



In Praise of the Phytogetic Medicinal Plant *Syzygium Aromaticum*: A Review

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ABSTRACT

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Syzygium aromaticum commonly known as Clove is considered to be the most precious spice among others, which has been continued to be utilized for centuries for different biological and therapeutic purposes. It is a tropical tree which belongs to the *Myrtaceae* family and natively originated from Indonesia. However, in current times it is found in a few other places of the world including Brazil. Clove is viewed as perhaps the most extravagant source of phenolic mixes, for example, eugenol, eugenol acetic acid derivatives and so on. These mixtures have incredible potential for restorative, organic and other rural applications. In this review we have tried to figure out some of the important medicinal or therapeutic as well as phytobiotic and agricultural utilizations of the products prepared from Clove. We have tried to give an extra emphasis on the application of clove as a product of herbal contraception however for this purpose dose of the extract (either aqueous or ethanolic) of clove plays the vital role in this case. Although for establishing or making clove products commercially available as a safe product for herbal contraception or other medicinal impacts, more studies are required, and it could open a new era in the field of herbal medicine that would be much safer and feasible.

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Introduction

The indigenously grown or herbal medication has become famous now a days. Regardless of amazing specialized movement, the usage of the common items with remedial properties is as old as human progress and even roughly 70-80% of the total population keeps relying upon non-traditional medicinal products of home-grown source for their essential therapeutic services (Mishra et al., 2013). Spices for instance clove, mint, oregano, thyme, cummin cinnamon and so on have been utilized for a considerable length of time as a nourishment additive specially for the medicinal values in case of both human and Agriculture. Clove (*Syzygium aromaticum*) is a spice which has many medicinal/therapeutic properties. This is an air dried, unopened, pink flowering bud of the tree *Syzygium aromaticum* (Figure 1).

Clove is originated from tropical evergreen tree of the family *Myrtaceae* and its little ruddy brown blossom buds, which are utilized as a flavor. From the most pungent flavor exchanges clove is considered to be the foremost vital among the others and accepted to be indigenous to the Moluccas, or Zest Islands, of Indonesia. For its solid smell and sharp taste, cloves are utilized to flavor numerous cuisines, especially meats and pastry kitchen items in Europe.

History and Trading of *Syzygium Aromaticum*

Primarily, a clearly dated archeological discovery of clove is considerably goes with proves which have two illustrations, found at an exchanging harbour in Sri Lanka, dated to around 900-1100 AD (Andaya et al., 1993). A prior detailed discovery, in Syria, dated to around 1700 BC, though is not accepted to be a clove (Lape et al., 2010, Kingwell-Banham, 2019).

Until advanced times, discovery of clove was restricted on some islands within the Moluccas (verifiably called the Flavor Islands), counting Bacan, Makian, Moti, Ternate, and Tidore (Turner, 2004). In fact, the clove tree that specialists accept is the most seasoned within the world, named Afo, is on Ternat; the tree is between 350 and 400 yrs, a long time old (Worrall, 2012). Sightseers are told that seedlings from this exceptionally old tree were stolen by a Frenchman named Pierre Poivre in 1770, exchanged to the Isle de France (Mauritius), and after that to Zanzibar, which was once the world's biggest producers of cloves (Worrall, 2012).

Until cloves were harvested outside of the Maluku Islands, they were traded like oil, with a purpose of

exportation (Worrall, 2012). As the Dutch East India Company set its control of the flavor trade inside the seventeenth century, they searched for an impressive plan of action in cloves as they had in nutmeg. But the trading policy was, "not at all like nutmeg and mace, which were constrained to the diminutive Bandas, clove trees developed all over the Moluccas, and the exchange in cloves was constrained policing powers of the organization in the past".

Cultivation and Harvesting

The clove tree is cultivated in beach front extents at most noteworthy rises of 200 m over the sea level. The age of bloom buds, which is the marketed part of this tree, starts after 4 m quite a while of farm. Bloom buds are gathered inside the improvement stage before blooming. The arrangement probably should be possible truly or artificially intervened using a brand name phytohormone which frees ethylene inside the vegetal tissue, making new development of events (Kamatou et al., 2012). Nowadays, the high producing countries of clove are Indonesia, India, Malaysia, Sri Lanka, Madagascar and Tanzania phenomenally the Zanzibar Island (Filho et al., 2013). Clove in Brazil, is refined inside the upper east region, inside the province of Bahia inside the areas of Valença, Ituberá, Taperoá, Camamu and Nilo Peçanha, where around 8 000 hectares are created, delivering close around 2500 tons for each year (Oliveira et al., 2007, Oliveira et al., 2009).

