

Pharmacological, Bioactive Chemical Constituents and Medicinal uses of *Syzygium Aromaticum L*

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ABSTRACT

Herbal medicinal products have been documented as a significant source for discovering new pharmaceutical molecules that have been used to treat serious diseases. Many plant species have been reported to have pharmacological activities attributable to their phytoconstituents such as glycosides, saponins, flavonoids, steroids, tannins, alkaloids, terpenes, etc. *Syzygium aromaticum* (clove) is a traditional spice that has been used for food preservation and possesses various pharmacological activities. *S. aromaticum* is rich in many phytochemicals as follows: sesquiterpenes, monoterpenes, hydrocarbon, and phenolic compounds. Eugenyl acetate, eugenol, and β -caryophyllene are the most significant phytochemicals in clove oil. Several reports documented the analgesic, antioxidant, anticancer, antiseptic, anti-depressant, antispasmodic, anti-inflammatory, antiviral, antifungal, and antibacterial activity of eugenol against several pathogenic bacteria including methicillin-resistant *Staphylococcus epidermidis* and *S. aureus*. Cloves were taken over the centuries for diarrhea, most liver, stomach and bowel ailments, and as a stimulant for the nerves. Traditionally cloves have been used to treat flatulence, nausea and vomiting. In tropical Asia cloves have been given to treat such diverse infections as malaria, cholera and tuberculosis, as well as scabies. Traditional uses in America include treating worms, viruses, candida, various bacterial and protozoan infections. Laboratory tests on cloves identify eugenol as being the possible reason for the antimicrobial actions, and confirm cloves' effectiveness in inhibiting food-borne pathogens as well as other bacteria and fungi. The volatile oil of cloves (about 85-92% eugenol) was highly active against a range of test microorganisms, being classified as bactericidal in nature. Along with the recreational uses of cloves, they are also said to be a natural anthelmintic.

KEYWORDS: *Syzygium Aromaticum*, Health Benefits, Cloves

INTRODUCTION

Cloves are the aromatic flower buds of a tree in the family Myrtaceae, *Syzygium aromaticum*. They are native to the Maluku Islands (or Moluccas) in Indonesia, and are commonly used as a spice, flavoring or fragrance in consumer products, such as toothpaste, soaps, or cosmetics. Cloves are available throughout the year owing to different harvest seasons across various countries. The traditional medicinal system based on the use of herbal remedies still plays an important role in the health care system. In recent decades, medicinal plants have been gaining wider acceptance due to the perception that these plants being natural products have lesser side effects and improved efficacy than their synthetic counterparts [1,2]. Currently, about 80% of the world's inhabitants rely on traditional medicines as a major form of their primary health care [3]. Pharmacologically, various herbal plants possess bactericidal, virucidal, fungicidal activities; they are used in embalment, in food preservation, and have anti-inflammatory, antimicrobial, spasmolytic, sedative, analgesic, and local anesthetic activities [4,5].

Many plant species have been reported to have pharmacological activities attributable to their phytoconstituents such as glycosides, saponins, flavonoids, steroids, tannins, alkaloids, terpenes and accordingly [6]. Up to date, herbal remedies have been documented as a vital source for discovering novel pharmaceutical molecules that have been used to treat serious diseases. These identified phytochemicals have been considered a remarkable leading compound in the search for effective and new drugs [7]. Clove can be used to promote the flow of saliva and gastric juices. If you have stomach pain or gas in the stomach then the use of cloves can help to relieve the stomach pain. You can prepare a cup of clove tea by taking a cup of boiling water and adding a teaspoon of clove powder to it. Then let the water and clove steep for a few minutes before you drink it. Clove tea has been known to relieve nausea and vomiting. When cloves are used externally on the body it can relieve the pain in chronic rheumatism, toothache and lumbago.

