

Syzygium aromaticum (L.) Merr. & L.M. Perry.: Phytochemistry, Biological activities and Therapeutic Potential – A Mini Review

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Abstract

Clove (*Syzygium aromaticum* (L.) Merr. & L.M. Perry.) is an important medicinal plant widely recognized for its diverse biological activities and therapeutic potential. Its major bioactive constituents, particularly eugenol and other phenolic compounds, contribute to its antioxidant, antimicrobial, anti-inflammatory and analgesic properties. Various studies have also reported its potential applications in oral health, digestive disorders and other health-related conditions. The biological activities of clove are largely associated with its ability to modulate oxidative stress and microbial growth. Collectively, these review highlight the pharmacological significance of clove and support its continued investigation as a potential source of bioactive compounds for therapeutic applications.

Keywords: Clove, biological activities, therapeutic potential, *Syzygium aromaticum*, eugenol.

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Introduction

Syzygium aromaticum (L.) Merr. & L.M. Perry. (Clove), an important spice crop and also aromatic plant belonging to the family Myrtaceae, has been used for centuries as a food preservative and medicinal agent due to its antioxidant and antimicrobial properties (Tuiwawa *et al.*, 2013; Cock *et al.*, 2018). It is a native to the Moluccas, commonly known as the Spice Islands of Indonesia (Alfian *et al.*, 2019; Hariyadi *et al.*, 2020), and belongs to the genus *Syzygium*, which occurs naturally in tropical and subtropical regions. Over time, its cultivation and natural occurrence have extended to several parts of Africa, Asia, the Pacific and Oceanic regions, as well as countries such as India, Tanzania, Madagascar, Sri Lanka, Brazil and the West Indies (Bhowmik *et al.*, 2012; Cock *et al.*, 2018).



Figure: 1. *Syzygium aromaticum* (L.) Merr. & L.M. Perry.

S. aromaticum was introduced into India around 1800 AD by the East India Company through its 'spice garden' at Courtallam, Tamil Nadu. The successful acclimatization of the crop subsequently facilitated the establishment of clove cultivation after 1850 AD in the Nilgiris (Burliar), the southern region of the erstwhile Travancore State, and along the slopes of the Western Ghats. The present geographical distribution of clove cultivation in India encompasses the Nilgiris, Tirunelveli, Kanyakumari, and Ramanathapuram districts of Tamil Nadu; Kozhikode, Kottayam, Kollam, and Thiruvananthapuram districts of Kerala; and South Kanara district of Karnataka (Milind, 2011). The inflorescence is a terminal, trichotomous, corymbose panicle that is shortly pedunculate and branched from the base, with considerable variation in the number of flowers (Ravindran, 2006). The dried, unopened flower buds, which are commonly used as a culinary spice, impart a characteristic pungent taste. A brief scientific classification of *S. aromaticum* is presented in Table 1. Clove possesses pronounced antioxidant activity and may therefore function as an effective scavenger of free radicals (Rojas *et al.*, 2014). Phytochemical analysis of the dichloromethane extract of clove bud oil revealed the presence of carbohydrates, terpenoids, glycosides, steroids, sterols, tannins, and phenolic compounds, indicating a complex chemical composition (Kumar *et al.*, 2010). This phytochemical composition suggests the potential of clove bud oil for a range of biological activities and applications. Investigations on the chemical composition of clove essential oil have established

eugenol as its principal constituent (**Kasai et al., 2016; Khan et al., 2009; Marya et al., 2012; Matta, 2010**).

Table:1. Scientific classification of *S. aromaticum*

Kingdom	Plantae
Clade	Tracheophytes
Clade	Angiosperms
Clade	Eudicots
Clade	Rosids
Order	Myrtales
Family	Myrtaceae
Genus	<i>Syzygium</i>
Species	<i>aromaticum</i> (L.) Merr. & L.M. Perry.

