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Scavenger Tobacco Smoke: Survei Eksplorasi tentang Penggunaan dan Manfaat Kesehatan yang Dirasakan di Indonesia

Scavenger Tobacco Smoke: An Exploratory Survey on Usage and Perceived Health Benefits in Indonesia

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Abstrak

Tembakau telah dikenal sebagai tanaman obat selama ribuan tahun, namun asap rokok tembakau kini menjadi faktor risiko utama penyakit degeneratif akibat kontaminasi logam berat. Scavenger Tobacco Smoke (STS) dikembangkan sebagai solusi dengan menambahkan scavenger complex compounds, kombinasi antioksidan dan molekul scavenger yang menetralkan radikal bebas dan mengikat logam berat. STS menghasilkan partikel asap berukuran 70–100 nm, lebih kecil dibandingkan rokok konvensional, sehingga memiliki potensi sebagai terapi.Penelitian ini dilakukan untuk menggambarkan pola penggunaan STS di Indonesia melalui survei pada 209 responden dari November 2023 hingga Agustus 2024. Hasil menunjukkan 63% pengguna STS berasal dari Jawa Timur, dan 56% sebelumnya merokok rokok komersial. Alasan utama penggunaan adalah gaya hidup sehat "merokok dengan sehat" (57,1%) dan kondisi sakit (27,1%), termasuk kanker. Sebanyak 73% melaporkan peningkatan kebugaran dan 40% mengalami peningkatan kualitas hidup. Hasil ini menggambarkan bahwa meskipun persebaran STS masih tebatas dan mamiliki potensi untuk mengubah rokok menjadi lebih aman dan berpotensi sebagai agan terapi.

Kata kunci: *scavenger tobacco smoke*, senyawa kompleks pemulung, kualitas hidup, penyakit degenerative, obat herbal

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Abstract

Tobacco has been recognized as a medicinal plant for thousands of years; however, tobacco smoke is now a major risk factor for degenerative diseases due to heavy metal contamination. Scavenger Tobacco Smoke (STS) was developed as a solution by incorporating scavenger complex compounds, a combination of antioxidants and scavenger molecules that neutralize free radicals and bind heavy metals. STS produces smoke particles sized 70–100 nm, smaller than those of conventional cigarettes, offering potential therapeutic benefits. This study aimed to describe the usage patterns of STS in Indonesia through a survey of 209 respondents conducted from November 2023 to August 2024. The results showed that 63% of STS users were from East Java, and 56% were former commercial cigarette smokers. The primary reasons for use were a healthier lifestyle ("healthy smoking") (57.1%) and diseases reason (27.1%), including cancer. Additionally, 73% reported improved fitness, and 40% experienced enhanced quality of life. These findings highlight the despite limited distribution of STS and its potential to transform smoking into a safer and therapeutic option.

Keywords: scavenger tobacco smoke, scavenger complex compound, quality of life, degenerative diseases, herbal medicine

1 Introduction

Tobacco belongs to the Solanaceae family and has a long history of use among ancient civilizations. Since the 1st century BCE, the Maya civilization utilized tobacco in religious ceremonies and as a treatment for various ailments, ranging from wounds to digestive disorders. The spread of tobacco extended to regions such as Mexico through the migration of the Maya people [1]. In the 15th century, Christopher Columbus introduced tobacco to Europe, where it was referred to as a "sacred herb" believed to cure various diseases. By the mid-16th century, the medicinal use of tobacco was documented in European publications and became widely recognized in society [2,3].

Since the mid-20th century, tobacco has been identified as a major risk factor for degenerative diseases. The first retrospective study linking smoking habits to lung cancer was published in 1950. Further studies by Hammond and Horn confirmed that smoking-related mortality increased proportionally with the number of cigarettes consumed [4,5].

Meanwhile, the high levels of environmental pollution due to industrialization have exposed tobacco to harmful heavy metals, such as cadmium (Cd), zinc (Zn), and mercury (Hg). As a bioaccumulator, tobacco has the ability to absorb heavy metals from soil and air, and the levels of heavy metals accumulated in tobacco can even exceed those in the surrounding soil medium [6,7]. A research by Suszcynsky and Shann (1995) demonstrated that tobacco exposed to elemental mercury vapor (Hg^0) and ionic mercury (Hg^{2+}) in soil significantly accumulates these heavy metals in its leaves and roots, causing tissue damage and increased production of reactive oxygen species (ROS) [8]. The heavy metal contamination in tobacco contributes to the high levels of harmful substances in cigarette smoke, which are known to play a critical role in elevating carcinogenic risk and the incidence of various degenerative diseases [9].

