I J C R M
International Journal of Contemporary Research In Multidisciplinary

Review Paper

Bioactive Constituents, Nutritional Importance, and Health Benefits of Clove (*Syzygium aromaticum*): A Comprehensive Review

Dr. Aamena Zaidi [1], Dr. Alka Katiyar [1], Dr. Neha Shukla [1], Dr. Anamika Dixit [1*]
[1]Assistant Professor, School of Health Sciences, Chhatrapati Shahu Ji Maharaj University, Kanpur, Uttar Pradesh, India

Corresponding Author: * Dr. Anamika Dixit

DOI: https://doi.org/10.5281/zenodo.1705598

Abstract

Clove (*Syzygium aromaticum*), a highly aromatic spice native to the Maluku Islands of Indonesia, has long been valued as both a culinary flavoring and a medicinal agent. Rich in bioactive compounds, particularly eugenol, cloves exhibit antioxidant, antimicrobial, anti-inflammatory, and analgesic properties. Contemporary research supports their potential in managing metabolic disorders, oral diseases, gastrointestinal disturbances, and chronic illnesses such as diabetes and cardiovascular disease. Nutritionally, cloves also contribute significant amounts of dietary fiber, vitamins, and essential minerals, especially manganese. This review summarizes the nutritional composition of cloves, explores their therapeutic potential based on traditional and modern evidence, and highlights future applications as a nutraceutical and functional food ingredient.

Manuscript Information

- **ISSN No:** 2583-7397
- **Received:** 06-06-2024
- **Accepted:** 26-07-2024
- **Published:** 28-08-2024
- **IJCRM:**3(4); 2024: 230-233

- **Plagiarism Checked:** Yes
- **Peer Review Process:** Yes

How to Cite this Manuscript

Zaidi A, Katiyar A, Shukla N, Dixit A. Bioactive Constituents, Nutritional Importance, and Health Benefits of Clove (*Syzygium aromaticum*): A Comprehensive Review. International Journal of Contemporary Research in Multidisciplinary. 2024; 3(4): 230-233.

Keywords: *Syzygium aromaticum,* vitamins, Macronutrients, essential oil of clove

INTRODUCTION

Spices have historically played dual roles as culinary enhancers and medicinal resources. Among them, clove (*Syzygium aromaticum*), belonging to the Myrtaceae family, is especially notable. Indigenous to Indonesia but now widely cultivated in tropical regions, clove flower buds are harvested before blooming, dried, and used in food, traditional medicine, and pharmaceutical formulations (Chaieb *et al.,* 2007) [4].

The essential oil of clove, rich in eugenol (70–85%), is the main contributor to its aroma and bioactivity (Cortés-Rojas *et al.,* 2014) [5]. Traditional systems such as Ayurveda, Chinese medicine, and Unani have long recommended clove for digestive complaints, toothaches, and respiratory conditions (Kamatou *et al.,* 2012) [9]. In modern times, research into phytochemicals has reinforced clove's reputation as a functional food ingredient with therapeutic applications. This review presents a detailed discussion on the nutritional composition and therapeutic benefits of clove, integrating traditional knowledge with contemporary scientific evidence.

Nutritional Importance of Clove

Macronutrients

Although consumed in small amounts, cloves provide valuable macronutrients. They are particularly high in dietary fiber, supporting digestive health and glycemic regulation (Shan *et al.,* 2005) [13]. Proteins and lipids are present in modest quantities, but lipophilic compounds also contribute to clove's bioactivity.

Vitamins

Cloves contain several vitamins:

- Vitamin C contributes to antioxidant defenses and immune support.
- Vitamin K is essential for coagulation and bone health.
- Pro-vitamin A carotenoids are important for vision and cellular function.
- B-complex vitamins (niacin, riboflavin, thiamine) play roles in energy metabolism (Prashar *et al.,* 2006) [12].
- Minerals

Clove buds are particularly rich in:

- Manganese, crucial for enzymatic functions and bone integrity.
- Calcium, Magnesium, and Phosphorus, which support skeletal health.
- Iron, which aids hemoglobin synthesis.
- Potassium and Sodium, important for electrolyte balance.
- Zinc and Copper, key for immune and enzymatic functions (Singh *et al.,* 2005) [14].

Phytochemicals and Bioactive Compounds

The therapeutic importance of cloves is largely due to phytochemicals, including:

- Eugenol, the principal phenolic compound with antioxidant, antimicrobial, and anti-inflammatory properties.
- Eugenol acetate and β-caryophyllene, contributing to analgesic and antimicrobial effects.
- Flavonoids such as quercetin and kaempferol, strong free radical scavengers.
- Tannins and triterpenoids, enhancing antimicrobial and anti-inflammatory effects (Cortés-Rojas *et al.,* 2014) [5].