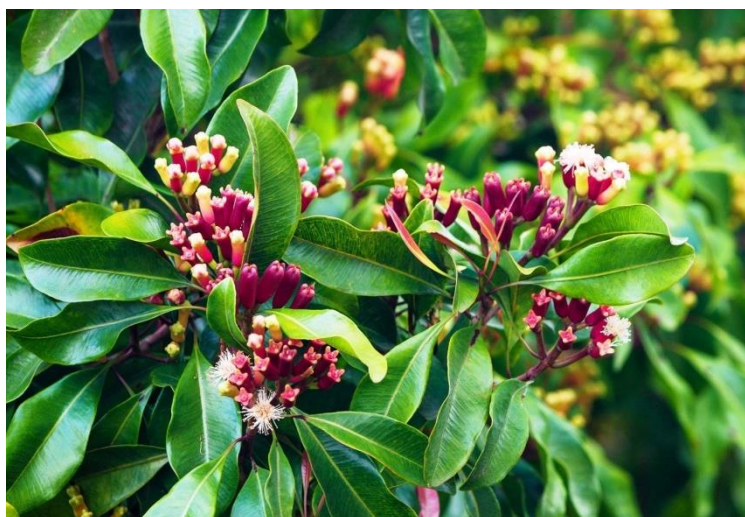


Figure 1. Herbs of *Syzygium Aromaticum*

Cloves can also help to relieve the pain of muscle cramps and some nerve conditions. You can apply clove oil along the nerve where the pain is. To deodorize a smelly drawer or closet you can put some cloves in a small container that is open and let it sit in the drawer or closet. Leave the container open and put it in a place that it will not spill. Or you can tie up a handful

of cloves in a handkerchief and put it in a closet or drawer[8]. The scent of cloves is pleasant and nice. Cloves are a very useful herb that has many uses for the body and the aroma. Cloves can be used to spice up foods like a ham or cake. Cloves can be purchased in a powder form or it can be in a dried whole flower bud form. You can buy cloves in a grocery store in the spice section. Clove is an herb. People use the oils, dried flower buds, leaves, and stems to make medicine. Clove is used for upset stomach and as an expectorant. Expectorants make it easier to cough up phlegm. Clove oil is used for diarrhea, hernia, and bad breath[9].

Scientific classification:

Kingdom	: Plantae
Clade	: Tracheophytes
Clade	: Angiosperms
Clade	: Eudicots
Clade	: Rosids
Order	: Myrtales
Family	: Myrtaceae
Genus	: Syzygium
Species	: <i>S. aromaticum</i>

Origin of Clove [10]

Cloves are the pink flowering bud of a form evergreen tree (*Eugenia aromatica*), which are dried until brown and used for medicinal and spicing purposes. Indigenous to the Moluccas spice islands of Indonesia, cloves also grow naturally in India, the West Indies, Tanzania, Sri Lanka, Brazil and Madagascar. With their sultry- sweet aromatic flavor and powerful essential oil compounds, cloves have been used for hundreds of years as a nutritional spice for food and a remedy for a variety of health concerns[11]. For over 2,000 years, both Indian and Chinese traditional medicine made extensive use of clove flowers and clove oil. Arabic traders brought the buds to Europe in 4th century A.D., and in the seventh and eighth century A.D. Europe, cloves became very popular as a medicinal flower, due to their ability to preserve foods, and mask the smell of poorly-kept foods [12, 13].



Figure 2. Flowers of Syzygium Aromaticum

Flower Description

Flowers emerge pale and glossy, turning first green and then a bright red as they mature to the fruiting stage. On commercially cultivated trees, flowers are picked at the bud stage before they progress to fruit (about 9 months after flowering). Time of flowering depends on the geographical location.

Phytochemicals

The compound eugenol is responsible for most of the characteristic aroma of cloves. Eugenol comprises 72–90% of the essential oil extracted from cloves, and is the compound most responsible for clove aroma. Complete extraction occurs at 80 minutes in pressurized water at 125 °C (257 °F). [14] Ultrasound-assisted and microwave-assisted extraction methods provide more rapid extraction rates with lower energy costs. Other phytochemicals of clove oil include acetyl eugenol, beta-caryophyllene, vanillin, crategolic acid, tannins, such as bicomin,[15] gallotannic acid, methyl salicylate, the flavonoids eugenin, kaempferol, rhamnetin, and eugenitin, triterpenoids such as oleanolic acid, stigmasterol, and campesterol and several sesquiterpenes.[16] Although eugenol has not been classified for its potential toxicity, it was shown to be toxic to test organisms in concentrations of 50, 75, and 100 mg per liter. Active Constituents of Clove Oil Approximately, 72-90% of the essential oil extracted from cloves has Eugenol [17]. Other essential oil ingredients of clove oil are,

