

Bioactivity of Alpha-Pinene Compound on Essential Oil: A Review

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Date of Submission: 30-01-2021

Date of Acceptance: 11-02-2021

ABSTRACT: Alpha-Pinene compound is one of the compounds contained in essential oils with the molecular formula $C_{10}H_{16}$ and its systemic name is 2,6,6-trimethyl bicyclo [3.1.1] -2-heptene. It is classified as a monoterpene compound found in turpentine oil. This review article aims to determine the bioactivity of alpha-pinene compounds in essential oil-producing plants. The content of alpha-pinene compounds in essential oils is produced from various plant families such as Annonaceae, Apiaceae, Asteraceae, Burseraceae, Euphorbiaceae, Lamiaceae, Myrtaceae, and Pinaceae. The results showed that the highest alpha-pinene content was found in the plant species *Santriatrimera* compared to the Burseraceae, *Hyptisspicigera* Lam, Lamiaceae, *Goniothalamusmacrocalyc*, and Annonaceae families. Alpha-pinene has bioactivity with many benefits such as anti-seizure, anti-inflammatory, antimicrobial, anti-cancer or anti-tumor, antibacterial, anti-fungal, and antioxidant.

Keywords: Bioactivity, alpha-Pinene, Essential oil

I. INTRODUCTION

Essential oil is one of the liquids and volatile secondary metabolites of plants that has a liquid phase and is volatile.^[1] It has properties such as a storable liquid at room temperature, odor, dissolving in organic solvents, and is insoluble in water. Essential oils are produced from plant tissues such as leaves, flowers, seeds, bark, stems, roots, and rhizomes.^[2] The essential oils demand increases every year along with the development of the perfume, fragrance, aroma, pharmaceutical, cosmetics, and aromatherapy industries.^[3]

Turpentine oil is a colored liquid (clear) and has a distinctive smell. It is known as the non-volatile spirit of turpentine.^[4] Monoterpene compounds are unsaturated hydrocarbons consisting of 10 carbon atoms. The smallest unit in the molecule is called isoprene. One of the

monoterpene compounds in turpentine oil is alpha-pinene or 2,6,6-trimethyl bicyclo [3.1.1] -2-heptene. Alpha-pinene with the molecular formula $C_{10}H_{16}$ is a colorless liquid with a characteristic odor like turpentine. Alpha-Pinene is a compound used for the synthesis of perfume, resin, drug, and other compounds. Alpha-pinene has characteristics such as; molecular mass 136.2; boiling point 155-156 °C; specific gravity (20°C) 0.864 g/mL; and Refractive Index (20°C) 1.4656.^[5]

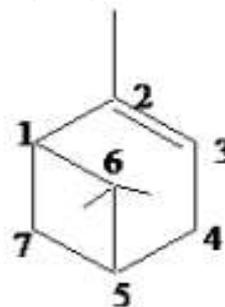


Figure1. The structure of alpha-pinene^[5]

II. COLLECTING THE DATA

This review article was prepared using literature study techniques in the form of primary data such as official books, national journals, and international journals from 2010-2020. The data search was carried out using online media with keywords namely bioactivity, α -pinene, and essential oils. The main reference searches used in this review article are through trusted websites such as ScienceDirect, Researchgate, Google Scholar, and other published journals.

Essential oil sources

Essential oils are obtained from various types of plants by various extraction methods. Various plants producing essential oils and containing alpha-pinene compounds can be seen in Table 1.

Table.1 The percentage content of alpha-pinene compounds from essential oil-producing plants

Species	Families	Part of plant	Extraction method	α -pinene compound content	Ref.
Dasydaschalonlongiusculum	Annonaceae	Leaves Bark	Steam distillation	28.9% 12.5%	[6]
Goniothalamusmacrocalyx Ban.	Annonaceae	Leaves	Steam distillation	50.0%	[7]
Uvariastrompierraeum Engl.	Annonaceae	Leaves	Steam distillation	22.80%	[8]
Foeniculum vulgare	Apiaceae	Leaves	Steam distillation	20,0%	[9]
Laserpitiumlatifolium	Apiaceae	Fruit	Steam distillation	44.0%	[10]
Seseli rigidum	Apiaceae	Fruit	Steam distillation	23.3%	[11]
Monticaliagreennaniana	Asteraceae	Flower Bark Wood	Steam distillation	29.0% 14.8%	[12]
Tanacetum argenteum	Asteraceae	Flower	Steam distillation	27.86%	[13]
Aucoumeaklainiana	Burseraceae	Leaves	Steam distillation	29.3%	[14]
Santiria trimera	Burseraceae	Leaves	Water distillation	51.5%	[15]
Croton conduplicatus Kunth	Euphorbiaceae	Bark	Steam distillation	35.35%	[16]
HyptisspicigeraLam.	Lamiaceae	Flower	Steam distillation	50.8%	[17]
Rosmarinus officinalis L	Lamiaceae	Flower	Steam distillation	19.43%	[18]
Salvia Lavandulifolia	Lamiaceae	Flower	Steam distillation	34.4%	[19]
Thymus algeriensis	Lamiaceae	Leaves	Steam distillation	19.5%	[20]
Callistemon citrinus	Myrtaceae	Leaves	Steam distillation	29.0%	[21]
PinuspeuceGriseb.	Pinaceae	Leaves	Steam distillation	27.34%	[22]