Source: (**Abdullah et al., 2023**)

Despite extensive research on the phytochemistry, essential oil composition and biological activities of *S. aromaticum* an integrated account of its botanical characteristics, distribution, phytochemical profile and therapeutic potential is needed. Therefore, the present review summarizes the available information on *S. aromaticum*, with emphasis on its phytochemistry, biological activities and Therapeutic Potential.

Phytochemistry of *S. aromaticum*

Clove essential oil is a colourless to pale-yellow liquid with a characteristic clove flavour and aroma. Its chemical composition and constituent proportions may vary depending on factors such as pretreatment, agroecological conditions, variety, and the extraction process. Clove buds contain a diverse range of secondary metabolites, including phenolic compounds, flavonoids, tannins, resins, and terpenoid constituents. Among these, the essential oil represents an important fraction of the volatile phytochemicals and is characterized predominantly by eugenol, eugenyl acetate, and β -caryophyllene (**Chaieb et al., 2007; Jirovetz et al., 2011; Sulaiman et al., 2020**). In addition to volatile constituents, clove buds contain several phenolic and flavonoid compounds, including quercetin, kaempferol, ferulic acid, caffeic acid, ellagic acid, salicylic acid, and gallic acid (**Cortes Rojas et al., 2014; Jain et al., 2026; Tariq et al., 2025; Etukudo et al., 2025**).

Among the identified phytochemical, Eugenol ($C_{10}H_{12}O_2$), a phenylpropanoid-derived phenolic compound, is considered the predominant constituent of clove essential oil and is widely associated with several of its reported biological activities (**Taleuzzaman et al., 2021**). The proportion of eugenol in clove essential oil may vary considerably depending on factors such as geographical origin, plant material, and extraction method, with reported values generally ranging from approximately 59–88% (**Ahamad et al., 2022; Hatami et al., 2019**). The Selected major phytochemical compounds of *S. aromaticum* along

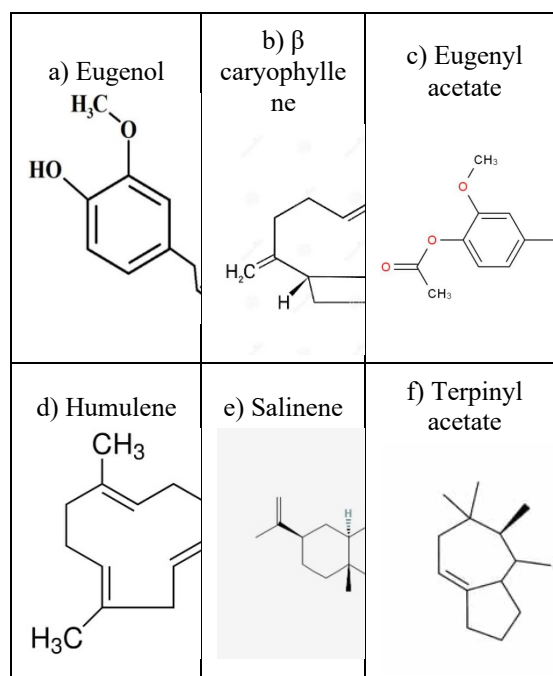
with their respective plant parts, and reported significance, are summarized in Table 2.

Table: 2. Selected major phytochemical compounds of *S. aromaticum*

S. No	Major Compounds	Plant Part	Reported Finding	Reference
1.	Eugenol	Leaves/essential oil	Identified as the major volatile constituent; 94.4% of leaf oil in the Little Andaman samples.	Raina et al., 2001; Srivastava et al., 2005; Pino et al., 2001
2.	β -caryophyllene	Buds and leaves/essential oil	Reported as a major constituent of clove bud and leaf oil	Srivastava et al., 2005
3.	Eugenyl acetate	Flower bud/essential oil	Major constituent of bud oil; 16.1% in Cuban clove bud oil.	Pino et al., 2001
4.	α -Humulene	Flower bud/essential oil	Identified among the sesquiterpene constituents (1.1%) of clove bud oil	Kapoor et al., 2005
5.	Caryophyllene oxide	Flower bud/essential oil	Identified as a characteristic oxygenated sesquiterpene	Kapoor et al., 2005

