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Eucalyptus: A Review on Agronomic and Medicinal Properties

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ABSTRACT: Eucalyptus belongs to the family Myrtaceae which is cultivated worldwide but native to Australia. Eucalyptus is widely cultivated all over the world for its medicinal and agronomic properties. Eucalyptus is extensively used in agroforest industry as it provides raw material for various industries. Eucalyptus is also used to curtail carbon dioxide emissions. This review paper discusses about the use of eucalyptus oil as it consists numerous compounds which manifest herbicide and pesticide properties. Extraction of eucalyptus oil by steam distillation process is also discussed. Eucalyptus oil contains 1,8-cineole, citronellyl acetate and other compounds which expresses medicinal properties such as antiseptic, anti-inflammatory, antibacterial, antifungal and numerous other properties. Primary use of Eucalyptus oil in treatment of diseases like asthama, bronchitis, and sinus depicts the importance of eucalyptus in our healthcare system.

Keywords: 1, 8- cineole, SARC-CoV-2, aromatherapy, eucalyptus, antimicrobial.

INTRODUCTION

From the ancient time product obtained from the plants has been used for the curing many disease. One of such important category plant named eucalyptus has been grown in the country like China, India, South Africa, Portugal, Brazil and Tasmania (Vecchio *et al.,* 2016) for the various purposes.

Eucalyptus is an evergreen tall tree first discovered from Australia and Tasmania. *Eucalyptus* belongs to the Myrtaceae family under which there are 900 species and subspecies present. After Acacia it is the largest genera. In more than 90 countries it is grown today. The oil extract from the different parts of the plant (leaves, fruits, buds and bark) shows antibacterial, antiseptic, antioxidant, anti-inflammatory, anticancer activity. Due to presence of these properties this is used for treatment of respiratory disease, common cold, influenza, sinus and congestion. The widely used species is *E. globulu*s due to its various propose of uses like perfume, cosmetics, food, beverages, aromatherapy, and phytotherapy (Vecchio *et al.,* 2016).

The anti-microbial activity of eucalyptus oil from *E. globulus* affects both gram-negative (*Salmonella enteritidis, Escherichia coli and pseudomonas aeruginosa*) and gram-positive bacteria (*Staphylococcus aurans, Enterococcus faecium, Listeria monocytogens 4b and Listeria monocytogens EGD-e*). (Bachir and Benali 2012; Lu *et al.,* 2016; Vecchio *et al.,* 2016). eucalyptus oil also shows the antifungal property against fungi like yeast (Marzoug *et al.,* 2011). These are the studies that supported potential use of eucalyptus oil in pharmaceutical industries because of its medicinal property and as natural preservatives for food as it prevents the development of the yeast (*Saccharomyces cerevisiae)* in fresh juices (Kumar *et al.,* 2014).

Eucalyptus oil can be used as imnunoregulate agent against infectious disease as it improves the innate cell-mediated immunity. From *Eucalyptus polybractea* a bioactive compound named eucalyptus oil extracted and can be used as an antiviral activity against the influenza virus and inhibit the avian influenza virus H11N9 in aerosol and vapor form. Enveloped virus like mumps and herpes can also be inhibited according, to a report eucalyptus oil exhibit in vitro antiviral activity (Asif *et al.,* 2020).

Eucalyptus plant is an important source of the dye, tannin, and protein. Isoprenoids (a volatile phytochemical) are present in the leaves part of the eucalyptus plant. This isoprenoid having the medicinal property. From the leaves of this plant various product like flavonoid, alkaloid, saponins and tannins are extracted (Kaur *et al.,* 2018). One of the active constituents of eucalyptus oil named 1,8-cineole along with it found to exhibit the muscle relaxation by decreasing the muscle contraction (Asif *et al.,* 2020). Eucalyptus oil has been a prominent agent against respiratory disease such as asthma and bronchitis.

According to various researches this antiviral efficiency can also be used to prevent SARC-CoV-2. Technique such as in vitro assay and molecular docking depicts the efficacy of eucalyptus oil against viral activity of SARC-CoV-2 (Asif *et al.,* 2020).

For pulp mills eucalyptus is one of the important hardwood resources. This tree grows fast and easily adapt to the different climate fluctuation and soil type (Carrillo *et al.,* 2017).

