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AN AGE OLD BOTANICAL WEAPON FOR HERBAL THERAPY: CAMPHOR TREE, CINNAMOMUM CAMPHORA

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ABSTRACT

This review paper highlights the recent updates of the fragrant camphor tree (Cinnamomum camphora) and camphor oil is used as a medicine for topical applications for controlling the current outbreak of corona virus (SARS-CoV-2) Delta variant (B.1.617.2) and Delta Plus (AY.1) in India. One of the best example is medicinal plant (sweet worm wood; Artemisia annua) containing camphor essential oil has been tested against corona virus (SARS-CoV-2) disease (covid-19). Therefore, medicinal plants containing camphor molecule could be used as an age old herbal therapy in the form of vapours for inhibiting corona virus (SARS-CoV-2). Traditionally camphor has been used as a fragrance in cosmetics, as a food flavourant, as a common ingredient in household cleaners, as well as in topically applied analgesics and rubefacients for the treatment of minor muscle aches and pains. There are many commercial products available in the Indian market where Camphor is used in products such as Vicks and VapoRub. Ravintsara oil is distilled from the leaves of Cinnamomum camphora in Madagascar is also tested against corona virus (SARS-CoV-2). Camphor is biologically characterised by insecticidal, antimicrobial, antiviral, anticoccidial, anti-nociceptive, anticancer and antitussive activities. It is also used as a skin penetration enhancer. However, camphor is a very toxic substance and numerous cases of camphor poisoning have been documented. Therefore, Cinnamomum camphora is used for topical applications and its components should be investigated further as a viable option in the treatment of viral diseases.

Keywords: Antiviral, camphor, herbal medicine, skin disease, poisonous tree, traditional medicine.

INTRODUCTION

Camphor tree, (Karpura) *Cinnamomum camphora* (L.) J. Presl is an important traditional herbal medicine belongs to the family *Lauraceae* well known for the secondary metabolite, camphor (1-5, 75). Camphor molecule is a bicyclic monoterpene ketone, and therefore, commonly known as naturally occurring monoterpenoid. Camphor widely exists in some aromatic plants, such as *Cinnamomum camphora*, *Eucalyptus globulus* and *Artemisia annua*. Camphor is the main component in the majority of plant essential oils used in medicine and cosmetics. The insecticidal and insect-expelling efficacy of camphor has been widely confirmed. *Cinnamomum camphora* is of increasing importance as a source of essential oil for the production of natural linalool used for fragrant applications in cosmetics (1-5, 75). *Cinnamomum camphora* tree is the source of natural camphor, and used commonly in an indigenous medicine and in a variety of sweetmeats (5-10, 75). Camphor oil is extracted from the wood of the Camphor tree *Cinnamomum camphora*. Leaves of *Cinnamomum camphora* contains about 60–90% essential oil (10-14). Camphor oil has anti-inflammatory and analgesic properties and is used for its aromatic properties, as an insect repellent, in embalming fluids, and in various topical skin preparations (8-11, 75). In general, camphor is used as a topical home remedies for a wide range of symptoms, and a long tradition of use as antiseptic, antipruritic, rubefacient, abortifacient, aphrodisiac, contraceptive and lactation suppressant. Camphor has a counter-irritant, rubefacient and mild analgesic action, and is the major component of liniments for relief of fibrosis's, neuralgia and similar conditions (3-17).

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The camphor tree is large with pale brown bark, dark green to yellowish leaves and small white flowers followed by small purple berries. All the plant parts of camphor tree have the distinctive, easy-to-recognise camphoraceous odour (10-22). Flowers are greenish in colour and arranged in panicles. The fruit is a 1-cm purple berry with a single seed. Camphor tree grows in the tropical rain forests at various altitudes from highland slopes to lowland forests including marshy places and on well-drained soils. The Camphor tree occurs naturally, and native to India, China, Japan, Mongolia, Taiwan, and Bhutan, but has been naturalised in other parts of the World (1-6). The genus *Cinnamomum* is widely distributed in South East Asia by about 200-350 species (2-14). India accounts for about 40 species of the genus *Cinnamomum* distributed in Western Ghats, Eastern Himalayas and Andaman Islands. Among the total 18 species recorded from South India, 16 are endemic to Western Ghats region including a new species of camphor, *Cinnamomum agasthyamalayanum* from Western Ghat of Kerala (12-14). The camphor tree is recognized very easily due to the smell of camphor due to the high content of volatile oil (6). Two commercially important known species of camphor are *Cinnamomum camphora* and *Cinnamomum capparucoronde*. Among these two, *Cinnamomum camphora* is widely cultivated in China, Taiwan, southern parts of Japan, Korea, and Vietnam, and the *Cinnamomum capparucoronde* is mainly found in the forests of Sri Lanka(13-17, 75).