In response to the hazards of conventional tobacco, Scavenger Tobacco Smoke (STS) was developed as an innovation to mitigate tobacco's harmful effects. STS integrates antioxidants and scavenger compounds, such as amino acids, that can neutralize oxidative stress and bind heavy metals

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(scavenger complex compounds), it reduces tobacco toxicity [10,11]. Antioxidants play a role in neutralizing free radicals formed during Fenton reactions, which produce hydroxyl radicals (•OH), as well as other radicals such as carbon-centered radicals, phenoxyl-type radicals, and alkoxyl radicals generated during the pyrolysis phase of tobacco combustion (below 450°C) [12].

Furthermore, the addition of antioxidants enhances molecular breakdown efficiency during pyrolysis, resulting in more complete molecular fragmentation. For instance, cellulose can break down into levoglucosan and furanose isomers, while lignin yields monomers such as coumaryl, vanillyl, and syringyl, which have potential as beneficial active compounds [13,14]. Amino acids such as histidine, cysteine, aspartic acid, and glutamic acid, added as scavenger compounds, act as metal chelators due to their functional groups in side chains, forming stable bonds with metal ions and preventing free interaction of metals with other molecules [15]. The addition of antioxidants and scavenger compounds significantly reduces the intensity of free radicals and the heavy metal content in cigarette smoke. This reduction has been demonstrated through Electron Spin Resonance (ESR) analysis, showing lower free radical intensity after the addition of antioxidants [16].

Additionally, the ultrafine particles produced by STS, measuring approximately 70–100 nm, improve solubility and penetration of active tobacco compounds into damaged tissues (targets), enabling more efficient and targeted therapeutic applications [17]. This characteristic contrasts with conventional cigarette smoke, which produces particles ranging from 100–1000 nm [18].

With this innovation, STS is expected to serve as a safer alternative with therapeutic potential, offering a complementary solution to reduce tobacco toxicity and enhance public health. Previous studies have highlighted the promising health benefits of STS, including regulating the immune system and preventing carcinogenesis, particularly in nasopharyngeal and colorectal cancers [11,19]. In addition, STS has been reported to improve the quality of life for individuals with degenerative diseases [20]. In Indonesia, the development of STS began about two decades ago, and it has since been consumed by certain segments of the general population. However, there is none of documentation about the usage record of STS consumed, therefore, this study aims to explore user characteristics, consumption patterns, and perceptions of STS in Indonesia, providing insights into the potential broader application of this technology.

2 Research Methods

This study was a cross-sectional survey design conducted from November 2023 to August 2024. The survey targeted only Scavenger Tobacco Smoke (STS) users with a minimum usage duration of one month. Data were collected using a structured questionnaire available both online and in-person. The questionnaire was designed to gather information on demographics, reasons for use, usage habits, health conditions, and perceptions of quality of life after using STS. Before completing the questionnaire, all respondents were required to provide informed consent, and all data collected were used exclusively for research purposes. From the population of STS users, 209 individuals self- reported their participation in the survey (204 from online respondents and 5 from offline respondents). The collected data were grouped and analyzed statistically. Descriptive statistical from mean analysis was conducted to summarize user demographics, STS usage patterns, and to examine the frequency of reported reasons for use and perceived benefits. The descriptive analysis results were presented in the form of text, tables, and graphs. This study obtained ethical approval from the Health Research Ethics Committee, Faculty of Medicine, Universitas Islam Malang, with approval number 078/LE.003/XI/01/2023.

