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A Comprehensive Review on Clove

Omkar Govardhan Patil[1], Omkar Rameshewar Naik[2], Abhay Patil[3], Prajakata Indalkar[4], Balaji Hake[5], Asmita B. Zodage[6]

[1,2,3,4,5]Students, Shivlingeshwar College of Pharmacy, Almala, Latur, MH

[6]Assistant Professor, Department of Pharmaceutics, Shivlingeshwar College of Pharmacy, Almala, Latur, MH

Abstract: *Clove (Syzygium aromaticum) is one of the most valuable spices that have been used traditionally as food preservative and for many therapeutic purposes. Clove is native of Indonesia but it has also been cultured in several parts of the world including Pakistan. This plant represents one of the richest sources of phenolic constituents as eugenol, and eugenol acetate and posseses great potential for pharmaceutical, cosmetic, food and agricultural applications. This article includes main studies reporting the phytochemical profile and pharmacological activities of clove and eugenol. The antioxidant and antimicrobial activities of clove are higher than many fruits, vegetables and other spices. Toxicological studies are also mentioned. The different studies reviewed in current work authenticate the traditional use of clove as food preservative and medicinal plant .Clove is a native of Indonesia but is also cultivated in many coastal areas at higher altitudes around the world. Health benefits of clove have been proved from centuries in treatment of many ailments and disease. Clove also shows antimicrobial, antiviral, anti-inflammatory, hepatoprotective, anti-stress, antinoceptive, anesthetic activities. Larvicidal activity of clove in dengue is a new application. Commercially, clove has been used for volatile oil extraction in formulating medicinal, food and cosmetic products. Clove oil comprises of many phytoconstituents, eugenol being an important one of the phenolic compounds. In respect to the points mentioned, this report is one of its kind as an attempt has been made to compile knowledgeable data of clove together in this article. Pharmacological activities, botanical description, phytochemistry, toxicity studies and uses of clove have been discussed.*

Keywords: Syzygium aromaticum, eugenol, antioxidant, Cloves, Laung

To conduct a comprehensive review of the existing literature on Clove (Syzygium aromaticum), encompassing its botanical characteristics, chemical composition, pharmacological properties, medicinal uses, and potential applications.

Objectives:-

1.Botanical and Chemical Characterization: To summarize the botanical features, chemical composition, and nutritional profile of Clove.

2.Pharmacological Properties: To review the pharmacological properties of Clove, including its antioxidant, anti-inflammatory, antimicrobial, and analgesic activities.

3.Medicinal Uses: To examine the traditional and modern medicinal uses of Clove, including its application in dental care, digestive health, and respiratory issues.

4.Potential Applications: To explore the potential applications of Clove in various industries, such as food, cosmetics, and pharmaceuticals.

5.Toxicity and Safety: To discuss the potential toxicity and safety concerns associated with Clove consumption and usage.

6.Future Research Directions: To identify gaps in current research and propose future research directions for Clove.

7.To incorporate clove in various cuisines and recipes, such as spice blends, desserts, stews, and beverages (e.g., chai, mulled wine), for its distinctive warm, sweet, and slightly spicy flavor profile

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I. INTRODUCTION

Spice like clove is used as a natural preservative and as an herbal drug from centuries for its antioxidant and antimicrobial properties. Syzygium aromaticum (S. aromaticum) commonly called as clove is a native from Maluku islands in east Indonesia belongs to Myrtaceae family and consists of about 1200 to 1800 flowering plant species . Clove cultivation is carried out at high altitudes above sea level of about 200 m in coastal regions

It's wide distribution is in the regions of tropical and subtropical lands of Asia (Indonesia, Sri Lanka, India, Tanzania, Malaysia), Madagascar, Africa and all over the pacific and oceanic regions . Clove is cultured in Brazil in its north east region in Bahia state (regions of Valenca, Itubera, Taperoa, Camamu & Nilo) on around 8000 hectares of Land.

Fig 1: Plant of Syzyglum aromaticum showing branches of tree

Clove is used for the treatment and cure of many diseases. One of the new applications include it as larvicidal agent to combat one of the seriousheath problems of tropical countries i.e.dengue 17. Clove is otherwise used in the treatment of digestion related disorders like loose motions, nausea, flatulence & dyspepsia. It acts as an antibacterial agent by improving body defense system against invading microbes. It is also used in the treatment of Athletes Foot disease, onchomysosis, and respiratory conditions like cough, old, asthma, bronchitis and sinusitis. Clove has shown to be affective in lung and skin carcinomas and also in diabetes as it controls blood glucose levels. Topical application of clove oil relieves muscular cramps and soothes headache. Sniffing its aroma helps in the reduction of restlessness, relieve mental fog, depression and drowsiness.