Two types of camphors

Basically there are two camphors; One is chemically and synthetically manufactured camphor is known as karpura which is burnt during puja ceremonies, religious rituals in temples in India due to aromatic smell (1-22, 75). Camphoric fumes are non-irritant to eyes. Camphor is a waxy, white or transparent solid with a strong

aromatic odour which sublimates at room temperature and melts at 180°C (2-22, 75). It is practically insoluble in water, but soluble in alcohol, ether, chloroform and other organic solvents. It is a bicyclic monoterpenoid (1,7,7-trimethylbicyclo[2.2.1]-2- heptanone) with a chemical formula of C10H16O and exists in two enantiomeric forms: (1*S*)-(−)-and (1*R*)-(+)-camphor (15-20). The synthetic production of camphor involves using turpentine oil as a starting material (16-20). Turpentine is used as the source of α-pinene through a distillation process. The α-pinene is converted into a camphene through the catalysis of a strong acid with acetic acid as the solvent. The camphene then undergoes Wagner-Meerwein rearrangement into the isobornyl cation, which is captured by acetate. The isobornyl acetate subsequently formed is hydrolysed to isoborneol, which is finally converted to camphor through dehydrogenation(4-15). The synthetic route from α-pinene produces a racemic mixture, *i.e.*, a 1:1 ratio of (−) and (+)-camphor (1-16). Camphor was used as a fumigation agent during the outbreak of infectious diseases, plague, smallpox and cholera. Rosewater together with camphor as a perfume ingredient was sprinkled over corpses before shrouding (10-22). The Chinese used camphor as a traditional herbal medicine, whilst the Japanese used it in torch-light material and added small quantities to fireworks to make them brighter (10-20).

The second camphor is a natural herbal camphor extracted from the camphor tree *Cinnamomum camphora* and *Cinnamomum agasthyamalayanum* used as a herbal medicine for many diseases (1-20, 75). Camphor, traditionally obtained through the distillation of the wood of the camphor tree. Camphor oil is extracted by steam from the chipped wood, root stumps and branches of the camphor tree. It is then rectified under vacuum and filter-pressed. The camphor tree is famous for the characteristic 'camphor' formed in the oil cells of different plant parts (15-20). It is a major source of natural camphor used commonly in an indigenous medicine and in a variety of confectionaries (17-20, 75). It is also applied externally to treat muscular strains and inflammations (17-20, 75).

Camphor: Herbal medicine

Cinnamomum camphora has long been prescribed in traditional Indian, Chinese and Iranian (Persian) herbal medicine for the treatment of inflammation-related diseases such as rheumatism, sprains, bronchitis, asthma, indigestion, muscle pains and lasioderma serricorne. Roots, stems, leaves and wood of *C. camphora* are all rich in essential oil which contains chemicals such as camphor, linalool, safrole and cineole as the major valuable ingredients. Camphor exhibits several biological properties such as antimicrobial, antibacterial, antiviral and antitussive effects, anti-mutagenic and anticancer activity, insecticidal activity (1-20). Camphor has been widely used as a fragrance in cosmetics, as a flavouring food additive and as a preservative in confectionary goods. Camphor is commonly used as an insect repellent, a plasticiser and as an intermediate in the synthesis of aroma chemicals (2-23, 75). Camphor is a common ingredient in the modern medicine in the topically applied analgesics and rubefacients for the treatment of minor muscle aches and pains. Camphor has been used to relieve the pain caused by breast engorgement by intramuscular injections(2-20). It has been applied as a topical anti-infective and anti-pruritic, and internally as a stimulant and carminative(1-23, 75). The various essential oils of several medicinal plant species containing camphor as the major components, exhibited antimicrobial activity. The composition of essential oil from the aerial parts of sweet wormwood (***Artemisia annua***) (23) includes camphor (44%), germacrene D (16%), *trans*-pinocarveol (11%), β-selinene (9%), β-caryophyllene (9%) and artemisia ketone (3%)(23-25). Aromatic plants, especially their essential oils, are known to exhibit antiviral properties. Sivropoulou *et al*. (24) investigated the antimicrobial, cytotoxic and antiviral activities of Greek sage (*Salvia fruticosa*) essential oil (24). These results demonstrated that the essential oil of Greek sage (*S. fruticosa*) and its four main components (1,8-cineole, α- and β-thujone, and camphor) exhibited high levels of virucidal activity against herpes simplex virus-1(24-25). However, this positive effect was accompanied by cytotoxic activity against African Green Monkey kidney (Vero) cells. Lavender cotton (*Santolina insularis*) essential oil, which is rich in camphor, deactivated herpes simplex type-1 (HSV-1) and type-2 (HSV-2) *in vitro* using plaque reduction assays with an IC-50 value of 0.88 µg/mL for HSV-1 and 0.7 µg/mL for HSV-2. Reduction of plaque formation assays showed inhibition of cell-to-cell transmission of both HSV-1 and HSV-2(23-25).