Phytochemical Constituents of Syzygium Aromaticum

Clove considered to be one of the major vegetal sources of phenolic mixes such as flavonoids, hidroxibenzoic acids, hidroxicinamic acids and hidroxiphenyl propens. Eugenol is the most bioactive compound of clove, which is found in fixations stretching out from 9381.70 to 14650.00 mg per 100 g of new plant (Diego et al., 2014). As for the phenolic acids, gallic acid is the compound found in higher amount (783.50 mg/100 g new weight). Albeit, other gallic acid derivates as hidrolizable tannins are appeared to be in higher amounts as well (2375.8 mg/100 g) (Shan et al., 2005). Caffeic, ferulic, elagic and salicylic acids are the other phenolic acids found in Clove. Flavonoids such as kaempferol, quercetin and its derivates (glycosilated) are found in clove in lower extracted amounts also. Extraction of essential oil up to 18% can be found inside the buds of blossom clove. The maximum part, 89% of the clove essential oil is eugenol and 5% to 15% is eugenol acid derivatives and β -cariofileno (Jirovetz et al., 2006). Another crucial compound found in essential oil of clove is α -humulen, which is up to 2.1%. Other slightly extracted mixes appear in lower levels in clove are other essential oils such as β -pinene, limonene, farnesol, benzaldehyde, 2-heptanone and ethyl hexanoate (Figure 2).

Therapeutic Uses of Clove or Syzygium Aromaticum

Dietary utilization of cloves can help in the alleviation of a high level of immunities, both internal and external (Neveu et al., 2010). In addition, this phytogetic element can be used either as a whole, ground form, or can be used as an essential oil.

Some of the most important uses of Clove in the field of medical sciences or as therapeutic components are given below:

Utilization As Rust Inhibitor or Antioxidant

These medicinal plants are the sort of substance with higher polyphenol compound taken after by normal items, seeds and vegetables. Among flavors, clove has all the remarks of being the higher source of polyphenols and a mixture of anti-cancer compounds. Clove (buds) has the higher cancer prevention agent and polyphenol substance, (168.660+/- 0.024) tetraethylammonium chloride (mmol of Trolox/100g dried weight) and (14.380+/- 0.006) g of gallic corrosive (reciprocals/100g of dried weight), respectively. Ethanol and aqueous concentrates of clove and lavender at the rate of 20, 40 and 60 μ g/mL showed up impediments up to 95% when attempted as metal quelants, superoxide radical absorbant and scavenging the DPPH radical. The successful cell reinforcement development of the two concentrates might be credited to the strong hydrogen producing limit, metal chelating capacity and scavangin of free radicals, hydrogen peroxide and superoxide (Gulcina et al., 2004).

Anti-cancer compounds are fundamental components for the treatment of memory deficiencies achieved by oxidative pressing factors (Abdel Wahhab et al., 2005). Earlier treatment with clove basic oil diminishes the oxidative pressure surveyed by malondialdehyde and decreased glutathione levels in cerebrum of mice. That review said that clove oil could return memory and learning shortfalls brought about by scopolamine in short and since a long-time age, because of the reduction in the oxidative pressure (Mehta et al., 2010). These works exhibited the invaluable sides of the utilization of clove as a rich wellspring of cell fortifications for the treatment of oxidative pressing factor decided memory setbacks.

Extricates from clove buds seem to be utilized as cancer prevention agents such as food antioxidants (Halder et al., 2011). Controlled delivery of cancer prevention agents could be accomplished by embodied clove powder got by utilizing maltodextrin.

Germicidal Activity of Clove

The antimicrobial or germicidal exercises of clove have been shown against a couple of bacterial and infectious strains. The watery solution of clove at 3% seemed to have bactericidal effect against all the food borne pathogens such as *Escherichia coli*, *Staphylococcus aureus* and *Bacillus cereus*. Definitely 1% mixture of clove extract seems to be indicated as an extraordinary inhibitory activity against various strains of microbes (Chatterjee et al., 2013).