A. Agronomic properties of Eucalyptus

Eucalyptus tree has properties like fast growth, straight form, valuable wood properties, and wide adoptability to soil and climate and at last but not the least easy management due to presence of those properties Eucalyptus species become an important hardwood for the pulp industries (Turnbull and Pryor 1984; Turnbull 1999; Myburg *et al.,* 2007; Gomes *et al.,* 2015). Beside this these woods are also used for smooth writing and printing paper, as these contain many small fibers, and these are smaller than other hardwood (Clarke *et al.,* 2008; Dutt and Tyagi 2011). From all this it is said that the pulpability factor of the *Eucalyptus* is better than other than hardwood species.

Eucalyptus oil has many commercial uses such as perfume, cosmetics, food, beverages, aromatherapy and phytotherapy in large scale in many countries its oil has some magical properties which is used for different propose like antibacterial, antiseptic, antioxidant, anti-inflammatory and anticancer activity (Dixit *et al.,* 2012; Egawa *et al.,* 1997).

As seen mostly on water logging areas many farmers plant this tree and earn money. Due to shortage of popular wood in the world, the *Eucalyptus* is used in the furniture industries. The charcoal is one of the most essential renewable energy source in the world. The charcoal of the *Eucalyptus* plant is very efficient because it provides more energy than the other hardwood charcoal. As the *Eucalyptus* plant are very tall in nature in some places these are use as electric poles.

This plant plays a great role in the decreasing of global warming and climate change. Now a days the pollution is one of the greatest problems in the world. The vehicles, industries produce lots of pollutants as a result of which it hampers the ozone layer balance. Due to this the sunlight directly fall on the earth surface, from the direct sunlight the people suffer from skin cancer and irritation. At present the deforestation of timber tree are done very frequently in the places like Ethiopia because it is now in developing stage of economy, population and urbanization (Mulugeta and Habtemariam, 2014). But By planting more and more *Eucalyptus* trees it helped as a solution to the above problem.

Jeanroy on 6th May 2020 said that a unique menthol like fragrance is produced from *Eucalyptus* plant for which it can be most often used as ornamental plant (Buchbauer, 2000).

Agroforestry gives benefits to the farmer as well as other those who are directly or indirectly related to farmer. It supplies raw material generate employment, beneficial for transportation corporation, wholesale and retail (Gomes *et al.,* 2015). The state board of forestry introduced a program in 1887. Established experimental station at six different station (Santa Moriah, Chico, Merced, Hesperia, San Jacinto and Lake Hemet). The main objective behind this project is to enhance the plantation of different *Eucalyptus* species.

Latter after some years these sites are converted into college of agriculture under university of California at Berkeley. After this event the ship manufacturing industries paid attention to this kind of tree and such fast-growing hardwood tree is lottery for them. From all these new product and energy production from the single tree attracted all the investor, scientists, industrialist, to focus on it. After half a century after the introduction of the *Eucalyptus* tree in the California, other events are organized in 1950s and 1960s. In this time era the fireboard became an essential commodity in construction of house and manufacturing of furniture's.

Product from tree is good but for a limited period, as forest helps in balancing the carbon dioxide content in the atmosphere against pollution and global warming.

B. Eucalyptus oil use as herbicide

There are various species of *Eucalyptus* species whose oil when applied in unessential herbs or weed kills them (Kohli *et al.,* 1998; Singh *et al.,*2005; Batish *et al.,* 2007; Setia *et al.,* 2007). It is reported that the species such as *E. citriodora* and *E. tereticornis* oil when applied in *Parthenium hysterophorus* in the form of vapors decrease their germination (Kohli *et al.,* 1998). Further this experiment was conducted in *Raphanus sativus, Amaranthus viridis*, *Zea mays* etc. the essential oil is more effective on *A. viridis* because of its small size comparing to *R. sativus* because of its larger seed. *E. citriodora* oil is more toxic than *E. tereticornis* (Batish *et al.,* 2004). Fumigation is the process of using gases to destroy the unwanted pests in the plant. Here fumigation using *Eucalyptus* oil is done which result in plant destruction by chlorosis, decreased cellular respiration, necrosis (Kohli *et al.,* 1998). The secondary metabolites oil such as phenolics, tannins, and monoterpenes contribute herbicidal activities (Vourc'h *et al.,* 2002; Bailey *et al.,* 2004; Foley and Moore, 2005). On different concentration oil was sprayed: Less than 50microliter/ ml – the toxicity was less, and reversible reaction took place. More than 50microliter/ml – the condition was not much improved

But-, more than 100microliter/ml – with the passage of time wilting of leaves took place. (Council of Europe, 1992) There are various factors which can affect the commercialization of this bio herbicides (Singh *et al.*, 2005) (Batish *et al.*, 2007).