1. Acetyl eugenol.
2. Beta-caryophyllene and vanillin
3. Crategolic acid, tannins, gallotannic acid, methyl salicylate (painkiller)
4. Flavonoids eugenin, kaempferol, rhamnetin, and eugenitin
5. Triterpenoids like oleanolic acid.
6. The dried buds of cloves contain about 15 - 20 percent of essential oils, and the bulk of this is eugenol. A kilogram of dried buds provides about 150 ml (1/4 of pint) of eugenol.

Health Benefits of Organically Certified Clove [18]

Clove is a natural antiviral, antimicrobial, antiseptic, and anti-fungal agent. It also holds aphrodisiac and circulation-stimulating capacities. The oil of cloves has been used in a variety of health conditions including indigestion, generalized stress, parasitic infestations, cough, toothaches, headache, and blood impurities. In fact, the expert panel German Commission recently approved the use of its essential oil as a topical antiseptic and anesthetic[19].

Clove may play a therapeutic role in the following conditions:

- **Powerful germicidal properties:** Clove is used extensively in dental care for relieving toothache, sore gums and oral ulcers. Gargling with clove oil can also aid in sore throat conditions and bad breathe [20].
- **Anti-Bacterial:** An effective aid for food poisoning, clove oil effectively kills many forms of bacterial infections from contaminated foods.
- **Antiseptic:** Clove oil can be used to reduce infections, wounds, insect bites and stings.
- **Anti-fungal:** Clove is also effective in reducing fungal infections such as athlete's foot.

- **Skin:** Excellent aid for skin disorders, such as acne.
- **General Stress Reliever:** Clove oil stimulates the circulatory system, clearing the mind and reducing mental exhaustion and fatigue. It has also been used to aid insomnia, memory loss, anxiety and depression.
- **Anti-Inflammatory:** Clove oil clears the respiratory passages, acting as an expectorant for treating many upper-respiratory conditions including colds, eye styes, bronchitis, sinus conditions, cough and asthma.
- **Blood Purifier:** Not only purifies the blood, but also aids in stabilizing blood sugar levels, and may have benefits for diabetic individuals.
- **General Immune System Booster:** Clove's antiviral and cleansing properties purify the body, augmenting our resistance to disease.
- **Premature Ejaculation:** Some research has shown that clove may be useful as a aid for premature ejaculation.
- **Cancer Prevention:** Preliminary studies suggest that clove oil may play a chemopreventive role, particularly in cases of lung, skin and digestive cancers.
- **Cardiovascular Health:** The active essential oil in clove, eugenol, has been shown to act as an effective platelet inhibitor, preventing blood clots.
- **Prevention from toxic exposure:** Studies show that clove oil can prevent toxicity related to exposure to environmental pollution.

