HTechJ Health and Technology Journal (HTechJ)

Volume 02 Number 01
February 2024
p-ISSN: 2986-5662
e-ISSN: 2985-959X

Nature's Gift: *Syzygium Aromaticum*

Arzu Özgen[1], İlknur Yücel[2]

[1] *Vocational School of Health Services, Istanbul Gelisim University, Istanbul, Turkey*
[2] *Vocational School of Health Services, Istanbul Galata University, Istanbul, Turkey*

Correspondence should be addressed to:
Arzu Özgen
aozgen@gelisim.edu.tr

Abstract:
From ancient times to now, cloves have been utilized in traditional and culinary practices. *Syzygium aromaticum*, also known as clove, is extracted from the buds of a flowering plant that belongs to the Myrtaceae family. This oil comprises 85% Eugenol (4-allyl-2-methoxyphenol), 5.5% Eugenyl acetate, and 1.5% β-caryophyllene. *S. aromaticum* is known for its antibacterial, antiviral, antioxidant, and anti-inflammatory properties. *S. aromaticum* has multiple beneficial effects, including antifungal, antiemetic, antispasmodic, analgesic, antiseptic, anticarcinogenic, antiallergic, and anti-mutagenic activity. However, there is a lack of comprehensive information available in the current literature. To ensure the safe and effective use of clove oil, it is important for health professionals to receive adequate training through in-service programs, symposiums, conferences, and congresses. It is crucial to remember that clove oil contains powerful chemical compounds, and uncontrolled use may result in harm. Therefore, it should only be used under the supervision of a health team. It is recommended to raise public awareness about the proper use of clove oil by health professionals.

Article info:
Submitted:
08-01-2024
Revised:
23-01-2024
Accepted:
25-01-2024

Keywords:
clove oil; eugenol; eugenyl acetate; β-caryophyllene; usage area

DOI: https://doi.org/10.53713/htechj.v2i1.139
This work is licensed under CC BY-SA License.

INTRODUCTION

The tropical perennial tree, Clove (*Syzygium aromaticum* (L.), is part of the Myrtaceae family, including myrtle, eucalyptus, and guava. Its taxonomic hierarchy can be found in Table 1. *S. aromaticum* can typically be found in woodland and rainforests (Miyazawa and Hisama, 2001). It grows best in loamy humus-rich soils and deep, loose laterite soils. The *S. aromaticum* tree is a small-medium-sized evergreen that can reach heights of 8-30 meters (Orwa et al., 2009). Its leaves are hairless and contain many oil glands on the undersurface. The flowers grow in clusters of small, terminal cymes, with 3-4 stalked flowers at the end of each stem. Clove is a valuable tropical spice plant commercially grown in India, Madagascar, Sri Lanka, Indonesia, and China's southern region (Taher et al., 2005). It is derived from dried, unopened flower buds, oleoresin, and eugenol. This essential oil has many applications in the pharmaceutical, cosmetic, food, tobacco, and agricultural industries (Ouadi et al., 2002).

Volume 02 Number 01
February 2024
p-ISSN: 2986-5662
e-ISSN: 2985-959X

Table 1. Taxonomic Hierarchy of *S. aromaticum*

Kingdom	Plantae – plantes, Planta, Vegetal, plants
Subkingdom	Viridiplantae – green plants
Infrakingdom	Streptophyta – land plants
Superdivision	Embryophyta
Division	Tracheophyta – vascular plants, tracheophytes
Subdivision	Spermatophytina – spermatophytes, seed plants, phanérogames
Class	Magnoliopsida
Superorder	Rosanae
Order	Myrtales
Family	Myrtaceae- myrtles, myrtacées
Genus	Syzygium P. Br. ex Gaetn.
Species	*Syzygium aromaticum* (L.) Merr, & L.M. Perry-clove, Synonym(s): *Caryophyllus aromaticus* L., *Syzygium aromaticum* Thunb., *Eugenia caryophyllus* (Spreng.) Bullock & S. Harrison, Common Name(s): clove [English]

(https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=506167#null, 23.06.2023).

