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Eucalpytus: An Underestimated Versatile Species

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ABSTRACT

Eucalyptus which has approximately 700 species throughtout the world has various impacts both positive and negative to mankind. This review paper discusses about the characteristics of the eucalyptus, eucalyptus oil's nature, eucalyptus oil's impact in bee keeping, its general impacts in the nature, its impact in hydrology which recently been a topic of concern in the southern states of India. Generally there is a misconception that Eucalyptus is confined only to the high altitude regions but a detailed study into it reveals the truth that it is grown in all the latitudes and altitudes of the earth. Every part of the plant has some form of benefit for humankind. But there is also a rising concern regarding the ground water depletion of the Eucalyptus tree which led to the banning of its cultivation is the southern states if India. Bee keeping which is one of the fastest growing agri sector has gained a benefit for Eucalyptus oil in controlling mite attack in the hives. Eucalpytus oil which has numerous benefits to human health, agriculture, cosmetics sector is also a notable benefit of Eucalyptus. Compared to other oils in bee hives eucalyptus oil was the most efficient one as it didn't caused effect to the honey bee and its effect in controlling mites was also very high.

Key words : *Eucalyptus, Protoeucalyptus, Essential oil and Darcian flow.*

Introduction

Eucalyptus are the world's most widely planted hardwood trees. Eucalyptus also shows the highest diversity of genes for specialized metabolites such as terpenes that act as chemical defence and privide unique pharmaceutical oils. Genome sequencing of the *Eucalyptusgrandis* sister species *E.globulus* and a set of inbred *E.grandis* genomic evolution and hotspots of inbreeding depression (Grattapaglia and Kirst, 2008).

Eucalyptus a genus of woody perenials native to Australia provides greater oppurtunity for a sustainable energy and biomaterials economy in many parts of the world lies in a better understanding of the molecular basis of superior growth and adaptation in woody plants like Eucalyptus. Eucalyptus has a remarkable adaptability of fast growth and superior wood properties which have driven their rapid adoption for plantation forestry in more than 100 countries across 6 continents. The subtropical *E.grandis* and temperate *E.globulus* stand out as targets of breeding programmes worldwide. Outcrossers with hermaphroditic animal pollinated flowers, Eucalyptus are highly heterozygous and display pre and post zygotic barriers to selfing to reduce inbreeding depression for fitness and survival.

Adaptations to aridity and consequently to drought, heat and salinity are considered major factors in the evolution of the genus and the resulting geographic distribution of species. However a number of eucalyptus species are currently showing decline in their natural range, probably related to climate change and increased drought. Introduction of Eucalyptus species into very different regions of the

world based on their distribution on the Australian continent (Popescu *et al*., 2007.

Eucalyptus general characteristics and history

Eucalptus belongs to the kingdom plantae, clade Rosids, Order Myrtales, Family Myrtaceae, Genus Eucalyptus and respective species which range approximately 700 throught the world. The *E.tereticornis* species is the most widely available species of all latitudes ranging 15° Sto 38°S. Eucalyptus native to Australia has almost all varieties in respective states of it. About three-quarters of Australian forests are eucalpytus forest. Many eucalpytus trees are adapted to wildfire, resprout after fire or have seeds that survive fire (Coppen, 2002). Eucalyptus have been grown in plantations in many other countries because they are fast growing and have valuable timber, or can be used for pulpwood, for honey production or essential oils. Leaf characteristics of Eucalyptus vary in response to plant genotype, ontogenic position and environment conditions.

We cannot know what the precursor of Eucalyptus were, but from an analysis of present rainforest and sclerophyllous vegetation of the australian environment, Protoeucalyptus may have the following characteristics.

