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# ESSENTIAL OILS AS A SOURCE OF BIOPESTICIDE IN MUSEUM PEST MANAGEMENT: A REVIEW

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## ABSTRACT

To manage the pest population, synthetic chemicals were used, but these substances are unsafe due to their carcinogenic side effects. Using alternative sources that are healthy for the environment and humans is crucial to preventing biodegradation. Essential oil products are organic materials having insecticidal properties that are used to control insects in a variety of industries. These substitutes are effective pesticides and suffer significantly fewer negative consequences. Insecticidal plant species are being promoted by researchers who are searching for new sources of natural pesticides. The current study focuses on research on pesticides, including its socioeconomic effects and sustainability in the essential oil industry. Termites are repelled by poppy seed essential oil and its toxic components. As an anti-microbial, fungicide, insecticide, insect repellant, herbicide, acaricidal, and nematicidal agent, *V. zizanioides* essential oil is employed. The essential oils of *T. vulgaris*, *R. officinalis, C. flexuosus,* and *S. aromaticum* are well known for their pesticidal properties. *M. piperita* repels ants, flies, lice, moths, and silverfish. Additionally, *M. spicata* and *O. basilicum* are effective fly deterrents. Also helpful against a range of insects include *J. Virginiana, A. vulgaris, M. leucodendron, P. roseum, L. angustifolia, M. piperita* and *M. angustifolia* essential oils. Neem trees were also studied for their potential as an insecticide, fungicide, repellant, etc.

**Keywords**: Essential oils, Insecticide, Anti-microbial, Fungicide, Insect repellant, Herbicide, Acaricide, and Nematicide

## Introduction

The growing usage of chemical pesticides for pest management is a very serious matter. Due to their toxicity and potential explosion threats for curators, scholars and the general public, these procedures were not safe. The use of synthetic chemicals has been restricted by the government due to their carcinogenicity, high and acute toxicity, long degradation durations, environmental pollution and adverse effects on materials and users, whereas traditional methods were not previously used for the protection and preservation of collections (Unnikrishnan and Nath, 2002; Xavier *et al.,* 2004; Feng and Zheng, 2007). The usage of botanical pesticides like essential oils has grown recently due to environmental concerns and insect populations that are resistant to chemical insecticides (Ayvaz *et al*., 2008). These essential oils are naturally occurring biocides that are derived from different medicinal plants (Isman, 2000). There are about 3,000 known essential oils, and about 300 stand out for their significant role in different industries like pharmaceuticals, fragrance and cosmetics (Bakkali *et al.*, 2008), in addition to having pesticidal potential (Chang and Cheng, 2002). These essential oils are insecticide control agents with a strong odour as are their volatile natural secondary metabolites among higher plants (Bruneton, 1999). According to Roger et al. (2012), these essential oils are made up of hundreds of different chemicals and combinations, each of which has distinct physical, chemical, and biological properties. Additionally, oleoresins can be produced from the extraction of aromatic plants using organic solvents; superior, solvent-free extracts can be produced using carbon dioxide, while the simpler method of essential oil extraction is steam distillation. The volatile essential oils and nonvolatile flavour components created by the organic solvent extraction of the essential oils are used extensively in the food, agricultural and medicinal industries (Roger *et al*., 2012). Due to their quick environmental degradation and higher selectivity that benefits beneficial insects, essential oil and the compound derivatives are regarded as an alternate method of eliminating numerous dangerous pests (Pillmoor *et al*., 1993).

These essential oils from plants were widely employed in the food and fragrance industries as flavours and scents. They were also well-known for their ability to ward off insects. Plant essential oils have been the subject of extensive research by scientists, who discovered that these compounds not only serve to ward off pests but also have certain insecticidal properties. The middle ages saw extensive usage of essential oils for parasitic, fungal and insecticidal purposes. Researchers discovered that a chemical made from fragrant herbs had insect-repelling qualities. They also showed that these substances have larvicidal and antifeedant properties (Adebayo *et al*., 1999; Larocque *et al*., 1999; Gbolade, 2001). In this review article, we summarize that the uses of several essential oils as pesticides and its impact on environment.