The word "clove" comes from the English language and is derived from the Latin word "clavus," which means nail. This is because the shape of the clove resembles the structure of a nail (Bhowmik et al., 2012). Cloves have been used in traditional and culinary arts throughout history (Zheng et al., 1992). The American Food and Drug Administration (FDA) has approved the safety of clove buds, clove oil, and certain clove components as a food supplement. Similarly, the World Health Organization (WHO) has set the acceptable daily intake of cloves for humans at 2.5 mg (Ogunwande et al., 2005). Cloves contain several essential minerals such as magnesium, manganese, potassium, iron, and selenium (Bhowmik et al., 2012). They also contain a variety of vitamins including B1, B6, C, K, riboflavin, and A. (Cao et al., 2015). The oil of *S. aromaticum* is extracted from the flowers, leaves, and roots of the clove plant.

Clove contains various chemical compounds such as hydrocarbon, monoterpenes, phenolics, and sesquiterpene compounds (Mittal et al., 2014). The oil extracted from *S. aromaticum* consists of 85% Eugenol (4-allyl-2-methoxyphenol), 5.5% Eugenyl acetate, and 1.5% β-caryophyllene (Prashar et al., 2006). Table 2 provides a detailed summary of these components and their activities.

Clove has been reported to be effective in relieving toothache and for periodontal therapy (Date and Kulkarni, 1995; Cai and Wu, 1996) It has also been shown to have antibacterial properties against various bacteria such as *Escherichia coli, Listeria monocytogenes, Salmonella enterica, Campylobacter jejuni, Salmonella enteritidis,* and *Staphylococcus aureus* (Beuchat, 2000; Cressy et al., 2003; Kalemba et al., 2003). Additionally, studies have revealed its antiviral, antioxidant, and anti-inflammatory effects, as well as its anti-fungal, anti-emetic, anti-spasmolytic, analgesic, antiseptic, anti-carcinogenic, anti-allergic, and anti-mutagenic properties (Liu et al., 1997; Kim et al., 1998; Miyazawa and Hisama, 2001). *S. aromaticum* is particularly effective against both gram-positive and gram-negative bacteria. (Chaieb et al., 2007).

According to a study conducted in 1999, clove oil has antiepileptic properties as it activates the central nervous system (Pourgholami et al., 1999) Additionally, studies on rats indicate that clove oil inhibits calcium and potassium channels in the heart (Kozam, 1977; Sensch et al., 2000).

Volume 02 Number 01
February 2024
p-ISSN: 2986-5662
e-ISSN: 2985-959X

Table 2. Main Active Chemical Components and Activities of *S. aromaticum*

Compound	Bioactivity	Reference
β-Caryophyllene	antibacterial, anti-fungal, antioxidant, anti-proliferative, anxiolytic, neuroprotective, sedative, antitumour,	Selles, dahham Francomano
α-Humulene	anti-inflammatory and antitumor activity, antiproliferative	Selles, Haro-González
Carvone	antidiabetic, anti-inflammatory, anticancer, neurological, antimicrobial, antiparasitic, antiarthritic, anticonvulsant, and immunomodulatory effects	Selles, Bouyahya,
α-Farnesene	antimicrobial, antiviral	Selles, Habibah
δ-Cadinene	antibacterial activity, antioxidant	Selles, Trong, Wang
Eugenol	analgesic, anti-inflammatory, hypotensive, anticarcinogenic, antioxidant, antiparasitic, antifungal, antimicrobial, antispasmodic, antiseptic, dental analgesic, antiviral, and leishmanicidal	Selles, Abdou
Eugenyl Acetate	antibacterial, anticancer, antimutagenic, antioxidant, and anti-virulence activity	Selles, Haro-González
α-Cubebene	antimicrobial, antioxidant	Wang

Characteristics of major components

β-Caryophyllene

β-Caryophyllene (BCP) is a bicyclic sesquiterpene that occurs naturally in many plants (Friedman et al., 2000). It has been approved as a flavoring agent by both the Food and Drug Administration (FDA) and the European Food Safety Authority (EFSA) (Fidyt et al., 2016). BCP is an active ingredient in essential oils obtained from various spices and food plants. This compound possesses numerous biological properties, such as anti-inflammatory, anticarcinogenic, antimicrobial, antioxidant, and analgesic activities (Friedman et al., 2000; Fidyt et al., 2016). Studies have revealed that it has significant anticancer activity and can inhibit the growth and proliferation of various cancer cells.