Coughing is a very common clinical symptom with largely ineffective current therapies. Aromatic vapours have been widely used in the symptomatic treatment of upper respiratory tract infections due to their known antitussive effects (1,26-27). Burrow and co-workers (1,26-27) investigated the effects of camphor vapour on nasal resistance to airflow and nasal sensation of airflow. Inhalation of camphor had no effect on nasal resistance to airflow, but a cold sensation in the nose with the sensation of improved airflow was described (1,26-27). These results indicated that camphor stimulated cold receptors in the nose (1,26-27). Both camphor and camphor lactam were tested for their antitussive activity in guinea-pigs with citric-acid induced cough (1,26-27). The camphor has an anti-nociceptive activity. Camphor has an extensive history in its use as a topical analgesic in balms and liniments (1,28-30). The pain-relieving effects of California sagebrush (*Artemisia californica*), containing the two major compounds 1,8-cineole (24%) and camphor (18%) (1, 28-30). Anecdotal use reported successful pain relief in all cases for patients suffering from lower back pain, arthritis, bruises, muscle and ligaments strains, broken bones and even cancer (1, 28-30). An alcoholic liniment provided rapid pain relief lasting 2–3 h with an onset of action of 20 min (1, 28-33). The anti-nociceptive activity of terpenoids is as a result of binding to capsaicin receptor (TRPV1), capsaicin receptor (TRPV3) and transient receptor potential (TRPM8) receptors. Camphor is a known agonist of TRPV2, TRPA1 as well as TRPV1 quickly deactivating TRP channels resulting in the long-term pain relief (1,26-27).

Mosquitoes are known as disease vectors of malaria, haemorrhagic dengue and yellow fever, Ebola, zika, chikungunya. As a major component of the essential oil of aromatic plants, camphor has shown repellency against *Anopheles culicifacies*, *Cx. quinquefasciatus, Anopheles gambiae* and *Anopheles funestus* (1, 31-33). It is evident that camphor has a great potential for development as an alternative green commercial insect repellent to replace the harmful synthetic agents currently in use(1, 31-37, 75). Camphor has been used for the stimulation of heart and peripheral circulation (1, 29-34). Osborne (1, 34) reported that in cardiac failure and collapsed conditions characterised by cold skin, a feeble pulse and failing heart, the subcutaneous injection of camphor in sterile oil caused the surface of the skin to become flushed, dilated the peripheral blood vessels and improved the whole circulation (1, 34). In addition, camphor also acts as a potential skin penetration enhancer (1, 35-36). Camphor showed maximum permeation and basil oil (*Ocimum basilicum*) containing methyl chavicol, eugenol, linalool, camphor and methyl cinnamate showed potential *in vitro* penetration enhancement of labetolol hydrochloride (1,35-36).

The effect of camphor on the sexual activity of male rats was investigated by Jamshidzadeh *et al*., 2006 (1, 35-36) by measuring the parameters mount latency and frequency as well as intromission latency and frequency (4, 37-38). The results indicated enhanced sexual desire and performance when camphor was administered at 50 mg/kg (1, 37-38). Allelopathy is the interaction of one plant with another through the release of biochemical compounds into the environment and can be indirect, direct, harmful or beneficial

(18, 39-40). Allelopathic activity can lead to the suppression of growth of one plant by another. The allelopathic effect influences the camphor laurel tree (*Cinnamomum camphora*) and was investigated on the seedling growth of fifty-two plant species and twenty-seven soil algal populations (18, 39-40, 75). The leaves had a direct allelopathic effect by significantly delaying germination and causing a reduction of radical and shoot length, leaf area and leaf number, specifically in the species associated with camphor laurel (*Cinnamomum camphora*) communities (18, 39-40). The persistence and dominance of camphor laurel trees (*Cinnamomum camphora*) may also be enhanced as the allelopathic activity reduced the competitiveness of surrounding vegetations (18, 39-40, 75). Therefore, this study concluded that monoterpenes such as camphor, which exhibits phytotoxic activity (1-36, 75) Therefore, potential bio-herbicides which could be developed into the natural pesticides (18, 39-40). Botanical pesticides have the advantage of providing novel modes of action against insects that can reduce the risk of cross-resistance as well as offering new leads for the design of target-specific molecules.

Recently one of the study conducted by Huo et al., (2020) (69) reported that the camphor has strong antifungal activity against F. oxysporum G5, F. solani G9, F. verticillioide and F. graminearum. This inhibition rate of the four phytopathogenic fungi could be increased by more than 80% by adding 2 mg/mL camphor in PDA media (69). The preliminary study on the mechanism exhibits that camphor could participate in and obstruct the formation of cell wall and cytomembrane of the phytopathogens. The involvement of camphor makes fungi release intracellular ions, nucleic acids and proteins necessary for normal cell activity, ultimately inhibiting the growth of fungi (69). The essential oils extracted from *Cinnamomum camphora* with strong antimicrobial activity may be related to their camphor content. Camphor may serve as a potential alternative fungicide for its friendliness to environment and humans(69).

