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REVIEW ARTICLE

CLOVE (*SYZYGIUM AROMATICUM)* – A REVIEW BASED UPON ITS TRADITIONAL THERAPEUTIC USES.

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ABSTRACT

Clove (*Syzygium aromaticum*), also known as "lavang" in Ayurveda, is a most commonly used spice in Indian traditional system. About 80% of the occupants utilize clove as a traditional prescription as it contains medicinal properties which helps in treating diseases like vomiting, asthma, nausea, liver and stomach disorder. Majorly clove is consumed as a spice in Indian home kitchens. This plant contains active constituents that possess anti-fungal, anti-viral, anti-microbial, antidiabetic, anti-platelet, anaesthetic, anti-inflammatory, anti-oxidant, antithrombotic, pain-relieving, and insect repellent properties. This plant serves as the richest source of phenolic compounds such as eugenol, eugenol acetate, and gallic acid which is used in various applications like in agriculture, pharmaceutical, and in various food preservatives.

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INTRODUCTION

A restorative plant is used by individuals for tremendous medicinal purposes and to maintain a good health, fight off infections or advance recuperation from ailment or setback. From the reported plant literature, it is discovered that clove is playing a good role in therapeutics (1). Moreover, the traditional medicines mainly the plant herbs are promoting the essential healthcare of a greater part of society universally more than the allopathic medicinal system. Clove or "Laung" is utilized as a food preservative (2). Restorative spices make a compelling hotspot for traditional and present-day medication. These plants have given shape to the traditional medicinal systems like Unani, Siddha, Ayurveda, and Chinese (3,4). In recent years, herbal plants have been obtaining great importance due to the concept that these plants being essential products have fewer side effects and improved adequacy than the allopathic medicinal system (5). Many plant species are known to have pharmacological activity because of the presence of their phytoconstituents such as glycosides, saponins, flavonoids, steroids, tannins, alkaloids, terpenes (6). *Syzygium aromaticum* (clove) is a common spice that has been used for food conservation and has different pharmacological actions.

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Cloves (Fig 1) are the sweet-smelling dried buds of a tree named botanically as *Eugenia caryophyllata* likewise sometimes *Syzgium aromaticum* and also used as a spice in home kitchens world widely. The term 'Clove' is derived from the French word 'Clou' and the English word 'Clout', both meaning 'nail'- as similar as flower bud of the Clove tree to a wide headed nail (7). This plant serves as one of the richest sources of phenolic compounds such as eugenol, eugenol acetate, and gallic acid and possesses great potential for pharmaceutical, cosmetic, food, agricultural, and for many other applications (8).

Fig. 1. Clove (*Syzgium aromaticum*)

Botanical distribution: Cloves are member of the genus comprising of 400-500 types of evergreen trees and herbs. The generic name is derived from the Greek word *syzygies* which mean paired.

Taxonomy of Clove/Laung (*Syzygium aromaticum*) (9)

Taxonomical Rank	Taxon
Kingdom	Plantae
Phylum	Spermatophyta
Subphylum	Angiospermae
Class	Dicotyledonae
Order	Myrtales
Family	Myrtaceae
Genus	*Syzygium*
Species	*aromaticum*
Common name	Laung