Eugenol

Eugenol (4-allyl-2-methoxyphenol; C10H12O2) belongs to the phenol group of aromatic compounds and is the primary component of clove oil (*S. aromaticum*) (Ulanowska and Olas, 2021; Zari et al., 2021). It contains various functional groups, such as allyl (-CH2-CH=CH2), methoxy (−OCH3), and phenol (OH) (Zari et al., 2021). The phenolic structure of eugenol makes it highly active against microorganisms. It can disrupt proteins, thereby altering the permeability of the cell membrane (Gupta et al., 2008; Bhuiyan et al., 2010).

According to Guénette et al. (2007), eugenol has been found to alleviate neuropathic pain (Guénette et al., 2007). Clove oil possesses biological properties because of its constituents Eugenol has been shown to have anticancer effects on various cancer cell lines through cell death, cell cycle arrest, migration inhibition, metastasis, and angiogenesis (Huang et al., 2002; Velluti et al., 2003). It is effective against multiple types of cancer, including leukemia, lung cancer, colon cancer, colorectal cancer, skin cancer, stomach cancer, breast cancer, cervical cancer, and prostate cancer (Cassona et al., 2021; Nisar et al., 2021).

Eugenyl Acetate

Eugenyl Acetate is an aromatic compound that belongs to the class of esters. It has been approved for safe use in food products by the Joint FAO/WHO Expert Committee on Food

Volume 02 Number 01
February 2024
p-ISSN: 2986-5662
e-ISSN: 2985-959X

Additives (JECFA) and the European Food Safety Authority (EFSA) (Tischer et al., 2019; Petrocelli et al., 2021). Eugenyl Acetate is derived from eugenol, a phenylpropanoid, and has been found to possess antibacterial, anticancer, antimutagenic, antioxidant, and anti-virulence properties (Haro-González et al., 2021).

CONCLUSION

Clove has been used to treat many systemic ailments throughout history. However, the literature needs more information about the specific areas of application and groups of clove oil users. It is essential to have more comprehensive details on *S. aromaticum*. Health professionals should receive in-service training, symposiums, conferences, congresses, and other scientific meetings about the appropriate use of clove oil. It is crucial to remember that clove oil contains potent chemical compounds that can be harmful if misused. Therefore, it should only be used under the guidance and supervision of the healthcare team. It is also recommended that the public be informed about the appropriate use of clove oil by health professionals.

ACKNOWLEDGEMENT

The authors thank the participant for the support to the study.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Beuchat, LR. (2000). Control of foodborne pathogens and spoil-age microorganisms by naturally occurring antimicrobials. In Microbial Food Contamination, Wilson CL, Droby S (eds). CRC Press: Boca Raton, FL; 149–169.

Bhowmik D, Kumar KS, Yadav A, Srivastava S, Paswan S, & Dutta AS. (2012). Recent trends in Indian traditional herbs Syzygium aromaticum and its health benefits. *J. Pharm. Phytochem, 1*, 13–22.

Bhuiyan MNI, Begum J, Nandi NC, & Akter F. (2010). Constituents of the essential oil from leaves and buds of clove (Syzigium caryophyllatum (L.) Alston). *African Journal of Plant Science, 4*(11), 451-454.

Cai L, & Wu CD. (1996). Compounds from Syzygium aromaticum possessing growth inhibitory activity against oral patho-gens. *J Nat Prod, 59*, 987–990.

Cao Y, Qin Y, Bruist M, Gao S, Wang B, Wang H, & Guo X. (2015). Formation and dissociation of the interstrand i-motif by the sequences d (XnC4Ym) monitored with electrospray ionization mass spectrometry. *Journal of The American Society for Mass Spectrometry, 26*(6), 994-1003.