3 Results and Discussion

Socio-demographic Respondents

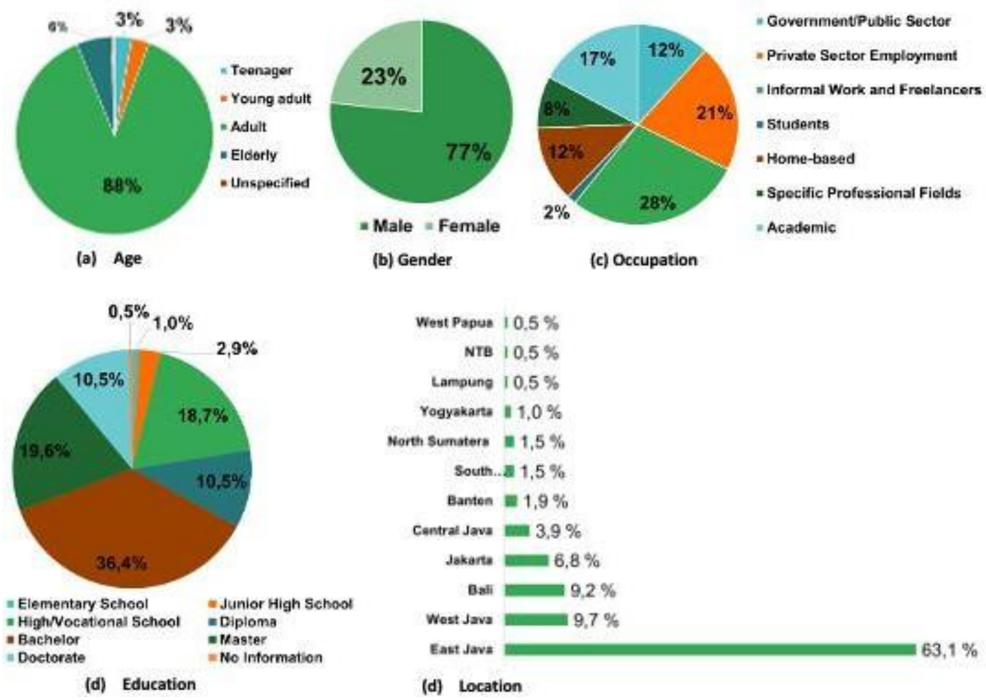

Figure 1 Socio-demographics depict STS usage patterns. The condition of respondents according to (a) age (b) gender (c) occupation (d) education (e) location

According to Figure 1, the profile of STS users provides valuable insights. The majority of respondents were adults (88%), with a higher proportion of females (77%) compared to males (23%). In terms of occupation, the largest proportion of respondents worked in the informal and freelance sectors (28%), followed by those in the private sector (21%) and academic (17%). Respondents employed in government, household, and specific professional fields represented smaller proportions. Regarding education, most respondents had attained higher education degrees, including bachelor's (36.4%), master's (19.6%), doctoral (10.5%), and diploma degrees (10.5%). Respondents with secondary and primary education levels made up a smaller proportion. Geographically, the majority of respondents were from East Java Province (63.1%), with smaller proportions from other provinces such as West Java (9.7%), Bali (9.2%), Jakarta (6.8%), Central Java (3.9%), and other regions with lower representation.

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History, habits, and patterns of STS consumption

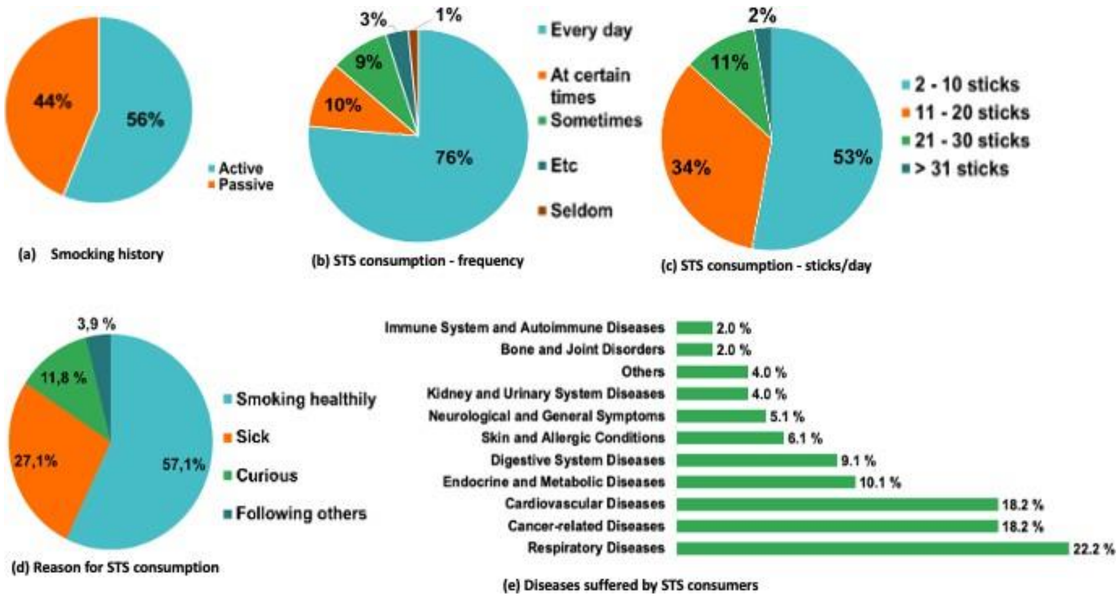

Figure 2 History, habits, and patterns of STS consumption. The condition of respondents by (a) smocking history (b) frequency (c) consumption-sticks/day (d) reason (e) diseases suffered by STS consumers