Characters	Protoeucalyptus
Habit	Tree
Bark	Rough
Cotyledons	Reniform
Juvenile leaf phase	Short
Adult leaves	Dorsivenral
Leaf oil glands	Few and small
Inflorescences	Terminal
Sepals	Present
Anthers	Versatile
Fruit	Slightly fleshy
Petals	Present
Seeds	Hemitropous

(Myburg *et. al*., 2014)

Eucalyptus oil characteristics

Plant essential oils are obtained from non-woody part of the polants especially foliage, with the help of steam or hydrodistillation. Prescence of volative monoterpenes or essential oils in the plants is the main defence strategy of plants particularly against herbivorous insects and pathogenic fungi.

Eucalyptus L'Herit is the major pulpwood tree having oil glabnds and is an excellent source of commercially important eucalyptus oil that have extensive use in pharmaceutical, perfumery and industry. *E.citriodora* is one of the world's major oil in terms of trade volume. Eucalyptus oil is also known to provide allelopathic property to the tree. Essential oil from its foliage has been demonstrated to retard the growth of associated vegetation. Eucalyptus oil has been placed under GRAS (Generally Regarded As Safe) category by Food and Drug Authorityof USA and classified non toxic(Myburg *et al*., 2014).

Eucalyptus oil are used as folk medicine and are anesthetic, anodyne, antiperiodic, antiphlogistic, antiseptic, astringent, deodrant, diaphrotic, disinfectant, expectorant, febrifuge, fumigant, hemostat, inhalent, insect repellant, preventitive, rubefacient, sedative yet stimulant, suppurative, tonic and vermifuge. The rapid advances in the identification of bioactive allelochemicals in eucalyptus oils have prompted research into potential natural herbicidal compounds for weed management in agriculture. Generally essential oils are secondary metabolities produced by plants in response to stress, infection or parasitic attack. Eucalyptus are volatile organic compounds foung in fruits, flowers, bark, seeds, wood and roots. However they are mainly extracted from leaves (Small, 1981). Oil extraction from eucalytus is generally affected by various characteristics like altitude, leaf age, seasons etc. Usually young leaves produce more oil than old leaves but leaves from older leaves have slighlty higher yield. The main component of eucalyptus oil is the prescence of monoterpenes and sesquiterpenes. The main components also varies from species to species. Eucalyptus essential oil has range of bioactivity like antimicrobial, antiviral, fungicidal, insecticidal, anti-inflammatory, antinociceptive activity, antioxidant capacity and phytotoxic (Table 1). Eucalyptus oil is ranked 4th among largely used insecticides for repelling insects from beehives (Kegley *et al*., 2008). The findings show the current world requirement is 2000 to 3000 tonnes annually with a turnover of $A 5 to 7 million. China has the major share (45 per cent) of the world market. Australia supplies less than 3 per cent. Eucalyptus oil poisoning if ingested is also documented but public awareness is generlly lacking. The toxic symptoms are rapid in onset which includes burning sensation in mouth and throat, vomiting, abdominal pain. Significant depression of consiousness is observed if ingested 5ml and mild depression of consiousness if ingested 2-3m (Kumar *et al*., 2015). Eucalyptus oil poisoning is

becoming less fashionable as is harzard remain only in children (Patel and Wiggins, 1980). The amount of extracted oil was determined and yield% of the extracted oil from each sample on the basis of various eucalyptus leaves samples by using following formula: % age yield of oil = Weight of oil x100 Weight of Eucalyptus leaves (Bachheti, 2015).

Eucalyptus oil and its importance in bee keeping

Bee hives are mostly affected by mites. Mite infestation is a severe problem in bee hives. Mites not only gets into the hives through ground but adult mites also gets into the hives in the bee back. When mites infestation is seen the bee hive there is high possibility of destruction of the entire hive. In order to prevent mite infestation in bee hives Apistan strips, dusting with powdered sugar or talc is also a method. Eucalyptus oil as it has high insecticidal property can be used in bee hives for control. In a laboratry experiment more than 80% mites died after immersion in 0.2% and 0.4% eucalyptus oil for 30 and 60 minutes (Tovey and McDonald, 1997). Varroa mites destruction percentage was high for eucalyptus oil 84.18% for 48 hours and 90.27% for 72 hours. Varroa mites was best controlled in 5m of eucalyptus oil. Application of eucalyptus oil also has an additional advantage of no bee toxicity (Bakar *et al*., 2014). The present experience, in which eucalyptus oil antimicrobial and miticide properties were tested in vitro, promotes the use of its active compounds for American fouldbrood and Varroosis management in honey bee colonies (Gende *et al*., 2010).