Vernacular Names of Clove (10,11)	
English	Clove
Hindi	Laung, Laumg, Lavang
Sanskrit	Bhadrasriya, Devakusuma, Devapuspa, Haricandana, Karampu, Lavanga, Lavangaka, Lavangam, Varala.
Malayalam	Grampu, Karampu, Karayampu
Marathi	Luvang
Kannada	Lavanga, Daevakusuma, Krambu
Tamil	Kirampu, Ilavankam, Kiraambu, Kirambu,Grambu
Telugu	Devakusumamu, Lavangamu, Lavangalu, Kaaravallu
Bengali	Lavanga
Gujarati	Lavang
Punjabi	Laung
Oriya	Labanga
Urdu	Laung, Loung
Arabic	Kabsh qarunfil, Kabsh qaranful, qaranful
Bulgarian	Karamfil
Chinese	Ding xiang
Dutch	Kruidnagel
Danish	Nellike
French	Giroflier ,Cloude girofle
German	Gewürznelke , Nelke
Greek	Garifalo
Georgian	Mikhaki, Mixaki
Hungarian	Szegfu
Indonesian	Cengke, Cengkeh
Italian	Chiodo di garofano
Japanese	Girofla, Choji, Kurobu
Korean	Jeonghyang
Latvian	Krustnaglinas
Nepalese	Lwaang
Norwegian	Nellik
Portuguese	Cravo de India
Persian	Mikhak
Pashto	Kala
Russian	Gvosdika, Pazhitnik grecheski, Shambala, Pazhitnik cennoj
Spanish	Clavo, Clavo de olor
Swedish	Kryddnejlika, Kryddnejlikor, Nejlikor
Turkish	Carenfil
Thai	Khan plu, Garn ploo
Vietnamese	Dhing huong

This is because the leaves and twigs present in few species develop at a similar point. The clove tree is monoecious, consists of hermaphrodite flowers that are self-pollinating. The tree grows between 8-10 years after the plantation of the tree. Clove tree consists of numerous semi-erect branches. Leaves are smooth, having several oil glands on the lower surface. Clove tree consists of little flowers, possesses cymose inflorescence. Every peduncle bears 3-4 stalked flowers toward the terminal region. Clove consists of minute sepals that have four-sided projections. Fruits are olive-shaped, single-seeded, and known as the 'mother of clove'. Fruits develop roughly 9 months after flowering and are develop when the excerpt changes into ruddy purple. The vast majority of the plant's parts are fragranced (leaves, flowers, and bark). The earthy coloured, dried, unopened flower buds are called cloves, a name derived from the French "clou" which means nail (12).

Geographical Distribution: The clove is highly produced in Indonesia, India, Malaysia, Sri Lanka, Madagascar, and Tanzania especially the Zanzibar island (13). Clove was first acquainted in India around 1800 AD by the East India organization in its 'flavor garden' in Courtallam, Tamil Nadu (14). The significant clove developing areas in India presently are Nilgiris, Tirunelveli, Kanyakumari, Nagercoil, and Ramanathapuram regions of Tamil Nadu; Kozhikode, Kottayam, Kollam, and Thiruvananthapuram regions of Kerala and South Kanara region of Karnataka (15). In Brazil, clove is refined in the upper east area, in the province of Bahia in the areas of Valença, Ituberá, Taperoá, Camamu, and Nilo Peçanha (16).

Phytochemicals constituents of clove: The chemical constituents of clove are divided into two parts i.e. volatile and non-volatile.

Volatile Chemical constituents: Clove yields various kinds of volatile oil from leaves, stem, buds and the fruit. 1. Stem oil: These oils differ extensively in yield and quality. The main extract of the oil is eugenol. The various volatile constituents are: 1) bud oil. The oil contains Eugenol (70–85%), eugenyl acetic acid (15%), and β-caryophyllene (5–12%), which together constitutes 99% of the oil. The constituents of the oil likewise incorporate methyl amyl ketone, methyl salicylate, α and β-humulene, benzaldehyde, β-ylangene, and chavicol. The fragrance of the clove is due to the presence of minor constituents like methyl amyl ketone, methylsalicylate. Stem oil also contains 76.4–84.8% eugenol and 1.5–8.0% eugenyl acetate. Both bud and stem oil contain 7.3–12.4% β-caryophyllene and 1.0–1.4% α- humulene (17). There are 36 compounds extracted from the volatile oil of clove buds (18).