			constituent (1%)	
6.	α Copaene	Clove essential oil	Detected by GC–MS as a characteristic minor volatile constituent	Kacani <i>et al.</i>, 2021
7.	Pachypodol	Flower bud	Isolated from flower buds; showed the strongest cytotoxicity among tested isolates against A2780 cells (IC ₅₀ 8.02 μ M)	Ryu <i>et al.</i>, 2016
8.	Oleanolic acid	Dried Flower bud	Isolated and structurally identified as a secondary metabolite	Kiran <i>et al.</i>, 2023
9.	Betulinic acid	Dried Flower bud	Isolated and identified by spectroscopic methods as a secondary metabolite	Kiran <i>et al.</i>, 2023

Figure 2: Chemical structure of major phytochemical constituents of *S. aromaticum*



Source: (Ahmad, 2024)

Biological Activities

The biological effects of *S. aromaticum* are closely associated with its diverse phytochemical constituents. Previous studies have reported that extracts and essential oil derived from different parts of the plant exhibit a broad spectrum of biological activities, including antibacterial (Palombo and Semple., 2002), antifungal, antioxidant (Dorman *et al.*, 2000), anti-inflammatory (Han and Parker, 2017), analgesic, antinociceptive, antispasmodic, anticancer (Ahmad *et al.*, 2024), antitumor, cardioprotective, antiviral, antiseptic, anesthetic, diuretic, hypothermic, chemoprotective, antiemetic, and repellent effects (Ediriweera *et al.*, 2009; Toda *et al.*, 2000; Park *et al.*, 2026; Pires Costa *et al.*, 2025; El Fager *et al.*, 2026; Ho *et al.*, 2026; Muhmood *et al.*, 2025). These findings highlight the diverse biological potential of *S. aromaticum* and provide a basis for further investigation of its pharmacological applications.

Antioxidant activity

Antioxidants play an important role in protecting against oxidative stress and have been investigated for their potential relevance in the prevention and management of several chronic conditions, including metabolic disorders, cancer, hepatic diseases, and neurodegenerative disorders (Ahmad *et al.*, 2024). The antioxidant potential of *S. aromaticum* essential oil has been evaluated using in vitro reducing-power assays. In one study, the reducing capacity of the essential oil was assessed based on its ability to reduce ferric ions, with the resulting absorbance measured spectrophotometrically at 700 nm. Butylated hydroxytoluene (BHT) was used as a reference antioxidant, and the assay was performed with repeated measurements to ensure reliability. The

findings support the antioxidant potential of clove essential oil and suggest that its phytochemical constituents may contribute to its reducing and free-radical-scavenging properties (Euch *et al.*, 2015; Ben *et al.*, 2021).

Antimicrobial Activity

The antimicrobial potential of *S. aromaticum* has been widely investigated, particularly for its essential oil. Clove essential oil has demonstrated antibacterial activity against a range of Gram-positive and Gram-negative bacteria, including *Pseudomonas aeruginosa*, *Bacillus subtilis*, *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Proteus vulgaris*, and *Escherichia coli*. Antibacterial activity has also been reported against methicillin-resistant *Staphylococcus epidermidis* and *Staphylococcus aureus*. Studies evaluating clove essential oil alone and in combination with rosemary essential oil further support its broad-spectrum antibacterial potential (Palombo and Semple, 2002).

In addition to antibacterial effects, clove-derived essential oil has exhibited antifungal activity against several fungal species. Previous studies have reported inhibitory effects against fungi including *Candida albicans* and dermatophytes, while clove essential oil has also demonstrated inhibitory effects against food-associated fungal pathogens under experimental conditions. These findings indicate that *S. aromaticum* particularly its essential oil and eugenol-rich fraction, possesses considerable antimicrobial potential and may warrant further investigation for food, pharmaceutical, and other biological applications (Ahamad *et al.*, 2024).