Table.1 shows the alpha-pinene compounds contained in essential oils from various plant families. The highest alpha-pinene compound content was found in the plant species Santriatrimera compared to the Burseraceae,

Hyptisspicigera Lam, Lamiaceae, Goniothalamusmacrocalyc, and Annonaceae families. Isolation of essential oils from plants can be conducted in 3 ways, namely: pressing, solvent extraction, and distillation. Refining or distillation

is the method most widely used to obtain essential oils. Refining is done by boiling the raw materials in a distilled kettle to produce steam. The steam is flowed from the water boiling kettle (boiler) into the boiler to separate the volatile oil^[5]. Table 1 shows the extraction method that is widely used is steam distillation.

Bioactivity of alpha-pinene compounds

Alpha-pinene compounds have bioactivity with benefits such as anti-seizure, anti-cancer, anti-tumor, antibacterial, anti-fungal, anti-inflammatory, antioxidant, and can also reduce the risk of cardiovascular disease.

Anticonvulsant

Ducrosiaanethifolia essential oil contains the main constituent compound of alpha-pinene. *Ducrosiaanethifolia* essential oil at doses of 200 and 500 mg/kg; and alpha-pinene at doses of 0.2 and 0.4 mg/kg were able to reduce locomotor activity in Wistar cumin rats^[23]. Other major constituents involved in the locomotor or anticonvulsant activity are β -myrcene, β -pinene, limonene, and decanal.^[24] The interaction of these compounds with neurotransmitters such as GABA (gamma-aminobutyric acid) and glutamic acid results in increased work affinity and decreased locomotor activity.^[23]

The results of the research from *Pistaciaintegerrima* containing alpha-pinene compounds as the main constituent compounds showed anticonvulsant activity in zebrafish and rats. Petroleum ether extract from *Pistaciaintegerrima* was able to reduce anticonvulsant activity at doses of 50 mg/kg, 100 mg/kg, and 200 mg/kg with the different onset of seizure parameters. In PTZ (pentylentetrazole) induced seizures in zebrafish, then in mice with doses of 50 mg/kg and 100 mg/kg. Besides, this extract was also able to reduce the anticonvulsant activity in the hind limbs of mice at doses of 50 mg/kg, 100 mg/kg, and 150 mg/kg with the maximum electric shock method.^[25]

Anti-inflammatory

The content of alpha-pinene compounds in *Foeniculumvulgare* Miller essential oil shows anti-inflammatory activity. The study reported that there was an anti-inflammatory effect of intraperitoneal alpha-pinene on carrageenan induced leg edema in rats. Alpha-pinene showed significant anti-inflammatory effects in 2 doses tested (0.025 mL/kg and 0.50 mL/kg). Peak response has

obtained a reduction in inflammation of 60.33% for 0.50 mL/kg alpha-pinene and 18.97% for 0.05 mL/kg alpha-pinene. Anti-inflammatory activity of *Foeniculumvulgare* Miller essential oil was compared with the drug indomethacin. Alpha-pinene in the indomethacin group had significantly lower anti-inflammatory effects at all doses. The alpha-pinene group at a dose of 0.05 mL/g showed anti-inflammatory activity compared to a dose of 0.50 mL/kg. The median effective dose (ED₅₀) of alpha-pinene was obtained as 0.039 mL/kg.^[26]

In other studies reported that *Senecioflammeus* essential oil has anti-inflammatory activity with the alpha-pinene as the main compound. Edema in rat feet induced carrageenan, 12-O-tetradecanoyl-phorbol-13-acetate (TPA) induced edema of the ear and granuloma induced by cotton pellets. In this study, *Senecioflammeus* essential oil (10, 30, and 90 mg/kg) edema of rat feet significantly reduced in a dose-dependent manner (17.4%, 52.9%, and 66.4%), reduced MPO activity, reduced TPA-induced ear edema in a dose-dependent manner (20.27%, 33.0% and 53.9%), and decreased cotton pellet-induced granulomas.^[27]

