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A REVIEW ON PHARMACOLOGICAL ACTIVITY AND BIOLOGICALLY ACTIVE CONSTITUENTS OF BAY LEAF.

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Abstract:

Bay laurel or bay leaf (*Laurus nobilis L.)* belonging to the *Lauraceae* family is a culinary herb cultivated in the Mediterranean region and in the warm climates of the southern United States, Central America, Europe, the Middle East, and Asia. As herb, it is used in various cuisines of India, France, Italy, and Turkey to add flavors to the dishes. It is very effective in the treatment of digestive problems. The oil obtained from the bay leaf is extracted from different parts of the plant and possesses potent biological and pharmacological properties and is used as an antibacterial agent, antifungal agent, antioxidant agent, and many more. Bay leaf contains certain chemical constituents such as Cineole, sabinene, α-pinene, and p-Cymene which possess great medicinal value. This review will focus on the biological potential and health benefits of bay leaf in all its form whether oil, powder, or extract, emphasizing on chemical composition and biological activities of the bay leaf which will be quite beneficial for its study.

Keyword:

Culinary herb, pharmacological properties, biological, oil extracts, chemical constituents.

1. Introduction:

Bay leaf (Laurus nobilis) (Fig. 1) is an evergreen perennial shrub in the laurel family (Lauraceae). It has been used for 1000 years and is an essential ingredient in many traditional dishes **(20).** The genus Laurus contains between 24,00 to 25,00 species, with many varieties found in the Southern Mediterranean region, Eastern Asia's subtropics and tropics, South and North America, the Balkans, and Asia Minor. The high variability among species is largely due to uncertainty about the exact number of species. Variability is found in the morphology, flower color, growth habitat, leaves, stems, and chemical composition. Traditional laurel species include Laurus azorica and L. nobilis. There are several plants with the common name bay laurel that are not in the genus Laurus, including bay rum tree (Pimenta racemosa). Various names have been given to L. nobilis. It is known as teejh pat in Urdu. It is commonly known as bay leaf or sweet bay in English. It is known as waraq ghaar in Arabic. It is known as lorbeer in German. It is known as Dafni in Greek. It is known as teejpatta in India, specifically in Hindi. Bay leaf unit production ranges from 30 to 70 kg per tree per year in Meghalaya, but the average range is 13 kg of dry leaves in Nepal **(21).** In the

Udaipur district, approximately 900 tonnes of bay leaf are produced, with Nepal exporting 2100 tonnes to India **(22).** The Aegean and Eastern Mediterranean regions have the most bay leaf collection areas for export **(23).** In 2002, Turkey exported 4869 tonnes of bay leaf to the United States **(24).**

FIGURE.1 Bay Leaf

Bay leaf has 32 genera. Sweet Bay, bay laurel, Grecian Laurel, true bay, and bay tree are all names for Laurus. It grows in the tropical and subtropical Himalayas at altitudes ranging from 900 to 2500 meters. It can also be found in tropical and subtropical Asia, as well as Australia, the Pacific region, and South Asia. It is found in various parts of India including Uttarakhand and Himachal Pradesh along with the Western Himalayas, as well as Sikkim, Assam, Mizoram, and Meghalaya
(2).

It is a tough multi-branched tree with smooth bark that can grow up to 10 m tall. It has narrow oblong-lanceolate alternate leaves. The flowers are four-lobed and small; the female has 2-4 staminodes and the male has 8-12 stamens. When ripe, the fruit becomes ovoid, black, and 10-15 in diameter. These are fragrant and aromatic plants native to southern Europe that produce fixed and volatile oil as well as camphor. Laurus nobilis is an industrially important plant that is used in foods, drugs, and cosmetics. The dried leaves and essential oils are widely used in the food industry to season meats, soups, and fish. Its antimicrobial and insecticidal properties are another reason why the bay is used in the food industry as a food additive. The fruits contain both volatile oils and fixed oils, which are primarily used in the production of soap. It has traditionally been used to treat dermatitis and rheumatism, as well as gastrointestinal issues such as flatulence, eructation, impaired digestion, and epigastric bloating **(25).**