Antidiabetic Activity

The antidiabetic potential of *S. aromaticum* has been investigated in experimental models. Certain constituents present in clove extracts have been suggested to contribute to their glucose-regulating effects. In an *in vivo* study, administration of clove extract to diabetic mice was associated with an improvement in blood glucose levels (Kuroda *et al.*, 2012). In addition, eugenol has been reported to improve insulin resistance and attenuate oxidative stress and inflammation in high-fat diet/streptozotocin-induced diabetic rats (Al-Trad *et al.*, 2019). These findings indicate the potential of clove-derived constituents as candidates for further investigation in diabetes-related research (Ahamad *et al.*, 2024).

Therapeutic Potential of *S. aromaticum*

Clove is a highly valuable plant, particularly due to the considerable medicinal and therapeutic importance of its various parts, such as the buds, leaves, roots and oil. It has been reported to be used in the management of cough, dizziness and epilepsy, and is also considered as a sleep inducer, blood thinner and mental stimulant (Pei *et al.*, 2001).

Figure 3: Schematic representation of the therapeutic potential of *S. aromaticum* based on

its major bioactive phytochemicals and reported biological activities

Clove has been widely used in oral-care preparations, particularly in mouthwashes and traditional remedies for toothache and pain. Its essential oil is also reported to possess antimicrobial activity against various microorganisms. Traditionally, clove has been used for respiratory complaints and digestive disturbances, including nausea, intestinal spasms, diarrhoea and flatulence. The aromatic properties of clove have also been associated with relief from headache and drowsiness in traditional medicinal practices (Bina *et al.*, 2012). These reported medicinal properties indicate the significant therapeutic potential of clove and support its continued use in traditional and modern healthcare applications.

Conclusion

S. aromaticum is a valuable medicinal plant with a diverse phytochemical profile and a broad spectrum of biological activities. The reported antioxidant, antimicrobial, anti-inflammatory, analgesic and other pharmacological properties highlight its considerable therapeutic potential. These biological effects, largely associated with bioactive constituents such as eugenol and other phenolic compounds, support the traditional and emerging medicinal applications of clove. However, further systematic studies are needed to clarify the underlying mechanisms, establish therapeutic efficacy and safety, and facilitate the development of evidence-based applications of clove in healthcare.

Reference

- Abdullah, A. Y. B., & Hossain, M. A. (2023). Review on phytochemicals and pharmacological activities of *Syzygium aromaticum*. 87-97.
- Ahamad, J. (2024). Ethnomedicinal and pharmacological significance of *Syzygium aromaticum* (clove): A review. *Journal of Angiotherapy*, 8(10), 1-9.
- Alfian A, Mahulette AS, Zainal M, Hardin, Bahrin AH. (2019), Morphological character of raja clove (*Syzygium aromaticum* L. Merr & Perry.) native from Ambon Island. *IOP Conf Ser: Earth Environ. Sci.*; 343(1): 012150.
- Al-Trad, B., Alkhateeb, H., Alsmadi, W., & Al-Zoubi, M. (2019). Eugenol ameliorates insulin resistance, oxidative stress and inflammation in high fat-diet/streptozotocin induced diabetic rat. *Life sciences*, 216, 183-188.
- Ben Hassine, D., Kammoun El Euch, S., Rahmani, R., Ghazouani, N., Kane, R., Abderrabba, M., & Bouajila, J. (2021). Clove buds essential oil: The impact of grinding on the chemical composition and its biological activities involved in consumer's health