According to Figure 2, the majority of respondents had a history of active smoking (56%), while the remainder were passive smokers (44%). Most respondents reported consuming STS daily (76%), followed by at certain time (10%), sometimes (9%), other frequencies (3%), and seldom (1%). The most common daily STS consumption was in the range of 2–10 cigarettes (53%), followed by 11–20 cigarettes (34%), 21–30 cigarettes (11%), and more than 31 cigarettes (2%).

The primary reason reported for consuming STS was the perception of healthier smoking (57.1%), reflecting a belief that STS offers a safer alternative to conventional cigarettes. Other motivations included curiosity (27.1%), sick (11.8%), and social influence (3.9%). Among STS consumers with existing illnesses, the reported conditions included respiratory disorders (22.2%), cancer-related diseases (18.2%), cardiovascular diseases (18.2%), and metabolic or endocrine disorders (10.1%). Other conditions included digestive issues (9.1%), skin allergies (6.1%), neurological disorders (5.1%), and kidney or urinary tract disorders (4%).

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Health outcomes and quality-of-life improvements

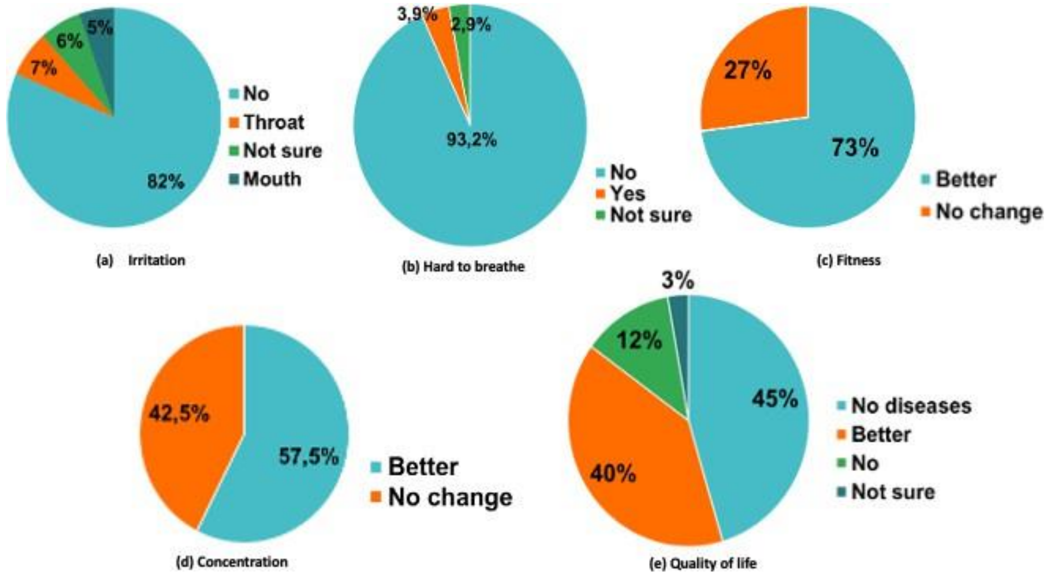

Figure 3 Health outcomes and quality-of-life improvements. The respondents feeling after consuming STS (a) irritation (b) hard to breath (c) fitness (d) concentration (e) quality of life

Figure 3 shows that most respondents reported positive impacts of STS usage on their health and quality of life. A total of 82% of respondents did not experience irritation, while 7% reported throat irritation, 6% were unsure, and 5% reported mouth irritation. Additionally, 93.2% of respondents stated they did not experience breathing difficulties after using STS, although a small proportion (3.9%) expressed uncertainty, and 2.9% reported experiencing breathing difficulties. In terms of fitness, the majority of respondents (73%) felt an improvement, while 27% did not notice any change. Regarding concentration, 57.5% of respondents reported improvements, whereas 42.5% indicated no change. Concerning overall quality of life, 40% of respondents felt it had improved, while 40% did not perceive any changes as they were not experiencing of diseases. Meanwhile, 12% expressed uncertainty, and 3% reported no significant health or disease-related benefits. These findings suggest that the majority of STS users have a positive perception of the product's effects, particularly regarding comfort, fitness, and concentration. Overall, this data indicates that STS has the potential to enhance health and quality of life.

