Nature's Gift: *Syzygium Aromaticum*

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Abstract:
From ancient times to now, cloves have been utilized in traditional and culinary practices. *Syzygium aromaticum*, also known as clove, is extracted from the buds of a flowering plant that belongs to the Myrtaceae family. This oil comprises 85% Eugenol (4-allyl-2-methoxyphenol), 5.5% Eugenyl acetate, and 1.5% β-caryophyllene. *S. aromaticum* is known for its antibacterial, antiviral, antioxidant, and anti-inflammatory properties. *S. aromaticum* has multiple beneficial effects, including antifungal, antiemetic, antispasmodic, analgesic, antiseptic, anticarcinogenic, antiallergic, and anti-mutagenic activity. However, there is a lack of comprehensive information available in the current literature. To ensure the safe and effective use of clove oil, it is important for health professionals to receive adequate training through in-service programs, symposiums, conferences, and congresses. It is crucial to remember that clove oil contains powerful chemical compounds, and uncontrolled use may result in harm. Therefore, it should only be used under the supervision of a health team. It is recommended to raise public awareness about the proper use of clove oil by health professionals.

Keywords:
clove oil; eugenol; eugenyl acetate; β-caryophyllene; usage area

INTRODUCTION

The tropical perennial tree, Clove (*Syzygium aromaticum* (L.), is part of the Myrtaceae family, including myrtle, eucalyptus, and guava. Its taxonomic hierarchy can be found in Table 1. *S. aromaticum* can typically be found in woodland and rainforests (Miyazawa and Hisama, 2001). It grows best in loamy humus-rich soils and deep, loose laterite soils. The *S. aromaticum* tree is a small-medium-sized evergreen that can reach heights of 8-30 meters (Orwa et al., 2009). Its leaves are hairless and contain many oil glands on the undersurface. The flowers grow in clusters of small, terminal cymes, with 3-4 stalked flowers at the end of each stem. Clove is a valuable tropical spice plant commercially grown in India, Madagascar, Sri Lanka, Indonesia, and China's southern region (Taher et al., 2005). It is derived from dried, unopened flower buds, oleoresin, and eugenol. This essential oil has many applications in the pharmaceutical, cosmetic, food, tobacco, and agricultural industries (Ouadi et al., 2002).
Table 1. Taxonomic Hierarchy of *S. aromaticum*

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Plantae – plantes, Planta, Vegetal, plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subkingdom</td>
<td>Viridiplantae – green plants</td>
</tr>
<tr>
<td>Infra kingdom</td>
<td>Streptophyta – land plants</td>
</tr>
<tr>
<td>Superdivision</td>
<td>Embryophyta</td>
</tr>
<tr>
<td>Division</td>
<td>Tracheophyta – vascular plants, tracheophytes</td>
</tr>
<tr>
<td>Subdivision</td>
<td>Spermatophyta – spermatophytes, seed plants, phanérogames</td>
</tr>
<tr>
<td>Class</td>
<td>Magnoliopsida</td>
</tr>
<tr>
<td>Superorder</td>
<td>Rosanae</td>
</tr>
<tr>
<td>Order</td>
<td>Myrtales</td>
</tr>
<tr>
<td>Family</td>
<td>Myrtaceae- myrtles, myrtacées</td>
</tr>
<tr>
<td>Genus</td>
<td>Syzygium P. Br. ex Gaetn.</td>
</tr>
</tbody>
</table>

The word "clove" comes from the English language and is derived from the Latin word "clavus," which means nail. This is because the shape of the clove resembles the structure of a nail (Bhowmik et al., 2012). Cloves have been used in traditional and culinary arts throughout history (Zheng et al., 1992). The American Food and Drug Administration (FDA) has approved the safety of clove buds, clove oil, and certain clove components as a food supplement. Similarly, the World Health Organization (WHO) has set the acceptable daily intake of cloves for humans at 2.5 mg (Ogunwande et al., 2005). Cloves contain several essential minerals such as magnesium, manganese, potassium, iron, and selenium (Bhowmik et al., 2012). They also contain a variety of vitamins including B1, B6, C, K, riboflavin, and A (Cao et al., 2015). The oil of *S. aromaticum* is extracted from the flowers, leaves, and roots of the clove plant.

Clove contains various chemical compounds such as hydrocarbon, monoterpenes, phenolics, and sesquiterpene compounds (Mittal et al., 2014). The oil extracted from *S. aromaticum* consists of 85% Eugenol (4-allyl-2-methoxyphenol), 5.5% Eugenyl acetate, and 1.5% β-caryophyllene (Prashar et al., 2006). Table 2 provides a detailed summary of these components and their activities.

Clove has been reported to be effective in relieving toothache and for periodontal therapy (Date and Kulkarni, 1995; Cai and Wu, 1996). It has also been shown to have antibacterial properties against various bacteria such as *Escherichia coli*, *Listeria monocytogenes*, *Salmonella enterica*, *Campylobacter jejuni*, *Salmonella enteritidis*, and *Staphylococcus aureus* (Beuchat, 2000; Cressy et al., 2003; Kalemba et al., 2003). Additionally, studies have revealed its antiviral, antioxidant, and anti-inflammatory effects, as well as its anti-fungal, anti-emetic, anti-spasmylic, analgesic, antiseptic, anti-carcinogenic, anti-allergic, and anti-mutagenic properties (Liu et al., 1997; Kim et al., 1998; Miyazawa and Hisama, 2001). *S. aromaticum* is particularly effective against both gram-positive and gram-negative bacteria (Chaieb et al., 2007).

