatherapy on smoking cessation, particularly in combination with other smoking cessation strategies, such as pharmacotherapy or behavioral counseling. Additionally, investigating the specific neurobiological mechanisms by which piperine affects nicotine cravings and dependence could provide deeper insights into its potential as a smoking cessation aid.

CONCLUSION

Black pepper (Piper nigrum) aromatherapy has a significant effect on reducing cigarette consumption and nicotine dependence among smokers. Over the four-week intervention period, participants in the black pepper aromatherapy group showed a progressive and more substantial decrease in both cigarette usage and nicotine dependence (measured by the FTND) compared to those in the control group. The results suggest that black pepper aromatherapy may serve as an effective, non-pharmacological aid in smoking cessation programs, with significant reductions in smoking observed as early as the first week of intervention. Moreover, the study highlights the potential of aromatherapy as a complementary strategy for managing nicotine addiction, offering an alternative with minimal side effects. These findings support the integration of black pepper aromatherapy into broader addiction management and harm reduction initiatives, particularly in regions with high smoking rates, like Indonesia.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest related to this study. All decisions related to study design, data collection, analysis, and publication were made by the research team to ensure the integrity and validity of the results.

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REFERENCES

1. Lian TY, Dorotheo U. The Tobacco Control Atlas: ASEAN Region, Fifth Edition. Southeast Asia Tobacco Control Alliance; 2021.
2. Menteri Kesehatan Repuublik Indonesia, World Health Organization and CDC. Global Youth Tobacco Surver Lembar Informasi Indonesia 2019. Geneva: World Health Organization; 2020.
3. Repositori Badan Kebijakan Pembangunan Kesehatan. Laporan Nasional Riskesdas 2018. Jakarta; 2019.

4. Megatsari H, Astutik E, Gandeswari K dkk. Tobacco advertising, promotion, sponsorship and youth smoking behaviour: The Indonesian 2019 Global Youth Tobacco Survey (GYTS). Tob. Induc. Dis. 2023;21:163.
5. Wittenberg, R.E., Wolfman, S.L., De Biasi, M., Dani, J.A., Nicotinic acetylcholine receptors and nicotine addiction: A brief introduction/ Neuropharmacology. 2020, 177: 108256.
6. Wang, J., Lindstrom, J..Orthosteric and allosteric potentiation of heteromeric neuronal 909 nicotinic acetylcholine receptors. British Journal of Pharmacology. 2018. 175(11):1805–1821.
7. Zoli, M., Pucci, S., Vilella, A., Gotti, C. Neuronal and Extraneuronal Nicotinic Acetylcholine Receptors. Current Neuropharmacology, 2018. 16: 338- 349.
8. Giulietti F, Filipponi A, Rosettani G. Pharmacological Approach to Smoking Cessation: An Updated Review for Daily Clinical Practice. High Blood Pressure & Cardiovascular Prevention. 2020. 27:349–362.
9. Palmer AM, Toll BA, Carpenter MJ, dkk. Review: Reappraising Choice in Addiction: Novel Conceptualizations and Treatments for Tobacco Use Disorder. Nicotine & Tobacco Research, 2022, 3–9.
10. Dib RE, Suzumura EA, Akl EA. Electronic nicotine delivery systems and/or electronic non-nicotine delivery systems for tobacco smoking cessation or reduction: a systematic review and meta-analysis. BMJ Open. 2017. 7:1- 21.
11. Ashokkumar K, Murugan M, Dhanya MK. Dkk. Phytochemistry and therapeutic potential of black pepper [Piper nigrum (L.)] essentialoil and piperine: a review. Clinical Phytoscience 2021. 7(52):1-11.
12. Cordell B, Buckle J. The effects of aromatherapy on nicotine craving on a U.S. campus: a small comparison study. J Altern Complement Med. 2013 Aug 1;19(8):709–13.
13. Dosoky NS, Satyal P, Barata LM, Kelly J, Da Silva R, Setzer WN. Phytochemistry and therapeutic potential of black pepper [Piper nigrum (L.)] essential oil and piperine: a review. Clinical Phytoscience 2021 7:1. 2021 Jun 9;7(1):1–11.
14. Weleff J, Dore S, Anand A, Barnett BS. Black Pepper (Piper nigrum) for Tobacco Withdrawal: A Case Report. Case Rep Psychiatry. 2022 Jan 1;2022(1):5908769.
15. DiPiazza J, Caponnetto P, Askin G, Christos P, Maglia MLP, Gautam R, et al. Sensory experiences and cues among E-cigarette users. Harm Reduct J. 2020 Dec 1;17(1). cules. 2019 Nov 21;24(23):4244.
16. Ashokkumar K, Vellaikumar S, Murugan M, Dhanya MK, Karthikeyan A, Akilan M, et al. Assessment of phytochemical diversity in essential oil composition of eighteen Piper nigrum (L.) accessions from southern India. Journal of Essential Oil Research. 2021;33(6):549–58.
17. Sharma MK, Suman LN, Srivastava K, Suma N, Vishwakarma A. Psychometric properties of Fagerstrom Test of Nicotine Dependence: A systematic review. Ind Psychiatry J. 2021 Jul;30(2):207.
18. Lim KH, Cheong YL, Sulaiman N, Yah XY, Mahadzir ME, Lim JH, et al. Agreement between the Fagerström test for nicotine dependence (FTND) and the heaviness of smoking index (HSI) for assessing the intensity of nicotine dependence among daily smokers. Tob Induc Dis. 2022 Nov 1;20(November):105.
19. Arslan Işık N. Aromatherapy and Quitting Smoking. Galician Medical Journal. 2020 Jun 30;27(2):E202022.
20. Mohanty R, Nayak R, Mohanty G, Das AC, Panda S. Smoking cessation: The aromatherapy way. Indian J Public Health Res Dev. 2019 Nov 1;10(11):1071–5.
21. Jang S, Park S, Jang BH, Park YL, Lee JA, Cho CS, et al. Study protocol of a pragmatic, randomised controlled pilot trial: clinical effectiveness on smoking cessation of traditional and complementary medicine interventions, including acupuncture and aromatherapy, in combination with nicotine replacement therapy. BMJ Open. 2017 May 1;7(5).