

**Review Article****Syzygium aromaticum L. (Clove): A vital herbal drug used in periodontal disease**

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ABSTRACT

Cloves are widely used in dental care, and are effective against a large number of bacteria. The main component of clove oil is eugenol, with β -caryophyllene and eugenyl acetate. The review of published results reveals a great opportunity to treat periodontal disease. The purpose of this study is to compare the bud, leaf and stem essential oil compositions from *S. aromaticum* and then to evaluate the correlation of the results with anatomic and geographical origins of the essential oil. Many commercial essential oils isolated from bud, leaf and stem were used in this work. The oils were analyzed by GC and then constituents were identified from the whole. The major constituent in oils was eugenol, with increasing percentages from bud (72.08 - 82.36%) to leaf (75.04 - 83.58%) and stem (87.52 - 96.65%). In the clove bud essential oil eugenyl acetate is the second major component (8.6 - 21.3%) while detected in considerably lower amount in the leaf (0 - 1.45%) and stem (0.07 - 2.53%). In leaf essential oil, the second main compounds were β -caryophyllene (11.65 - 19.53%) and α -humulene (1.38 - 2.17%), less represented in bud essential oils (2.76 - 8.64% and 0.34 - 1.04% respectively) and in stem essential oils (1.66 - 9.7% and 0.22 - 1.31% respectively). For each plant material, variation in the percentage of the main constituents was observed according to the sample geographic origin.

Introduction

Periodontal disease is caused by bacteria in dental plaque. Plaque is the sticky substance that forms on teeth soon after have brushed. In an effort to get rid of the bacteria, the cells of immune system release substances that inflame and damage the gums, periodontal ligament or alveolar bone. This leads to swollen, bleeding gums, a sign of gingivitis (the earliest stage of periodontal disease). Damage from periodontal disease also can cause teeth to become loose. This is a sign of severe periodontitis (the advanced stage of disease). It can prevent periodontal disease by practicing good oral hygiene and visiting dentist regularly [1]. Most people should see the dentist about once every six months. But if already have gum disease then it may need to visit more often. Daily brushing and flossing, when done correctly, can help to remove most of the plaque from teeth. Professional cleanings by dentist or dental hygienist will keep plaque under control in places that are harder for a toothbrush or floss to reach. If oral hygiene slips or skips dental visits, plaque builds up on the teeth. Eventually, it spreads below the gum line. The bacteria are

protected there because toothbrush can't reach them [2]. If plaque is not removed, the bacteria will continue to multiply and gum inflammation may get worse [3].

The buildup of plaque below the gum line causes the gums to become inflamed. As the gums swell, they detach from the tooth. This process forms a space, or "pocket," between the tooth and gum. Bacteria can grow rapidly in the pockets. This encourages further plaque buildup. If left untreated, periodontal disease may destroy the periodontal ligament and the alveolar bone, the structures that support teeth [4]. Another reason to remove plaque promptly is that over time it becomes hardened or calcified and turns into calculus. This is commonly called tartar. Even more plaque attaches to calculus because it's a rougher surface than tooth enamel. It's also rougher than cementum, a layer that covers the tooth root. Calculus and plaque buildup in layers. Using a tartar-control toothpaste may help slow the build-up of calculus around

teeth. It can't affect the tartar that already has formed below the gum line [5].

Anatomy of tooth

Each tooth consists of the crown above the gum line, and the root below the gum line. The main parts of a tooth include:

Enamel: Enamel is a hard mineral covering the surface of the crown. It protects the tooth.

Dentin: Dentin is the largest part of the tooth. Although not as hard as enamel, it provides additional protection to the tooth. It also supports the crown of the tooth.

Pulp: The pulp contains the nerve endings and blood vessels. If you eat something too hot or cold, or fall and hurt the tooth, it is the nerves in the pulp that hurt. The blood vessels feed the tooth to keep it alive and healthy.

Cementum: The cementum is the root part of the tooth connecting it to the jaw bone.