-climatic change
-toxicity towards useful plant
-volatility of *Eucalyptus* oil
-plant uptake
-concentartion of oil varies with season
-inconsistency with its conecentartion on different species
-lipophilicity
-effectiveness under field condition

Scientist have concluded that *Eucalyptus* oil in the form of herbicide could be used as bioherbicide (Batish *et al.*, 2006). Under organic farming this can be used as herbicide.

C. Eucalyptus oil use as insecticides

Insects damage the plants by chewing the leaves, sucking plant juices, secretion of toxic substances on shoot of the plant, create holes in the leaves which lead to poor growth of the plant not only that they also destroy the natural wooden fibers (Chapman, 2013). There are so many insects found in this world but only one out of three cause damage to the plant. These are insects such as gall mites, bagworm, leaf minor, moth, aphids, flies, mosquitoes, earwig, grasshopper etc. they cause more damage to the plant. Instead of harmful insecticides we can use *Eucalyptus* oil which is a natural insecticide (Yang *et al.*, 2004). The species such as *E. globulus* and its compound 1, 8 cineole damage and kills *Pediculus humanus* capitis and lice and they can be used in commercially as lice killers (Ceferino *et al.*, 2006). The oil of *Eucalyptus* is used as antifeedant against biting insect. Depending on the concentration of oil the effectiveness is measured (Ceferino *et al.*, 2006). It protects human against biting insects for example on applying in clothes the activity can be extended upto 8 days (Mumcuoglu *et al.*, 1996 and later said by Fradin and Day 2002).

It was concluded that 30% of the oil prevent mosquito biting for 2hour. However, the most important component in the oil should be cineole which is about 70% (Lucia *et al.*, 2007).

The table 1 shows the important insecticides and the insects they kill.

Table 1: Insecticidal activity of leaf essential oil of some *Eucalyptus* species.

***Eucalyptus* species (As an oil source)**	**Tested organism**	**References**
E. globulus	Kills pupae of *Musca domestica*. Toxic to *Aedes aegypti* larvae. Ovicidal and adulticidal against female *Pediculus humanus* capitis De (human body lice).	Batish *et al.*, 2008; Dhakad *et al.*, 2018.
E. citriodora	Toxicity against *Sitophilus zeamais*	Batish *et al.*, 2008; Dhakad *et al.*, 2018.
E. camaldulensis	Repels adult females of Culex pipiens. Egg mortality in *Tribolium confusum* and *Ephestia kuehniella*	Batish *et al.*, 2008; Dhakad *et al.*, 2018.
E. saligna	Repellent activity against *Sitophilus zeamais* and *Tribolium confusum*	Batish *et al.*, 2008; Dhakad *et al.*, 2018.
E. tereticornis	Larvicidal, pupicidal and adulticidal activity towards *Anopheles stephensi*	Batish *et al.*, 2008; Dhakad *et al.*, 2018.

D. Eucalyptus oil use as pesticide

Eucalyptus oil is having so many important functions in pharmaceutical, aromatic industries (Brooker and Kleinig, 2006) other than this they are used as pesticides. They have been used from hundreds of years as antimicrobial, antifungal and antiseptic agents (Brooker and Kleinig, 2006). They also provide allelopathic property to the trees (Brooker and Kleinig, 2006).

The species of *Eucalyptus* which has important pesticidal activities are *E. citriodora* which is world's most traded oil (Green, 2002), *E. globulus* (Tasmanian blue gum), *E. polybractea* (blue mallee) and *E. camaldulensis* (river red gum).

Table 2 shows the major constituents of *Eucalyptus* oil and their pesticidal activities.

Table 2: Pesticidal activity by Major constituents of leaf essential oil from *Eucalyptus* species.

Eucalyptus species	Major constituents	References
E. camaldulensis	Eucamalol	Batish *et al.*, 2008; Dhakad *et al.*, 2018.
E. robusta	α-Pinene	Batish *et al.*, 2008; Dhakad *et al.*, 2018.
E. camaldulensis *E. cinerea* *E. globules*	1,8-Cineole	Batish *et al.*, 2008; Dhakad *et al.*, 2018.
E. urophylla	γ –Terpinene	Batish *et al.*, 2008; Dhakad *et al.*, 2018.
E. grandis * *E. urophylla*	Alloocimene	Batish *et al.*, 2008; Dhakad *et al.*, 2018.
E. saligna	p-cymene	Batish *et al.*, 2008; Dhakad *et al.*, 2018.
E. citriodora	Citronellal	Batish *et al.*, 2008; Dhakad *et al.*, 2018.

