Malaysian Journal of Chemistry, 2026, Vol. 28(1), 72-78
(Special Issue: *3rd International Conference on Industry-Academia Initiatives in Biotechnology & Chemistry, iCIABC2025*)

Current Topics and Future Trends in Patchouli (*Pogostemon cablin*) Research: A Comprehensive Bibliometric Study

Nor Aisyah Omar[1], Muhammad Ashraf Fauzi[2] and Aini Norhidayah Mohamed[1]*
[1]Faculty of Industrial Science and Technology, Universiti Malaysia Pahang Al-Sultan Abdullah
[2]Faculty of Industrial Management, Universiti Malaysia Pahang Al-Sultan Abdullah
*Corresponding author (e-mail: ainin@ump.edu.my)

This study aims to provide a systematic overview and meta-analysis research on the patchouli plant and its mass application in numerous industries. This research has significance in presenting current research issues and the miscellaneous potential of *Pogostemon cablin* from the Web of Science (WOS) database. Co-citation and co-word analysis were adopted to identify and map the research landscape of the main topics in the literature system. The study was carried out with the number of publications retrieved about the predetermined subjects totalling 400 documents from 1970-2024. Four main clusters were created for each analysis respectively. Themes of bioactivity that deal with actual biological consequences and metabolic pathways are becoming more prevalent. The findings of this evaluation can be coordinated for emerging topics in engineered application of patchouli and sustainable green technology.

Keywords: *Pogostemon cablin*, patchouli, bibliometric analysis, Web of Science

Received: May 2025; Accepted: November 2025

Practices in natural therapies as an alternative treatment to modern synthetic medicines have emerged as a prominent area of study among researchers over the recent years. Plant-based medicines using essential oil through the integration of traditional methods and modern approaches received significant attention as they are perceived as safe with low risk of side effects [1]. A diverse range of chemical compounds are found to be present abundantly in essential oil extracted from different parts of plants such as leaves, roots, stems, and flowers. The chemical composition of the oil depends on the geographical location, species, cultivation technique, and extraction method used. Patchouli is an essential perennial herb belonging to the family Lamiaceae, originating in Malaysia and India [2]. It is extensively cultivated in Southeast Asia for its multiple uses in various industries. Besides being best known in the cosmetic and perfumery industry, it has been reported to have many therapeutic activities like anti-cancer, anti-microbial, anti-oxidant, anti-inflammatory, anti-depressant, gastroprotection and cardio-protective properties [3]. Additionally, several studies reported patchouli to exhibit bioactivity in the central nervous system, potentially leading to the treatment of neurological disorders [4-8]. This review aims to provide collective information on the potential benefits of this medicinal plant, as reported in the literature. Bibliometric analysis is a branch of library science that classifies literature according to specific attributes. There are recognised conceptual connections between the focus area of prior and present-day studies to understand the topic's growth and evolution better. This method may be a practical approach to discovering complicated connections within a substantial literature [9].

EXPERIMENTAL

Methods

A science mapping method known as bibliometric research is applied in this study. This technique mainly focuses on the connections between numerous fields, disciplines, researchers, and individual publications using information cited from scholarly literature [10].

This quantitative tool has gained much interest from academicians since it integrates categorization and visualization to map the structure of the scientific area [11]. Hence, this study concludes and provides an insight into the complete publication on botanical, physical, and chemical properties of patchouli plants and essential oil using bibliometric analysis.

Web of Science (WOS) is the most comprehensive citation database in the world, and it holds a vast record of articles from the highest-impact journals [12]. It is vital for scholars since it offers detailed data on citations, keywords, and references.

A search query was established using two primary sub-keywords and correlated terms discovered in previous studies, synonyms, and thesaurus searches. We employed the following search string (Table 1) to identify relevant literature related to 1) patchouli and 2) component, constituent, or compound. Duplicate records were excluded in this study. The search in the WOS database was conducted on February 27, 2024. The VOS viewer version 1.6.20 was utilized to present the subject's network visualization.