Anti-cancer or Anti-tumor

The Alpha-pinene compound is one of the constituent components found in *Callistemon viminalis*. It has antitumor activity at a concentration of 50 μ g/mL observed in melanoma (HT144) culture for 48 days from leaves and flowers (200 μ g/mL) with a reduction in viability of 40% and 25%, respectively. The antiproliferative activity of *Callistemon viminalis* from leaves was more able to inhibit the growth of carcinoma HT144 than from flowers in cells derived from melanoma. The decrease in cell viability in HT144 culture was related to the presence of compounds contained in the essential oils *Callistemon viminalis* 1,8 cineole, α -pinene, and α -terpineol, resulting in a decrease in the viability of synergistic action on the constituents found.^[28]

Antiulcerogenic or anti stomach ulcer

The results of the study reported that essential oils containing alpha-pinene compounds from species *hyptishad* antiulcerogenic activity. Gastric ulcers were induced in male Swiss rats (20-30 g) by absolute ethanol or oral indomethacin for 45 minutes with α -pinene (10, 30, and 100 mg/kg). The stomach was removed after 1 hour and the gastric lesion area was measured. A-pinene pretreatment inhibited ethanol-induced gastric

lesions, reduced volume, and acidity of gastric juice, and increased gastric wall mucus ($P < 0.05$). The relationship between α -pinene concentration and the gastroprotective effect of Hyptical Species was P Pearson = 0.98. [29]

Antibacterial

Nutmeg essential oil contains alpha-pinene, sabinene, 2- β -pinene, and myristicin compounds as the main constituent compounds. Nutmeg essential oil has antibacterial activity carried out by dilution and diffusion methods. The dilution test could not obtain the MIC and MBC values, while the diffusion test showed that the essential oil of nutmeg with a concentration of 7.50% can inhibit *Staphylococcus aureus* with an inhibition zone diameter of 9.25 mm and in *bacterieshericia coli* with an inhibition zone diameter of 7.375 mm. [30] In another study, eucalyptus leaf essential oil contains alpha-pinene compounds as one of its constituent compounds. The ethanol extract of eucalyptus leaves has antibacterial activity against Methicillin-Resistant *Staphylococcus aureus* (MRSA) indicated by the formation of the inhibition zone diameter at concentrations (w/v) 50%, 60%, 70%, 80%, 90%, and 100 %, namely 17.2 mm, 18.1 mm, 19.1 mm, 19.4 mm, 19.7 mm, and 20.1 mm. [31]

Anti-fungi

Another study reported that the alpha-pinene compound was one of the main constituent compounds in *Zingiberofficinale var. rubrum* and had antifungal activity. It inhibits the growth of *Candida albicans* fungi by using the disc diffusion method. The lowest antifungal effect was at a concentration of 20% with an average inhibition zone of 8.3 mm. While the highest effect was at the highest concentration (100%) with an average inhibition zone of 39.6 mm. The disease caused by being infected with *Candida albicans* is candidiasis of the mouth, skin, digestive tract, nails, lungs, and vagina. Fungal infections of the skin generally take the form of thrush, vulvovaginitis, and diaper rash. [32] The alpha-pinene compound in *Cuminumcyminum L.* can inhibit the growth of *Aspergillusflavus* PICC-AF39, *Aspergillusflavus* PICC-AF24, *Aspergillusparasiticus* NRRL-2999, and *Aspergillusniger* by reducing AFB1 production. Aflatoxin B1 (AFB1) is a highly toxic and hepatocarcinogenic metabolite produced by *Aspergillus* species. [33]

Antioxidants

Ferulagocampestris essential oil in the fruit and roots shows the presence of alpha-pinene as one of its constituent compounds. It has antioxidant activity with IC50 values in the range 0.022-0.025 ml. About 1 mg Trolox is equivalent to 1.69-1.92 ml of *Ferulagocampestris* essential oil. [34] The alpha-pinene compounds in *Juglansregia L* essential oil showed high antioxidant activity comparable to ascorbic acid and butylated hydroxyl toluene. BHT with IC50 values of 34.5 and 56.4 $\mu\text{g/ml}$ were calculated by DPPH and hydroxyl radical tests. [35]

III. CONCLUSION

The search results concluded that alpha-pinene compounds were contained in essential oils and were produced from various plant families. The highest alpha-pinene compound content is found in the plant species *Santriatrimera* compared to the *Bursera* family, *Hyptisspicigera* Lam, family *Lamiaceae*, *Goniothalamusmacrocalyc*, and family *Annonaceae*. Alpha-pinene has bioactivity with some benefits such as anti-seizure, anti-inflammatory, anti-cancer/anti-tumor, antiulcerogenic/anti-peptic ulcers, antibacterial, anti-fungal, and antioxidant. Also, alpha-pinene compounds in plants can be developed as drugs for various diseases.

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