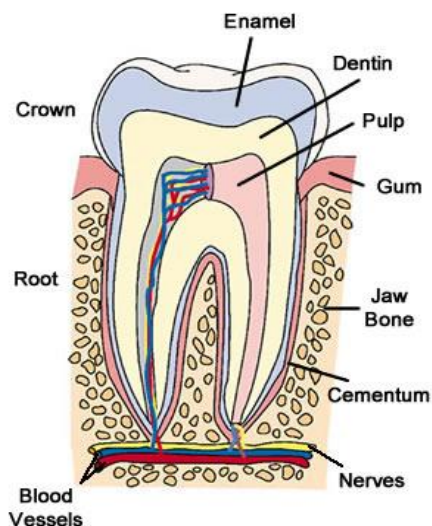


Figure No. 1: Anatomy of Tooth

Risks and Prevention

The bacteria in plaque are the main cause of periodontal disease. But several other factors also can contribute. They include other diseases, medicines and oral habits. These factors can increase risk of gum disease or make it worse once the infection has set in.

Genes

Some people are more likely than others to get periodontal disease because of their genes. But genes do not make gum disease inevitable. Even people who are highly prone to periodontal disease can prevent or control the disease with good oral care.

Smoking and tobacco use

Smoking increases the risk of periodontal disease. The longer smoke, and the more smoke, the higher the risk. If already exist periodontal disease, then smoking makes it more severe. Smoking is a major reason that some cases of periodontal disease are resistant to treatment. Smokers tend to collect more tartar on their teeth. They often develop deeper periodontal pockets once they have gum disease. They also are likely to lose more bone as the disease gets worse. Unlike many other factors that affect the health of gums, the decision to smoke or not is under control. Quitting smoking can play a major role in bringing periodontal disease under control.

Misaligned or crowded teeth, braces or bridgework

Anything that makes it more difficult to brush or floss teeth is likely to enhance plaque and tartar formation. The more plaque and tartar, have the greater chance of developing gum disease. Dentists and periodontists can show the best ways to clean teeth, even if they are hard to clean. For example, use of special tools and ways of threading floss to clean around bridgework or slide under braces. If overcrowded or crooked teeth are a problem, dentist might recommend orthodontics. This could straighten out smile and give a better chance of preventing disease.

Grinding, gritting or clenching of teeth

These habits won't cause periodontal disease. However, they can lead to more severe disease if gums are already inflamed. These habits exert excess force on the teeth. This pressure appears to speed up the breakdown of the periodontal ligament and bone. In many cases, people can learn to stop this habit simply by recognizing when it is happening and then relaxing. If these efforts don't work, dentist or periodontist can create a custom guard appliance to help reduce the pressure of clenching or grinding on the teeth. This device is sometimes called an occlusal guard, night guard, mouth guard or bite guard.

Stress

Stress can make periodontal disease worse and harder to treat. Stress weakens body's immune system. This makes it harder for body to fight off infection, including periodontal disease.

Fluctuating hormones

Whenever hormone levels go up and down in the body, changes can occur in the mouth. Puberty and pregnancy can temporarily increase the risk and severity of gum disease. So can menopause.

Medicines

Several types of medicines can cause dry mouth, or xerostomia. Examples include certain drugs for depression and high blood pressure. If don't have enough saliva, plaque is more likely to form. This may lead to tooth decay (cavities). Other medicines may cause the gums to enlarge. This makes them more likely to trap plaque. These medicines include **46**

- Phenytoin (Dilantin and other brand names), used to control seizures.
- Cyclosporine (Neoral, Sandimmune), used to suppress the immune system in people who have had organ transplants.
- Nifedipine (Adalat, Cardizem and others) and other calcium channel blockers, used to treat high blood pressure, chest pain (angina) or heart arrhythmias.

Diseases

People with certain diseases have a higher risk of developing periodontal disease. For example, people with diabetes are more likely to get periodontitis than people without diabetes. Their gum disease is also likely to be more severe. Other diseases that increase periodontal disease risk include inflammatory conditions such as rheumatoid arthritis and HIV infection. Having one of these diseases can make the control of periodontal disease more difficult. But a good periodontist or dentist who is aware of these problems can give guidance on how to maintain periodontal health.

Age

Studies indicate that older people have the highest rates of periodontal disease. Data from the Centers for Disease Control and Prevention indicates that over 70% of Americans 65 and older have periodontitis.

Other systemic diseases

Other systemic diseases that interfere with the body's inflammatory system may worsen the condition of the gums. These include cardiovascular disease, diabetes, and rheumatoid arthritis.