Camphor: Botanical pharmacy

Camphor (Cinnamomum) is traditionally used for the pharmaceutical preparations against various ailments. Camphor is one of the important chemical compounds derived from *Cinnamomum camphora*, employed in pharmaceuticals, especially liniments and insecticides (41-44, 75). Due to its high healing significance, camphor has been used as an antiemetic, antidiarrhoeal, antiflatulent and stimulant agent in Ayurvedic medicine insecticides (41-45). Camphor has been used for the various therapeutic purposes such as analgesic, antifungal, antiviral, antibacterial, antiseptic, antispasmodic, antipruritic, anti-inflammatory, anti-infective, expectorant and nasal decongestant insecticides (40-47, 75). It is used as one of the ingredients in many formulations such as balms, oils, liniments and creams insecticides (38-48). There are many scientific reports which have reported that camphor has anthelmintic, and hepatoprotective activities, as a remedy for relief of pain, inflammation and skin irritation (38-48). Natural camphor has been used internally in the treatment of hysteria, epilepsy and chorea (39-47). For external application, camphor is used as one of the constituents of oils, liniments, balms and ointments. Moreover, wood, leaves, barks and twigs of camphor tree were used medicinally in the Indian systems of medicine (38-50).

Camphor poisoning

Camphor is very toxic in nature and toxicity has been reviewed and well documented**.** Camphor occurs in nature in its dextrorotatory form (D-camphor), while the laevorotatory form (L-camphor) exists only as a synthetic form. The two enantiomers present different profiles of toxicity. The main problems about camphor toxicity in humans are connected more to the large availability of camphor-containing products and their diffused perception as un-hazardous medicines rather than in the intrinsic toxicity of camphor. The oral consumption of higher concentrations of 3.5 g of camphor can cause death (1, 45-58, 75). Further consumption of 2.0 g of camphor causes toxic effects in adults leading to congestion of the gastrointestinal tract, kidney and brain (1, 44-59). In humans, the characteristic symptoms of camphor poisoning after ingestion are nausea, vomiting, headache, dizziness, muscular excitability causing tremor and twitching, convulsions and delirium depending on the dosage (1, 45-59). In a severe overdose for several hours, causing coma and death by asphyxia or exhaustion (1, 44-59). Camphor can also cause skin and eye irritation on contact. Inhalation and skin exposure may resulted in the acute poisoning (1, 45-59). Camphor poisoning is very toxic as no antidote is known (1, 44-59). In the human body, camphor is oxygenated to alcohol campherol and then conjugated with glucuronic acid in the liver to become soluble in water before being excreted in the urine (1, 44-59). Following oral ingestion, high concentrations of camphor have been detected in the foetal brain, liver, kidney, blood, as well as in amniotic fluid (1, 44-60). Many aromatic medicinal plants contain camphor as a major component (45-58). Millet *et al.,* 1981(1, 45) investigated the toxicity of some commercial essential oils including sage (*Salvia officinalis*), hyssop (*Hyssopus officinalis*), thuja (*Thuja occidentalis*) and cedar (*Juniperus* and *Cupressus* spp.). For sage (*Salvia officinalis*) oil, 3.2 g/kg of sage oil caused tonic-clonic convulsions in un-anaesthetised rats resulting in death. It was determined that the toxicity of sage (*Salvia officinalis*) oil appeared to be related to the presence of camphor (1, 44-59, 75).

Artemisia annua: **Camphor used for controlling corona virus (SARS-CoV-2)**

One of the studies in China showed that, the alcoholic extract of sweet wormwood (***Artemisia annua***) was the second most potent herbal medicine used on SARS-CoV outbreak in 2005(1, 59-62, 75). This tonic cocktail of the plant *Artemisia annua*, belongs to a family of *Asteraceae* which has anti-malarial properties (1, 59-63). Antimalarial drugs led to the discovery of artemisinin, a compound which is extracted from *Artemisia annua* (1, 59-62). The plant parts have been used for the preparation of a tonic COVID-19 Organics, Malagasy Institute of Applied Research has been used as a immunity booster for the patients suffering from covid-19 (59-62). The clinical trials of this medicinal plant yet to be conducted. The composition of essential oil from the aerial parts of sweet wormwood (***Artemisia annua***) (23) includes camphor (44%), germacrene D (16%), *trans*-pinocarveol (11%), β-selinene (9%), β-caryophyllene (9%) and artemisia ketone (3%) (23, 25, 62). Aromatic plants, especially their essential oils, are known to exhibit antiviral properties due to the presence of camphor oil. *Artemisia annua* extracts showed a very little toxicity and artemisinin-based drugs were widely used to treat malaria even in newborns (1, 59-62, 75). Further pre-clinical and clinical trials need to be done for the evaluation of safety and efficacy of this polyherbal formulation. *Cinnamomum camphora* produces a wide variety of essential oils with six chemotypes or chemical variants, linalool, 1,8-cineole, borneol, nerolidol and safrol (63-68, 75). The chemotypes are classified on the geographical origin of the tree and part of the tree used for the extraction of essential oil such as leaf or wood/bark (63-68). Camphor trees with the safrole chemotype from **China** are the source of Chinese sassafras oil, a safrole dominant fraction from the crude oil is distilled from *Cinnamomum camphora* in China (63-69). Ravintsara oil is distilled from the leaves of *Cinnamomum camphora* in Madagascar and contains at least 45% of 1,8-cineole, which is higher than Ravensara (*Cryptocarya agathophylla*) oil (5%) (63-68). Another interesting fact is that rather than being high in camphor, it is high in 1,8-cineole and eucalyptol and found very different species compared to camphor trees grown in Asia. It has an invigorating camphoraceous scent and some chemical similarity to Eucalyptus