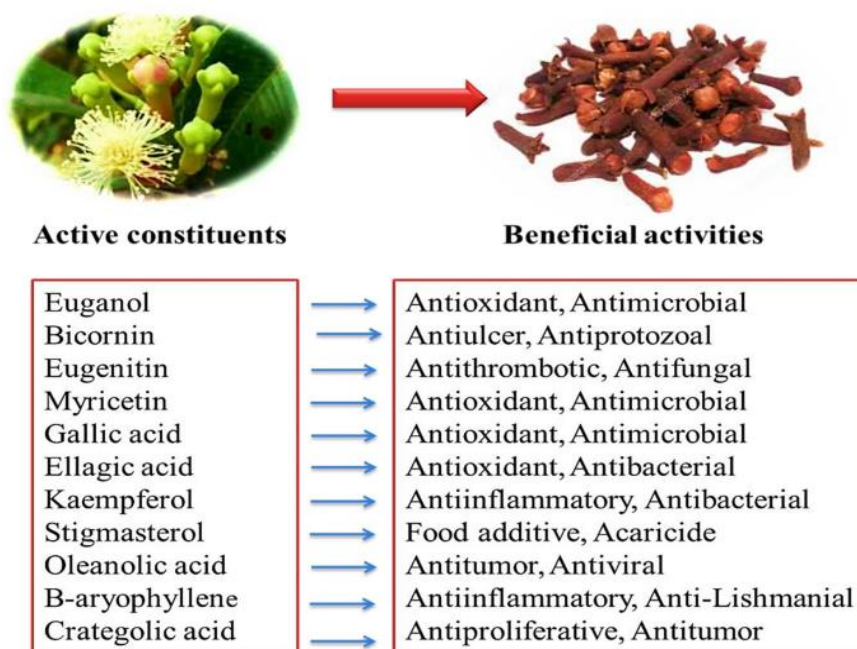


Figure 3. Active Constituents of Syzygium Aromaticum

Medicinal uses Clove Oil: Clove oil is produced by a steam distillation process. So you're probably better off buying the oil rather than trying to make it yourself. Clove oil is available almost anywhere. Clove oil is an unusually powerful antioxidant. Antioxidant capacity is measured by ORAC (Oxygen Radical Absorption Capacity). Although the dried buds or powders rank highly among anti-oxidants, clove oil is the monster antioxidant [21].

Nutritional/Medicinal Value:

Clove is one of the highest sources of manganese you'll find. Manganese is vital for metabolism, contributes enzymes, promotes bone strength, and also adds to clove's high ORAC antioxidant value. Magnesium, calcium, vitamins C and K also make strong appearances in clove. Clove is high in fiber also. Omega-3 is in abundance in clove as well as many phytonutrients that enhance the immune system. Clove greatly boosts your humoral immunity, which protects your blood and tissues. Clove has anti-viral anti-bacterial properties as well. It has been discovered to help prevent adult onset diabetes by tripling insulin levels[22].

Anti-Inflammatory Activity

The anti-inflammatory properties of cloves are the result of two important and powerful phytonutrients, eugenol and isoeugenol. These phytonutrients reduce inflammation in the body and prevent the development of some conditions like arthritis or chronic conditions[23].

Antioxidant Activity

Cloves are a powerful antioxidant that aid in the treatment of a variety of chronic health conditions. Antioxidants help to reduce oxidative stress that inhibits chronic diseases like heart disease, cancer, and diabetes. Clove is rich in eugenol, a natural antioxidant, that fights 5 times more against free radicals than any other antioxidant. It stops cell damage thus preventing the development of multiple diseases[24].

Transnational Uses of Clove[25]

Clove: is very well known as spice as well as herb all over the world. An English name clove, has been derived from the Latin word 'nail' as the shape resembles to small sized nails. It is widely used for medicinal as well as culinary purposes. Cloves are actually the dried flower buds of tree that is member of Myrtaceae family. Clove is an evergreen tree that bears sanguine flowers in clusters. The medicinal uses of this dried bud are as follows:

Cholera: The intake of cloves is very much effective in the treatment of cholera. Add some four grams of cloves to boiling water. Boil it, till the half water gets evaporated. Drink this water to prevent from severity.

Digestive disorder: Cloves boost the digestive system of the body as, it regulates the enzyme flows. Intake of this herb reduces the irritation level in intestine and cures indigestion problem. Mix the powdered cloves with teaspoonful of honey, and consume this mixture before going to bed.

Coughs: Take a clove with rock salt and chew it thoroughly to ease down soreness of throat. It also helps in relieving the inflammation of pharynx. You may even burn a clove and chew it, to get relieved from severe cough. Clove oil when mixed with honey, gives amazing effect of recurring cough[26].

Teeth troubles: From ancient era, clove is used in India and china to cure tooth aches. They are highly beneficial in reducing the pain of tooth. Due to its antiseptic properties, it is also

guards the tooth from infections. Apply the clove oil which reduces the pain in gums and decayed tooth[27-30].