†Paper presented at the 3rd International Conference on Industry-Academia Initiatives in Biotechnology & Chemistry

Table 1. Search string in WoS database.

No	Keywords	Justification
1	"patchouli" OR "pogostemon"	To identify literature related to patchouli essential oil
2	"component*" OR " constituent*" OR "compound*"	To identify literature related to chemical compositions of patchouli essential oil

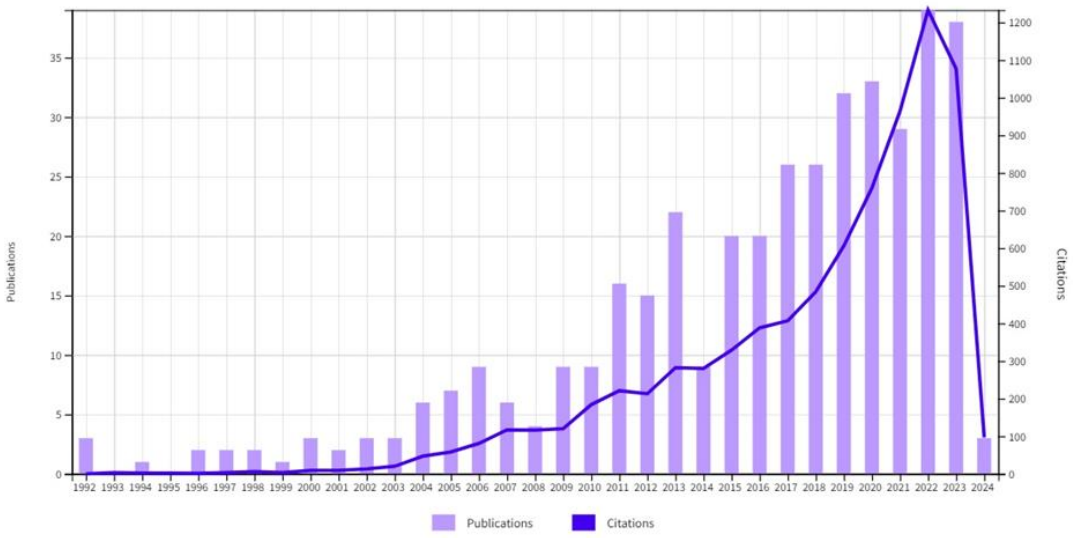

Figure 1. Publications and citations index retrieved from WOS database.

RESULTS AND DISCUSSION

The initial search returned 452 documents. After filtering only journal publications from 1970 until 2024, to ensure all publications are within a full calendar year, the search returns to 400 journal publications. The number of citations is 8,135 and 7,014 (without self-citations). The average citations were 20.34, with an h-index of 43. The number of publications and citations received for the subject is shown in Figure 1. Upward trend is showcased in the figure indicating an increase in popularity over time. It is expected to grow in the future with a significant impact on commercial, pharmacological, and technological interests due to growing demand in biotechnological advances and global market for natural products.

Co-citation Analysis

Of 12,379, 42 cited references are included, with a threshold of 13 cited references in the co-citation analysis. The threshold was determined by testing the value several times, ranging from 10 to 15, until 13 was considered to have produced the most robust and appropriate clusters. The threshold should not be too high, causing missing crucial themes (over filtering), and neither it should not be too low, causing redundancy of clusters (under filtering). The top 3 documents are [13] (56 citations), [2] (40 citations) and [14] (38 citations).

The network map is shown in Figure 2, showing 4 clusters, suggesting four unique themes in the knowledge structure of patchouli. The thematic distinction discovered in this analysis is supported by the variation in visual density and linking strength between the clusters. Highly interconnected clusters such as chemical compositions and pharmacological properties represent central research themes, while sparser clusters such as safety and toxicity of patchouli highlight emerging topics.