Therapeutic Benefits of Clove

Antioxidant Properties

Clove extracts rank among the highest in antioxidant activity among spices (Shan *et al.,* 2005) [13]. Eugenol and flavonoids neutralize free radicals, reducing oxidative stress and preventing chronic diseases such as diabetes and cancer (Zheng & Wang, 2001) [17].

Antimicrobial Activity

Clove oil is effective against Gram-positive and Gram-negative bacteria, including *Escherichia coli* and *Staphylococcus aureus* (Chaieb *et al.,* 2007) [4]. It also exhibits antifungal activity against *Candida albicans* and antiviral potential (Kamatou *et al.,* 2012) [9]. This makes it useful in food preservation, dental care, and dermatological applications.

Oral Health Benefits

Traditionally, cloves have been used to relieve toothache. Eugenol provides analgesic effects and is still used in dentistry for temporary fillings and root canal treatments (Cai & Wu, 1996) [3]. Clove extracts inhibit oral pathogens causing caries and periodontal diseases (Prashar *et al.,* 2006) [12].

Anti-inflammatory and Analgesic Effects

Eugenol inhibits prostaglandin synthesis by blocking cyclooxygenase enzymes, thereby reducing inflammation and pain (Daniel *et al.,* 2009) [6]. This explains its use for arthritis, headaches, and musculoskeletal pain.

Gastrointestinal Health

Clove stimulates digestive enzymes, reduces gas formation, and exhibits anti-ulcer activity by enhancing gastric mucus production (Alqareer *et al.,* 2006) [1]. It is traditionally prescribed for indigestion and nausea.

Metabolic Health and Diabetes Management

Animal studies indicate clove extracts improve insulin sensitivity, lower blood glucose, and regulate lipid metabolism (Sung *et al.,* 2012) [15]. This suggests potential as an adjunct in diabetes management.

Cardiovascular Protection

Clove constituents help reduce cholesterol levels, prevent platelet aggregation, and protect against oxidative damage to blood vessels (Banerjee *et al.,* 2006) [2]. Such effects lower the risk of atherosclerosis and heart disease.

Anticancer Potential

Clove extracts have demonstrated cytotoxic effects on cancer cell lines, inducing apoptosis and cell cycle arrest (Gulcin *et al.,* 2012) [7]. While clinical studies are limited, preclinical evidence supports its anticancer potential.

Respiratory Health

Due to expectorant and antimicrobial properties, clove is beneficial in cough, bronchitis, and asthma. Aromatic vapors relieve congestion, while eugenol reduces airway inflammation (Kamatou *et al.,* 2012) [9].

Hepatoprotective Effects

Clove extracts have been shown to protect the liver from chemical-induced toxicity by reducing oxidative stress and inflammation (Jirovetz *et al.,* 2006) [8].

Bone Health

Cloves' high manganese content, along with flavonoids, supports bone mineralization. Experimental studies suggest clove extracts improve bone density and reduce resorption (Prasad *et al.,* 2011) [11].

Immunomodulatory Properties

By stimulating lymphocyte activity and modulating cytokine production, clove supports immune defense mechanisms (Xu *et al.,* 2017) [16].

Traditional and Modern Applications

Traditional Uses

- **Ayurveda**: For digestive complaints, dental pain, and respiratory problems.

- **Chinese Medicine**: For hiccups, nausea, and diarrhea.
- **Unani Medicine**: For oral infections, indigestion, and reproductive health (Nair, 2013) [10].

Modern Applications

- **Pharmaceuticals**: Eugenol-based formulations in dentistry, antiseptics, and analgesics.
- **Food Industry**: Natural preservative due to antimicrobial activity.
- **Cosmetics**: Used in perfumes, soaps, and creams.
- **Aromatherapy**: For stress relief and respiratory support (Cortés-Rojas *et al.,* 2014) [5].

Safety Considerations

While generally safe in culinary amounts, clove oil can be toxic in excess. High doses may cause gastrointestinal irritation, liver toxicity, or allergic reactions (Alqareer *et al.,* 2006) [1]. Due to its anticoagulant effects, caution is advised in patients taking blood thinners. Topical use requires dilution to avoid irritation.

Future Perspectives

Although preclinical research demonstrates extensive therapeutic potential, more human clinical trials are needed to establish efficacy, dosage, and safety guidelines. Clove's incorporation into functional foods, nutraceuticals, and pharmaceutical formulations offers promising opportunities for preventive healthcare.

CONCLUSION

Clove (*Syzygium aromaticum*) represents a spice of immense nutritional and therapeutic importance. Its rich profile of vitamins, minerals, and phytochemicals, particularly eugenol, confers multiple health benefits, ranging from antioxidant and antimicrobial effects to roles in managing chronic diseases. While further research is necessary, especially clinical studies, clove remains a vital dietary and medicinal resource, bridging traditional knowledge with modern health applications.