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Fig 2: Different varletles of clove (A) Penang; (B) Zanziber; (C) Ripe frult of clove plant

Pharmacological actions of clove is classified into various categories based on its activity into antimicrobial, anti-inflammatory, anti-stress , antioxidant, antiviral , hepatoprotective, and antinoceptive activities etc.

Origin of Clove

Clove (Syzygium aromaticum) is native to the Spice Islands of Indonesia, specifically the Maluku Islands (also known as the Moluccas), which are part of modern-day Indonesia. It has been used for thousands of years in culinary, medicinal, and cultural practices. The spice was highly valued in ancient trade routes, especially in the Indian Ocean region, and was introduced to Europe through Arab traders.

The cultivation of cloves spread over time to other tropical regions, including parts of Africa, India, Sri Lanka, and even South America, due to its popularity and high value in trade. Today, the largest producers of cloves are Indonesia, Madagascar, and Tanzania

Clove

Clove Varieties: Exploring the Diversity:-

Eugenia caryophyllata :- The most common and widely cultivated clove variety, known for its robust flavor and versatility.

Syzygium aromaticum :- A less common but highly highly prized clove variety, variety, with a more delicate delicate and complex aroma, aroma.

Indonesian Cloves:-Renowned for their exceptional quality, Indonesian cloves are considered the global standard for the spice.

Zanzibar Cloves:- Grown on the island of Zanzibar, Zanzibar, these cloves are known known for their slightly sweeter sweeter and more aromatic profile.

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The Nutritional Profile of Clove:-

Antioxidants Clove:- it is rich in antioxidants, including eugenol, which may which may help protect against oxidative stress and inflammation.

Dietary Fiber Clove:- it is a good source of dietary fiber, which can aid Digestion and promote gut health.

Sustainability and the Future of Clove:-

Sustainable Farming Promoting eco-friendly farming practices to ensure the long-term viability of clove production

Biodiversity Protection:-

Preserving the natural habitats and ecosystems that support the cultivation of high-quality clove.

Fair Trade Partneraships:-

Establishing fair trade networks to support local growers and ensure ensure equitable distribution of benefits.

Product Development :-

Exploring new applications and products that leverage the unique unique properties of clove, driving market growth.

Consumer Education :-

Raising awareness about the importance of sustainable clove clove cultivation and consumption.

History:-

Clove is an ancient spice, which is believed to be originated in the first century, before Christ. The first clue Hussain et al., 2017 (207 B.C. to 220 A.D.). At that time, a Chinese Physician wrote that court visitors were required to hold clove in their mouth to prevent the Emperor from visitor's bad breath. Cloves were traded to Europe by the Arabs in 4th century A.D. The origin and source of clove was a mystery, until the discovery of Indonesia or Moluccas Island, by Portuguese, in 16th century.In 17th century A.D., cloves were introduced to Sri Lanka. In 18th century A.D., cloves were established in India by East India Company. In European countries, there is a tradition to make "Pomanders" by studding oranges with clove buds, and to hang them around the homes, during Christmas, for decorative purpose and to spread fragrance.Demography/Location Clove requires damp tropical and sub-tropical environments for growth. It has been cultivated in the following countries: Indonesia, Sri-Lanka, India, Tanzania, Malaysia, Madagascar, and Pakistan.Botany, Morphology, Ecology Clove is a scented dried bud of Syzgium aromaticum tree, used as seasoning in food cuisines. S. aromaticum is an evergreen tree which grows upto a height of 8 to 12m; having large quadrangle leaves and cheerful flowers arranged in form of clusters. Young flower buds are of pale color and slowly changes to green, which changes to bright red when buds are ready for harvesting.

Harvesting should be done when buds have 2 cm length, long calyx terminating in four closed petals (forming a tiny ball in the core) and spreading sepals. Clove growth requires welldrained, loamy, and organic matter rich soils. Constant temperature above 10ºC is crucial, while, optimum temperature is around 20 to 30 ºC. This species cannot tolerate water logged conditions. Areas having annual rainfall of 150 to 300 cm are best for its growth.

Uses of Clove

Culinary Uses:-

Spice in Cooking: Cloves are used in both whole and ground forms in a variety of dishes, especially in Indian, Middle Eastern, and Southeast Asian cuisines. They add a warm, aromatic flavor to meats, curries, soups, stews, rice dishes, and sauces.

Baking: Cloves are commonly used in spice blends for baking, such as in gingerbread, pumpkin pie, and spice cakes.

Flavoring Beverages: Cloves are often added to teas, mulled wines, and other beverages to infuse a rich, aromatic flavor.

Medicinal Uses:-

Pain Relief: Clove oil, which contains eugenol, is commonly used as a topical analgesic, particularly for dental pain, such as toothaches or gum discomfort.