Claim and recommendation

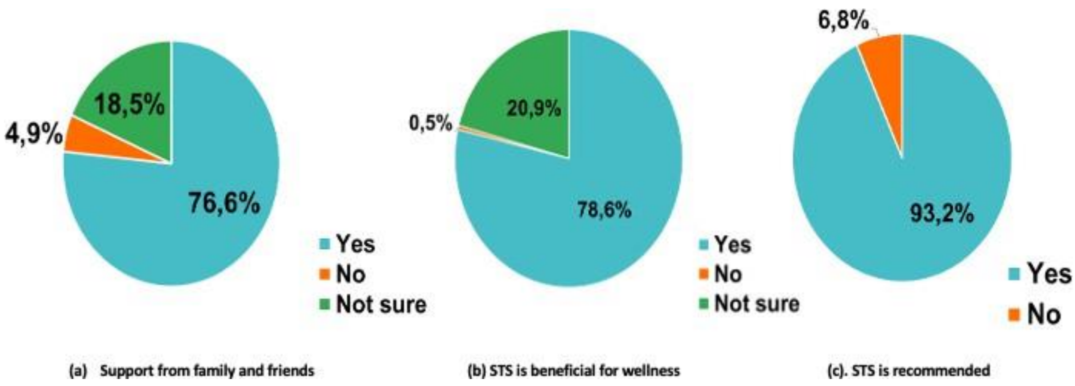

Figure 4 Claim and recommendation. The claim and recommendation of respondents after consuming STS (a) support from family and friends (b) beneficial for wellness (c) recommendation

Based on Figure 4, the majority of respondents (76.6%) reported receiving support from family and friends regarding their STS use, indicating a positive social acceptance of STS consumption within their social environments. However, 18.5% of respondents were uncertain about receiving support, and 4.9% stated that they did not receive any support. This social support plays a significant role in the continuity of STS usage, as it helps users feel validated in their decision. Additionally, 78.6% of respondents felt that STS was beneficial for their well-being, reflecting a generally positive perception of the product. However, 20.9% were uncertain about its benefits, and only 0.5% stated that they did not perceive any benefits. This uncertainty may stem from a lack of prolonged experience or limited information about STS.

The majority of respondents (93.2%) expressed a willingness to recommend STS to others, indicating a high level of satisfaction with the product. Those recommending STS likely believe the product offers tangible benefits, such as improved fitness or well-being. Nonetheless, 6.8% of respondents reported that they would not recommend STS.

The findings of this study provide valuable insights into the profile of Scavenger Tobacco Smoke (STS) users in Indonesia. The majority of respondents were adult females with higher education levels, indicating that this group is more open to innovations and demonstrates greater awareness of the health benefits of the products they consume. In terms of occupation, most users were from the informal and private sectors. However, compared to conventional smokers in general, data from 2018 shows that men in the poorest socioeconomic groups had the highest tendency to smoke, and those with lower levels of education tended to have a higher proportion of smokers. This includes a higher number of women found smoking within low-education communities. Additionally, active smokers in Indonesia predominantly come from lower-middle socioeconomic groups, indicating an economic vulnerability aspect: low-income households are more burdened by cigarette consumption [21].

The primary reason for using STS was "healthy smocking," reflecting the perception that STS is a safer alternative to conventional cigarettes. Most respondents reported routine daily use of STS, with consumption predominantly in the range of 2–10 cigarettes per day. This habit suggests that STS has become an integral part of users' daily routines, replacing conventional cigarettes as a safer choice.

STS offers a safer and more health-beneficial alternative to smoking due to the presence of scavenger complex compounds. These are low-molecular-weight bioinorganic complexes capable of binding heavy metals such as Hg, Pb, and Cd. These compounds form stable chelation complexes with heavy metals, thereby preventing further damage to cells and tissues. Additionally, these complexes regulate free radicals through electron interactions on their molecular surfaces, effectively inhibiting free radical transitions and reducing oxidative damage [22].