## Essential oil as insecticide

There is a dearth of research on the physiological effects of essential oils on insects, but when certain essential oils or their constituents are used to treat insects, they produce symptoms that point to a neurotoxic mode of action (Coats *et al*., 1991; Kostyukovsky *et al*., 2002). However, a number of studies have examined the possible utility of essential oil treatments in biological control of several insect pests.These natural compounds may dissolve in the environment more quickly than essential oils, and some of them have higher selectivity that benefits good insects (Pillmoor *et al*., 1993). The use of natural derivatives is thought to be an alternative method for eradicating dangerous lepidoptera larvae. Their ovicidal and antifeeding actions have been proven by recent research (Bathal *et al.,* 1993) their ability to stall growth, prevent adults from emerging and result in egg death (Marimuth,1997) their arrestant and repellant function (Naumann, 1995), as well as their deterrent effects on oviposition (Landolt *et al*., 1999). The use of controlled-release substances allowing for the more efficient use of lesser doses of pesticide over a specified period of time demonstrates good decision-making to satisfy several requirements for efficacy, suitability to mode of application and minimization of environmental damage (Kydonyeus, 1980). According to the findings, the tested oils (*Thymus herba-barona* Loisel, *Rosmarinus officinalis L, Myrtus communis L, Eucalyptus globules* Labill, *Salvia officinalis L, and Helichrysum italicum* (Roth)) have intriguing larvicidal effects that make them suitable for use in integrated control strategies. Ants, cockroaches, bedbugs, headlice and moths can all be repelled by the compounds in the roots of vetiver grass (Handerson *et al*., 2005). Additionally, vetiver oil and its components are poisonous and repellant to termites (Ibrahim *et al*., 2004). The chemicals made from vetiver oil have a variety of insecticidal properties and are safe for the environment. Vetiveria plant components are also utilized as a natural insecticide and in traditional medicine (Sujatha, 2010). According to Batish et al. (2008), the biological activities of eucalyptus *Vetiveria zizanioides* essential oil include anti-microbial, fungicidal, insecticidal, insect repellant, herbicidal, acaricidal and nematicidal action. Pesticidal qualities are well-known for the essential oils of thyme (*Thymus vulgaris*), rosemary (*Rosmarinus officinalis)*, vetiver, lemongrass (*Cymbopogon flexuosus)*, and clove (*Syzygium aromaticum*). Ants, flies, lice, moths, and silverfish are all deterred by peppermint *(Mentha piperita*) (Nasrin *et al.,* 2022). It also works well to repel flies to use basil (*Mentha spicata*) and spearmint (*Ocimum basilicum*). Along with this, *Juniperus virginiana, Artemesia vulgaris, Melaleuca leucodendron, Pelargonium roseum, Lavandula angustifolia, M. piperita,* and *Melaleuca angustifolia* essential oils are also efficient against a variety of insects (Kordali *et al.,* 2005). The volatile oil components of *Mentha* species, on the other hand, successfully combat the common stored grain pests *Callosobruchus maculates* and *Tribolium castanum* (Tripathi *et al.,* 2002). Additionally, it has been discovered that lemongrass and eucalyptus oil work well as insecticides, miticides, antifeedants and animal repellents (Mohan *et al*.,

2011). There are numerous essential oils with diverse pest control properties, including those from *Cedrus* species, *Piper* species, *Cymbopogon citratus, Lavandula angustifolia syn L. officinalis, Tanacetum vulgare, Rabdosia melissoides, Acorus calamus, Eugenia caryophyllata, Ocimum* species, *Gaultheria procumbens, and Bunium persicum* (Mohan *et al*., 2011). Since ancient times, citronella (*Cymbopogon winterianus*) essential oil has been utilized as an animal and insect repellant. Citronellal, the primary monoterpene ingredient of citronella oil, has been primarily responsible for larvicidal efficacy (Mohan *et al*., 2011). When placed in closets, drawers, chests and vetiver root essential oil is known to shield clothing and other priceless items from insect attack. The essential oils from the rhizomes of *Zingiber officinale* and *P. cubeba* berries both have insecticidal and feeding-resistance effects on *T. Castaneum* and *S. oryzae* (Chaubey, 2012). Since ancient times, aromatic plants and their essential oils have been used for flavour and fragrance, as a spice or condiment, in medications, as antimicrobial/insecticidal agents, and to ward off pests in areas where stored goods are protected (Theis *et al.,* 2020). These provide useful substitutes for synthetic pesticides without having a negative impact on the environment (Dorman *et al.,* 2000; Bakkali *et al*., 2008). However, efforts to describe their pest control activity in vitro began in the 1900s (Theis *et al*., 2003). Furthermore, due to their contact insecticidal and fumigant properties as well as the less onerous regulatory approval processes for their investigation as a result of their long history of use, essential oils are gaining more and more attention on a daily basis (Isman, 2000). These essential oils are being tested as prospective options for managing insect and disease outbreaks as well as weeds (Isman, 2006; Bakkali *et al*., 2008). It is primarily due to the fact that essential oils are simple to extract, environmentally friendly because they are biodegradable and easily metabolized in the environment, do not persist in soil and water (Bakkali *et al*., 2008), have low to no toxicity toward vertebrates like fish, birds and mammals (Mishra *et al*., 1997), and are crucial for protecting plants from pests (Bakkali *et al*., 2008). In China, *Cacopsylla chinensis* is a significant pest of pears, and the hydrodistillation procedure used to produce the clove buds' essential oil, which shown insecticidal and repellant properties to manage this pest (Enan, 1998; BaoliangTian *et al.,* 2015). The ingredients 1, 8-cineole, citronellal, citronellyl acetate, pcymene, eucamalol, limonene, linalool, pinene, terpinene, terpineol, alloocimene, and aromadendrene are responsible for the pesticidal activity of eucalyptus oils (Fooley *et al*., 2015). The componenteucalyptus essential oilsconstituents work together synergistically to produce overall pesticidal efficacy (Maden, 1996). One of the most significant eucalyptus oil constituents is 1, 8-cineoles, which is also a distinctive compound of the genus *Eucalyptus* and is largely responsible for a number of its pesticidal qualities (Cimanga *et al*., 2002). To defend against mosquitoes and other dangerous arthropods, eucalyptus oil exhibits its effectiveness as a natural insect repellent,