Headaches:

Ground the cloves into powder form and mix it with salt crystals. Add milk to this mixture, it is very effective remedy for headaches[31].

Earache: Boil cloves in sesame oil and pour three to four drops of oil in ear. It will immediately cure earaches. Apart from the medicinal uses, it is used in culinary worldwide. It is main ingredient of the spice in Indian curries and also included in the preparation of curry powder. Clove oil is also used in the production of bath salt, soaps, and perfumes It contains very good amounts of vitamin A and beta carotene levels[32-33]. These compounds are known to have antioxidant properties. Vitamin A is also required by the body for maintaining healthy mucus membranes and skin and is also essential for vision. Consumption of natural foods rich in flavonoids helps to protect body from lung and oral cavity cancers[34].

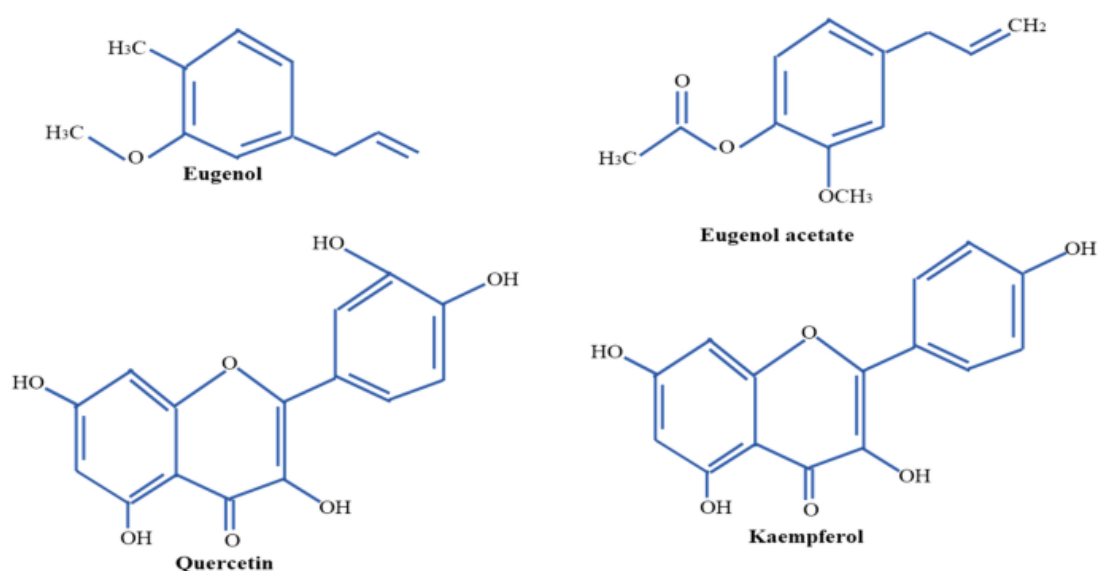


Figure 4. Chemical structures of compounds found in cloves

Medicinal Uses of Cloves [35-37]:

- Clove oil is an antiseptic in nature and effective against streptococcus and staphylococcus bacteria and therefore it is used in respiratory and digestive diseases.
- An infusion of cloves is used in nausea, vomiting, flatulence and dyspepsia.
- Clove oil is popularly used for tooth aches from time immemorial.
- Infusions of cloves are used for controlling of Cholera and Asthma.
- Along with honey clove powder is used for controlling vomiting.
- Because of its anesthetic nature it is used in ear ache.
- Clove oil is used in headaches.

Culinary Uses

In order to keep the fragrance and flavor intact, clove is generally grounded just before

preparing dishes and added at the last moment in the cooking recipes. This is because prolonged cooking results in evaporation of its essential oils.

- This popular spice has been used in preparation of many popular dishes in Asian and Chinese cuisine since ancient times. Along with other spices like pepper, turmeric, ginger etc. It is being used in marinating chicken, fish and meats.
- Some Indian vegetarian and chicken curries and rice dishes (biryani) contain cloves and in the Middle East it is used in meat and rice dishes.
- They are also been used in the preparation of soups, barbecue sauces, pickling and as main ingredient in variety of curry powders[38].