E. Medical properties of Eucalyptus

Natural products have been an essential resource for various bio-medical compounds which are important for production of pharmaceuticals agents which can curtail inflammation, infection, cancer and various other diseases. Natural products are a potential source of drug leads which contains medically and pharmacologically important compounds which shows analgesic, antifungal, antibacterial, antiviral, as well as antifungal properties. One of the most important sources is *Eucalyptus* oil which is extracted from the leaves of *Eucalyptus globulus* (Myrtaceae). *Eucalyptus* oil is a vital source of pharmaceutical agents used in the treatment of diseases. *Eucalyptus* oil contains an exponential amount of secondary metabolites such as 1, 8- cineole, citronellal, citronellyl acetate, p-cymene, eucamalol, limonene, linalool, β- pinene, γ-terpinene, αterpinol, alloocimene and aromadendrene (Nezhad *et al.*, 2009) which possess anti-inflammatory, analgesic, antimicrobial, anticancer, antioxidant and insecticidal properties. Certain secondary metabolites contain anticancer cytochrome p40 inhibitors which reveals the medicinal importance of *Eucalyptus* oil (Adnan, 2019).

F. Eucalyptus Species Used for Oil Production

Eucalyptus globulas is one of the most prominent species, widely used for oil production in India, China, Spain, Brazil, Bolivia and Uruguay. *Eucalyptus smithii* is the primary species for oil production in Switzerland, and South Africa. Zimbabwe produces most of its essential oil production from *Eucalyptus polybractea* whereas *Eucalyptus viridis*, *Eucalyptus radiata* are extensively used for oil production in Australia, South Africa. The most prominent specie of *Eucalyptus camaldulensis* is used in perfumery as it contains high amount of citronella and other compounds with scents. Indian and Chinese Perfumery Industry extracts most of its *Eucalyptus* from *Eucalyptus citriodora* meanwhile, Brazilian perfume Industry extracts oil from *Eucalyptus staigeriana.*

G. Extraction of Eucalyptus oil

Essential oil from *Eucalyptus* can be extracted by various methods such as hydro distillation, turbo distillation, steam distillation and other methods which are not as common as the methods mentioned above. Every single extraction method depends upon the distiller which plays an important role in maintaining plant quality which is essential for final therapeutic product. Another point worth mentioning is that distillers often enhance the quality of the plant by removing contaminations which can provide better results. For example, the blue color of German chamomile is observed when it undergoes steam distillation extraction (Khandge *et al.*, 2017). Steam distillation is one of the most popular and easy method for *Eucalyptus* oil extraction. This process distills mixture of compounds below the boiling points which prevents any further damage to the compounds. *Eucalyptus* oil contains certain compound with can sustain temperature up to 200°C or higher. In this process steam or boiling water, is used where compounds are volatilized at 100°C atmospheric pressure (Khandge *et al.*, 2017). The extraction of *Eucalyptus* oil via steam distillation is easy and provides quality result. Steam distillation is widely used for extraction of *Eucalyptus* oil due to its ability to distill compounds which are temperature sensitive such as oils, resins, hydrocarbons, etc. which are generally insoluble in water and can degrade is they exceed their respective boiling point.

Table 3: Physical and Chemical properties of *Eucalyptus* Oil (Khandge *et al.*, 2017).

State	Liquid- Oil
Color	Pale Yellow
Taste	Cooling pungent taste
Boiling Point of Cineole	176 °C – 177 °C
Density	0.921- 0.923
Odor	Camphoraceous with sweet odor
Solubility	Insoluble in water but soluble in high concentration alcohol, oil, fats, oil etc.