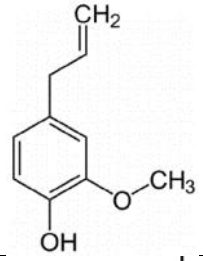
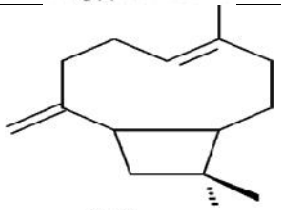
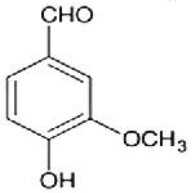
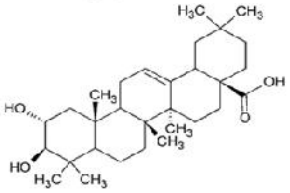
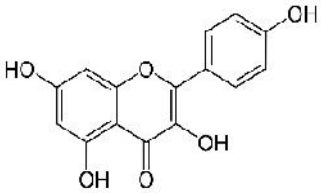
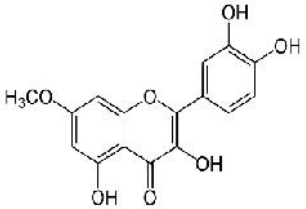
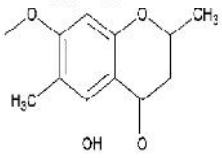
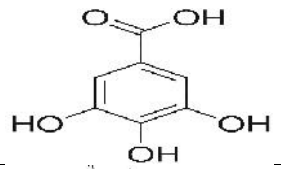
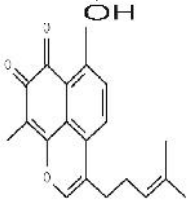
2) Leaf Oil: Clove leaves yield 3.0–4.8% basic oil. The oil content during the various phases of leaf development reveals that the eugenol content in the leaves increases from 38.3 to 95.2% with development, while the substance of eugenol acetic acid derivation (51.2 to 1.5%) and caryophyllene (6.3 to0.2%) diminished. Clove bud and leaf oil contain different classes of chemical extract, for example, monoterpenes, sesquiterpenes, aldehydes, and ketones (19). 3) Clove Stem Oil: Clove stem contains 6% of oil. The stem oil consists of light yellow fluid containing 80.2% eugenol and 6.6% β-caryophyllene (20). 4) Fruit Oil: It contains 2% of oil, which possesses 50–55 % eugenol. Non-Volatile Chemical constituents: Few non-volatiles oils have been isolated from clove, which include tannins, sterols, triterpenes, and flavonoids.

Tannins: 10-13% of tannins components are present in non-volatile oil among which Eugenin and ellagitannin were separated from the plant. Eugenol glucoside gallate, a chromone C-glycoside, galloyl, and hexahydroxy diphenyl esters of 2, 4, 6-trihydroxy acetophenone- 3-glucopyranoside were extracted from leaves (21). The two ellagitannins, syzyginin A (1, 2, 3-tri-O-galloyl–4, 6-(S) - tergalloyl-βD-glucoside) and syzyginin B, were also obtained from the clove leaves (22).

Triterpenes: Cloves have about 2% of the triterpene and oleanolic acid. Maslinic acid and 2 α-hydroxyoleanolic acids were also extracted from clove buds (23,24).

Sterols: Sterols extracted from clove include sitosterol, stigmasterol, and campesterol (25).

Table 1. Phytochemical constituents of Clove

Chemical constituent	Biological property	Chemical structure
Eugenol	Antimicrobial, Analgesic, Antioxidant, Anticancer, Anthelmintic, Antiulcer, Anti-inflammatory, Anti-depressant, Bone preserving, antipyretic, Antithrombotic (28).	
β-caryophyllene	Antitumor, anti-apoptotic Anesthetic, Anti-lishmanial, Anti-inflammatory, Antioxidant, antibiotic (29,30,31,32,33).	
Vanillin	Antimicrobial, Antioxidant, Antidepressant (34,35,36).	
Crategolic acid	Antitumor (37).	
Kaempferol	Antimicrobial, Antioxidant, Anti-inflammatory, Anticancer (38,39,40).	
Rhamnetin	Anti-inflammatory, Antioxidant, Cardio protective, Antifungal (41,42,43).	
Eugenitin	Antifungal (44).	
Gallic acid	Antimicrobial, Antioxidant, Anti-inflammatory (45,46).	
Biflorin	Antibacterial, Antioxidant, Anticancer (47,48).	