Poor nutrition and obesity

A diet low in important nutrients can compromise the body's immune system and make it harder for the body to fight off infection. Because periodontal disease begins as an infection, poor nutrition can worsen the condition of gums. In addition, research has shown that obesity may increase the risk of periodontal disease.

Symptoms of gum disease includes

- Red or swollen gums
- Tender or bleeding gums
- Painful chewing
- Loose teeth

- Sensitive teeth
- Swollen gums
- Bleeding while brushing, flossing, or eating hard food
- Gums that are receding or pulling away from the teeth, causing the teeth to look longer than before
- Loose or separating teeth
- Pus between gums and teeth
- Sores in mouth
- Persistent bad breath
- A change in the way teeth fit together when bite
- A change in the fit of partial dentures

Any of these symptoms may be a sign of a serious problem, which should be checked by a dentist.

Syzygium aromaticum L. (Clove)



Figure No. 2: Clove

Scientific classification

Table No. 1: Scientific classification of Clove

Kingdom	Plantae
(unranked)	<u>Angiosperms</u>
(unranked)	<u>Eudicots</u>
(unranked)	<u>Rosids</u>
Order	<u>Myrtales</u>
Family	<u>Myrtaceae</u>
Genus	<u>Syzygium</u>
Species	S. aromaticum

Synonyms

- *Syzygium aromaticum*(L.) Merrill & Perry
- *Caryophyllus aromaticus* L.
- *Eugenia aromatica* (L.) Baill.
- *Eugenia caryophyllata* Thunb.

- *Eugenia caryophyllus* (Spreng.) Bullock & S. G. Harrison

Clove is used in the cuisine of Asian, African, and the near and Middle East countries, lending flavor to meats, curries, and marinades, as well as fruit such as apples, pears or rhubarb. Cloves may be used to give aromatic and flavor qualities to hot beverages, often combined with 47 ingredients such as lemon and sugar [6]. They are a common element in spice blends such as pumpkin pie spice and speculoos spices. In Mexican cuisine, cloves are best known as *clavos de olor*, and often accompany cumin and cinnamon. A major component of clove taste is imparted by the chemical eugenol, and the quantity of the spice required is typically small. It pairs well with cinnamon, allspice, vanilla, red wine and basil, as well as onion, citrus peel, star anise, or peppercorns [7].

Clove (*Syzygium aromaticum*) is one of the most valuable spices that has been used for centuries as food preservative and for many medicinal purposes. Clove is native of Indonesia but nowadays is cultured in several parts of the world including Brazil in the state of Bahia. This plant represents one of the richest source of phenolic compounds such as eugenol, eugenol acetate and gallic acid and posses great potential for pharmaceutical, cosmetic, food and agricultural applications. This review includes the main studies reporting the biological activities of clove and eugenol [8]. The antioxidant and antimicrobial activity of clove is higher than many fruits, vegetables and other spices and should deserve special attention. A new application of clove as larvicidal agent is an interesting strategy to combat dengue which is a serious health problem in Brazil and other tropical countries. Pharmacokinetics and toxicological studies were also mentioned [9]. The different studies reviewed in this work confirm the traditional use of clove as food preservative and medicinal plant standing out the importance of this plant for different applications.

Macroscopical characters

The volatile oil is situated in the schizolysigenous oil glands or ducts which are present in all 1 parts of the flower buds (hypodermis).

Size: Length varies from 12 to 17 mm.

Type: Actinomorphic, bisexual, epigynous. The flower bud has a spherical head and a sub-cylindrical hypanthium tapering at the lower end.

Calyx: Polysepalous, 4 hard and thick sepals with oil glands

Corolla: Polypetalous, 4 petals imbricate, enclose the stamens and forms the head of the bud Androecium- numerous stamens, free and introrsely;

Gynasium: Binocular, inferior with ovules stamens, free Placentation axial.

Style: Single and erect.

Colour: Dark brown;

Odour: Aromatic, spicy, Strong.

Taste: Pungent, aromatic.



Figure No. 3: Eugenia caryophyllus Plant

Microscopical characters of Clove flower bud

Transverse section of clove hypanthium below the ovary shows epidermis, cortex and columella:

Epidermis

Single layered small cells with straight walls and has a very thick cuticle. Epidermal layer gets intercepted by Ranunculaceous type of stomata.

Cortex

The three distinct zones or regions in the cortex can be made out.