- security. *BioMed Research International*, 2021(1), 9940591.
- Bhowmik D, Kumar KPS, Yadav A, Srivastava S, Paswan S, Dutta AS, (2012), Recent Trends in Indian Traditional Herbs *Syzygium Aromaticum* and Its Health Benefits. *Journal of Pharmacognosy and Phytochemistry*, 1(1), 13-23.
- Bina rani, G.R. Kachhawa, Rajesh Kumar Yadav, Vikram Chauhan and Raaz Maheshwari.: (2012). Phytochemical Effectiveness of Clove Oil: A Review article. *Intern. J. Research in Pharmacology and Pharmacotherapeutics*.2012; 1(2): 230-233
- Chaieb, K., Hajlaoui, H., Zmantar, T., Nakbi, K. A. B., Rouabhia, M., & Mahdouani, K. (2007). The chemical composition and biological activity of essential oil *Eugenia cryophyllata* (*Syzygium aromaticum* L., Myrtaceae). *Phytotherapy Research*, 21, 501–506.
- Cock I.E., Cheesman M. (2018). Plants of the genus *Syzygium* (Myrtaceae): A review on ethnobotany, phytochemistry. medicinal Bioactive properties and Compounds of Medicinal Plants. Ed Goyal MR, Ayeleso A. Apple Academic Press, USA.
- Cortes Rojas, D. F., de Souza, C. R. F., & Oliveira, W. P. (2014). Clove (*Syzygium aromaticum*): a precious spice. *Asian Pacific Journal of Tropical Biomedicine*, 4(2), 90-96.
- Dorman, H. D., & Deans, S. G. (2000). Antimicrobial agents from plants: antibacterial activity of plant volatile oils. *Journal of applied microbiology*, 88(2), 308-316.
- Ediriweera ER, Ratnasooriya WD. A review on herbs used in treatment of diabetes mellitus by Sri Lankan Ayurvedic and traditional physicians. *Ayu*. 2009;30(4):373-91.
- El Fager, O., Ouadghiri, Z., Wahnou, H., Elkoraichi, I., El Fager, A., Mazti, A., ... & Mtairag, E. M. (2026). Dual anti-inflammatory and immunomodulatory effects of clove essential oil and eugenol: targeting neutrophil functions and experimental arthritis. *Inflammopharmacology*, 34(1), 763-777.
- Etukudo, E. M., Usman, I. M., Ovioun, A., Ojiakor, V. O., Makena, W., Owembabazi, E., ... & Anyanwu, E. (2025). Exploring the neuroprotective potentials of flavonoid metabolites in *Syzygium aromaticum*: A review with in-silico insight to therapeutic potential. *Journal of Experimental Pharmacology*, 587-611.
- Euch El, S. K., Bouajila, J., & Bouzouita, N. (2015). Chemical composition, biological and cytotoxic activities of *Cistus salviifolius* flower buds and leaves extracts. *Industrial Crops and Products*, 76, 1100-1105.