radiata or globulus (63-68). Ravintsara is an excellent insecticide and has antiviral, analgesic, anti-inflammatory, and anti-spasmodic properties (63-68). Ravintsara essential oil is one of the best herbal medicine for the lungs and energetically can boost memory, relaxed mind, and increase the confidence of the person (63-68). The main chemical 1,8 cineole of Ravintsara essential oil has also shown cognitive enhancement (63-69). The "Ho-Sho" essential oil is steam distilled from the wood and leaf of the camphor tree, *Cinnamomum camphora* known for the high content of linalool. This camphor tree is native to the habitat of China, Japan, Taiwan and Vietnam (63-68). The Ho-Sho wood essential oil provides an alternative to rosewood essential oil (63-69). The Japanese true camphor tree or "Hon-Sho" yields an oil that has more than 50% camphor constituent (63-68). Camphor trees in India or Sri Lanka are also a source of camphor-rich oil (63-69). The trees grown in this region produce an oil with a linalool component between 70-90% and small quantities of camphor, gamma-terpinene and myrcene (63-69).

CONCLUSION

Camphor is one of the most important plant secondary metabolite with proven biological properties. Camphor has been used as a household natural remedy for many health disorders. The biological activities have been attributed to camphor including antibacterial, antifungal, antimutagenic, antitussive and insecticidal properties. The camphor is known for an antivirucidal activity. The aroma of camphor has led to its wide use in ointments and inhalants, particularly as an adjunct to treat the common cold. Medicinal plants containing camphor molecule has been exploited for controlling corona virus (SARS-CoV-2) disease (covid-19) particularly during the outbreak of Delta variant (B.1.617.2) and Delta Plus (AY.1) in India (70-75). Further, bioactivity was determined in many cases using an essential oil rich in camphor. However, pure camphor did not possess the same activity as the essential oil. In addition to its many medicinal uses, camphor is also useful molecule in the chemical reactions where it is used extensively as a catalyst and served as a initiation of chemical reactions (75). FDA has already confirmed and warned about the toxicity of camphor and children's should be avoided of using camphor. Toxicity of camphor has been well documented. Higher concentrations of oral consumption of camphor could cause death, and hence used for external applications (75).