The scavenger complex compounds in STS also provide significant comfort to its users. This is evident from the majority of respondents reporting no irritation or breathing difficulties while using STS, indicating that STS not only reduces toxicity but also minimizes adverse effects commonly associated with conventional smoking. Conventional cigarettes are known to cause various issues, such as halitosis, intraoral lesions, dry mouth, discomfort, taste disturbances, and shortness of breath [23,24]. Uncontrolled exposure to free radicals and heavy metals in conventional cigarettes can lead to respiratory irritation and inflammation, ultimately diminishing user comfort and increasing the risk of health complications.

STS usage has been reported to positively impact users, such as feeling more refreshed and experiencing improved concentration. The results of this study also indicate that respondents experienced an improvement in quality of life when consuming STS, which contrasts with the experience of conventional cigarette users [25]. Perbaikan ini is likely attributed to the role of nicotine in STS. Nicotine, as a ligand of the nicotinic acetylcholine receptor (nAChR), is known to enhance the release of neuromediators such as dopamine, serotonin, and catecholamines, which are critical for cognitive and physiological functions. Previous studies have demonstrated that nicotine can improve attention, working memory, fine motor skills, and episodic memory through the activation of nAChR subunits, including $\alpha 4$, $\beta 2$, and $\alpha 7$ [26]. Additionally, nicotine stimulates the mesolimbic pathway, inducing psychostimulant effects, increasing muscle blood flow, and enhancing oxygen transport, resulting in greater energy and stamina [27].

While there are currently various safer smoking alternatives, some, such as low-tar or low- nicotine cigarettes, have been shown to offer no significant health benefits. Studies indicate that low- tar or "light" cigarettes remain hazardous and are not safer than regular cigarettes. A six-year study involving over 900,000 individuals revealed that lung cancer risks remained high [28,29]. Similarly, electronic cigarettes (e-cigarettes) have been associated with increased cancer risk due to chemical components that can damage DNA, induce carcinogenesis, and impair vascular function by increasing endothelial cell permeability and H_2O_2 release [30,31]

Overall, STS appears to be well-received socially. This social acceptance strengthens the potential of STS as a safer smoking alternative, particularly because of its perceived benefits, such as improved quality of life, even among users with degenerative diseases. The innovation of adding antioxidants and scavenger agents in the form of scavenger complex compounds enables STS to neutralize free radicals and heavy metals while offering a solution for smokers who seek the benefits of nicotine with minimal risks. Although STS demonstrates significant potential benefits, further research is required to specifically evaluate its effects on various diseases and long-term health outcomes.

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4 Conclusion

STS is a innovation designed to reduce the negative impacts of conventional cigarettes by incorporating scavenger complex compounds—a combination of antioxidants and scavenger molecules—that neutralize free radicals and bind heavy metals, thereby lowering toxicity during tobacco combustion. The smaller particle size of STS smoke (70–100 nm) provides additional advantages in reducing health risks. Research indicates that although the distribution of STS in Indonesia is still uneven, the majority of users report improvements in fitness, concentration, and quality of life, making it a healthier alternative. Furthermore, STS shows potential as a therapeutic agent, particularly for users with health conditions such as respiratory disorders, heart disease, and cancer. However, more detailed studies are required to fully understand its mechanisms. Overall, STS shows potential to offer a safer alternative, presenting opportunities to positively transform smoking paradigms.

5 Declerations/Statements

5.1. Acknowledgement

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5.2. Funder

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5.3. Author Contribution

Sherry Aristyani: data collection, article drafting; Saraswati Subagjo: data collection, supervising; Tintrim Rahayu: data collection; Gatra Ervi Jayanti: data collection; Sutiman Bambang Sumitro: supervising.

5.4. Ethics

Health Research Ethics Committee, Faculty of Medicine, Universitas Islam Malang, with approval number 078/LE.003/XI/01/2023.

5.5. Conflict of Interest

The authors stated that none of conflict of interest.

6 References

[1] T. Sadik, *Traditional use of tobacco among Indigenous peoples of North America*. Chippewas of the Thames First Nation, 2014. [Online]. Available: https://cottfn.com/wp- content/uploads/2015/11/TUT-Literature-Review.pdf

[2] A. Charlton, "Medicinal uses of tobacco in history," *Journal of the Royal Society of Medicine*, vol. **97**, no. 6, pp. 292–296, 2004. https://doi.org/10.1177/014107680409700614

[3] J. Hanafin and L. Clancy, "History of tobacco production and use," *Progress in Respiratory Research*, vol. **42**, pp. 1–18, 2015. https://doi.org/10.1159/000369289