- Gülçin, İ. (2011). Antioxidant activity of eugenol: A structure–activity relationship study. *Journal of Medicinal Food*, 14(9), 975-985.
- Han, X., & Parker, T. L. (2017). Anti-inflammatory activity of clove (*Eugenia caryophyllata*) essential oil in human dermal fibroblasts. *Pharmaceutical Biology*, 55(1), 1619-1622.
- Hariyadi, Mahulette AS, Yahya S, Wachjar A. (2020), Agro-morphologies and physicochemical properties of flower bud, stem and leaf oils in two clove varieties (*Syzygium aromaticum* L. Merr. and Perry.) originated from Ambon island. *Chiang Mai Univ. J. Nat. Sci*. 2020; 19:516-530.
- Hatami, T., Johnner, J. C., Zabot, G. L., & Meireles, M. A. A. (2019). Supercritical fluid extraction assisted by cold pressing from clove buds: Extraction performance, volatile oil composition, and economic evaluation. *The Journal of Supercritical Fluids*, 144, 39-47.
- Ho, T. Y., Lo, H. Y., Chen, C. C., Huang, H. C., & Hsiang, C. Y. (2026). Clove (*Syzygium aromaticum*) and its bioactive constituent eugenol alleviate psoriatic inflammation by modulating the IL-36/IL-17A axis: a proteomic and mechanistic study. *Frontiers in Pharmacology*, 17, 1839501.
- Jain, A., Jangid, T., Bhardwaj, G. S., & Jangir, R. N. (2026). *Syzygium aromaticum*: A Systematic Review of its Phytochemistry and Pharmacological Applications. *Letters in Functional Foods*, 3(1), E26669390425078.
- Jirovetz, L., Buchbauer, G., Stoilova, I., Stoyanova, A., Krastanov, A., & Schmidt, E. (2006). Chemical composition and antioxidant properties of clove leaf essential oil. *Journal of Agricultural and Food Chemistry*, 54(17), 6303-6307.
- Kacaniova, M., Galovicova, L., Borotova, P., Valkova, V., Duranova, H., Kowalczewski, P. L., ... & Vukovic, N. L. (2021). Chemical composition, in vitro and in situ antimicrobial and antibiofilm activities of *Syzygium aromaticum* (Clove) essential oil. *Plants*, 10(10), 2185.
- Kapoor, R., Ali, M., Alkhtar, M. S., Kaskoos, R. A., Siddiqui, A. W., & Mir, S. R. (2005). Composition of volatile oil of *Syzygium aromaticum* buds. *Journal of Essential Oil Bearing Plants*, 8(2), 196-199.
- Kasai H, Shirao M, Ikegami-Kawai M. (2016), Analysis of volatile compounds of clove (*Syzygium aromaticum*) buds as influenced by growth phase and investigation of antioxidant activity of clove extract. *Flavour Fragr. J.*; 31:178-184.
- Khan MS, Zahin M, Hasan S, Husain FM. (2009), Inhibition of quorum sensing regulated bacterial functions by plant essential oils with