Home Remedies of Cloves

Respiratory Aid: Aromatherapy is the best way to use cloves as a respiratory aid. Make clove tea and breathe in the aroma from the hot tea. A pomander as pictured can be hung in various places to have a continual aroma therapy and improve respiratory problems.

- **Air Freshener:** Cloves have a great aroma and can be used in a variety of ways to remove offensive smells rather than using aerosols or other artificial air fresheners. Make an atomizer in a spray bottle mixing clove oil with water; shake well before each use as oil and water do not stay mixed. A clove pomander is another way, see instructions below for how to make one. After the pomander has lost its effectiveness, the cloves still have more aroma to share, crush slightly and add to a potpourri. Cloves are always a great addition to spicy potpourris or an oilburner[39].
- **Mosquito Repellent:** Using the same atomizer you freshen the air with, shake and spray lightly on exposed skin.

Specific Health Benefits of Cloves

Cloves have analgesic properties that can be used for treatment of various dental problems like tooth aches. They also boost memory and blood circulation, and are beneficial for the heart, liver and stomach. Cloves can effectively cure many digestive problems like stomach ulcers, flatulence and dyspepsia, since they stimulate your body's enzymes and boost digestion. Because of the antiseptic and germicidal benefits of cloves, they help fight infections like cold, flu, bronchitis, arthritic pain and athlete's foot[40].

Anti-Inflammatory Benefits of Cloves Chemical analysis shows that cloves have 36 different ingredients, the most important being an essential oil called eugenol. Cloves also contain a variety of flavonoids which contribute to clove's anti-inflammatory (and antioxidant) properties. Aromatherapists often use clove oil to treat the symptoms of rheumatism and arthritis. The aromatic clove oil, when inhaled, can help relieve certain respiratory conditions like coughs, colds, asthma, bronchitis and sinusitis[41].

Analgesic Benefits of Cloves

The analgesic property of clove oil can be used for treatment of various dental problems like tooth aches. A cotton ball soaked in the clove oil can work wonders on the aching tooth. Clove oil is also used to relieve pain from sore gums and improves overall dental health[42].

Antiseptic Benefits of Cloves

Clove and clove oil are antiseptic in nature and work as an effective remedy for some common problems such as cuts, fungal infections, burns, wounds, athlete's foot and bruises. The antiseptic properties of clove oil are why it's a common ingredient in various dental creams, toothpastes, mouth wash, and throat sprays. Clove and clove oil boost the immune system by purifying the blood and help to fight against various diseases[43].

Digestive Health Benefits of Cloves

Cloves can effectively cure many digestive problems. Cloves are known to have medicinal qualities to cure flatulence, loose stools, indigestion and nausea. Cloves are useful in relieving the symptoms of diarrhea, gastric irritability and vomiting.

Side-Effects of Clove

- Clove oil is very powerful oil and at times has unpleasant taste.
- If it is used directly as clove oil, the concentration should be below 1%.
- It should be avoided during pregnancy.

CONCLUSION

Clove is a common spice used as a flavorant and natural preservative in food industries due to its rich phenolic constituents like eugenol and eugenol acetate etc. These phenolic constituents possess enormous antioxidant activities, anti-glycation, antinociceptive and antimicrobial properties which enhanced the bioactivities of clove spices. Several in vitro and in vivo assays have been conducted to ascertain the potentials of clove spices as well as its cytotoxicity. Due to its beneficial effects, clove spices have been applied for use in agriculture as insecticides, anesthesia, antioxidants etc. In general, methods used for processing of herbs and spices including clove spices are drying, solvent extraction, microwave assisted extraction, supercritical carbon dioxide extraction, ultrasound assisted extraction and microencapsulation. Pharmacologically, clove and its main constituents possess antimicrobial, antioxidant, anti-inflammatory, analgesic, anticancer, and anesthetic effects. Moreover, they showed insecticidal, mosquito repellent, aphrodisiac, and antipyretic activities.

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