The antibacterial action of clove, oregano (*Origanum vulgare*), narrows (*Pimenta racemosa*) and thyme (*Thymus vulgaris*) essential oil was tried against *E. coli* O157:H7 demonstrating the various evaluations of hindrance of these basic oils (Sofia et al., 2007). Clove extracts containing eugenol and carvacrol epitomized in a non-ionic surfactant were tried against four strains of two significant foodborne pathogens, *E. coli* O157:H7 and *Listeria monocitogenes*, results fortify the work of eugenol to hinder the development of these microorganisms on surfaces of the various food stuffs (Burt et al., 2003).



Figure 1. *Syzygium aromaticum* flower before and after drying

Antifungal Usability of Clove

Rana et al. chosen the antifungal activity of clove oil in a few strains and showed this size of reasonableness *Mucor sp.*>*Microsporium gypseum*>*Fusarium moniliforme* NCIM 1100>*Trichophyllum rubrum*>*Aspergillus sp.*>*Fusarium oxysporum* MTCC 284 (Rana et al., 2011). The chromatographic examinations introduced that for the antifungal action, eugenol was the principal compound, to be dependent on because of lysis of the spores and micelles. Genuinely the same component having the activity of film interruption and disfigurement of macromolecules created by eugenol was primarily introduced by Devi et al. (2010).

The anticandidal activity of eugenol and carvacrol was tried in a vaginal candidiasis model, microbial and histological techniques were used to recognize the tests with the controls. The outcomes suggest that eugenol and carvacrol may be a promising antifungal operator for treatment and prophylaxis of vaginal candidiasis (Chami et al., 2004).

In extension to the broad-spectrum activity of eugenol against microbes or microscopic creatures, an examination introduced that eugenol and cinnamaldehyde at 2 µg/mL subdued the advancement of 31 strains of *Helicobacter pylori*, after 9 h and 12 h of brooding, moreover the action is much more intense than that of amoxicillin without any baleful effect. To exert the antimicrobial activity those mixtures were tried at low p as *Helicobacter pylori* stays in the stomach (Ali et al., 2005).

Analgesic Effect of Clove (Antinociceptive)

The work of clove as analgesic or pain relief have been accounted for since the thirteenth century, for toothache, agony of joint and antispasmodic, eugenol is the the major compound responsible for this activity. The progression of the component has been credited to the order of calcium and chloride diverts in ganglionar cells (<https://www.herbwisdom.com/herb-cloves.html>). The voltage dependant effects of eugenol in sodium and calcium alterations and in receptors imparted inside the trigeminal ganglio additionally added to the agony soothing impact of clove (Li et al., 2008). Different outcomes indicated that the pain-relieving impact of clove is because of the activity as capsaicin agonist (Ohkubo et al., 1997). The fringe antinociceptive action of eugenol was accounted for by Daniel et al. indicating noteworthy movement at dosages of 50, 75 and 100 mg/kg (Daniel et al., 2009). At the point when the oil is applied hastily to the body, it can mitigate torment from stiffness, gout, or different agonies began from Inflammation.

Antiviral Effect of Clove

Eugenin, a compound extricated from *S. aromaticum* and from *Geum japonicum* has the antiviral movement, which was tried against herpes infection strains being compelling at 5 µg/mL. It was anticipated that eugenin normally assaults viral DNA by inhibiting viral DNA polymerase synthesis mechanism (Kurokawa et al., 1998).

In another investigation, liquid extricates of *S. aromaticum* (L.) Merr. et Perry when joined with acyclovir demonstrated solid antiherpes simplex infection type 1 (HSV-1) movement among others and different plants were *Geum japonicum* Thunb., *Rhus javanica* L., and *Terminalia chebula* Retzus. This synergic activity was more grounded in cerebrum than in skin and it was also shown that those blends were not noxious to mice (Mishra and Singh, 1995).