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Digestive Health: Clove is believed to aid digestion, alleviate bloating, and reduce nausea. It has traditionally been used in Ayurvedic and Traditional Chinese Medicine for these purposes.

Antiseptic Properties: Due to its antibacterial and antifungal properties, clove is used in topical treatments for infections, wounds, and skin conditions.

Respiratory Health: Cloves can help clear mucus and act as an expectorant. They are sometimes used in herbal teas for coughs and colds.

Aromatherapy

Essential Oils: Clove essential oil is used in aromatherapy for its calming and soothing effects. It is believed to help reduce stress, relieve anxiety, and even enhance focus

II. CHEMISTRY (DRUG PROFILE)

Clove is a vital source of phenolic compounds such as flavonoids, hydroxycinamic acids, hydroxybenzoic acids, and hydroxyphenyl propenes. Eugenol is the chief bioactive constituent of clove, which is present in concentrations ranging from 9 381.70 to 14 650.00 mg/100 g of fresh plant weight. With regard to the phenolic acids, gallic acid is found in higher concentration (783.50 mg/100 g fresh weight) [6]. Other phenolic acids found in clove are caffeic, ferulic, elagic and salicylic acids. Flavonoids including kaempferol, quercetin and its derivates (glycosilated) are also found in trace amounts. Appreciable amounts of essential oil are present in aerial parts of clove. Chemical profile of this oil is generally found by GCMS analysis [711]. Good quality clove bud contains volatile oil (15 to 20%), which mainly comprises of eugenol (70 to 85%), eugenyl acetate (10 to 15%), and beta-caryophyllene (5 to 12%). Other minor constituents including methyl amyl ketone, kaempferol, gallotannic acid, α-humulene, βhumulene, methyl salicylate, crategolic acid, and benzaldehyde are responsible for the characteristic pleasant fragrance of clove . Figure 1 shows structures of some important compounds of clove

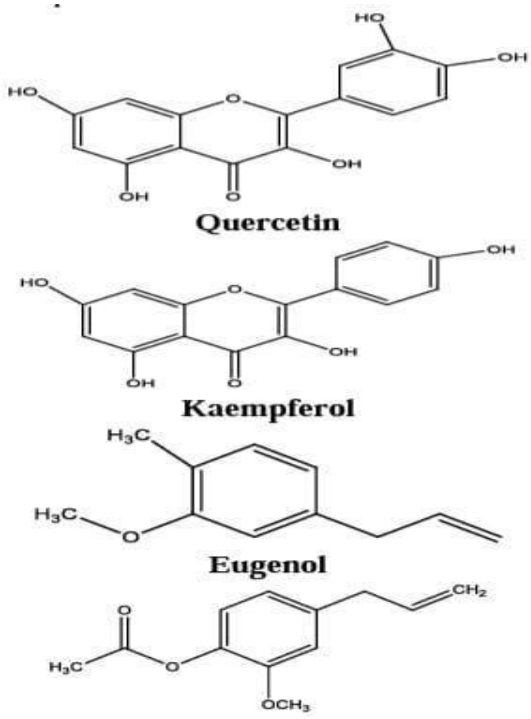

Fig.1. Structures of some important phytochemicals found in Syzygium aromaticum

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Clove

Synonym: Clove bud, Clove flower, Caryophyllum, Laung

BIOLOGICAL SOURCE: Clove consists of dried flower buds of Eugenia caryophyllus, family Myrtaceae. It should contain Pemba, Penang, Madagascar, Caribbean islands, Sri Lanka and India. In India, cloves are grown in Nilgiri, Tenkasi-hills and in Kanyakumari district of Tamil Nadu state, It is also cultivated in not less than 7.0 per cent (w/w) of eugenol calculated on dried basis.

CHEMICAL CONSTITUENTS: Clove contains about 15 to 20 per cent of volatile oil; 10 per cent to 13 per cent of tannin (gallotannic acid), resin, chromone and eugenin, .The volatile oil of the drug contains eugenol (about 70 to 90 per cent), eugenol acetate, Caryophyllenes and small quantities of esters, ketones and alcohols.

USES: Clove is used as a dental analgesic, carminative, stimulant, lavouring agent, an aromatic and antiseptic. It is also used in the preparation of igaretts. The oil is used in perfumery and also in the manufacture of vanillin.