Figure 2 illustrates the co-citation analysis of patchouli publications from WOS database. The mapping indicates four main clusters of patchouli oil with interpretation as follows:

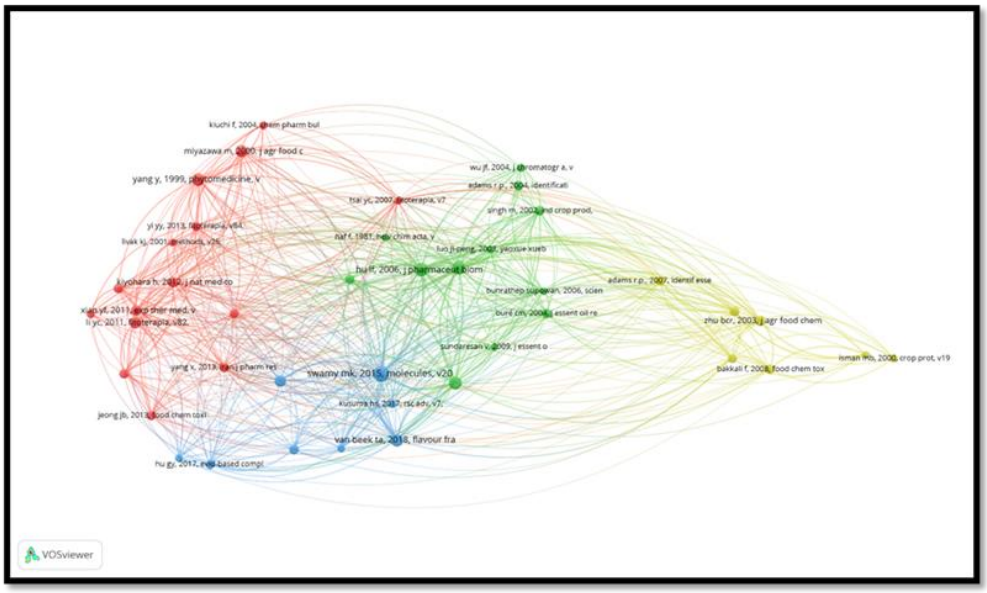

Figure 2. Co-citation analysis of Patchouli.

Cluster 1 (Red) Consists of 15 Items

Considering the relevance and densities of these documents in this cluster, Cluster 1 can be classified as "Biological activities of phytochemicals present in patchouli". Most of the articles in this cluster discussed the processes and reactions exhibited by the chemical compounds in patchouli. One of the earliest articles was [15], explaining the usage of these Traditional Chinese drugs in managing nausea and vomiting. Patchouli alcohol showed anti-emetic activity by suppressing the excessive contraction of digestive organ muscles by blocking the inflow of Ca^{2+} through the cell membrane. One of the most cited publications, [16], exhibited mutagenic activities of flavonoids extracted from patchouli by suppressing the *umu* gene expression of SOS response in *Salmonella typhimurium* against the mutagen 2-(2-furyl)-3-z9-nitro-2-furyl) acrylamide. Similarly, this cluster showcased several other pharmacological effects, anti-inflammatory activity of patchouli alcohol [17,18] and anti-microbial properties of pogostone and its analogues [19].

Cluster 2 (Green) Comprises of 12 Items

The primary theme for this cluster is perceived as "Chemical constituents of patchouli oil." One of the earliest articles was by [20], which outlined the synthesis of the racemate and both enantiomers of patchouli alcohol, the main constituent in patchouli oil. A study by [14] discussed the correlation between sesquiterpenes synthesis and its diverse profile of patchouli. To control the quality of patchouli, a standard fingerprint of collected *Pogostemon cablin* from various regions was established by [2]. Meanwhile, a study by [21] showed that several compounds like α- and β-patchoulene, patchouli alcohol, β-caryophyllene, α-guaiene, seychellene and selinene in *Pogostemon cablin* were quantitatively higher as compared to another variety of patchouli, *Pogostemon travancoricus*.

Cluster 3 (Blue) Represents 8 Items

Most of the articles in this cluster provide insights into the medicinal values of patchouli. This cluster is labelled "The pharmacological activities of patchouli." [13] provided thorough understanding of the phytochemistry and pharmacological properties of patchouli essential oil and other plant extracts based on the available scientific literature. The mechanisms of action of numerous bioactive compounds present in patchouli oil are well summarized by [22]. [23] critically reviewed many pieces of literature on patchouli oil, emphasizing the oil's qualitative and quantitative chemical analysis.

Cluster 4 (Yellow) Consists of 7 Articles

This cluster is labelled "The insecticidal and repellence properties of patchouli oil." Patchouli oil has been deemed to be a viable alternative to traditional insecticides, which are potentially toxic. [24] recorded that patchouli alcohol showed repellent activities towards Formosan subterranean termites. In another study, patchouli oil also displayed insecticidal activity towards urban ant species [25]. Additionally, [26] thoroughly studied the cytotoxicity of the bioactive components in patchouli oil.

Co-word Analysis

Figure 3 visualizes the co-occurrence of keyword analysis. From the mapping, it can be concluded that

there are four main clusters of patchouli oil. The following are the descriptions of the four clusters in the co-word of keyboard analysis:

Cluster 1 (Red) Presents 15 Keywords

The theme for this cluster is "biological and chemical studies of patchouli oil and its application in fragrance production." Representative keywords include pogostone, patchouli alcohol, patchouli oil and in vitro. Patchouli oil is highly regarded for its distinct, enduring, pleasant, woody, earthy, camphoraceous scent. It is an essential ingredient in perfumery and cosmetics as a fixative with lasting character in many fragrances [14]. The important criterion for patchouli oil quality standard in the market is the patchouli alcohol content. Hence, a higher concentration of pogostone in Sulawesi's patchouli oil may contribute to an inferior oil quality [23].

Cluster 2 (Green) Consists of 14 Keywords

It is labelled as "botanical analysis and chemical composition of patchouli." The main keywords are patchouli, alcohol, patchoulol, plant and gas chromatography-mass spectrometry (gc-ms). This theme integrates plant science with analytical chemistry, emphasizing natural products and their uses in various industries, including agriculture, medicine, and fragrance. Patchouli plant is a profitable commodity widely grown throughout Indonesia, China, India, and Malaysia [13].

Cluster 3 (Blue) Comprises of 12 Items

The theme for this cluster is "chemical composition, bioactivity and safety assessment of *Pogostemon cablin*." The main identified keywords are chemical-composition, constituents, essential oil, *Pogostemon cablin*, antimicrobial and toxicity. This cluster encompassed a holistic approach to exploring the potential benefits of *Pogostemon cablin* and ensuring its safe application in the pharmaceutical, cosmetics, and food industries [26]. Cytotoxicity includes membrane damage of a cell. In a study by [24], direct injury on permeable membranes of treated termites with high doses of patchouli oil and patchouli alcohol indicated acute topical toxicity of *Pogostemon cablin*.