- The peripheral region containing 2 to 3 layers of big, ellipsoidal, schizo-lysigenous oil glands embedded in the radially elongated parenchymatous cells.
- The middle region containing 1 or 2 rings of bicollateral vascular bundles associated with a few pericyclic fibres, embedded in thick walled parenchyma and
- The inner region made of loosely arranged aerenchyma.

Columella

Forms the central cylinder containing thick wall parenchyma with a ring of bicollateral vascular bundles towards the periphery of the cylinder. Numerous sphaeraphides are seen scattered throughout the columella and to a certain extent in the middle cortical zone [10].

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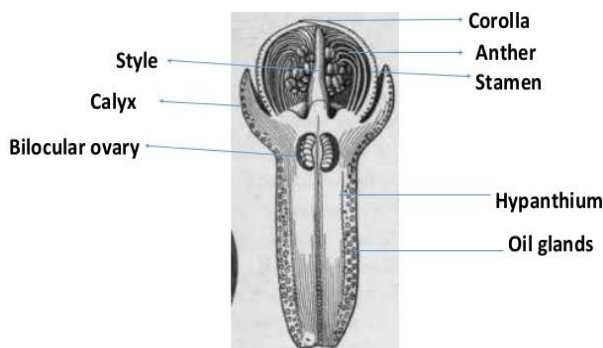
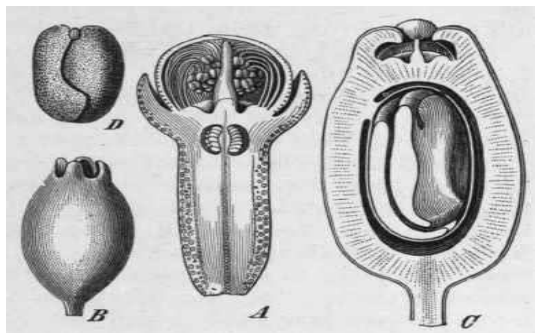


Figure No.4: L.S. of Clove

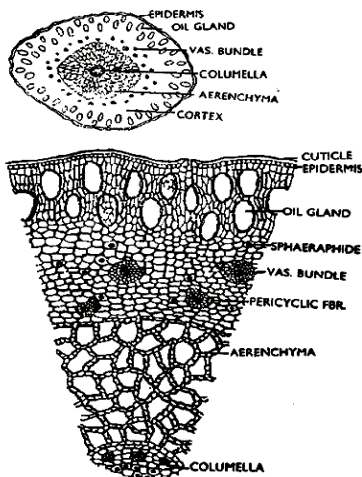


Figure No. 5: T.S. of Clove

Chemical constituents

Volatile oil (16-21%):- Phenol chiefly Eugenol (80-88), acetyl eugenol (10- 15%); α and β -Caryophyllene.

Tannins (10-13%) – Pyrogallol tannins.

Other substances are methyl furfural and dimethyl furfural.

Substitutes and Adulterants

As per the official definition, clove bud should contain clove oil between 15 -21% and not less. Sub-standard products will have obviously less than 15%. Over ripe buds and immature buds do not contain the prescribed percentage of oil. At times the oil is withdrawn internationally and cloves free of oil is mixed with genuine drug or sold as such. The following are the usual adulterants [11].

Exhausted clove

Volatile oil is partly or completely removed. As a result buds appear darker in colour, shrunken in form and yield no oil even after pressing hard between the fingers.

Clove stalks

The stalks, which creep in while collecting the buds. When present in excess are considered as adulterants. These stalks do not contain essential oil but only to the tune of 5%. It is easy to spot them out as they appeared dark brown, angular; trichotomously branched, with nodes enlarged and with high percentage of crude fibre (13.6%). The crude fibre in official clove varies between 6.2-9.8%. If in powdered form, excess of clove stalk can be made out by the presence of calcium oxalate prism and large thick walled stone cells which however are absent in official clove powder [12].

Clove fruits (Mother clove)

These also contain clove oil but only around 3 to 5% and hence considered as an adulterant. These cloves are distinctly larger (20-25 mm/ 10-17 mm), ovate and taper below. The single seed present in the fruit contains starch, which is absent in clove bud. Using a simple micro chemical test for starch, the adulterant can be detected [13].