- special reference to clove oil. *Lett Appl. Microbiol.*; 49:354-360.
- Kiran, Z., Khan, H. N., Rasheed, S., Begum, S., Iqbal Choudhary, M., Sara, ... & Atta-ur-Rahman. (2023). Isolation of secondary metabolites from *Syzygium aromaticum* (L.) Merr. & LM Perry. (cloves), and evaluation of their biological activities. *Natural Product Research*, 37(12), 2018-2023.
- Kumar U, Kumar B, Bhandhari A, Kumar Y. (2010), Phytochemical investigation and comparison of antimicrobial screening of clove and cardamom. *Int. J. Pharm. Sci. Res.*; 1:138-147.
- Kuroda, M., Mimaki, Y., Ohtomo, T., Yamada, J., Nishiyama, T., Mae, T., ... & Kawada, T. (2012). Hypoglycemic effects of clove (*Syzygium aromaticum* flower buds) on genetically diabetic KK-A y mice and identification of the active ingredients. *Journal of natural medicines*, 66, 394-399.
- Marya CM, Satija G, Avinash J, Nagpal R, Ahmad A. (2012.), In vitro inhibitory of clove essential oil and its two active principles on tooth decalcification by apple juice. *International Journal of Dentistry*.
- Matta FB. Essential oils from six herbal plants for biocontrol of the maize weevil. *Hort. Science*. 2010; 45:592-598.
- Milind P, Khanna D. Clove: A Champion Spice, *IJRAP*, 2 (1), 2011, 47-54.
- Muhmood, M. A., Safi, F., Ahmed, M. M., & Almeani, S. A. L. (2025). *Syzygium aromaticum* phytoconstituents target SARS-CoV-2: integrating molecular docking, dynamics, pharmacokinetics, and miR-21 rs1292037 genotyping. *Viruses*, 17(7), 951.
- Palombo, E. A., & Semple, S. J. (2002). Antibacterial activity of Australian plant extracts against methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin resistant enterococci (VRE). *Journal of Basic Microbiology*: 42(6), 444-448.
- Park MJ, Gwak KS, Yang I, Choi WS, Jo HJ, Chang JW, et al. Antifungal activities of the essential oils in *Syzygium aromaticum* (L.) Mar. Et Perry and *Leptospermum petersonii* Bailey and their constituents against various dermatophytes. *J Micro biol*. 2007;45(5):460–5.
- Pei, S. Ethnobotanical approaches of traditional medicine studies: some experiences from Asia. *Pharmaceu Botany*.2001; 39: 74-79.
- Pino, J.A., Marbot, R., Agüero, J. & Fuentes, V. (2001). Essential Oil from Buds and Leaves of Clove (*Syzygium aromaticum*) Grown in Cuba. *Journal of Essential Oil Research*, 13, 278–279.
- Pires Costa, E., Maciel dos Santos, M., de Paula, R. A., da Silva, D. A., Lopes, R. P., Teixeira, R. R., & Gonçalves, R. V. (2025). Antioxidant and anti-inflammatory activity of eugenol, bis-eugenol, and clove essential oil: an in vitro study. *ACS omega*, 10(28), 31033-31045.
- Raina, V. K., Srivastava, S. K., Aggarwal, K. K., Syamasundar, K. V., & Kumar, S. (2001). Essential oil composition of *Syzygium aromaticum* leaf from Little Andaman, India. *Flavour and fragrance journal*, 16(5), 334-336.
- Ravindran PN. Advances in spice research- History and Achievements of Spice Research in India Since Independence. In: Ravindran PN, Nirmal Babu K, Shiva KN, Kallapurackal JA, editors.2006. Agrobios, Jodhpur
- Rojas CDF, de Souza CR, Oliveira WP. Clove (*Syzygium aromaticum*): a precious spice. *Asian Pac. J. Trop. Biomed*. 2014; 4:90-96.
- Ryu, B., Kim, H. M., Lee, J. S., Lee, C. K., Sezirahiga, J., Woo, J. H., ... & Jang, D. S. (2016). New flavonol glucuronides from the flower buds of *Syzygium aromaticum* (Clove). *Journal of agricultural and food chemistry*, 64(15), 3048-3053.
- Srivastava, A. K., Srivastava, S. K., & Syamsundar, K. V. (2005). Bud and leaf essential oil composition of *Syzygium aromaticum* from India and Madagascar. *Flavour and fragrance journal*, 20(1), 51-53.
- Sulaiman, F. A., Nafiu, M. O., Yusuf, B. O., Muritala, H. F., Adeyemi, S. B., Omar, S. A., ... & Otohinoyi, D. A. (2020). The GC-MS fingerprints of *Nicotiana tabacum* L. extract and propensity for renal impairment and modulation of serum triglycerides in Wistar rats. *J. Pharm. Pharmacogn. Res*, 8(3), 191-200.
- Taleuzzaman, M., Jain, P., Verma, R., Iqbal, Z., & Mirza, M. (2021). Eugenol as a potential drug candidate: a review. *Current topics in medicinal chemistry*, 21(20), 1804 1815.
- Tariq, H., Alhudhaibi, A. M., & Abdallah, E. M. (2025). *Syzygium aromaticum* (clove buds) as a natural antibacterial agent: a promising alternative to combat multidrug-resistant bacteria. *Frontiers in microbiology*, 16, 1674590.
- Toda M, Kawabata J, Kasai T. Alpha-glucosidase inhibitors from clove (*Syzygium aromaticum*). *Biosci Biotechnol Biochem*. 2000;64(2):294–8.
- Tuiwawa SH, Craven LA, Sam C and Crisp MD. The genus *Syzygium* (Myrtaceae) in Vanuatu. *Blumea-Biodiversity, Evol. Biogeogr. Plants*.2013; 58(1):53-67.