H. Pharmacological Activities

Eucalyptus has almost 900 different species found all over the world where, only 300 species contain the essential oils which holds medical properties in its

leaves (Pino *et al.,* 2002). Uses of these oils are broadly classified into three categories which are medicinal, industrial and perfumery. *Eucalyptus* oil contains medicinal properties such as antimicrobial activity which inhibits the growth of microbes such as bacteria, fungi, soil-borne pathogens (Dhakad *et al.,* 2018). *Eucalyptus* oil has been also used to treat various diseases such as infections, colds, sore throats, bronchitis, pneumonia, stiffness, neuralgia (Hutchings *et al.,* 1996). Antimicrobial activity attributed the major reason of antimicrobial activities of *Eucalyptus* oil is attained by certain compounds such as 1, 8-cineole, α-pinene, β-pinene and limonene (Raju and Maridas 2011). According to some researcher compounds like cajanol and monoterpenoid indole alkaloid. Wei *et al.,* (2011) can cleave microbial DNA which will ultimately damage microbial DNA. Other medicinal uses of *Eucalyptus* primarily consist as decongestant agent, antiseptic sprays, and ointments. Perfumes industry utilizes specific compounds extracted from *Eucalyptus* plant such as citronella which has a lemon scent whereas, geranyl acetate has a rose scent. Industrial application consists of utilization of oils to manufacture of soaps, germicides, disinfectants, deodorants, and germicides. Synthetic methanol and thymol is also produced by taking *Eucalyptus* oil as a substrate.

***Eucalyptus* oil can also be used to treat different kinds of disease such as**:

Bronchitis: Certain factors such as smoking, air pollution can lead to inflammation in the lining of the bronchial tube which causes bronchitis. *Eucalyptus* oil has the ability to curtail bacterial actions by acting as an efflux pump inhibitor which enhances our immune system to control the growth of bacterial species responsible for bronchitis.

Sinus: Inflammation in nasal passage and surroundings of cavity can triggered by allergies which can be prevented by *Eucalyptus* oil. *Eucalyptus* oil can be used as a spray which can address the pain and inflammation caused by allergic reaction or any bacterial action. Compounds present in *Eucalyptus* oil can soothe mucus membrane in the case of any infection or and medical conditions such as allergies.

Asthma: It is a condition which makes a person difficult to breathe by extensive chest pain and coughing which occurs due to inflammation or production of extra mucus which can block nasal passage. For many years *Eucalyptus* oil has been used in various medicines such as Vicks VapoRub which can heal coughing making it easier for the person to breathe.

(i) Antiseptic Activity. *Eucalyptus* Oil is one of the most powerful antiseptic agents as it contains certain compounds such as 1, 8-cineole and citronellyl acetate which can cleave bacterial cell wall as well as bacterial DNA. According to many researchers the age of *Eucalyptus* oil is an essential factor as when it is old, ozone formation occurs due to direct explosion to the air which makes it a better antiseptic agent.

(ii) Antimicrobial activity. *Eucalyptus* Oil holds antibacterial effect against various pathogenic microorganisms such as of *Klebsiella* spp., *Proteus* spp., *Pseudomonas* spp., *Escherichia coli,* and *Staphylococcus aureus*. Antimicrobial activity of *Eucalyptus* oil depends upon the concentration of oil used against a specific microorganism. One of the easiest methods to examine antimicrobial activity is MIC assay. The minimum Inhibitory Concentration assay is used to analyze the minimum dose required to kill bacteria. Such as only 5 µl is capable of controlling the growth of *Escherichia coli and Klebsiella* spp. and in the case of *Staphylococcus aureus* only 25 µl of oil is required to curtain its functionality. Whereas the growth of *Pseudomonas and Proteus spp*. can be inhibited by 50 µl of *Eucalyptus* oil. An increase dose of *Eucalyptus* oil will generally stop bacterial growth which will increase the diameter of the inhibition zone in MIC assay (Trivedi *et al.,* 2004). Oil extracted from *Eucalyptus largiflorens* exhibits high antimicrobial activity against all microorganisms including bacteria, yeasts, and molds. Microorganism such as *Escherichia coli, and Shigella dysenteriae* does not get highly effected by *Eucalyptus* oil. Antimicrobial activity of *Eucalyptus* oil depends upon various other factors such as concentration and amount of bacterial inoculum used. Results depicts that *Eucalyptus* oil shows high antagonistic properties against *S. aureus and P. aeruginosa*. Whereas *Eucalyptus* oil shows 100% inhibition of *S. aureus* with the largest inhibition zone during MIC assay (Adnan, 2019).

(iii) Antifungal Activities. *Eucalyptus* oil is often use for the treatment of facial demodicidosis which is a disease caused by Dematatious fungi which invades sebaceous glands areas of the skin causing dryness, redness rash and sometimes erythema. *Eucalyptus* oil extracted from *Eucalyptus globulus* with mildly diluted glycerol can completely cure facial demodicidosis (Kesharwani *et al.,* 2018). Another fungi *Malassezia furfur* which is a causative agent of seborrheic dermatitis and tinea versicolor can also be treated using oil extracted from *Eucalyptus globulus* leaves.