REFERENCES

1. Chen W, Vermaak I, Viljoen A. Camphor—A Fumigant during the back death and a coveted fagrant wod in acient Egypt and Babylon—A Review. Molecules. 2013;18: 5435- 5445. (doi:10.3390/molecules18055434).
2. Alam K, Nawab M, Kazmi MH. Pharmacological and therapeutic profile of Käfür (Cinnamomum camphora (L.) J. Presl) – A Review. Hippocratic Journal of Unani medicine. 2019; 20(3): 1-16.
3. Chopra RN, Nayar SL,Chopra IC. Glossary of Indian Medicinal Plants, National Institute of Science Communication and Information Resoures (CSIR), New Delhi, 2009; 8th ed, p. 65.
4. Khare CP. Indian Medicinal Plants An Illustrated Dictionary, Springer Science+Business Media, LLC, New Delhi. 2007;148-149.
5. Kirtikar KR, Basu BD. Indian Medicinal Plants, Oriental Enterprises, Dehradun, 3rd ed., Vol. IX, 2012; 2957-2958.
6. Robi1 AJ, Sujanapal P, Udayan PS. Cinnamomum agasthyamalayanum sp. nov. (Lauraceae) from Kerala, India. International Journal of Advanced Research. 2014; 2 (10): 1012-1016.
7. Garg N, Jain A. Therapeutic and medicinal uses of Karpura-A review. International Journal of Science and Research. 2015; 6 (4): 1174-1181.
8. Geetha Kumary MP, Santhosh Kumar ES, Pandurangan AG, Shaju T. Cinnamomum dubium Nees (Lauraceae) a new record for India. Indian Journal of Forestry. 2007; 30(1): 7374.
9. Barua A, Nath SC. Cinnamomum tamala var. ellipticum var. nov. (Lauraceae) from northeast India. Nordic Journal of Botany. 2008; 26: 203–206.
10. Kostermans AJGH. The South Indian species of Cinnamomum Schaeff. (Lauraceae). Bull. Bot. Surv. India. 1983; 25: 90–133.
11. Kostermans, AJGH. A monograph of the genus Cinnamomum Schaeffer (Lauraceae)- Part I. Ginkgoana. 1986; 6: 1-196.
12. Kostermans AJGH, Cinnamomum In: Dassanayake M.D. and Fosberg, F.R. (Eds.). A Revised Handbook to the Flora of Ceylon, Amerind Publishing Co., New Delhi. 1995; 9: 12–129.
13. Nirmal Babu K, Shylaja M, Ravindran PN. Cinnamon and Cassia: The Genus Cinnamomum (Medicinal and Aromatic Plants - Industrial Profiles). CRC Press. 2003.
14. Remya Krishnan RV, Santhosh Kumar ES, Radhamany PM, Valsaladevi G, Jagadeesan R. Cinnamomum mathewianum sp. nov.(Lauraceae): A new species from Kerala, India. International Journal of Advanced Research. 2014; 2(7): 11–15.
15. Rohwer JG, Lauraceae. In: Kubitzki, K., Rohwer, J. G., and Bittrich, V. [eds.]. The families and genera of vascular plants, Springer Verlag, Berlin. 1993; 2: 366–391.
16. Kumar M, Ando Y. Single-wall and multi-wall carbon nanotubes from camphor-a botanical hydrocarbon. Diamond Relat. Mater. 2003; 12: 1845–1850.
17. Okamoto Y, Yamahi K, Kobayashi K. Allelopathic activity of camphor released from camphor tree (Cinnamomum camphora). Allelopathy J. 2011; 27:123–132.
18. Schenk JR, 2009. Phytochemistry, allelopathy and the capability attributes of camphor laurel (Cinnamomum camphora (L.) Ness & Eberm.). Ph.D. Thesis, Southern Cross University, Lismore, Australia, 2009.
19. Hamidpour R, Hamidpour S, Hamidpour M, Shahlari M Camphor (Cinnamomum camphora), A traditional remedy with the history of treating several diseases. International Journal of Case Reports and Images. 2012; ISSN – [0976-31 98].
20. Nirmal Babu K, Sajina A, Minoo D. Micropropagation of camphor tree (Cinnamomum camphora). Plant Cell, Tissue and Organ Culture. 2003; 74**:** 179–183. (https://doi.org/10.1023/A:1023988110064).
21. Donkin RA. Dragon's brain Perfume: An Historical Geography of Camphor; Koninklijke Brill: Leiden, The Netherlands. 1999; 141.
22. Philpott NW. Intramuscular injections of camphor in the treatment of engorgement of the breasts. CMAC. 1929; 20: 494–495.
23. Lopes-Lutz D, Alviano DS, Alviano CS, Kolodziejczyk PP. Screening of chemical composition, antimicrobial and antioxidant activities of Artemisia essential oils. Phytochemistry. 2008; 8: 1732–1738.
24. Sivropoulou A, Nikolaou C, Papanikolaou E, Kokkini S, Lanaras T, Arsenakis M. Antimicrobial, cytotoxic and antiviral activities of Salvia fruticosa essential oil. J. Agric. Food Chem. 1997;45: 3197–3201.
25. De Logu A, Loy G, Pellerano ML, Bonsiqnore L, Schivo ML. Inactivation of HSV-1 and HSV-2 and prevention of cell-to-cell virus spread by Santolina insularis essential oil. Antiviral Res**.** 2000; 48: 177–185.
26. Burrow A, Eccles R, Jones AS. The effects of camphor, eucalyptus and menthol vapour on nasal resistance to airflow and nasal sensation. Acta Otolaryngol. 1983; 96:157–161.