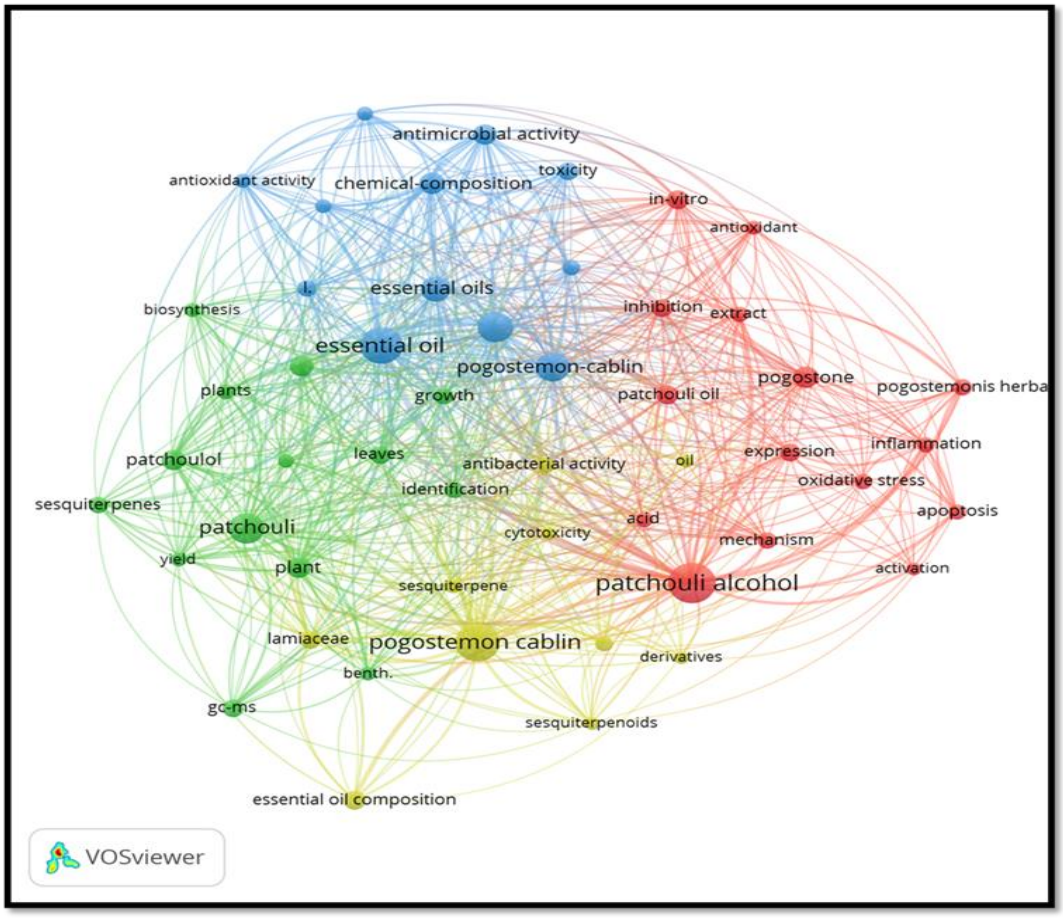

Figure 3. Co-word analysis of patchouli oil from VOSviewer.

Cluster 4 (Yellow), with 10 Keywords

It dealt with "phytochemical analysis and pharmacological properties of patchouli oil." The related keywords are *Pogostemon cablin*, Lamiaceae, flavonoids and antibacterial activity. This cluster reflects the current trends in natural product research and pharmaceutical development, highlighting patchouli's pharmacological potential, especially in combating bacterial infections [22] and viruses [23,24]. [2] also established that patchouli alcohol from *Pogostemon cablin* was the primary component responsible for patchouli oil's significant antibacterial properties.

Pogostemon cablin have been conducted extensively and cited rigorously due to its unique biochemical and pharmacological profile. In co-citation analysis, cluster number 1 reflects publication clusters and citation hotspots center on several recurring bioactive sesquiterpenes. Recent narrative and systematic reviews that summarise diverse pharmacological reports for *Pogostemon cablin* are consistent with the findings in this cluster [31]. Cluster number 2 describes the importance of a reliable *Pogostemon cablin* standard fingerprint to ensure the purity, safety, and efficacy of patchouli oil, which is crucial for modern phytochemical standardization and drug development [2]. Among the popular research topics are patchouli oil's phytochemicals and biological activities. Publication by [13] is related to the issue, as discussed in cluster number 3. [27] found 16 chemical compounds of *Pogostemon cablin* from Malaysia. The 5 major components include β-patchoulene, α-guaiene, α-patchoulene, patchouli alcohol and α-bulnesene. Similarly, cluster number 4 was labelled as phytochemical analysis and pharmacological properties of patchouli oil in co-word keyword analysis, represented by the following publications [16,19]. A study by [28], found patchouli oil to be beneficial in the treatment of ulcerative colitis [28]. These findings provide a mechanistic basis for considering patchouli-derived preparations as therapeutic candidates in ulcerative colitis treatment, although rigorous human clinical trials are required.

In co-word analysis, another prevalent topic of interest in patchouli is its extensive application in the perfumery and cosmetics industry, as presented in cluster number 1. Patchouli oil is mainly comprised of mainly sesquiterpenes and sesquiterpenoids such that help bond and balance other fragrance components. Natural sesquiterpenes such as α-bulnesene and α-guaiene contributed both olfactory richness and biological functionality to patchouli oil [14]. Cluster number 2 suggests botanical analysis keywords frequently co-occurred with chemical composition terms are highly associated in phytochemical characterization and botanical authentication [13]. Cluster number 3 describes the necessity of a systematic toxicological validation and dose-response studies in patchouli oil. Despite significant progress in the pharmacological aspects, the safety assessment subtheme remains comparatively underrepresented [26]. The co-occurrence of phytochemical and pharmacological keywords suggests that modern research is moving beyond compositional profiling toward explaining the structure-activity relationships underlying its therapeutic potential as indicated in cluster number 4. Future research should prioritise chemotype-based pharmacological evaluation and standardized analytical and extraction method [30].

The pharmacological properties of patchouli plant have been the subject of numerous studies in the recent years. However, it is challenging to generalise the findings due to limitations in chemical and dose standardisation as well as lacking evidence in human-based studies. Furthermore, human data are scarce and mechanistic evidence is still developing which makes the need for well-planned, dose-controlled in vivo research and early-stage clinical evaluations to support the evidence-based application of patchouli oil in medicine cosmetics and functional products. Additionally, new research concentrating on chemotype-specific cultivation, sustainable agronomic optimization and farmer-centered innovation in patchouli production is also warranted to fill in gaps within the existing literature.

Inevitably, this study has several limitations, including restricted articles obtained from one database. This study opted for WOS as it offered robust and reliable datasets. The first limitation is that only journal publications were selected in this review to ensure they have undergone rigorous peer-review. Another limitation of this study is the author's classification of the themes and publication's content, which may have resulted in biases or a tendency to classify based solely on the author's understanding. The determination of the quality of the theme in the clusters is also subjective to the author's perception and analysis.

CONCLUSION

400 publications related to patchouli were retrieved from the WOS database. This review aims to provide collective information on the potential benefits of this medicinal plant, as reported in the literature. In a conclusion, this study systematically identifies and defines the gap within the current literature while shedding light on discovering the promising potential of patchouli plant in other spectrums. It is a strategic multipurpose crop for future study especially in medicine development as well as commercial growth in the green economy because of its bioactive chemicals, economic potential, and environmental adaptability.

ACKNOWLEDGEMENTS

This study was not supported by any grants from funding bodies in the public, private, or not-for-profit sectors.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

REFERENCES

1. Rasheed, S., Zahid, S., Jamil, I., Rafi, U., Bano, E., Aslam, M. and Ahmad, F. (2023) A comprehensive review on biomedical application of plant-derived essential oils. *Materials Chemistry and Mechanics*, **1(1)**, 1–23.

2. Hu, L. F., Li, S. P., Cao, H., Liu, J. J., Gao, J. L., Yang, F. Q. and Wang, Y. T. (2006) GC–MS fingerprint of *Pogostemon cablin* in China. *Journal of Pharmaceutical and Biomedical analysis*, **42(2)**, 200–206.

3. Lee, H. S., Lee, J., Smolensky, D. and Lee, S. H. (2020) Potential benefits of patchouli alcohol in prevention of human diseases: a mechanistic review. *International immunopharmacology*, **89**, 107056.

4. Shin, Y. K., Lee, S. Y., Lee, J. M., Kang, P. and Seol, G. H. (2020) Effects of short-term inhalation of patchouli oil on professional quality of life and stress levels in emergency nurses: A randomized controlled trial. *The Journal of Alternative and Complementary Medicine*, **26(11)**, 1032–1038.