Cassano R, Cuconato M, Calviello G, Serini S, & Trombino S. (2021). Recent advances in nanotechnology for the treatment of melanoma. *Molecules, 26*, 785. doi: 10.3390/molecules26040785.

Chaieb K, Hajlaoui H, Zmantar T, Kahla-Nakbi AB, Rouabhia M, Mahdouani K, & Bakhrouf A. (2007). The chemical composition and biological activity of clove essential oil, E. caryophyllata (Syzigium aromaticum L. Myrtaceae): a short review. *Phytother Res, 21*, 501–506.

Chami F, Chami N, Bennis S, Bouchikhi T, & Remmal A. (2005). Oregano and clove essential oils induce surface alterationof Saccharomyces cerevisiae. *Phytother Res, 19*, 405–408.

Volume 02 Number 01
February 2024
p-ISSN: 2986-5662
e-ISSN: 2985-959X

Cressy HK, Jerrett AR, Osborne CM, & Bremer PJ. (2003). A novel method for the reduction of numbers of Listeria monocytogenes cells by freezing in combination with an essential oil in bacteriological media. *J Food Protect, 66*, 390–395.

Date KB, & Kulkarni PH. (1995). Assessment of Rasadanti in various oral disorders. *Ayurveda Res Pap II*, 165–175

Fidyt K, Fiedorowicz A, Strządała L, & Szumny A. (2016). β-caryophyllene and β-caryophyllene oxide—natural compounds of anticancer and analgesic properties. *Cancer medicine, 5*(10), 3007-3017.

Friedman M, Henika PR, & Mandrell RE. (2002). Bactericidal activities of plant essential oils and some of their isolated constituents against Campylobacter jejuni, Escherichia coli, Listeria monocytogenes, and Salmonella enterica. *J Food Prot, 65*, 1545–1560.

Guénette SA, Ross A, Marier JF, Beaudry F, & Vachon P. (2007). Pharmacokinetics of eugenol and its effects on thermal hypersensitivity in rats. *European journal of pharmacology, 562*(1-2), 60-67.

Gupta C, Garg A, Uniyal R, Gupta S. (2008). Comparison of antimicrobial activities of clove oil and its extract on some food borne microbes. *The Internet Journal of Microbiology, 7*(1).

Haro-González JN, Castillo-Herrera GA, Martínez-Velázquez M, & Espinosa-Andrews H. (2021). Clove Essential Oil (Syzygium aromaticum L. Myrtaceae): Extraction, Chemical Composition, Food Applications, and Essential Bioactivity for Human Health. *Molecules, 26*, 6387. https://doi.org/10.3390/molecules26216387

Huang Y, Ho SH, Lee HC, & Yap YL. (2002). Insecticidal properties of eugenol, isoeugenol and methyleugenol and their effects on nutrition of Sitophilus zeamais Motsch. (Coleoptera: Curculionidae) and Tribolium castaneum (Herbst) (Coleoptera: Tenebrionidae). *J. Stored Prod. Res, 38*, 403-412.

Kalemba D, Kunicka A. (2003). Antibacterial and antifungal properties of essential oils. *Curr Med Chem, 10*, 813– 829

Kim HM, Lee EH, Hong SH. et al. (1998). Effect of Syzygium aromaticum extract on immediate hypersensitivity in rats. *J Ethnopharmacol, 60*, 125–131

Kozam G. (1977). The effect of eugenol on nerve transmission. *Oral Surgery, Oral Medicine, Oral Pathology, 44*(5), 799-805.

Liu H, Mao P, & Hong S. (1997). Study on the virus function of extracorporeal restraining HCMV by Chinese traditional medicine Syzygium aromaticum Thunb. Med. J. Chin. *People's Liberation Army, 1*, 73-75

Mittal M, Gupta N, Parashar P, Mehra V, & Khatri M. (2014). Phytochemical evaluation and pharmacological activity of Syzygium aromaticum: a comprehensive review. *Int J Pharm Pharm Sci, 6*(8), 67-72.