In Turkish folk medicine, the aqueous extract of bay leaf is used for stomachache treatment, as an anti-hemorrhoidal, antirheumatic, diuretic, and snakebite antidote. It has recently been used to prevent migraines and treat diabetes **(3).** One of the plants that can be used to lower cholesterol levels is bay leaves (Syzygium polyanthum) **(26).**

Secondary metabolites found in bay leaves include saponin, terpenoid, flavonoid, polyphenol, alkaloid, and essential oil. Bay leaf extract has been shown to lower cholesterol levels in animal blood in several in vivo studies. One of the chemical components of bay leaves, flavonoid (phenolic compound), is thought to play a role in lowering cholesterol levels in the blood. Furthermore, Lee et al. demonstrated that flavonoids can lower cholesterol levels by inhibiting the action of HMG-CoA Reductase **(27).**

Several studies have shown that flavonoids and phenolic acids, two classes of polyphenolic compounds, have antioxidant properties such as anti-inflammatory actions, inhibition of oxidative enzymes, and free radical scavenging **(4).**

The essential oil (0.8 to 3%) from the leaves contains mostly 1,8-cineol (up to 50%) but also contains eugenol, acetyl and methyl eugenol, alpha, and beta-pinene, phellandrene, linalool, geraniol, and terpineol **(47)**. The essential oil in dried laurel fruits ranges from 0.6 to 10%. This

essential oil's aroma is primarily due to terpenes (cineol, terpineol, - and -pinene, citral), but it also contains cinnamic acid and its methyl ester. The potential antimicrobial role of laurel essential oil has also been investigated. The anticonvulsant activity of laurel essential oil is due to methyl eugenol, and pinene. Cineol, eugenol, and methyl eugenol, on the other hand, also cause motor impairment and sedation. The essential oil of laurel leaves is also known to have analgesic and anti-inflammatory properties. L. nobilis methanolic extracts contain polar compounds (such as phenols, flavones, and flavanols) and exhibit antioxidative activity **(5).**

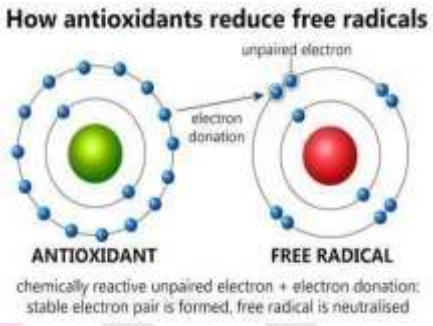
Sesquiterpene lactones are found in the roots and leaves of Bay trees and two distinct chemical types were discovered with laurenobiolide and costunolide as major compounds **(28,30).** Sesquiterpene lactones found in bay leaf were discovered to have a variety of pharmacological properties such as inhibitory effects on NO production (anti-inflammatory), inhibitory effects on alcohol absorption, and enhancement of liver glutathione S-transferase (GST) activity **(30,31).** Bay leaves and fruits have traditionally been used to treat skin rashes, earaches, and rheumatism. It is also a stomachic, astringent, carminative, diaphoretic, stimulant, emetic, emmenagogue, abortifacient, and insect repellent. The cosmetic industry uses essential oil in creams, perfumes, and soaps **(6).**

2. Taxonomical Classification

- Kingdom: Plantae
- Division: Magnoliids
- Order: Laurels
- Family: Lauraceae
- Genus: Laurus
- Species: Laurus nobilis