Aid in Digestion

Utilization of Clove can soothe and relax the inner membrane of the intestines, through this it can also help in resolving the upset stomach. As clove can act as an antimicrobial agent, so killing opportunistic parasites and bacteria in the digestive tract that hamper the digestion, can also be executed by the clove oil/ethanolic or aqueous clove extract. In appropriate dosage, it can help to relieve excessive gas bloating.

Relieving Dental Pain in Gum

Clove has shown to have analgesic properties. This property is especially effective for tooth pain. To treat any disease of gum, whole clove can be applied directly to the particular areas of the gum. Gum having thin skinned membrane absorbs the oil of clove and thus exert the analgesic effect, so the topically get relief from pain. That's the reason almost all the good tooth pastes of renowned companies contain clove as an essential element. Although clove can also be used to outer membrane of the skin to help in case of sun burn or poison ivy, but in this case clove has a low effectiveness.

Effect of Clove on as a Contraceptive Phytochemical Compound

S. aromaticum or clove has a positive impact in case of the reproductive system. Although very few researches have been conducted on the issue. But still some works have been done, here we are trying to emphasize on those studies.

A study focusing on male genital system found that *S. aromaticum* flower bud caused dose-dependent biphasic effect on male reproductive system in mice; lower dose of *S. aromaticum* appears to be stimulatory, while the higher doses have adverse effect on male reproduction. The results suggested that the lower dose of *S. aromaticum* may have androgenic effect (Mishra and Singh, 2006). They have found that, in case of the body weight there was no effect of the dose of the oil extract of clove treated mouse and the control. Yet, on the reproductive organ's weight it had sway, so when 15 mg portion was given to the treated mice loads of epididymis and original vesicle was practically same with the control. Be that as it may, in treated mice with higher dosages (30 mg and 60 mg) loads decreased essentially contrasted with controls. So, they reported that the impact of clove separate on the

regenerative framework works absolutely in a subordinate way.

Another group of researchers in their study had observed that, a distinguishable reduction in the number of spermatozoa in cauda epididymis of mice treated with higher dosages of *S. aromaticum* is likely to be caused by the suppressive effect on spermatogenesis, (Mishra and Singh, 1995) mean while modification in sperm motility and morphology might have resulted from disturbances in functional environment of epididymis in the treated mice (Rajlakshmi et al., 1992). It is worthy to mention here that Buch et al., (Buch et al., 1988) have also reported about the spermicidal property of *S. aromaticum* oil on ejaculated human spermatozoa.

Secretory function of epididymis and seminal vesicle is completely dependent on androgen (Lo and Lamb et al., 2004), however biosynthesis of testosterone is also dose dependent, and at lower dose it is stimulated while suppressed at higher doses.

Previously a study has been done by another researcher group, using a combination of *Ricinus communis*, *Abrus precatorius* and *Syzygium aromaticum* on the reproductive system of male Swiss albino mice. Where Bhakta et al., (2019) has shown that the gross weight, width and length of testes was reduced in case of the treated mice compared to the control one. Moreover microscopically, changes in a single focus of the herbal extract treated testis showed that the number of the seminiferous tubules decreased in the treated group mice compared to the control (Bhakta et al., 2019). The amount of the spermatozoa within the lumen of the seminiferous tubules also reduced, in case of the treated mice it was 35% whereas in case of the control mice it was 70%. Along with that fibrous thickening of the membrane was found surrounding the seminiferous tubules and at the same time, vacuolization within the seminiferous tubules was also found in the treated mice, which were not the features in case of the control mice. In the control group, huge number of the sertoli cells within the seminiferous tubules and the leydig cells in between the seminiferous tubules were found, but in the treated group T there were reduction of the number of the sertoli and leydig cells. In this experiment a total of 4.4 mg/ kg Body weight of the combined herbal extract was fed per mice for the treatment purpose. In this case also it could be a dose dependent effect of the herbal extracts on the testes of male mice, which could be recovered by reducing the dose to be treated with (Bhakta et al., 2019).

Another analyst additionally attempted to discover the impact of *Syzygium aromaticum* on the regenerative arrangement of male mice (BALB/c), for the reason, the mice were then treated with 250, 500 and 1000 mg/kg/day of *S. aromaticum* remove for 34 days.

They did the hormonal test where they found, the creatures were taken care of with 500 and 1000 mg/kg/day of *S. aromaticum* remove and demonstrated a huge lessening in testosterone level contrasted and the negative control ($P < 0.05$) (Delghani et al., 2012).