27. Laude EA, Morice AH, Grattan TJ. The antitussive effects of menthol, camphor and cineole in conscious guinea-pigs. Pulm. Pharmacol. 1994; 7: 179–184.
28. Green BG. Sensory characteristics of camphor. J. Invest. Dermatol. 1990; 94: 662–666.
29. Xu H, Blair NT, Clapham DE. Camphor activates and strongly desensitizes the transient receptor potential vanilloid subtype 1 channel in a vanilloid-independent mechanism. J. Neurosci. 2005;25, 8924–8937.
30. Adams JD. The use of California sagebrush (Artemisia californica) liniment to control pain. Pharmaceuticals. 2012; 5: 1045–1053.
31. Ansari MA, Razdan RK. Relative efficacy of various oils in repelling mosquitoes. Indian J. Malariol. 1995; 32: 104–111.
32. Seyoum A, Palsson K, Kunga S, Kabiru EW, Lwande W, Killeen GF, Hassanali A, Knols BG. Traditional use of mosquito-repellent plants in western Kenya and their evaluation in semi-field experimental huts against Anopheles gambiae: Ethnobotanical studies and application by thermal expulsion and direct burning. Trans. R. Soc. Trop. Med. Hyg. 2002; 96: 225–231.
33. Seyoum A, Killeen GF, Kabiru EW, Knolls BGJ, Hassanali A. Field efficacy of thermally expelled or live potted repellent plants against African malaria vectors in western Kenya. Trop. Med. Int. Health. 2003; 1005–1011.
34. Osborne OT. Camphor and strychnine as cardiac stimulants. JAMA. 1928; 90: 403.
35. Ramesh G, Vamshi VY, Kishan V, Madhusudan RY. Studies on the influence of penetration enhancers on in vitro permeation of carvedilol across rat abdominal skin. Curr. Trends Biotechnol. Pharm. 2007;1: 62–69.
36. Jain R, Aqil M, Ahad A, Ali A, Khar RK. Basil oil is a promising skin penetration enhancer for transdermal delivery of labetolol hydrochloride. Drug Develop. Ind. Pharm. 2008; 34: 384–389.
37. Jamshidzadeh A, Sajedianfard J, Nekooeian AA, Tavakoli F, Omrani GH. Effects of camphor on sexual behaviors in male rats. IJPS. 2006; 2: 209–214.
38. Nikravesh MR, Jalali M. The effect of camphor on the male mice reproductive system. Urol. J. 2004; 1: 268–272.
39. Okamoto Y, Yamahi K, Kobayashi K. Allelopathic activity of camphor released from camphor tree (Cinnamomum camphora). Allelopathy J. 2011; 27: 123–132.
40. De Martino L, Mancini E, de Almeida LFR, de Feo V. The antigerminative activity of twenty-seven monoterpenes. Molecules. 2010; 15: 6630–6637.
41. Maridass M, Victor B. Ethnobotanical uses of Cinnamomum Species Tamil Nadu India. Ethnobotanical Leaflets. 2008; 12 (150-55): 1-6.
42. Mishra AK, Swivedi SK, Kishore N, Dubey NK. Fungistatic properties of essential oil of Cinnamomum camphora. International Journal of Pharmacognosy. 1991; 29(4): 259-262.
43. Zuccarini P. Camphor: Risks and benefits of a widely used natural product. J. Appl Sci Environ Manage. 2009;13(2): 69-74.
44. Singh R, Jawaid T. Cinnamomum camphora (Kapur): Review. Pharmacognosy Journal. 2012; 4 (28): 1-5.
45. Arena JM. Poisoning: Toxicology, Symptoms, Treatments. 4th ed.; CC. Thomas: Springfield, IL, USA. 1979.
46. Love JN, Sammon M, Smereck J. Are one or two dangerous? Camphor exposure in toddlers. J. Emerg. Med. 2003; 27:49–54.
47. Phelan WJ. Camphor poisoning: Over-the-counter dangers. Pediatrics. 1976; 57: 428–431.
48. Manoguerra AS, Erdman AR, Wax PM, Nelson LS, Caravati EM, Cobaugh DJ, Chyka PA, Olson KR, Booze LL, Woolf AD et al., Camphor poisoning: An evidence-based practice guideline for out-of-hospital management. Clin. Toxicol. 2006; 44: 357–370.
49. Millet Y, Jouglard J, Steinmetz MD, Tognetti P, Joanny P, Arditti J. Toxicity of some essential plant oils. Clinical and Experimental Study. Clin. Toxicol. 1981; 18: 1485–1498.
50. Juteau F, Masotti V, Bessière JM, Dherbomez M, Viano J. Antibacterial and antioxidant activities of Artemisia annua essential oil. Fitoterapia. 2002; 73: 532–535.
51. Tirillini B, Velasquez ER, Pellegrino R. Chemical composition and antimicrobial activity of essential oil of Piper angustifolium. Planta Med. 1996; 62: 372–373.
52. Kamdem DP, Gage DA. Chemical composition of essential oil from the root bark of Sassafras albidum. Planta Med. 1995; 61: 574–575.
53. Viljoen A, van Vuuren S, Ernst E, Klepser M, Demirci B, Baser H, van Wyk B. Osmitopsis astericoides (Asteraceae)—The antimicrobial activity and essential oil composition of a Cape-Dutch remedy. J. Ethnopharmacol. 2003; 88: 137–143.
54. Hammerschmidt FJ, Clark AM, Soliman FM, El-Kashoury ES, Abd El-Kawy MM, El-Fishawy AM. Chemical composition and antimicrobial activity of essential oils of Jasonia candicans and J. montana. Planta Med. 1993; 59: 68–70.
55. Lopes-Lutz D, Alviano DS, Alviano CS, Kolodziejczyk PP. Screening of chemical composition, antimicrobial and antioxidant activities of Artemisia essential oils. Phytochemistry. 2008; 8: 1732–1738.
56. Viljoen AM, Njenga EW, van Vuuren SF, Bicchi C, Rubiolo P, Sgorbini B. Essential oil composition and in vitro biological activities of seven Namibian species of Eriocephalus L.(Asteraceae). JEOR. 2006; 18: 124–128.
57. Damjanoviæ-Vratnica B, Dakov T, Šukoviæ D, Damjanoviæ J. Chemical composition and antimicrobial activity of essential oil of wildgrowing Salvia officinalis L. from Montenegro. JEOBP. 2008; 11: 79–89.
58. Kelen M, Tepe B. Chemical composition, antioxidant and antimicrobial properties of the essential oils of three Salvia species from Turkish flora. Bioresour. Technol. 2008; 99: 4096–4104.
59. Malabadi RB, Meti NT, Chalannavar RK. Role of herbal medicine for controlling coronavirus (SARS-CoV-2) disease (COVID-19). International Journal of Research and Scientific Innovations. 2021a; 8(2): 135-165.
60. Malabadi RB, Meti NT, Chalannavar RK. Applications of nanotechnology in vaccine development for coronavirus (SARS-CoV-2) disease (Covid-19). International Journal of Research and Scientific Innovations. 2021b; 8(2): 191-198.
61. Kapepula PM, Kabengele JK, Kingombe M, Bambeke FV et al., Artemisia Spp. derivatives for COVID-19 treatment: Anecdotal use, political hype, treatment potential, challenges, and road map to randomized clinical trials. Am. J. Trop. Med. Hyg. 2020; 103(3): 960–964. (doi:10.4269/ajtmh.20-0820).
62. Haq FU, Roman M, Ahmad K, Ur Rahman S, Ali Shah SM, Suleman N, Ullah S, Ahmad I, Ullah W. Artemisia annua: Trials are needed for COVID-19. Phytotherapy Research. 2020; 34: 2423–2424. (https://orcid.org/0000-0002-9391-0032).
63. Blanchard JM. Cinnamomum camphora a cineole (Ravintsara), A plant for the prevention of hospital-acquired infections?. Phytotherapy. 2007; **5:** 15-20. (https://doi.org/10.1007/s10298-007-0202-1).
64. Guo X, Cui M, Deng M, Liu X, Huang X, Zhang X, Luo L. Molecular differentiation of five Cinnamomum camphora chemotypes using desorption atmospheric pressure chemical ionization mass spectrometry of raw leaves. Nature-Scientific Reports. 2017; 7: 46579. (DOI: 10.1038/srep46579).