When other oils are been tested on the honey bees the adult workers showed lower body mass but eucalyptus oil didn't have any impact on the honey bees. Eucalyptus oil also decreased the walking activity of adult worker. Worker larvae when fed with eucalyptus oil emerged with body mass similar to those in control treatment. Sugar syrup with eucaluptus oil had the least forager visit. But decrease in the walking of adult worker bees when treated with eucalyptus oil was also a major concern (Xavier *et al*., 2015). Eucalyptus was a best component to mange Varroa ites in 200 ppm concentration. Eucalyptus oil have fumigant effect against mites. Among the various components of eucalyptus oil, 1, 8-cineole is the most important one. In fact, it is a characteristic compound of the genus Eucalyptus which is largely responsible for a variety of its pesticidal properties and insecticide effects (Bakar *et al*., 2019). Significant acaricidal potential of Eucalyptus species essential oils against V. destructor [16,21,28,31], showed that the association (EEO + thymol) gives a better efficiency than the treatment with thymol alone to reduce the population of the parasite inside the apiary. It should be known that the conventional treatments based on thymol alone

Table 2. Bioactivity of Eucalyptus essential oil on organisms

Species	Bioactivity	Reference
ANTIMICROBIAL ACTIVITY		
E. camaldulensis,*E. tereticornis*	Antimicrobial activity	(Chaudhari *et al.*, 1989)
E. citriodora	Antibacterial activity against *Escherichia coli, Staphylococcus aureus, Proteus mirabilis, Pseudomonasaeruginosa, Proteus vulgaris*.	(Nair *et al.*, 2008)
E. globulus	Antimicrobial activity against *S. aureus, E. coli*	(Ahonkhai and Ayinde, 2005)
ANTIFUNGAL ACTIVITY		
E. camaldulensis,*E. tereticornis*	Antifungal activity	(Chaudhari *et al*., 1989)
E. globulus	Antifungal effects against three *Candida* species	(Lim and Shin, 2008)
E. citriodora	Antifungal effects against mildew and wood decay fungi	(Su *et al.*, 2006)
INSECTICIDAL ACTIVITY		
E. globulus	Repellent effects against adults *Aprionagermarii, Psacothea*	(Yan and Tan, 1998)
E. citriodora	*hilaris* and *Monochamusalternatus*	(Lucia *et al.*, 2007)
OTHERS		
E. citriodora,*E. tereticornis, E. globulus*	Anti-inflammatory and analgesic effects	(Silva *et al.*, 2003)
E. tereticornis	Relaxant effects on guinea-pig tracheal smooth muscle	(Coelho-de-Souza *et al.*, 2005)