3. Pharmacological Activities:

3.1. Antioxidant Activity

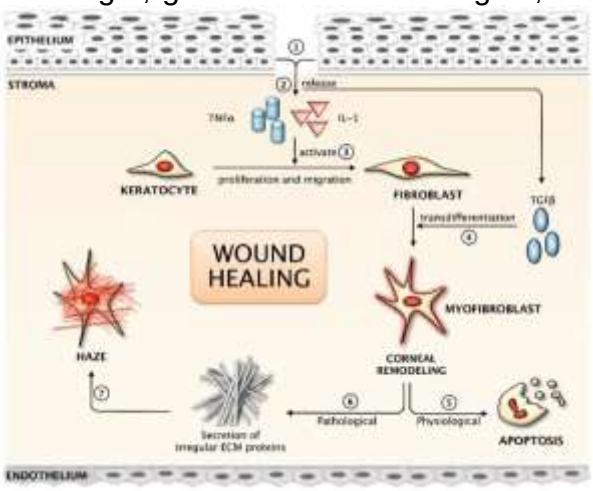


The antioxidant properties of lyophilized aqueous and ethanol extracts of Laurus nobilis were investigated. To determine the total antioxidant capacity of both extracts, the antioxidant activity, reducing power, free radical scavenging, superoxide anion radical scavenging, hydrogen peroxide scavenging, and metal chelating activities were evaluated. In a linoleic acid emulsion, both

extracts demonstrated significant total antioxidant activity. Concentrations of 20, 40, and 60g/ ml inhibited lipid peroxidation of linoleic acid emulsion by 84.9, 95.7, 96.8, and 94.2, 97.7, and 98.6% for water and ethanol extracts, respectively. However, 60 g/ ml of the standard antioxidants butylated hydroxy anisole (BHA), butylated hydroxytoluene (BHT), and alpha-tocopherol inhibited lipid peroxidation in linoleic acid emulsion by 96.6, 99.1, and 76.9%, respectively **(9,48).**

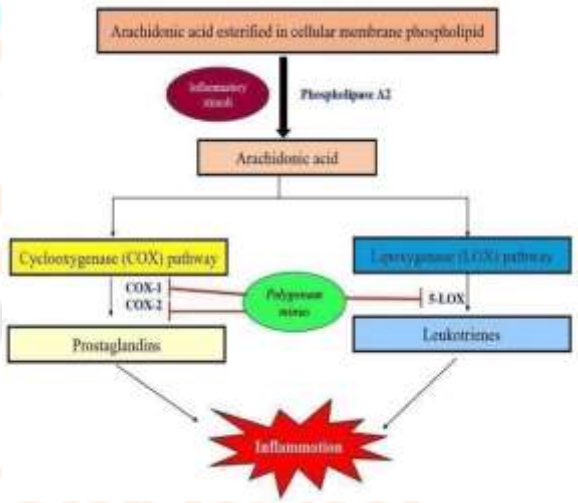
3.2.Wound Healing Activity

The aqueous extract of L. nobilis was found to have better wound-healing activity than the aqueous extract of Allamanda. Many wound healing models, both excision and incision, were used to estimate wound healing activity. Tensile strength, granulation tissue weights, rate of wound closure, period of epithelialization, histopathology of the granulation tissue, and hydroxyproline content of the granulation tissue were all studied to assess wound healing activity. Animals treated with bay leaf had a relatively high rate of wound contraction, hydroxyproline content, and granulation tissue weight. When compared to Allamanda cathartica-treated animals, bay leaf-treated animals had a higher number of inflammatory cells and less collagen **(8, 49).**



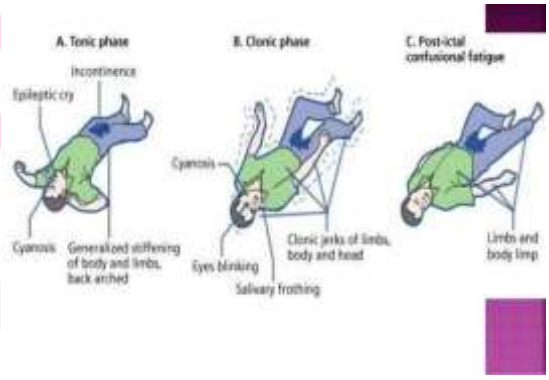
3.3.Analgesic and Anti-inflammatory

In mice and rats, the essential oil of Laurus nobilis Linn. was tested for analgesic and anti-inflammatory properties. In tail-flick and formalin tests, the essential oil had a significant analgesic effect, a dose-dependent anti- inflammatory effect in formalin-induced edema, and a moderate sedative effect at anti- inflammatory doses. The essential oil's analgesic and anti-inflammatory effect was comparable to that of reference analgesics and non-steroid anti-inflammatory drugs such as morphine and piroxicam. Ethanol and aqueous extracts obtained from the leaves and seeds of Laurus nobilis were also tested for anti- inflammatory activity in a carrageenan-induced hind paw edema model in mice without inducing any gastric damage, with the ethanol extract showing prominent anti-inflammatory activity **(3,11).**