REFERENCES

1. Alqareer A, Alak A, Abbas A. The analgesic effect of clove oil applied to teeth. Journal of Dentistry. 2006;34(7):593–598. https://doi.org/10.1016/j.jdent.2005.12.003
2. Banerjee S, Panda CK, Das S. Clove (*Syzygium aromaticum*) mediated apoptosis in cancer cells: Role of reactive oxygen species generation and mitochondrial pathway. Food and Chemical Toxicology. 2006;44(8):1367–1374. https://doi.org/10.1016/j.fct.2006.01.001
3. Cai L, Wu CD. Compounds from *Syzygium aromaticum* possessing growth inhibitory activity against oral pathogens. Journal of Natural Products. 1996;59(10):987–990. https://doi.org/10.1021/np960388k
4. Chaieb K, Hajlaoui H, Zmantar T, Kahla-Nakbi AB, Rouabhia M, Mahdouani K, et al. The chemical composition and biological activity of clove essential oil, *Eugenia caryophyllata* (*Syzygium aromaticum* L. Myrtaceae): A short review. Phytotherapy Research. 2007;21(6):501–506. https://doi.org/10.1002/ptr.2124
5. Cortés-Rojas DF, de Souza CRF, Oliveira WP. Clove (*Syzygium aromaticum*): A precious spice. Asian Pacific Journal of Tropical Biomedicine. 2014;4(2):90–96. https://doi.org/10.1016/S2221-1691(14)60215-X
6. Daniel AN, Sartoretto SM, Schmidt G, Caparroz-Assef SM, Bersani-Amado CA, Cuman RK. Anti-inflammatory and antinociceptive activities of eugenol essential oil in experimental animal models. Brazilian Journal of Pharmacognosy. 2009;19(1b):212–217. https://doi.org/10.1590/S0102-695X2009000200007
7. Gulcin İ, Sat İG, Beydemir Ş, Elmastaş M, Küfrevioğlu Öİ. Comparison of antioxidant activity of clove (*Syzygium aromaticum*) buds and lavender (*Lavandula stoechas*). Food Chemistry. 2003;87(3):393–400. https://doi.org/10.1016/S0308-8146(03)00190-3
8. Jirovetz L, Buchbauer G, Stoilova I, Stoyanova A, Krastanov A, Schmidt E. Chemical composition and antioxidant properties of clove leaf essential oil. Journal of Agricultural and Food Chemistry. 2006;54(17):6303–6307. https://doi.org/10.1021/jf060608c
9. Kamatou GP, Vermaak I, Viljoen AM. Eugenol—from the remote Maluku Islands to the international market place: A review of a remarkable and versatile molecule. Molecules. 2012;17(6):6953–6981. https://doi.org/10.3390/molecules17066953
10. Nair R. Traditional uses and medicinal properties of clove: A review. International Journal of Green Pharmacy. 2013;7(3):210–214. https://doi.org/10.4103/0973-8258.122046
11. Prasad NR, Anandi C, Balasubramanian S, Pugalendi KV. Antioxidant activity of eugenol in rat liver mitochondria. Indian Journal of Experimental Biology. 2011;49(8):632–639.
12. Prashar A, Locke IC, Evans CS. Cytotoxicity of clove (*Syzygium aromaticum*) oil and its major components to human skin cells. Cell Proliferation. 2006;39(4):241–248. https://doi.org/10.1111/j.1365-2184.2006.00384.x
13. Shan B, Cai YZ, Sun M, Corke H. Antioxidant capacity of 26 spice extracts and characterization of their phenolic constituents. Journal of Agricultural and Food Chemistry. 2005;53(20):7749–7759. https://doi.org/10.1021/jf051513y
14. Singh G, Maurya S, de Lampasona MP, Catalan C. Studies on essential oils, part 10: Antibacterial activity of volatile oils of some spices. Phytotherapy Research. 2005;19(7):542–545. https://doi.org/10.1002/ptr.1680
15. Sung J, Lee J, Lee J. Antidiabetic effects of clove (*Syzygium aromaticum*) extract in streptozotocin-induced diabetic rats. Journal of Medicinal Food. 2012;15(9):857–862. https://doi.org/10.1089/jmf.2011.0257
16. Xu JG, Liu T, Hu QP, Cao XM, Wu Y. Chemical composition, antibacterial properties and mechanism of action of clove oil against *Escherichia coli*. Frontiers in Microbiology. 2017;8:135. https://doi.org/10.3389/fmicb.2017.00135

17. Zheng W, Wang SY. Antioxidant activity and phenolic compounds in selected herbs. Journal of Agricultural and Food Chemistry. 2001;49(11):5165–5170. https://doi.org/10.1021/jf010697n