[4] E. C. Hammond and D. Horn, "The relationship between human smoking habits and death rates: a follow-up study of 187,766 men," *Journal of the American Medical Association*, vol. **155**, no. 15, pp. 1316–1328, 1954. https://doi.org/10.1001/jama.1954.03690330020006

[5] A. W. Musk and N. H. De Klerk, "History of tobacco and health," *Respirology*, vol. **8**, no. 3, pp. 286–290, 2003. https://doi.org/10.1046/j.1440-1843.2003.00483.x

[6] R. Vera-Estrella, M. F. Gómez-Méndez, J. C. Amezcua-Romero, B. J. Barkla, P. Rosas- Santiago, and O. Pantoja, "Cadmium and zinc activate adaptive mechanisms in *Nicotiana tabacum* similar to those observed in metal-tolerant plants," *Planta*, vol. 246, no. **3**, pp. 433– 451, 2017. https://doi.org/10.1007/s00425-017-2700-1

[7] K. Kozak and D. M. Antosiewicz, "Tobacco as an efficient metal accumulator," *BioMetals*, vol. **36**, pp. 351–370, 2023. https://doi.org/10.1007/s10534-022-00431-3

[8] E. M. Suszcynsky and J. R. Shann, "Phytotoxicity and accumulation of mercury in tobacco subjected to different exposure routes," *Environmental Toxicology and Chemistry*, vol. **14**, no. 1, pp. 61–67, 1995. https://doi.org/10.1002/etc.5620140108

[9] X. Su, M. Narayanan, X. Shi, X. Chen, Z. Li, and Y. Ma, "Mitigating heavy metal accumulation in tobacco: Strategies, mechanisms, and global initiatives," *Science of The Total Environment*, vol. **926**, p. 172128, 2024. https://doi.org/10.1016/j.scitotenv.2024.172128

[10] Pusat Studi Nanobiologi, Pengembangan teknologi kretek sehat tanpa kehilangan cita-rasa [Homepage]. 2011. [Online]. Available: http://smartbio.org/research/pengembangan-teknologi-kretek-sehat-tanpa-kehilangan-cita-rasa. (Accessed: Jan. 25, 2012)

[11] D. Novrial, I. Riwanto, S. B. Sumitro, and I. Wijaya, "The effects of cigarette smoke nanoparticles in the colorectal carcinogenesis of Wistar rats," Berkala Penelitian Hayati, vol. **23**, no. 1, 2017. https://doi.org/10.23869/45

[12] Z. Maskos, L. Khachatryan, R. Cueto, W. A. Pryor, and B. Dellinger, "Radicals from the pyrolysis of tobacco," Energy Fuels, vol. 19, no. **3**, pp. 791–799, 2005. https://doi.org/10.1021/ef040088s

[13] A. Darmawan, A. Wardoyo, and D.Santjojo, "Pengukuran emisi partikel ultrafine dari asap pembakaran rokok kretek dengan zat aditif," Brawijaya Physics Student Journal., vol. **1**, no. 1, 2013.

[14] W. K. Nita, A. Y. P. Wardoyo, and C. S. Widodo, *Pengaruh penambahan zat aditif pada rokok terhadap emisi partikel ultrafine (UFP)*, Undergraduate thesis, Universitas Brawijaya, 2013.

[15] N. Dolev, Z. Katz, Z. Ludmer, A. Ullmann, N. Brauner, and R. Goikhman, "Natural amino acids as potential chelators for soil remediation," *Environmental research*, vol. **183**, p. 109140, 2020.: https://doi.org/10.1016/j.envres.2020.109140

[16] A. A. S. A. Sukmaningsih, S. Permana, D. J. D. H. Santjojo, A. Y. P. Wardoyo, and S. B. Sumitro, "Investigating natural transition metal coordination anthocyanin complex in Java plum (*Syzygium cumini*) fruit as free radical scavenging," *RASĀYAN Journal of Chemistry*, vol. **11**, no. 3, pp. 1193–1203, 2018.