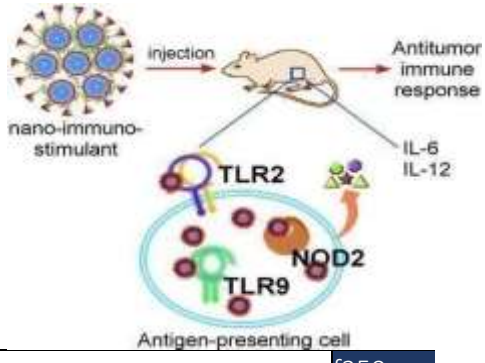
3.4.Anticonvulsant Activity

The anticonvulsant activity of L. nobilis leaf essential oil against experimental seizures was investigated. The essential oil protected mice from tonic seizures caused by maximum electroshock, particularly pentylenetetrazol. Sedation and motor impairment were observed in anticonvulsant doses of the essential oil. This effect may be due to the presence of methyl eugenol, eugenol, and pinene in bay essential oil **(10,50).**



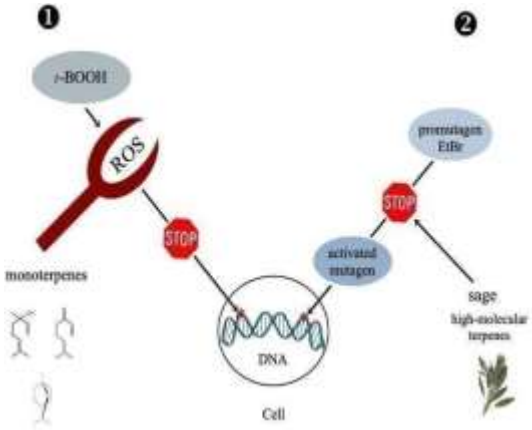
3.5.Immunostimulant Activity

The immunostimulant effects of bay leaf powder on rainbow trout were demonstrated by feeding them dietary constituents. Experiment diets were fed to three groups of rainbow trout. Nonspecific immune parameters such as phagocytosis in blood leukocytes, extracellular or intracellular respiratory burst activity, lysozymes, and protein levels were examined after 21 days and revealed immunostimulant activity **(1).**



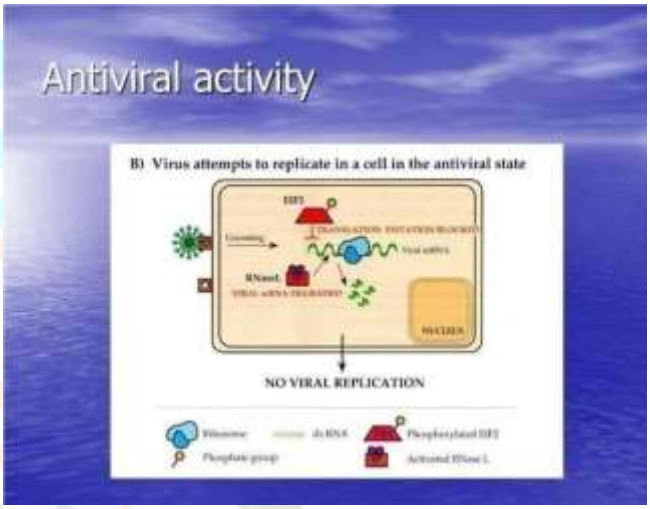
3.6.Antimutagenic Activity

The antimutagen was isolated chromatographically from a bay leaf ethyl acetate extract and identified instrumentally as 3kaempferol p coumarate. The yield was 20 mg from 100g of bay, and the IC50 value, which is the amount required to inhibit the mutagenicity of 20 mg of TrpP2 by 50%, was 1.9g. This value is comparable to that of strong antimutagens like flavones and flavanols. The antimutagenicity was due to a demutagenic action that prevented Trp-P-2 from being metabolically activated to its ultimate carcinogenic form. The kaempferol moiety aided in the activity **(1,12).**