5. Astuti, P., Khairan, K., Marthoenis, M. and Hasballah, K. (2022) Antidepressant-like activity of patchouli oil var. Tapak Tuan (*Pogostemon cablin Benth*) via elevated dopamine level: a study using rat model. *Pharmaceuticals*, **15(5)**, 608.

6. Xu, Q. Q., Su, Z. R., Hu, Z., Yang, W., Xian, Y. F. and Lin, Z. X. (2022) Patchouli alcohol ameliorates the learning and memory impairments in an animal model of Alzheimer's disease via modulating SIRT1. *Phytomedicine*, **106**, 154441.

7. He, H., Xie, X., Zhang, J., Mo, L., Kang, X., Zhang, Y. and You, Z. (2023) Patchouli alcohol ameliorates depression-like behaviors through inhibiting NLRP3-mediated neuroinflammation in male stress-exposed mice. *Journal of Affective Disorders*, **326**, 120–131.

8. Lin, L. T., Zhang, S. T., Shang, B. L., Dai, Y. Q., Cheng, X. Q., Wu, Q. G. and Liu, S. J. (2024) The effect and mechanism of Patchouli alcohol on cognitive dysfunction in AD mice induced by Aβ1-42 oligomers through AMPK/mTOR pathway. *Brain Research Bulletin*, 111030.

9. Lin, T. C., Tang, K. Y., Lin, S. S., Changlai, M. L. and Hsu, Y. S. (2022) A Co-word Analysis of Selected Science Education Literature: Identifying Research Trends of Scaffolding in Two Decades (2000–2019). *Frontiers in Psychology*, **13**.

10. Donthu, N., Kumar, S., Mukherjee, D., Pandey, N. and Lim, W. M. (2021) How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, **133**, 285–296.

11. Linnenluecke, M. K., Marrone, M. and Singh, A. K. (2020) Conducting systematic literature reviews and bibliometric analyses. *Australian Journal of Management*, **45(2)**, 175–194.

12. Singh, V. K., Singh, P., Karmakar, M., Leta, J. and Mayr, P. (2021) The journal coverage of Web of Science, Scopus, and Dimensions: A comparative analysis. *Scientometrics*, **126**, 5113–5142.

13. Swamy, M. K. and Sinniah, U. R. (2015) A comprehensive review on the phytochemical constituents and pharmacological activities of *Pogostemon cablin* Benth.: an aromatic medicinal plant of industrial importance. *Molecules*, **20(5)**, 8521–8547.

14. Deguerry, F., Pastore, L., Wu, S., Clark, A., Chappell, J. and Schalk, M. (2006) The diverse sesquiterpene profile of patchouli, *Pogostemon cablin*, is correlated with a limited number of sesquiterpene synthases. *Archives of Biochemistry and Biophysics*, **454(2)**, 123–136.

15. Yang, Y., Kinoshita, K., Koyama, K., Takahashi, K., Tai, T., Nunoura, Y. and Watanabe, K. (1999) Anti-emetic principles of *Pogostemon cablin* (Blanco) Benth. *Phytomedicine*, **6(2)**, 89–93.

16. Miyazawa, M., Okuno, Y., Nakamura, S. I. and Kosaka, H. (2000) Antimutagenic activity of flavonoids from *Pogostemon cablin*. *Journal of Agricultural and Food Chemistry*, **48(3)**, 642–647.

17. Xian, Y. F., Li, Y. C., Ip, S. P., Lin, Z. X., Lai, X. P. and Su, Z. R. (2011) Anti-inflammatory effect of patchouli alcohol isolated from *Pogostemonis Herba* in LPS-stimulated RAW264. 7 macrophages. *Experimental and Therapeutic Medicine*, **2(3)**, 545–550.