(iv) Antitumor Activity. *Eucalyptus globulus* contains specific compounds which exhibits antitumor promoting activities. Compounds such as Euglobals 1a, III, IV, V, 1a 2 and IVa are some specific compounds out of *twenty-one euglobals which were* isolated form leaves of various species of *Eucalyptus* such *as E. ampifolia, E. globulus, E. grandis, and E. blakelyi* which can significantly inhibit 12-O-tetradecanoylphorbol-13-acetate located in Epstein-Barr virus which act as a tumor promotor by inducing viral activation. Euglobal G1 and euglobal III depicts strong inhibition of Raji cells by interrupting is cell cycle. Both the compounds can also prevent mouse skin tumor promotion according to an in vivo carcinogenesis test

(Takasaki *et al.*, 1995). Euglobal III, Ib, Ic, IIb, IVa and IVb can inhibit NF- kappa B cell induction by controlling nuclear translocation which occurs in LPS of THP-1 cells (Zhou *et al.*, 2003).

(v) Antioxidant Activity. Antioxidant potential of *Eucalyptus* oil was determined by DPPH free radical method which is an antioxidant assay which measures the free radical scavenging activity to measure the antioxidant capabilities of the compound. DPPH assay of *Eucalyptus* oil was done in comparison to ascorbic acid which revealed radical scavenging activity against DPPH molecules. The antioxidant capabilities of *Eucalyptus* oil majorly depend upon the concentration as during the test scavenging activity increased with increase in concentration. Antioxidant potential of ascorbic acid has been found to be comparatively higher than of *Eucalyptus* oil (Adnan, 2019).

FUTURE PROSPECTIVE

Based upon the different medicinal and agronomic properties of *Eucalyptus* plant and its commercial aspects many efforts in its research and development activities have been initiated. To have improved wood quality my hybrids of the plant have been developed and more work in this area is going on. Genomic initiatives in the plant can help us in development of improved fast growing varieties. More research on the medicinal potential of its oils and extracts and to find out more bioactive effective against zoonotic and infectious diseases can be carried out.

CONCLUSION

Eucalyptus has many commercial uses. It has many natural as well as cloned varieties. Among all the varieties *E. globus* is mostly used species due to its gum production. Due to its high demand, and moderate productivity different methods are being used to raise the production capacity. Different parts of the plant can be used as a source of medicine. 1,8-Cineole, γ – Terpinene and various other major constituents of leaf essential oil from *Eucalyptus* species can be used as a various purpose like pesticides. *Eucalyptus* oil can be also used as herbicide which is applied in killing of unessential herbs or weed. Product like phenolics, tannins, and monoterpenes can be used as herbicidal activity. For the extraction of the *Eucalyptus* oil from *Eucalyptus* plant various methods like steam distillation, hydro distillation, turbo distillation can be used. It is found that the oil obtained from the *Eucalyptus largiflorens* shows high antimicrobial activity. Product like citronellyl acetate and 1, 8-Cineole can be used as an antiseptic and having ability to damage the bacterial genetic material as well as its cell wall. Oil extracted from the *Eucalyptus* plant can be also used to treat the disease like pneumonia, asthma, bronchitis etc.

REFERENCES

Bachir, R. G., & Benali, M. (2012). Antibacterial activity of the essential oils from the leaves of *Eucalyptus globulus* against Escherichia coli and Staphylococcus aureus. *Asian Pacific journal of tropical biomedicine*, *2*(9), 739-742.

Batish, D.R., Setia, N., Singh, H.P., Kohli, R.K. (2004). Phytotoxicity of lemon-scented eucalypt oil and its potential use as a bioherbicide. *Crop Prot.*, **23**, 1209–1214.

Batish, D.R., Singh, H.P., Setia, N., Kaur, S., Kohli, R.K. (2006). Chemical composition and phytotoxicity of volatile essential oils from intact and fallen leaves of *Eucalyptus citriodora*. Z. Naturforsch. c61, 465–471.

Batish, D.R., Singh, H.P., Setia, N., Kohli, R.K., Kaur, S., Yadav, S.S. (2007). Alternative control of littleseed canary grass using eucalypt oil. Agron. Sust. Dev,27, 171–177.

Bailey, J. K., Schweitzer, J. A., Rehill, B. J., Lindroth, R. L., Martinsen, G. D., & Whitham, T. G. (2004). Beavers as molecular geneticists: a genetic basis to the foraging of an ecosystem engineer. *Ecology*, *85*(3), 603-608.