With respect to quality, the organization of 1000 mg/kg/day of *S. aromaticum* separate prompted a huge decline in the sperm check ($P < 0.05$) contrasted and the other two unique portions and furthermore the negative control. The semen examination of the creatures treated with 1000 mg/kg/day indicated a critical lessening in the

level of the sperms. The seminiferous tubules in the testicles of creatures that were taken care of with 1000 mg/kg/day contained less sperms contrasted and those of the negative control creatures ($P < 0.05$). If there should be an occurrence of the test mice the fluid extraction of Clove was taken care of while Ethanolic concentrate of *S. aromaticum* can upgrade male sexual movement. Hence, it has been utilized in home grown medication as a Spanish fly in such instances of male sexual issue or debility (Tajuddin et al., 2003). Moreover, from this study it was also proven that the effect of *S. aromaticum* is highly dependent on the dose. Beside these effects of the *S. Aromaticum*, it has also some agricultural effects and it can also act as a larvicidal. Such as:

Agricultural Use of Clove Oil

Nowadays, the utilization of the pesticides or insecticides has been increased drastically in the agricultural fields for the purpose harvesting maximum crop. But the chemicals which are used as the pesticides have many devastating side effects to the human body as well to the field itself.

In this regard, the clove essential oil can also be used as insecticide for killing the bugs and other harmful insects which cause harm to the crops in the agricultural fields. Park and Shin detailed the chance of work of clove basic oil to control the japonesse termite *Reticulitermes speratus* Kolbe (Park and Shin, 2005). Additionally, Eamsobhana et al. seen that 5% clove fundamental oil have 100% of repellent movement against the chigger *Leptotrombidium imphalu*. So, clove oil can be a more secure and less expensive option in contrast to manufactured anti-agents which are generally utilized and have some hurtful symptoms to the gathered yield just as to the human wellbeing in since quite a while ago run (Eamsobhana et al., 2009).

Larvicidal Effect of Clove Oil

In the recent time Dengue, a mosquito borne disease, has become a common disease especially in the south East Asia particularly Bangladesh and India, previously malaria was at that chart. But for last two to three years the problem of Dengue has increased a lot particularly during the rainy season. Many chemical sprays are there to kill the larva of the mosquito, but those are highly toxic and may also have some long run harmful effects on the human health and also to the environment. In this regard, a botanic origin of product is highly needed.

Past investigations have indicated that a detailing containing 10% of clove basic oil has been exhibited to be compelling against the bit of *Aedes aegypti* (L.) and *Anopheles dirus* Peyton and Harrion with an insurance time of (80.33 +/- 10.56) and (60.00 +/- 10.00), separately. Eugenol, eugenol acetic acid derivation and beta-caryophyllene were viable in repellency of red imported fire ants *Solenopsis invicta* (Hymenoptera: Formicidae) (Kafle and Shih et al., 2003). Clove oil was additionally demonstrated powerful for repellent of pestiferous social wasps *Vespula pensylvanica* (Saussure) and paper wasps for the most part *Polistes dominulus* (Christ) (Zhang et al., 2013). So, in this circumstance the clove oil could be a viable option for being utilized as a larvicidal operator.

Conclusion

According to the presented information in this review we could conclude that *S. aromaticum* is a highly potential candidate of the herbal medicine among the other plants who have medicinal values as it shows antioxidant, antimicrobial, antifungal, antiviral, analgesic properties. Along with these it also aids in digestion as well as relief from blot, relief tooth pain. Most importantly it has a very vital impact on the reproductive system although according to the previous studies it has been proven that its effect is completely dependent on the dose. Although it could be a potential source of herbal contraceptive agent. Furthermore, it has role in the agriculture and also as larvicidal agent. Its proven biological as well as medicinal activities suggest to develop the commercial form of medicine for both the human and animals but of course for any herbal product the key point is to maintain the dose which distinguishes a drug from being poison. So, for more vast utilization of clove originated products, more rigorous experiments and also studies are needed, which will also open up the secret why this herbal plant has been used for centuries.

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Conflicts of interest

The authors declare that there is no conflict of interest towards the publication of this article.

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