According to a study conducted in 1999, clove oil has antiepileptic properties as it activates the central nervous system (Pourgholami et al., 1999). Additionally, studies on rats indicate that clove oil inhibits calcium and potassium channels in the heart (Kozam, 1977; Sensch et al., 2000).
Table 2. Main Active Chemical Components and Activities of S. aromaticum

<table>
<thead>
<tr>
<th>Compound</th>
<th>Bioactivity</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>β-Caryophyllene</td>
<td>antibacterial, anti-fungal, antioxidant, anti-proliferative, anxioytic, neuroprotective, sedative, antitumour,</td>
<td>Selles, dahham</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Franchomano</td>
</tr>
<tr>
<td>α-Humulene</td>
<td>anti-inflammatory and antitumor activity, antiproliferative</td>
<td>Selles, Haro-González</td>
</tr>
<tr>
<td>Carvone</td>
<td>antidiabetic, anti-inflammatory, anticancer, neurological, antimicrobial, antiparasitic, antiarthritic, anticonvulsant, and immunomodulatory effects</td>
<td>Selles, Bouyahya</td>
</tr>
<tr>
<td>α-Farnesene</td>
<td>antimicrobial, antiviral</td>
<td>Selles, Habibah</td>
</tr>
<tr>
<td>δ-Cadinene</td>
<td>antibacterial activity, antioxidant</td>
<td>Selles, Trong, Wang</td>
</tr>
<tr>
<td>Eugenol</td>
<td>analgesic, anti-inflammatory, hypotensive, anticarcinogenic, antioxidant, antiparasitic, antifungal, antimicrobial, antispasmodic, antiseptic, dental angesic, antiviral, and leishmanicidal</td>
<td>Selles, Abdou</td>
</tr>
<tr>
<td>Eugenyl Acetate</td>
<td>antibacterial, anticancer, antimutagenic, antioxidant, and anti-virulence activity</td>
<td>Selles, Haro-González</td>
</tr>
<tr>
<td>α-Cubebene</td>
<td>antimicrobial, antioxidant</td>
<td>Wang</td>
</tr>
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</table>

Characteristics of major components

β-Caryophyllene (BCP) is a bicyclic sesquiterpene that occurs naturally in many plants (Friedman et al., 2000). It has been approved as a flavoring agent by both the Food and Drug Administration (FDA) and the European Food Safety Authority (EFSA) (Fidyt et al., 2016). BCP is an active ingredient in essential oils obtained from various spices and food plants. This compound possesses numerous biological properties, such as anti-inflammatory, anticarcinogenic, antimicrobial, antioxidant, and analgesic activities (Friedman et al., 2000; Fidyt et al., 2016). Studies have revealed that it has significant anticancer activity and can inhibit the growth and proliferation of various cancer cells.

Eugenol

Eugenol (4-allyl-2-methoxyphenol; C10H12O2) belongs to the phenol group of aromatic compounds and is the primary component of clove oil (S. aromaticum) (Ulanowska and Olas, 2021; Zari et al., 2021). It contains various functional groups, such as allyl (-CH2-CH=CH2), methoxy (-OCH3), and phenol (OH) (Zari et al., 2021). The phenolic structure of eugenol makes it highly active against microorganisms. It can disrupt proteins, thereby altering the permeability of the cell membrane (Gupta et al., 2008; Bhuiyan et al., 2010).

According to Guénette et al. (2007), eugenol has been found to alleviate neuropathic pain (Guénette et al., 2007). Clove oil possesses biological properties because of its constituents. Eugenol has been shown to have anticancer effects on various cancer cell lines through cell death, cell cycle arrest, migration inhibition, metastasis, and angiogenesis (Huang et al., 2002; Velluti et al., 2003). It is effective against multiple types of cancer, including leukemia, lung cancer, colon cancer, colorectal cancer, skin cancer, stomach cancer, breast cancer, cervical cancer, and prostate cancer (Cassona et al., 2021; Nisar et al., 2021).

Eugenyl Acetate

Eugenyl Acetate is an aromatic compound that belongs to the class of esters. It has been approved for safe use in food products by the Joint FAO/WHO Expert Committee on Food...
Additives (JECFA) and the European Food Safety Authority (EFSA) (Tischer et al., 2019; Petrocelli et al., 2021). Eugenyl Acetate is derived from eugenol, a phenylpropanoid, and has been found to possess antibacterial, anticancer, antimutagenic, antioxidant, and anti-virulence properties (Haro-Gonzéllez et al., 2021).

CONCLUSION

Clove has been used to treat many systemic ailments throughout history. However, the literature needs more information about the specific areas of application and groups of clove oil users. It is essential to have more comprehensive details on S. aromaticum. Health professionals should receive in-service training, symposiums, conferences, congresses, and other scientific meetings about the appropriate use of clove oil. It is crucial to remember that clove oil contains potent chemical compounds that can be harmful if misused. Therefore, it should only be used under the guidance and supervision of the healthcare team. It is also recommended that the public be informed about the appropriate use of clove oil by health professionals.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES