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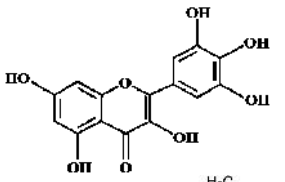
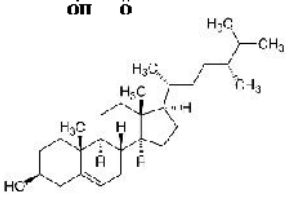
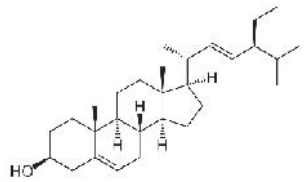
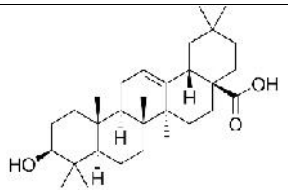
Myricetin	Antimicrobial, Antioxidant, Anticancer, Anti-inflammatory (49,50,51).	
Campesterol	Antibacterial, Antinociceptive, Anti-carcinogenic (52,53,54).	
Stigmasterol	Antitumor, Acaricidal, Block cartilage degradation (55,56,57).	
Oleanolic acid	Anti-diabetic, Antimicrobial, Anticancer (58,59,60).	

Flavonoids: A chromone C-glucoside, isobiflorin (5, 7-dihydroxy-2- methoxychromone-8-C-β-D-glucopyranoside), and biflorin were isoated from the ethanolic extract of cloves. The seed of the clove possesses various ailments viz., apigenin 6-C-(β-D-xylopyranosyl-(1→2″)- β-Dgalactopyranoside)-7-O-β-D-glucopyranoside and apigenin-6-C-(β-D-xylopyranosyl-(1→ 2″)-β-Dgalactopyranoside)-7-O-β-D-(6-O-pcoumaryl glucopyranoside) (26, 27). The chemical structures of some major chemical constituents are shown in table no. 1

Folk Use: About 80% of the world's population depend on traditional medicines because of their fewer side effects and good results (61). Traditionally, cloves have been utilized quite for a long time in the treatment of vomiting, flatulence, nausea, liver, bowel, and stomach disorders, and as a stimulant for the nerves. In tropical Asia, cloves have been used to restrain various microorganisms as scabies, cholera, malaria, and tuberculosis. Also in America, clove has been traditionally used in repressing food-borne microbes to treat infections, worms, candida, and diverse bacterial and protozoan contaminations (62).

Clove/Laung in Ayurveda: Clove, also known as Lavang in Ayurveda, is normally used as a cooking spice. This fragrant, delightful flavor contains an abundance of healing potential and has been yearly used for treating many medical issues (63). Ras panchak i.e. properties of clove according to traditional ayuervedic system is given in Table no. 2

Laung is a spice that balances the three fundamental doshas of human body i.e. Vata (Space and Air component), Pitta (Fire and water component), and Kapha (Water and earth component). Although it will build Pitta (heat) when taken in access.

It exhibits properties like Deepana (Appitizer), Pachana (Digestion), Ruchya (Appitizer), Chakshushya (improves site), Kapha-Pittaghana properties. It is used in Trishna (Thirst) Chhardi (Vomiting), Aadhmana (Bloating), Shoola (Pain), Kasa (Cough), Shwasa (Respiratory problem), Hikka (Hiccups), Kshaya (generalise weakness) that are named diseases. According to Ayurveda, it causes lysis of gathered Kapha. Which is considered as a Dosha among Tridosha (65).

Properties of Laung: Sansthanik karma Baham (□र□□□ □□ □ह्म): It is used in the perfume industry. It inhibits the bad smell and odor.

Table 2. Ras Panchak (Properties) of Clove as per Ayurveda

Sanskrit/English	Sanskrit/English
Virya/Potency	Sheeta/Cold
Vipak/Metabolic property	Kattu/Pungent
Guna/Physical property	Laghu/small, Sanigadh/oily
Rasa/Taste	Tikta/Bitter, Kattu/Pungent

Abhiyantar- Nadisansathan (□I□□□न्ति□- □□□ □र□□□) It is useful in the nervous system.

Take 1/2 teaspoon of clove powder with 1 teaspoon of Brahmi powder and put a touch of ginger powder. Mix these spices in 1/2 cup of warm water and take them multiple times every day after every meal. Pachan: Sansathan (□□□□- □र□□□): It helps in indigestion. After every diet take 1 teaspoon of clove powder in 1 teaspoon of nectar. For more potency, include 1/2 teaspoon of Trikatu Churna (avoid Pitta) and increase the quantity of nectar to 1-1/2 teaspoons (66).

Table 3. Reported therapeutic uses of clove

Various uses of Clove	
Anti-viral	The clove bud essential oil extract called Eugenin was proven to have significant inhibitory impact on herpes simplex virus at 10µg/ml dosage (72). The antiviral action of eugenin, a compound segregated from *S. aromaticum* and *Geum japonicum*, was examined against herpes infection strains being viable at 5 µg/mL, and it was shown eugeniin is important in the viral DNA combination by the restraint of the viral DNA polymerase(73,74).
Analgesic activity	Eugenol extracted from clove was associated with the analgesic activity of clove (75).
Anti-inflammatory	Eugenol, b-caryophyllene, kaempferol, and rhamnetin, Eugenia are known to possess significant Anti-inflammatory activities (76,77).
Anti-hypersensitivity	Aqueous extract obtained from the bud of clove flower was proved to have great impact on immediate hypersensitivity in rats by inhibiting the histamine release from mast cells (78).
Anti-carcinogenic	Eugenol and few other extracts like sesquiterpenes, b-caryophyllene, b-caryophyllene epoxide, a-humulene, humulene epoxide showed strong anti-cancerous properties by activating the detoxifying enzyme, glutathione -S-transferase, in mouse liver small intestine(79).
Larvicidal agent	Clove, as a larvicidal specialist has a great methodology to battle dengue which is a genuine medical condition in Brazil and other tropical nations (80).
Aphrodisiac	50% ethanolic concentrate of clove delivered a significant and supported expansion in the sexual activity of normal male rats, with no obvious gastric ulceration and antagonistic impacts (81).
Anti-oxidant	Eugenol possesses anti-oxidant activities (82). The essential oil of clove leaf was shown to have scavenging activity against the 2,2-diphenyl-1-picryl hydrazyl(DPPH) radical at lower concentrations than eugenol, butylated hydroxytoluene (BHT), and butylated hydroxyanisole (BHA). It also has an inhibitory effect against hydroxyl radicals (83,84).
Anti-bacterial	The essential oil of clove was proved to be effective against *Streptococci*, *Staphylococci*, and *Pneumomocci*, *S. mutans*, and *Enterococcus faecalis* bacteria which are the main cause of several diseases (85,86,87,88).
Antinociceptive	Clove, as pain-relieving herb wasnoted since the thirteenth century, for toothache, joint torment, and antispasmodic, due to the presence of eugenol as the principal compound liable for this movement(89).
Anti-platelet	It was found that eugenol and acetyl eugenol when utilized in combination potentiated restraint of platelet collection instigated by arachidonate, adrenaline, and collagen, shows anti-platelet activity (90).
Mosquito-repellent	*Anopheles albimanus*, *Aedes aegypti*, *A. dirus*, and *Culex quinquefasciatus* got repelled by clove oil, due to its mosquito-repellent activity (91,92).
Insecticidal	The clove leaf and bud oils exhibited great insecticidal property against the human headlouse (*Pediculus capitis*) (93).
Anaesthetic	Clove oil eugenol is widely used as an anesthetic in aquatic research for channel catfish and many more fishes (94,95).
Hepatoprotective	The ethanol extract of clove indicated exceptional hepatoprotective action against paracetamol-initiated liver injury in female rats (96).
Anti-pyretic	Eugenol was found to diminish fever in hares when given intravenously in low dosages. Eugenol was more compelling in decreasing fever than acetaminophen (97)
Carminative	Cloves have a carminative action as it enhances peristalsis and increase hydrochloric acid in the stomach. (98).
Memory enhancer	Ethanolic extract of clove is utilized to improve the learning and memory capacity (99).
Earache	When warm clove oil is utilized with sesame oil, it provides relief from the earache. Thus used as a good remedy for earache (100).
Anti-stress	The hydro-alcoholic extract of clove is associated with anti-stress properties (101).