Blown clove

Here mature clove flowers without corolla and stamens are also admixed. These eventually are very low in their oil content.

Chemical constituents of Clove

Some Important components are; Flavonoids, Hidroxibenzoic acid, Hidroxicinamic acid, Hidroxiphenyl propens, Eugenol, Phenolic acids, Gallic acid, Kaempferol, Quercetin, Caffeic acid, Ferulic acid, Elagicacid, Salicylic acids, B-cariofileno [14].

Clove represents one of the major vegetal sources of phenolic compounds as flavonoids, hidroxibenzoic acids, hidroxicinamic acids and hidroxiphenyl propens. Eugenol is the main bioactive compound of clove, which is found in concentrations ranging from 9 381.70 to 14 650.00 mg per 100 g of fresh plant material [15].

Biological Activity

Clove is an important medicinal plant due to the wide range of pharmacological effects consolidated from traditional use for centuries and reported in literature. A review of several scientific reports of the most important biological activities of clove and eugenol is presented in the following paragraphs.

Antioxidant Activity

Recently, the United States Department of Agriculture in collaboration with Universities and private companies create a database with the polyphenol content and antioxidant activity of different kind of foods. Based on this database, Pérez-Jiménez *et al.* classified the 100 richest dietary sources of polyphenols. Results indicate that the spice plants are the kind of food with higher polyphenol content followed by fruits, seeds and vegetables. Among spices, clove showed the higher content of polyphenols and antioxidant compounds.

Extracts from clove buds could also be used as food antioxidants. The shelf-life and frying stability of encapsulated and un-encapsulated eugenol-rich clove extracts were tested in soybean oil. Controlled release of antioxidants could be achieved by encapsulated clove powder obtained by spray drying using maltodextrin and arabic gum as wall materials.

Antimicrobial Activity

The antimicrobial activities of clove have been proved against several bacterial and fungal strains. Sofia *et al.* tested the antimicrobial activity of different Indian spice plants as mint, cinnamon, mustard, ginger, garlic and clove. The only sampled that showed complete bactericidal effect against all the food-borne pathogens tested *Escherichia coli* (*E. coli*), *Staphylococcus aureus* and *Bacillus cereus* was the aqueous extract of clove at 3%. At the concentration of 1% clove extract also showed good inhibitory action.

Antinociceptive

The employment of clove as analgesic have been reported since the 13th century, for toothache, join pain and antispasmodic, being the eugenol the main compound responsible for this activity. The mechanism evolved has been attributed to the activation of calcium and chloride channels in ganglionar cells. The voltage dependant effects of eugenol in sodium and calcium channels and in receptors expressed in the trigeminal ganglio also contributed to the analgesic effect of clove. Other results show that the analgesic effect of clove is due to the action as capsaicin agonist. The peripheral antinociceptive activity of eugenol was reported by Daniel *et al.* showing significant activity at doses of 50, 75 and 100 mg/kg.

Antiviral

The antiviral activity of eugenin, a compound isolated from *S. aromaticum* and from *Geum japonicum*, was tested against herpes virus strains being effective at 5 µg/mL, and it was deducted that one of the major targets of eugenin is the viral DNA synthesis by the inhibition of the viral DNA polymerase.

Conclusion

Clove is used to treat various health conditions, including intestinal parasites, migraine headaches, colds, impotence, and gastrointestinal problems such as nausea, vomiting, diarrhea and gas. The health benefits of clove oil can be attributed to its antimicrobial, antifungal, antiseptic, antiviral, aphrodisiac and stimulating properties. The oil is used for treating a variety of health disorders including toothaches, indigestion, cough, asthma, headache, and stress and blood impurities. Clove is rich in minerals such as calcium, hydrochloric acid, iron, phosphorus, sodium, potassium, and vitamin A and vitamin C. The most prominent use of clove oil is in dental care. The germicidal properties of the oil make it very effective for relieving dental pain, tooth ache, sore gums and mouth ulcers. Clove oil contains the compound eugenol, which has been used in dentistry since numerous years. Gargles with diluted clove oil help in easing the throat. The characteristic smell of clove oil helps removing bad breath. As a result, clove oil is added to numerous dental products and medications, including, mouth washes, and tooth pastes. Dentists also mix clove oil with zinc oxide and prepare a white filling material as a temporary alternative to root canal.

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