Buchbauer, G. (2000). The detailed analysis of essential oils leads to the understanding of their properties. *Perfumer & flavorist*, **25**(2), 64-67.

Brooker, M.I.H. and Kleinig, D.A. (2006). Field Guide to *Eucalyptus*. vol.1. South-eastern Australia, Third edition. Bloomings, Melbourne.

Council of Europe (1992). Flavouring substances and natural sources of flavourings. Volume I, 4th Edition: Chemically-Defined Flavouring Substances.

Ceferino, T. A., Julio, Z., Mougabure, C. G., Fernando, B., Eduardo, Z. and Maria, I. P. (2006). Fumigant and Repellent Properties of Essential Oils and Component Compounds against Permethrin-resistant *Pediculus humanus* capitis (Anoplura: Pediculidae) from Argentina. *J. Med. Entomol.*, **43**: 889– 895.

Batish, D.R., Singh, H.P., Kohli, R. K., & Kaur, S. (2008). *Eucalyptus* essential oil as a natural pesticide. *Forest ecology and management*, **256**(12), 2166-2174.

Dixit A, Rohilla A, Singh V. (2012). *Eucalyptus globulus*: A new perspective in therapeutics. *Int. J. Pharm. Chem. Sci.*, **1**(4): 1678-83.

Dhakad, A. K., Pandey, V. V., Beg, S., Rawat, J. M., & Singh, A. (2018). Biological, medicinal and toxicological significance of *Eucalyptus* leaf essential oil: a review. *Journal of the Science of Food and Agriculture*, **98**(3), 833-848.

Egawa, H., Tsutsui, O., Tatsuyama, K., & Hatta, T. (1977). Antifungal substances found in leaves of *Eucalyptus* species. *Experientia*, **33**(7), 889-890.

Foley, W. J., & Moore, B. D. (2005). Plant secondary metabolites and vertebrate herbivores–from physiological regulation to ecosystem function. *Current opinion in plant biology*, **8**(4), 430-435.

Fradin, M.S., Day, J.F. (2002). Comparative efficacy of insect repellents against mosquito bites. *New England J. Med.*, **347**, 13–18.

Gomes, F. J. B., Colodette, J. L., Burnet, A., Batalha, L. A. R., Santos, F. A., & Demuner, I. F. (2015). Thorough characterization of Brazilian new generation of eucalypt clones and grass for pulp production. *International Journal of Forestry Research*, *2015*.

Green, C. (2002). Export Development of Essential Oils and Spices by Cambodia. C.L. Green Consultancy Services, Kent, UK.

Hutchings A., Scott AH., Lewis G., Cunningham A. (1996). Zulu Medicinal Plants. An Inventory. Scottsville: University of Natal Press.

Lu, H., Shao, X., Cao, J., Ou, C., & Pan, D. (2016). Antimicrobial activity of *Eucalyptus* essential oil against Pseudomonas in vitro and potential application in refrigerated storage of pork meat. *International journal of food science & technology*, **51**(4), 994-1001.

Marzoug, H. N. B., Romdhane, M., Lebrihi, A., Mathieu, F., Couderc, F., Abderraba, M., ... & Bouajila, J. (2011). *Eucalyptus oleosa* essential oils: chemical composition and antimicrobial and antioxidant activities of the oils from different plant parts (stems, leaves, flowers and fruits). *Molecules*, **16**(2), 1695-1709.

Carrillo, I., Vidal, C., Elissetche, J. P., & Mendonça, R. T. (2018). Wood anatomical and chemical properties related to the pulpability of *Eucalyptus globulus*: a review. *Southern Forests: a Journal of Forest Science*, **80**(1), 1-8.

Kohli, R. K., Batish, D. R., & Singh, H. P. (1998). Eucalypt oils for the control of parthenium (*Parthenium hysterophorus* L.). *Crop Protection*, ***17***(2), 119-122.

Khandge, R., Sane, S., Khatri, N., Satao, N. (2017). Extraction of Essential oils: *Eucalyptus* Oil. *Journal of Emerging Technologies and Innovative Research*, Volume **4**, Issue 6.

Kaur, S., Gupta, S., & Gautam, P. B. (2019). Phytochemical analysis of *Eucalyptus* leaves extract. *Journal of Pharmacognosy and Phytochemistry*, **8**(1), 2442-2446.