[17] K. Elumalai, S. Srinivasan, and A. Shanmugam, "Review of the efficacy of nanoparticle-based drug delivery systems for cancer treatment," *Biomedical Technology*, vol. **5**, pp. 109–122, 2024. https://doi.org/10.1016/j.bmt.2023.09.001

[18] C. H. Keith and J. C. Derrick, "Measurement of the particle size distribution and concentration of cigarette smoke by the 'conifuge'," *Journal of Colloid Science*, vol. **15**, no. 4, pp. 340–356, 1960. https://doi.org/10.1016/0095-8522(60)90037-4

[19] R. Ardiani, N. Maretasari, W. Lestari, A. Prasetyo, U. Sadhana, and Sarjadi, "Perbedaan gambaran histopatologi dan aktivitas proliferasi sel mukosa nasofaring mencit C3H yang dipapar Divine Kretek (Studi eksperimental laboratorik terhadap respon nanobiologik pada mencit C3H yang diinduksi karsinogenesis nasofaring)," in *Proc. KONAS IAPI*, Makassar, Indonesia: IAPI, 2012.

[20] G. E. Jayanti and S. Subagjo, "Balur and improving quality of life," *The Journal of Tropical Life Science*, vol. **6**, no. 1, pp. 35–40, 2016.

[21] D. Hapsari, O. Nainggolan, and D. Kusuma, "Hotspots and regional variation in smoking prevalence among 514 districts in Indonesia: Analysis of Basic Health Research 2018," *Global Journal of Health Science*, vol. **12**, no. 10, pp. 32–44, 2020. https://doi.org/10.5539/gjhs.v12n10p32

[22] S. B. Sumitro and S. Alit, "Herbal medicine, radical scavenger, and metal detoxification: Bioinorganic, complexity, and nanoscience perspectives," *IOP Conference Series: Earth and Environmental Science*, vol. **130**, p. 012003, 2018. https://doi.org/10.1088/1755- 1315/130/1/012003

[23] S. Sagiroglu, A. Erdogan, A. Doganer, and R. A. Okyay, "Otorhinolaryngological symptoms among smokeless tobacco (Maras powder) users," *Northern clinics of Istanbul,*, vol. 6, no. 3, pp. 284–292, 2018. https://doi.org/10.14744/nci.2018.50024

[24] E. Sever, E. Božac, E. Saltović, S. Simonić-Kocijan, M. Brumini, and I. Glažar, "Impact of the Tobacco Heating System and Cigarette Smoking on the Oral Cavity: A Pilot Study," *Dentistry journal,*, vol. **11**, no. 11, p. 251, 2023. https://doi.org/10.3390/dj11110251

[25] S. Wachsmann, L. Nordeman, and A. Billhult, "Tobacco impact on quality of life, a cross- sectional study of smokers, snuff-users and non-users of tobacco," *BMC Public Health*, vol. 23, p. 886, 2023.: https://doi.org/10.1186/s12889-023-15844-z

[26] G. Valentine and M. Sofuoglu, "Cognitive effects of nicotine: Recent progress," *Current neuropharmacology,*, vol. **16**, no. 4, pp. 403–414, 2018. https://doi.org/10.2174/1570159X15666171103152136

[27] T. Mündel, "Nicotine: Sporting friend or foe? A review of athlete use, performance consequences and other considerations," *Sports medicine (Auckland, N.Z.)*, vol. **47**, no. 12, pp. 2497–2506, 2017. https://doi.org/10.1007/s40279-017-0764-5

[28] National Cancer Institute, *"Light" cigarettes and cancer risk*, 2010. [Online]. Available: https://www.cancer.gov/about-cancer/causes-prevention/risk/tobacco/light-cigarettes- fact-sheet#:~:text=No.,no%20safer%20than%20regular%20cigarettes

[29] Harvard Health Publishing, *Low-tar cigarettes are not a safer choice*, 2017. [Online]. Available: https://www.health.harvard.edu/cancer/low-tar-cigarettes-are-not-a-safer-choice

[30] L. Mohammadi, D. D. Han, F. Xu, A. Huang, R. Derakhshandeh, P. Rao, A. Whitlatch, J. Cheng, R. J. Keith, N. M. Hamburg, P. Ganz, J. Hellman, S. F. Schick, and M. L. Springer, "Chronic e-cigarette use impairs endothelial function on the physiological and cellular levels," *Arteriosclerosis, thrombosis, and vascular biology,* vol. **42**, no. 11, pp. 1333–1350, 2022. [https://doi.org/10.1161/ATVBAHA.121.317749

[31] R. Sahu, K. Shah, R. Malviya, D. Paliwal, S. Sagar, S. Singh, B. G. Prajapati, and S. Bhattacharya,, "E-cigarettes and associated health risks: An update on cancer potential," *Advances in respiratory medicine,*, vol. **91**, no. 6, pp. 516–531, 2023. https://doi.org/10.3390/arm91060038