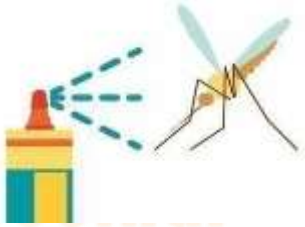
3.7.Antiviral Activity

By visually scoring the virus-induced cytopathogenic effect post-infection, essential oils of Laurus nobilis were evaluated for their inhibitory activity against SARS-CoV and HSV-1 replication in vitro. With an IC (50) value of 120 g/ml and a selectivity index (SI) of 4.16, Laurus nobilis oil indicated activity against SARSCoV. The presence of beta- ocimene, 1, 8-cineole, alpha-pinene, and beta-pinene as the main constituent was identified in this oil **(3).**



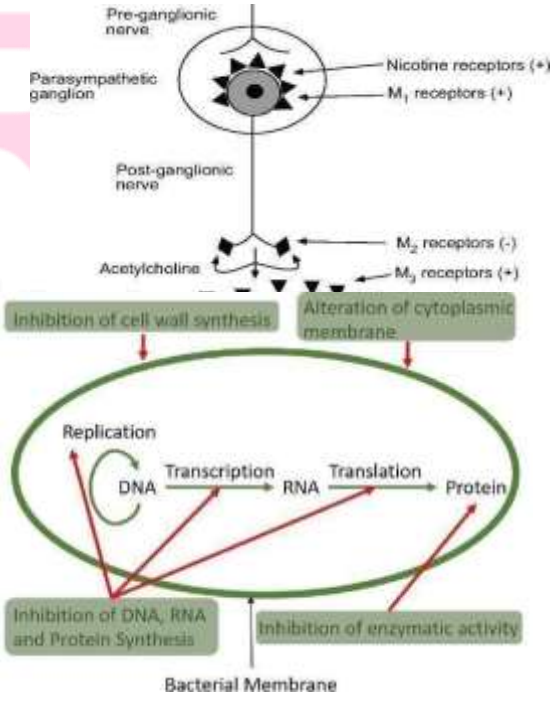
3.8.Insect Repellent Activity

Essential oils extracted from the seeds of fresh foliage of the laurel Laurus nobilis Linn. were tested for repellent activity against adult females of Culex pippins, the most common pest mosquito in Antalya's urban and suburban settings. The essential oils indicated repellent properties **(3,14).**



3.9.Anticholinergic Activity

The ethanolic extract, decoction, and essential oil of Laurus nobilis were tested for acetylcholinesterase (AChE) enzyme activity. The essential oil fraction was discovered to have a greater than 50% inhibitory potential for AChE. It also inhibited AChE at a potent 64% (1 mg ml1) in the ethanolic fraction**(7,13).**



3.10.Antimicrobial Activity

In vitro antibacterial activity was indicated by L. nobilis essential oil, methanolic extract of seed oil, and seed oil. However, the methanolic extract of seed oil outperforms both essential oil and seed oil in terms of antibacterial activity. Similarly, the antibacterial activity of L. nobilis essential oil against Staphylococcus aureus, Bacillus subtilis, and Staphylococcus intermedius was determined in another study. The essential oil of L. nobilis demonstrated good antibacterial activity, with minimal inhibitory concentrations of 0.35 and 0.56 mg/mL, respectively. The antibacterial activity of bay leaf may be attributed

to its main constituent, 1,8 cineol. L. nobilis antifungal activity was tested in vitro on seven strains of plant pathogenic fungi at different concentrations such as 50,125, and 250 mg/mL. The highest antifungal activity was observed at a concentration of 250mg/ml against the fungus Botrytis cinerea **(1,15,16).**

3.11. Antiulcerogenic Activity

The antiulcerogenic activity of Laurus nobilis seeds was tested in rats with an ethanol-induced gastric ulcer. The results showed that 20 and 40% of aqueous extracts and the oily fraction of these seeds had antiulcerogenic activity **(7,18).**