Pharmacological Uses

1. Antimicrobial activity:- Antimicrobial properties of Syzygium aromaticum and Rosmarinus officinalis essential oils were tested against multidrug resistant isolates including Pseudomonas aeruginosa, Enterococcus feacalis, Acinetobacter baumannii, and Staphylococcus aureus, and two controlled strains Pseudomonas aeruginosa-ATCC27853 and Staphylococcus aureus-ATCC29213, using agar well diffusion model. Both oils exhibited significant inhibition against tested strains, with minimum inhibitory concentrations ranging from 0.312-1.25% (v/v) for clove oil, and 0.312-5% (v/v) for rosemary oil . A comparative analysis was carried out to evaluate the antiseptic potential of clove extract (ethanolic) and clove oil against some food borne pathogens. Ten bacterial and seven fungal strains were tested using agar well diffusion method. Sodium propionate was used as a standard food preservative. Results revealed the greater antimicrobial effect of clove oil, when compared to extract and sodium propionate. In another study, clove oil was tested against five dermophytes including Trichophyton rubrum, Epidermophyton floccosum, Microsporum canis, Microsporum gypseum, and Trichophyton mentagrophytes. Maximum inhibitory effect (≈60%) against all fungal strains was shown at dose of 0.2mg/ml . Antibacterial activity of six spices (clove, mint, cinnamon, ginger, mustard, and garlic) was evaluated against Escherichia coli, Bacillus cereus, and Staphylococcus aureus, using dilution, cup, and paper disc diffusion assays. Results revealed the maximum inhibitory action of clove, mustard, and cinnamon at 1% concentration. Garlic showed good inhibitory action at 3% concentration. However, mint and ginger had negligible inhibition at same concentration . Essential oils of Piper nigrum, Syzygium aromaticum, Pelargonium graveolens, Myristica fragrans, Origanum vulgare, and Thymus vulgaris were evaluated for antimicrobial activity against twenty five bacterial strains, including food borne, animal, and plant pathogens.considerable inhibitory action was observed by the volatile oils in a dose dependent behavior.

2. Cytotoxic activity Anti-oxidant, genotoxic and cytotoxic potentials of borneol and eugenol (clove oil derivative) were evaluated as the capability of modulating resistance against DNA Hussain et al., 2017 damaging effects of H2O2, on different strains of human cells: malignan hepatome cells (HepG2), malignan colon cells (caco-2) and non malignan human fibroblast (VH10). Results revealed the remarkable anti-oxidative potential of eugenol at all the tested doses. It was also verified that the citotoxic potential of eugenol was more powerful than borneol. With regard to toxicity, eugenol exhibited strong DNAdamaging effects on human fibroblast (VH10), medium damaging effects on colon cells (caco-2) and non genotoxic effects on hepatome cells.

3. Antioxidant activity A study was performed to assess the antioxidant potential of aqueous and alcohol extracts of some selected spices including onion, garlic, pepper, cinnamon, mint, ginger, and clove. Generally phenolic and flavonoids are responsible for antioxidant activities of the oil. All spices inhibited lipid oxidation in a dose dependent manner. Among all, clove showed maximum, whereas, onion showed minimum inhibitory potential. Antioxidant activities of clove, sage, and oregano essential oils were evaluated using DPPH (2,2-diphenyl- 1-picrylhydrazyl) free radical quenching, BCB (β-carotene bleaching), and FRP (Fe(lll) reducing power) methods. Butylated hydroxytoluene was used as standard antioxidant. Essential oils were added to soybean oil at doses of 0.006 and 0.01g/ml, for thirty

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days, at accelerated oxidation level. Among all examined oils, the clove oil showed more potent ($p<0.05$) antioxidant activity followed by oregano and sage oils.

III. CONCLUSION

Herbs are staging comeback and in the present days herbal products represent safety and security as compare to synthetic drug which leads toward research in herbal medicines.The traditional knowledge may play important role if a holistic approach, and involvement and participation of tribes for documentation, preservation and use for the benefit of humankind, before it is lost forever.Clove is a remarkable spice with a rich history of use across many cultures for culinary, medicinal, and practical purposes. Its unique, warm flavor enhances a wide variety of dishes, and its powerful medicinal properties have made it a valued ingredient in traditional remedies for pain relief, digestive health, and more. Beyond its uses in food and medicine, clove serves as a natural insect repellent and a key component in aromatherapy and skincare. Whether used for its flavor, healing benefits, or aromatic qualities, clove continues to play an important role in both everyday life and traditional practices. Its versatility and effectiveness in so many areas highlight why it remains a prized ingredient around the world.The fruit of the plant Syzygium aromaticum has been used since centuries in every part of the globe. It has pharmacological benefits like antimicrobial,antiinflammatory, antinoceptive, hepatoprotective, anti-stress, and anesthetic. Clove has proved to be a good antioxidant as well. The single drop of its oil is many times stronger and effective as compared to other antioxidants like blueberries and wolf berries. Based on all the above information it is found to be a very effective plant with many proved benefits having least adverse effects. The proved biological activities suggest the development of more herbal products containing clove as an ingredient which are useful medicinally for humans as well as for animals.

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