currently encounter a resistance phenomenon on the part of *V. destructor*. *E. amygdalina* is less toxic and has moderate acaricidal property compared to *E. globulus.* The same result was found in the species E. robusta and E. sideroxylon which exhibited a strong acaricidal effect on Varroa and a chemical composition rich in 1,8-cineole, with respective percentages of 65.79% and 40.24%. Thymol is a product whose efficacy in the control of mites is established and that this effect could be potentiated by combining it with local Eucalyptus essential oils (Atmani-Merabet *et al*., 2020). Eucalyptus essential oil is shown to exhibit octopaminergic agonist activity (Rattan, 2010). Eucalyptus EO, which is rich in 1-8-cineol, has proved effective against *V. destructor* (Ghasemi *et al*., 2011). Eucalyptus oil contains citronella which has been shown to cause significant mortality in the tracheal mite (Calderone and Spivak, 1995). Apilife Var® is a product based on thymol, menthol, eucalyptus and camphor, mixed in a matrix of vermiculite. Apilife Var® was significantly more effective (p = 0.002) with a median number of fallen varroa of 95.8% (mean = 95.5%). The results show that Apilife Var® is a product with a considerable acaricide action on varroa infestations, with an even emission of volatiles under a tropical subhumid climate, with no harm to the bee population on the hive (Rodríguez-Dehaibes *et al*., 2017). Eucalyptus oil led to 100% decrease in infection rate. Eucalyptus oil 's dropping off percentage of varroa mites are 28.50% after 24 hours, 74.52% after 48 hours and 56.69% after 72 hours, having an total average percentage of 53.24%. From the above result it is infered that Eucalyptus oil stands in rank after neem oil and thyme oil in dropping off percentage (Mohammed and Fhad, 2022). Using n-butanol (50%), acetic acid (0.5%), ammonia (5%) and eucalyptus oil (50%) alone or in a combination play an important role as baits agent to improve the trapping of oriental hornets which involves in killing of honey bee and honey bee brood (Khodairy, 2008). Treatment with Apistan® was superior but not significantly different that eucalyptus leaves. Treatment with eucalyptus smoke showed the highest mortality of mites (Nazer and Al-Abbadi 2003). Greater wax moth (*Galleria mellonella* L.) is another pest that causes serious worldwide damage to honey bee colonies. Eucalyptus oils caused wax moth mortality at low concentrations, but did not affect colony population growth. Eucalyptus oil (E*ucalyptus* spp.) has eucaliptol as its main constituent and can also effectively control several crop pests, including Alphitobius diaperinus (Pinto Júnior *et al*., 2010) and Spodoptera frugiperda (Souza *et al*., 2010). Eucalyptus oil, and tobacco extract led to wax moth mortality at all concentrations ($P<0.05$). The greater susceptibility of the greater wax moth compared to bees may also be due the larvae having a less developed chitin layer compared to adult individuals, which limits larvae physical protection against eucalyptus oil (Chapman, 2013).

The lack of harmful effects on colony population growth after the application of eucalyptus oils may have been due to reduced exposure to the product because bee larvae remain individually housed within the alveoli (Telles *et al*., 2020).

Eucalytus impacts

Eucalyptus plays an important role in riverbank stabilisation and as fauna habitat, often being dominant tree in riparian communities. It is also used in land restoration activities (Butcher *et al*., 2009). Eucalyptus was introduced with the purpose of providing multipurpose use and rescues the remaining indigenous forests from being destroyed. The greatest positive contribution of eucalyptus is perhaps replacing indigenous species for fuelwood, thereby preventing further degradation of natural forests. Furthermore, certain Eucalyptus species, by quickly producing firewood, would eliminate the causes which frequently may have led to land degradation and desertification (Kenya forest service, 2009). The tree plantations enhance the regeneration by suppressing competitive grass species, and other light demanding species and creating a micro-climate that favors colonization and as "stepping stones" between remnant natural forests and agricultural matrix enhancing seed dispersal (Bayle, 2019). It further noted that, eucalyptus species have effects on the germination, radical and growth of a given crop. This adverse effect is motivated by proper management of eucalyptus plantation. Eucalyptus and water cycle, interaction of eucalyptus with other plants and animals allelopathy effect of eucalyptus and to identify the impacts of eucalyptus on crops, Soil nutrients and soil water (Amenu, 2017). The allelochemicals present in Eucalyptus leaves are quite effective in decreasing the chlorophyll content and cell surviving percentage of *Parthenium histerephorus (*Kohli *et al.,* 1988).