Rakatvah: sansathan (□क्त□□ □रा□□): It possesses heart-healing properties. It is useful in regulating blood circulation. Take 1/2 teaspoon of clove powder with 1/2 teaspoon of cinnamon and an enormous spot of ginger powder. This can either be taken in 1 cup of warm water or with 1 to 2 teaspoons of nectar (or both). Take this twice every day.

Sawashan: Sansathan (□□□□- □रा□□): It reduces Kapha and helps in respiratory problems.

Mutaravha: Sansathan (□त्र□□- □रा□□): It helps in the urination process.

Tawacha (□□□□- □रा□□): It helps in curing skin problem. **Taapkram** (□I□क्र□- □रा□□): It maintains the body equilibrium i.e. homeostasis. Saatmbhikaran (□□□□-□□□) It reduces the toxic effects and adaptivity produces in our body. Shirshooljanyapratishyay (sinusitis induced headache)- Local application of lepa (paste) on the forehead.

Other Properties: It is also known to cure various problems
Mukharoga,kantharoga (dental disorder) – Chewing of clove gives relief in toothache
Aamvata (Rheumatoid Arthritis)
Katishool (Backache)
Grudhrasi (Sciatica)
Dantshool (Toothache)- Cotton plug of lavang tail
Dhvajbhang (Erectile Dysfunction) – Oil application on the penis for aphrodisiac action Aamplapitta (Hyperacidity)– Aampachan, Agnideepan (appetizer) Pitta vidah Shanti (Reducing Burning Sensation) Aruchi (Anorexia) Agnimandya (Loss of appetite) Chhardi(Vomiting) Trushna (Excessive thirst)

Modern View on Clove/Laung: Modern formulations (remodelled herbal medications) represents the induced modifications on the already existed forms of the herbal preparations either by changing the chain compositions, administration route or preparation methods. This is the reason behind association of severe adverse impacts and toxicity of these drugs. (67). Pollutants are affecting the modern herbal drug formulations at various processing stages. Furthermore, intentional adulteration of the natural ingredients with inorganic chemicals or something is more harmful (68,69,70). The contamination and replacement of natural medicines is the main issue in the herbal industry as its causing a significant impact on the business and utilization of natural products (71). Eugenol, major chemical constituent of clove, is used widely as a flavouring agent and in topical herbal formulations to treat toothache. This herbal drug is a best ayervedic alternative for treating toothache topically instead of using allopathic medications as there is no associated side effects with herbal formulation as in case of analgesics mainly non-steroidal anti-inflammatory drugs (NSAIDS).

Modern Therapeutic Uses of Clove: Clove is now being explored by scientists due to its wide range of pharmacological effects. On the basis of reported scientific reports, most important biological activities of clove and eugenol is presented in Table no. 3.

Conclusion

Syzygium aromaticum (clove, lavang, laung) is a well-known medicinal herb having various proven therapeutic properties as per the published scientific reports. Eugenol is the main principle constituent of clove responsible for the restorative property of clove. It is a most commonly used spice and food preservative traditional ayurvedic. According to ayurveda, clove is a best home remedy for treating several ailments and disorders. Thereby, reported biological activities suggest that herbal formulation developed using clove is beneficial for human and animals use

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