Miyazawa M, & Hisama M. (2021). Suppression of chemical mutageninduced SOS response by alkylphenols from clove (Syzygium aromaticum) in Salmonella typhymurium TA1535/pSK1002 umu test. *J Agric Food Chem, 49*, 4019–4025.

Nisar MF, Khadim M, Rafiq M, Chen J, Yang Y, & Wan CC. (2021). Pharmacological Properties and Health Benefits of Eugenol: A Comprehensive Review. Oxidative Med. *Cell Longev,* 1–14. doi: 10.1155/2021/2497354.

Ogunwande I, Olawore N, Ekundayo O, Walker T, Schmidt J, & Setzer W. (2005). Studies on the essential oils composition, antibacterial and cytotoxicity of Eugenia uniflora L. *Int. J. Aromather, 15*, 147–152.

Orwa C, Mutua A, Kindt R, Jamnadass R, & S Anthony. (2009). *Agroforestree Database: a tree reference and selection guide version 4.0 2009* (http://www.worldagroforestry.org/sites/treedbs/treedatabases.asp)

Volume 02 Number 01
February 2024
p-ISSN: 2986-5662
e-ISSN: 2985-959X

Ouadi S, Sierro N, Goepfert S, Bovet L, Glauser G, Vallat A, ... & Ivanov NV. (2002) The clove (Syzygium aromaticum) genome provides insights into the eugenol biosynthesis pathway. *Communications Biology, 5*(1), 684.

Petrocelli G, Farabegoli F, Valerii MC, Giovannini C, Sardo A, & Spisni E. (2021). Molecules Present in Plant Essential Oils for Prevention and Treatment of Colorectal Cancer (CRC). *Molecules, 26*, 885. doi: 10.3390/molecules26040885.

Pourgholami MH, Kamalinejad M, Javadi M, Majzoob S, & Sayyah M. (1999). Evaluation of the anticonvulsant activity of the essential oil of Eugenia caryophyllata in male mice. *Journal of ethnopharmacology, 64*(2), 167-171.

Prashar A, Locke IC, & Evans CS. (2006). Cytotoxicity of clove (Syzygium aromaticum) oil and its major components to human skin cells. *Cell Proliferation, 39*(4), 241-248.

Sensch O, Vierling W, Brandt W, & Reiter M. (2000). Effects of inhibition of calcium and potassium currents in guinea-pig cardiac contraction: comparison of β-caryophyllene oxide, eugenol, and nifedipine. *British Journal of Pharmacology, 131*(6), 1089-1096.

Taher YA, Samud AM, El-Taher FE, ben-Hussin, G4, Elmezogi JS, Al-Mehdawi BF, & Salem HA. (2005) Experimental evaluation of anti-inflammatory, antinociceptive and antipyretic activities of clove oil in mice. *Libyan J Med, 10*, 28685.

Tischer JS, Possan H, Luiz J, Malagutti NB, Martello R, Valério A, & Oliveira JV. (2019). Synthesis of eugenyl acetate through heterogeneous catalysis. *Journal of Essential Oil Research, 31*(4), 312-318.

Ulanowska M, & Olas B. (2021). Biological Properties and Prospects for the Application of Eugenol -A Review. *Int. J. Mol. Sci, 22*, 3671. https://doi.org/10.3390/ijms22073671

Velluti A, Sanchis V, Ramos AJ, Marı'n S. (2003). Inhibitory effect of cinnamon, clove, lemongrass, oregano and palmarose essential oils on growth and fumonisin B1 production by Fusarium proliferatum in maize grain. *Int. J. Food Microbiol, 89*, 145-154.

Zari AT, Zari TA, & Hakeem KR. (2021). Anticancer Properties of Eugenol: A Review. *Molecules, 26*, 7407. https://doi.org/10.3390/molecules26237407

Zheng GQ, Kenney PM, & Lam LKT. (1992). Sesquiterpenes from clove (Eugenia caryophyllata). *J Nat Prod, 55*, 999–1003.