Eucalyptus impacts in hydrology

It has also a harmful effect on the environment and ecology by draining water resources; it enhances soil erosion, suppresses undergrowth, depletes soil nutrients and allopathically affects nearby agricultural crop. Eucalyptus is a well-known forest species of high water uptake ranging from 50 Lt/d/plant to even 90 Lt/d/plant, depending upon the adequacy of supply. But, it is also reported that, in stress situation, its roots can grow even up to 20-30 feet and extract more water. Borewells near Eucalyptus are generally deeper as it obsorbs more water (Joshi and Kuppannan, 2011). The effect of Eucalyptus species on water reserves depends on root architecture, root depth, leaf area, age, climatic conditions and management regime (FAO, 2011). Eucalyptus roots can grow even up to 6-9 m in stress conditions and extract more water. Indeed, Roots of some species can grow to 30 m in depth and extract the ground water (FAO, 2011). Nilgiris (Blue mountains) in Western Ghats (hilly ranges) of South India that forms substantial part of catchments to rivers Moyar and Bhawani. A number of reservoirs have been constructed on Moyar and Bhawani rivers for hydroelectric power generation and irrigation, contributing about 40% of the total hydro-electric power generated in the State of Tamil Nadu. There is a rising concern of Eucalyptus tree causing effect to ground water in the Nilgiris region (Sikka *et al.,* 2003). Preliminary observations indicate that plantations of *Eucalyptus camaldulensis* (a phreatophytic species commonly grown in the region) often cause localized drawdowns of water tables and a net flux of shallow, saline groundwater from surrounding grasslands or relatively deep in the soil (Jobba´gy and Jackson, 2004). It was also found that transpiration by roots is the main cause of decrease in groundwater in the day time, while increase in groundwater in the night time is due to Darcian flow or upwelling of deeper sources caused by the pressure of the shallower aquifers. When transpiration rates in grassland communities are expected to decrease with increasing water stress and senescence, deeprooted trees such as Eucalyptus spp. May have the most impact on local water tables and hydrologic balance (Engel *et al.,* 2005). In some places though the Eucalyptus trees deplete the groundwater upto a certain extent farmers continue to grow it as it gives quicker yield of wood biomass for fuel, construction and cash. Impact of Eucalyptus on soil properties and moisture are limited to great extent to 20m away from the tree. Since *Eucalyptus* spp. are fast growing, and deep and dense rooted, the reduction and drying out of previously functional water stores nearby in the watershed is a result of its great water suction ability in addition to it causing water repellency in the soil and poor undergrowth, both reducing infiltration and the water table. Crops (maize and undergrowth) should be cultivated at distances greater than 15 - 20 m from Eucalyptus stands (Chanie *et al.,* 2013). Higher CO_2 concentration may cause a partial stomatal closure (Table 3) and, consequently, a reduction of stomatal conductance and transpiration, resulting in higher water use efficiency by plants (Ainsworth and Long, 2004, Ainsworth and Rogers, 2007).

Table 3. Stomatal frequency (number mm^{-2}) in the leaves of Eucalyptus species

Species	Abaxial side	Adaxial side
E. *urophylla*	365±13	148±8
E. camaldulensis	248±11	184±10
E. pellita	304±19	Nil
E. tereticornis	241±9	216±7
E. deglupta	484±21	Nil
E. brassiana	199±4	159±8

(Kallarackal *et al.,* 2002)

Conclusion

Eucalyptus, its evolution from Protoeucalytus was studied which gives a basic idea about its nature. Characteristics of Eucalyptus tells us about the functioning of the plants, its morphology etc. The main component of the Eucalyptus which is its oil, which is categorised as an Essential oil(EO) is studied in detail. Its benefits in bee keeping and various other benefits are discussed in a detailed manner, which sheds light on the future oppurtunities of using Eucalyptus oil in bee keeping. This review paper also talks about the rising concern of eucalyptus tree's impact in the ground water table, which led to the banning of it in the southern states of india. The reason behind the banning is that, the roots of the tree has an highly effective growing in search of water which results in negative impact on the nearby plants and ground water level. Eucalyptus which has a direct impact in most of our day to day needs both in a positive way and negative way in which,

positive way is far ahead.

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