Kesharwani, V., Gupta, S., Kushwaha, N., Kesharwani, R.and Patel, D.KM. (2018). A review on therapeutics application of *Eucalyptus* oil. *International Journal of Herbal Medicine*, **6**(6): 110-115.

Adnan, M. (2019). Bioactive potential of essential oil extracted from the leaves of *Eucalyptus globulus* (Myrtaceae). *J. Pharmacogn. Phytochem*, **8**(1), 213-216.

Asif, M., Saleem, M., Saadullah, M., Yaseen, H. S., & Al Zarzour, R. (2020). COVID-19 and therapy with essential oils having antiviral, anti-inflammatory, and immunomodulatory properties. *Inflammopharmacology*, 1-9.

Myburg, A. A., Potts, B. M., Marques, C. M., Kirst, M., Gion, J. M., Grattapaglia, D., & Grima-Pettenatti, J. (2007). Eucalypts. In *Forest trees* (pp. 115-160). Springer, Berlin, Heidelberg.

Mumcuoglu, K. Y., Galun, R., Bach, U., Miller, J., & Magdassi, S. (1996). Repellency of essential oils and their components to the human body louse, Pediculus humanus humanus. *Entomologia Experimentalis et Applicata*, **78**(3), 309-314.

Nezhad, F. M., Zeigham, H., Mota, A., Sattari, M., & Yadegar, A. (2009). Antibacterial activity of *Eucalyptus* extracts on methicillin resistance *Staphylococcus aureus*. *Research Journal of Biological Sciences*, **4**(8), 905-908.

Pino, J. A., Marbot, R., Quert, R., & García, H. (2002). Study of essential oils of *Eucalyptus resinifera* Smith, *E. tereticornis* Smith and *Corymbia maculata* (Hook.) KD Hill & LAS Johnson, grown in Cuba. *Flavour and fragrance journal*, **17**(1), 1-4.

Raju, G., & Maridas, M. (2011). Composition, Antifungal and Cytotoxic activities of Essential oils of Piper barberi fruits. *International Journal of Biological Technology*, **2**(2), 100-105.

Singh, H.P., Batish, D.R., Setia, N., Kohli, R.K. (2005). Herbicidal activity of volatile oils from *Eucalyptus citriodora* against *Parthenium hysterophorus*. *Ann. Appl. Biol.*, **146**, 89–94.

Setia, N., Batish, D.R., Singh, H.P., Kohli, R.K. (2007). Phytotoxicity of volatile oilfrom *Eucalyptus citriodora* against some weedy species. *J. Environ. Biol*., **28**, 63–66.

Turnbull, J. W. (1984). Choice of specific and seed sources. *Eucalyptus for wood production*, 6-65.

Turnbull, J. W. (1999). Eucalypt plantations. *New Forests*, **17**(1), 37-52.

Trivedi, N. A., & Hotchandani, S. C. (2004). A study of the antimicrobial activity of oil of *Eucalyptus*. *Indian Journal of pharmacology*, **36**(2), 93.

Kumar Tyagi, A., Bukvicki, D., Gottardi, D., Tabanelli, G., Montanari, C., Malik, A., & Guerzoni, M. E. (2014). *Eucalyptus* essential oil as a natural food preservative: in vivo and in vitro antiyeast potential. *BioMed research international*, *2014*.

Takasakl, M., Konoshima, T., Kozuka, M., & Tokuda, H. (1995). Anti-tumor-promoting activities of euglobals from *Eucalyptus* plants. *Biological and pharmaceutical bulletin*, **18**(3), 435-438.

Vourc'h, G., Russell, J., Martin, J.L. (2002). Linking deer browsing and terpene production among genetic identities in *Chamaecyparis nootkatensis* and *Thuja plicata* (Cupressaceae). *J. Hered.* **93**, 370–376.

Vecchio, M. G., Loganes, C., & Minto, C. (2016). Beneficial and healthy properties of *Eucalyptus* plants: A great potential use. *The Open Agriculture Journal*, **10**(1): 52-57.

Wei, X. (2011). Monoterpenoid indole alkaloids mediating DNA strand scission from *Turpinia arguta*.

Zhou, J.Y., Tang, F.D., Mao, G.G., Shao, J., Wang, Y., Bian, R.L. (2003). Effect of *Eucalyptus globulus* oil on activation of nuclear factor-kappa B in THP-1 cells. *Zhejiang Da Xue Xue Bao Yi Xue Ban*., **32**: 315-318.

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