65. da Silva JKR, Figueiredo PLB, Byler KG, Setzer WN. Essential oils as antiviral agents, potential of essential oils to treat SARS-CoV-2 infection: An in-silico investigation. Int. J. Mol. Sci. 2020; 21: 3426. (doi:10.3390/ijms21103426).
66. Ankita S, Chandra SS, Arti T. Phytochemical study and antimicrobial activities of Cinnamomum camphora. World J. Pharmaceutical Research. 2014; 3(2): 2287-2294.
67. Costa R, Pizzimentib F, Marotta F, Dugo P, Santi L, Mondello L. Volatiles from steam-distilled leaves of some plant species from Madagascar and New Zealand and evaluation of their biological activity. Natural Product Communications. 2010; 5 (11): 1803-1808.
68. Patne T, Mahore J, Tokmurke P. Inhalation of essential oils: Could be adjuvant therapeutic strategy for covid-19. International J. Pharmaceutical Sciences and Research. 2020; 11(9): 4095-4103.
69. Huo H, Gu Y, Cao Y, Liu N, Jia P, Kong W. Antifungal activity of camphor against four phytopathogens of Fusarium. Research Square. 2020; 1-13. (https://doi.org/10.21203/rs.3.rs-274895/v1).
70. Malabadi RB, Kolkar KP, Meti NT, Chalannavar RK. Melatonin: One molecule one- medicine for many diseases, coronavirus (SARS-CoV-2) disease (Covid-19); Function in plants. International Journal of Research and Scientific Innovations. 2021c; 8(3): 155-181.
71. Malabadi RB, Kolkar KP, Meti NT, Chalannavar RK. Vaccine development for coronavirus (SARS-CoV-2) disease (Covid-19): Lipid nanoparticles. International Journal of Research and Scientific Innovations. 2021d; 8(3): 189-195.
72. Malabadi RB, Kolkar KP, Meti NT, Chalannavar RK. Role of botanical essential oils as a therapy for controlling coronavirus (SARS-CoV-2) disease (Covid-19). International Journal of Research and Scientific Innovations. 2021e;8(4): 105-118.
73. Malabadi RB, Kolkar KP, Meti NT, Chalannavar RK. Role of plant based hand sanitizers during the recent outbreak of coronavirus (SARS-CoV-2) disease (Covid-19). Significances of Bioengineering & Biosciences. 2021f; 5(1): 458-468.
74. Malabadi RB, Kolkar KP, Meti NT, Chalannavar RK. Outbreak of Coronavirus (SARS-CoV-2) Delta variant (B.1.617.2) and Delta Plus (AY.1) with fungal infections, Mucormycosis: Herbal medicine treatment. International Journal of Research and Scientific Innovations. 2021g; 8(6): 59-70.
75. Malabadi RB, Kolkar KP, Meti NT, Chalannavar RK. Camphor tree**,** Cinnamomum camphora (L.); Ethnobotany, and pharmacological updates. Biomedicine. 2021h; 41 (2): 181-184.

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