3.12. Acaricidal Activity

Laurus nobilis leaf oils were tested for acaricidal activity against Psoroptes cuniculi. The acaricidal activity of L. nobilis oil was 73% at a concentration of 10%; at 5%, the average activity was significantly reduced to 51%, while dilutions of 2.5%, 1.25%, and 0.625% were ineffective **(3,17).**

3.13. Neuroprotective Activity

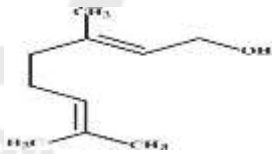
The effects of an n-hexane fraction extracted from the leaves of Laurus nobilis on dopamine-induced intracellular reactive oxygen species (ROS) production and apoptosis in human neuroblastoma SH-SY5Y cells were studied. In comparison to apomorphine (APO, IC50=18.1 M) as a positive control, the IC50 value of hexane fraction for Induced apoptosis was 3.0 g/ml, and the IC50 values of costunolide and dehydrocostus lactone, respectively, were 7.3 M and 3.6 M. In DA-induced SH-SY5Y cells, hexane fraction and these major compounds significantly inhibited ROS generation. The potential neuroprotective effects of hexane fraction in vivo were investigated using a rodent 6hydroxydopamine (6-OHDA) model of Parkinson's disease. 6-OHDA was injected into the substantia nigra of young adult rats, and tyrosine hydroxylase (TH)positive neurons were measured using immunohistochemistry **(3,19).**

4. Chemical Constituents Of Bay Leaf

1. Linalool

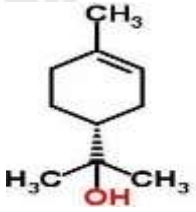
Linalool is the name given to two enantiomers of a naturally occurring terpene alcohol found in a variety of flowers and spice plants. Linalool is hydrogenated to produce dihydro and tetrahydro linalool, which are more resistant to oxidants and may be found in home cleaning products. It is a metabolite, a volatile oil component, an antibacterial agent, and an aroma ingredient in plants. Linalool is used in the production of soaps, scents, flavoring agents in food, home items, and pesticides **(32,33).**

2. Geraniol



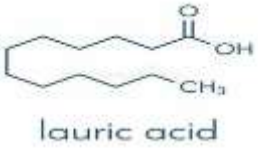
Geraniol is both a monoterpenoid and an alcoholic compound. With a rose-like scent, it is commonly used in perfumes. It is also widely used as an insect repellent, particularly against mosquitoes **(35).**

3. Terpineol



Terpineol, also known as alpha-terpineol, is a naturally occurring terpene alcohol that is found in various essential oils, including pine, cajuput, and eucalyptus. It has been found to exhibit a range of medicinal activities, including anti-inflammatory, analgesic, antioxidant, antimicrobial, sedative, and anticancer activity **(45)**.

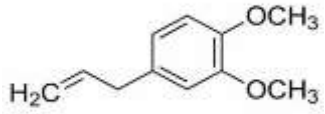
4. Lauric Acid



Lauric acid, systematically dodecanoic acid, is a saturated fatty acid with a 12-carbon atom chain, thus having many properties of medium-chain fatty acids. Insect-repellent and anti-bacterial properties are provided by the lauric acid found in bay laurel leaves (35).

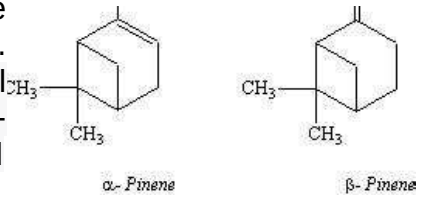
5. Phellandrene

Phellandrene is a naturally occurring organic compound that can be found in various essential oils, such as eucalyptus, ginger, and cumin. It is a bicyclic monoterpene with two isomers: alpha-phellandrene and beta-phellandrene. Both isomers have been studied for their medicinal properties, which include anti-inflammatory, analgesic, antimicrobial, anticancer, anti-obesity,and antidiabetic activity **(46)**.