and also has an antifeedant effect on herbivores. According to (Yang *et al.*, 2004), the main monoterpene 1, 8-cineole and essential oils from *E. globules* were harmful to human head lice. Essential oils and 1, 8-cineole, one of its main components, had greater pediculicidal action than commercially available pediculides such as deltaphenothrin or pyrethrum (Batish *et al*., 2006). Therefore, the creation of novel products for the management of human head lice may include essential oils (Yang *et al*., 2004). Additionally, eucalyptus oil has been employed as an antifeedant particularly against biting insects (Caferino *et al*., 2004). According to Trigg, (1999a), products used by humans as insect repellant can shield users from biting insects. *E. globulus* essential oil is harmful to *Aedes aegypti* larvae, as was shown by (Lucia, *et al*., 2007). It has been demonstrated that eucalyptus oils high in cineole are effective against the varroa mite, a significant honey bee parasite called *Varroa jacobsoni* (Calderone *et al*., 1995). According to Choi et al. (2004), eucalyptus essential oils can be used as a natural acaricide to control *T. urticae*. The essential oils from *E. citriodora, E. globulus* and *E. staigeriana* were tested for their biocidal activity against the tick *Boophilus microplus* by Chagas et al. (2002). They concluded that these oils could be used as an environmentally and ecologically safe acaricide. Gardulf et al. (2004) demonstrated that the commercially available product Citriodiol-1, which is based on eucalyptus essential oil, significantly reduced the number of tick bites on humans and concluded that it could be used to reduce tick-borne diseases. According to Irwine (1995), sweet basil (*Ocimum basilicum*) may have pesticide properties. Essential oils from basil that deter, poison, or prevent the growth of several insects (Grainge *et al*., 1988). Eugenol, which has been demonstrated to have a potent mosquito-repelling effect, is the main component of the essential oils from the basil plant (Choge *et al*., 1981). Another terpene present in basil called linalool is poisonous to pests that live in storage spaces (Weaver *et al*., 1981). Hassan Ali et al. (1998) showed that a wide variety of insect species are impacted by essential oils. When used against *R. dominica* and *T. castaneum*, *Laurus nobilis* essential oil was found to be poisonous (Ben Jemba *et al*., 2012). The primary constituent of clove buds was 2-methoxy-4-(2-propenyl)-phenol, which made up 83 percent of the total and trans-caryophyllene, which made up 12 percent, was the second most prevalent constituent. Testing for toxicity and repulsiveness against *R. dominica, S. oryzae*, and *T. castaneum* was conducted using these two pure chemicals and clove oil (Zeng *et al.,* 2010).

**History of Essential Oil as Pesticide and Insecticide**

After a long period of time, the history of essential oils was known. In comparison to manufactured pesticides, certain plants have demonstrated insecticidal and caricidal properties (Bell *et al.,* 1990; Sahayaraj *et al*., 2000). Many plants and plant extracts have been known to have pesticidal properties since the first half of the 20th century. Natural products, however, lost their significance after the Second World War as a result of the development of synthetic organic

substances. The concentrated nature of the organic compounds is what causes them to have a strong knock-down impact on pest species in compared to other pesticides in the 1950, these compounds produced good results (Berger, 1994). The use of DDT other acutely hazardous organophosphorous chemicals has negative long-term impacts on the environment and people. In 1988, it was predicted that 600000 metric tonnes of pesticides were consumed annually in developing nations, with a sharp growth of 184% between 1980 and 1984 (WHO, 1990). But after some years, it started to show interest once more in plant products with pesticidal qualities (Jacobson, 1975; 1971). It was first observed that some plants protect themselves more effectively than others. A few thousand years ago, scientists believed that neem trees, which are members of the Meliaceae family, were pesticides (Philogene, 2005). The most promising plant now employed for pest control is the neem tree. This sacred tree is used in India for a variety of purposes, including shade, building poles, tooth sticks, and insecticides (National research council, 1992). After that, numerous investigations into the neem trees ability to repel pests were conducted (Schmutterer, 1981). Toward the end of the nineteenth century, it was thought to be poisonous (Whittaker, 1971). As time goes on, the use of botanical pesticides rises steadily and is regarded as one of the most environmentally friendly and safest methods available.

**Conclusion**

The greatest technique to eradicate insect pests is by using essential oils. With regard to a variety of insects, they exhibit insecticidal, fungicidal, and repellent properties. These are sophisticated chemical compounds having many mechanisms of action that increase their activity through the interaction of their constituent parts. Because of their flammability, essential oils are utilized as food pest fumigants and in agriculture as fumigants. The essential oils have strong anti-insect activity, and the things they've been applied to exhibit no hazardous residues. Last but not least, products made with essential oils have low toxicity, are quickly broken down, and are environmentally beneficial.

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