18. Li, Y. C., Xian, Y. F., Ip, S. P., Su, Z. R., Su, J. Y., He, J. J. and Lin, Z. X. (2011) Anti-inflammatory activity of patchouli alcohol

isolated from *Pogostemonis Herba* in animal models. *Fitoterapia*, **82(8)**, 1295–1301.

19. Yi, Y. Y., He, J. J., Su, J. Q., Kong, S. Z., Su, J. Y., Li, Y. C. and Su, Z. R. (2013) Synthesis and antimicrobial evaluation of pogostone and its analogues. *Fitoterapia*, **84**, 135–139.

20. Näf, F., Decorzant, R., Giersch, W. and Ohloff, G. (1981) A Stereocontrolled Access to (±)-, (−)-, and (+)-Patchouli Alcohol. *Helvetica Chimica Acta*, **64(5)**, 1387–1397.

21. Sundaresan, V., Singh, S. P., Mishra, A. N., Shasany, A. K., Darokar, M. P., Kalra, A. and Naqvi, A. A. (2009) Composition and comparison of essential oils of *Pogostemon cablin* (Blanco) Benth. (Patchouli) and *Pogostemon travancoricus Bedd*. var. *travancoricus*. *Journal of Essential Oil Research*, **21(3)**, 220–222.

22. Junren, C., Xiaofang, X., Mengting, L., Qiuyun, X., Gangmin, L., Huiqiong, Z. and Cheng, P. (2021) Pharmacological activities and mechanisms of action of *Pogostemon cablin* Benth: a review. *Chinese Medicine*, **16**, 1–20.

23. Fan, Y., Zhang, Q., Zhang, W., Lai, Y., Long, H., Huang, H. and Li, G. (2023) Inhibitory effects of Patchouli alcohol on the early lifecycle stages of influenza A virus. *Frontiers in Microbiology*, **13**, 938868.

24. Yu, Y., Zhang, Y., Wang, S., Liu, W., Hao, C. and Wang, W. (2019) Inhibition effects of patchouli alcohol against influenza a virus through targeting cellular PI3K/Akt and ERK/MAPK signaling pathways. *Virology Journal*, **16**, 1–16.

25. van Beek, T. A. and Joulain, D. (2018) The essential oil of patchouli, *Pogostemon cablin*: A review. *Flavour and Fragrance Journal*, **33(1)**, 6–51.

26. Zhu, B. C. R., Henderson, G., Yu, Y. and Laine, R. A. (2003) Toxicity and repellency of patchouli oil and patchouli alcohol against Formosan subterranean termites *Coptotermes formosanus* Shiraki (Isoptera: Rhinotermitidae). *Journal of Agricultural and Food Chemistry*, **51(16)**, 4585–4588.

27. Albuquerque, E. L., Lima, J. K., Souza, F. H., Silva, I. M., Santos, A. A., Araújo, A. P. A. and Bacci, L. (2013) Insecticidal and repellence activity of the essential oil of *Pogostemon cablin* against urban ant species. *Acta tropica*, **127(3)**, 181–186.

28. Huang, Y., Zhao, P., Zhang, X., Fu, H. and Fu, C. (2025) Uncovering the pharmacological mechanisms of Patchouli essential oil for treating ulcerative colitis. *Journal of Ethnopharmacology*, **336**, 118737.

29. Bakkali, F., Averbeck, S., Averbeck, D. and Idaomar, M. (2008) Biological effects of essential oils: A review. *Food Chem. Toxicol*., **46**, 446–475.

30. Yahya, A. and Yunus, R. M. (2013) Influence of sample preparation and extraction time on chemical composition of steam distillation derived patchouli oil. *Procedia Engineering*, **53**, 1–6.

31. Fatima, S., Farzeen, I., Ashraf, A., Aslam, B., Ijaz, M. U., Hayat, S. and Muzammil, S. (2023) A comprehensive review on pharmacological activities of pachypodol: A bioactive compound of an aromatic medicinal plant *Pogostemon cablin* Benth. *Molecules*, **28(8)**, 3469.