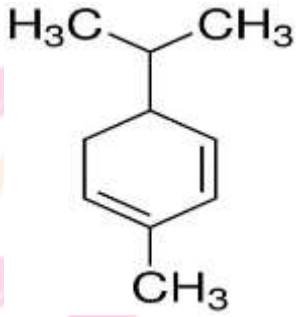
6. α and β-pinenes

Pinene is an unsaturated bicyclic monoterpene family. Pinene has two geometric isomers in nature: α-pinene and β- pinene. These compounds have been studied for their medicinal properties, which include anti-inflammatory,antimicrobial,antioxidant,neuroprotective,insecticidal, antiallergic, anticancer, and anticonvulsant **(44).**



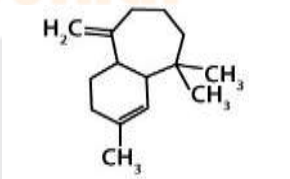
7. Methyl Eugenol

Methyl eugenol is a natural organic compound that belongs to the phenylpropene class of chemicals. Its chemical formula is C11H14O2, and its systematic name is 1,3,4,5tetramethoxy-2- (3,4,5-trimethoxyphenyl) pent-1-one. Methyl eugenol is commonly found in essential oils of various plants such as basil, bay leaves, cinnamon, and nutmeg. It is also used as a flavoring agent in food products and as an attractant for fruit flies, which makes it an important component of many insect traps used in agriculture. The compound may have evolved in response to pathogens, as methyl eugenol has some antifungal activity. It also repels many insects. However, methyl eugenol has been identified as a potential carcinogen in animal studies, and the International Agency for Research on Cancer (IARC) has classified it as a Group 2B carcinogen, meaning it is possibly carcinogenic to humans. As a result, the use of methyl eugenol as a food additiveis regulated by various governmental agencies around the world **(43).**



8. Sesquiterpenes

Sesquiterpenes are a family of chemical molecules present in many plants that have been demonstrated to have a variety of therapeutic properties. Sesquiterpene lactones were detected in the roots and leaves of Bay trees, and two unique chemical kinds with laurenobiolide and costunolide as significant constituents were discovered **(28,30).** Sesquiterpene lactones contained in bay leaf have been reported to have a number of pharmacological activities, including anti-inflammatory effects on NO generation, inhibition of alcohol absorption, and augmentation of liver glutathione S-transferase (GST) activity **(30,31).** Sesquiterpenes have therapeutic properties such as anti-inflammatory, antibacterial, antioxidant, anticancer, neuroprotective, and analgesic **(41,42).**



Sesquiterpene: Himachalene

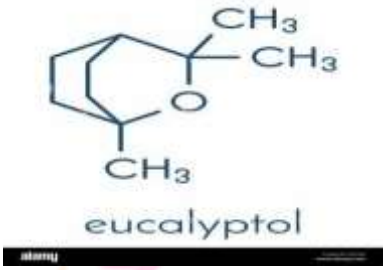
9. Terpenes

Terpenes or terpenoids are the most varied category of compounds found in plants and may be divided as mono, di, tri, tetra, and sesquiterpenes based on the number of isoprene units. They are generally found in plants and are the main component of essential oils derived from plants. Common plant terpene sources include tea, cannabis, thyme, citrus fruits, and Spanish sage. Terpenes serve numerous roles in plants, including signaling, pigments, solvents, taste, and

therapeutic uses. Terpenes have anticancer, antibacterial, antiviral, antifungal, analgesic, antihyperglycemic, antiparasitic, and anti- inflammatory activities. They are also used to increase skin penetration and prevent inflammatory diseases. Terpene is utilized in the production of numerous pharmaceuticals. Also effective against diseases, herbivores, mycorrhiza, and pollinators. Terpenes, according to some researchers, offer a wide variety of therapeutic benefits as antiplasmodial and antimalarial drugs. In the modern world, monoterpenes are widely explored for their antiviral, antidiabetic, and anticancer properties. **(39,40).**

10. Eucalyptol

Eucalyptol, also known as 1,8-cineole, is a natural organic compound that is found in the essential oils of many plants, particularly in eucalyptus, hence its name. Eucalyptol has been studied for its various medicinal properties, some of which include Anti-inflammatory, Analgesic, Antimicrobial, Expectorant and Neuroprotective. Eucalyptol also exhibits insecticidal and insect repellent properties. **(37,38).**



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