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Essential Oil - A Potential Green Pesticide

Abhay Kumar Mishra*[1], Digvijay Singh[2], Pragya Bharti[3] and Kumar Chiranjeeb[4]

[1]Dept. of Plant pathology, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar (848 125), India

[2]Dept. of Plant Breeding and Genetics, Bihar Agricultural University, Sabour, Bhagalpur (813 210), India

[3]Dept. of Plant pathology, I.A.S. Banaras Hindu University, Varanasi, Uttar Pradesh (221 005), India

[4]Dept. of Soil Science, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar (848 125), India

Abstract

Many plants are known to synthesize a large number of aromatic and volatile compounds consisting mainly of secondary metabolites which are known to play an important role in their defence mechanism. These aromatic and volatile fractions are known as Essential oil (EO). At present more than 3000 Essential oils has been identified from different plants species. The use of essential oil is not new to mankind. Traditional medicine system such as Ayurveda contains detail description about its uses against many human ailments such as use of cinnamon, ginger and sandal wood for healing purposes. Apart from this, EO has been reported to be an important component of food and cosmetics throughout the world.

Introduction

Essential oils are produced by aromatic plants which are obtained by various processes such as steam distillation, solvent extraction, soxhlet extraction, solid-phase micro-extraction and hydro-distillation. Various plant parts such as leaves, seeds, roots, flowers, barks and buds are known to synthesize these oils which are finally stored in the secretory cells or glandular cells of the plant. They are highly soluble in organic solvents. These oils mainly consist of mixture of secondary metabolites in various proportions. Approx 20 to 60 different types of chemicals are known to be present in these oils. The biological properties of EO are greatly influenced by the presence of those bioactive compounds whose concentration is significantly more than the others.

Plant species	Major components
Zingiber officinale	α-Zingiberene and β-sesquiphellandrene
Pine pinea	Limonene, α and β-pinene
Mentha piperita	Menthol and menthone in
Eucalyptus globules	α-Pinene, 1, 8 -cineol
Syzygium aromaticum	Eugenol and β-caryophyllene
Citrus lemon	Limonene and β-pinene
Cymbopogon nardus	Citronellal and linalool
Azadirachta indica	Eicosane, Geraniol and Citral

All these compounds however can be grouped into two major classes- Terpenes haydrocarbons (monoterpenes and sesquiterpenes) and Oxygenated compounds (alcohols, Phenols aldehydes and easters). The composition of these compounds however depends on the method employed for their extraction and parts of the plant used.

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Corresponding Author

Abhay Kumar Mishra

e-mail: abhaymishra1001@gmail.com

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E-mail: *bioticapublications@gmail.com*

Properties of Essential Oil

The biological activity of EOs depends on the type and concentration of constituents present in it such as Monotepenes, sesquiterpenoids, benzenoids and phenylpropanoid. They have been found to posses' anti-inflammatory, antioxidant, anti-carcinogenic and antimicrobial properties. Tea tree oil has been shown to reduce inflammation and speed up the healing process of wounds. It has also shown its ability *in-vitro* to help in differentiation of monocytes which help to fight against infection. EO obtained from *C. limettiodes* inhibited colon cancer (SW480) by causing cell-apoptosis (Jayaprakasha *et al*., 2013). It has ability to prevent oxidation of virgin olive oil in storage. Due to such properties, EO is widely used in pharmaceutical and food industry.

Essential Oil against Plant Pathogens

Presence of essential oil in many aromatic plants has drawn the attention of many researchers to understand its role in plant physiology. The discovery of antimicrobial property of EO confirms its active role in plant defence system. This property has attracted many researchers to explore its possibilities in managing plant diseases as an alternative to synthetic pesticides.

The negative effect of synthetic pesticides triggered more attention towards Biological control which employed beneficial organisms (entomopathogenic fungi, entomopathogenic nematodes, predatory insects, beneficial soil microorganisms) and products against harmful pests. Biological products derived from living organisms (microorganism or plants) also falls in this category (*Bt*., Plant oils, Essential oils, chitosan, seaweed extract).

EOs has shown remarkable antifungal, antibacterial and insecticidal properties in many experiments. EO obtained from *Schinus terebinthifolius* significantly inhibited the growth of many phytopathogenic bacteria *in-vitro* especially G+ bacteria. *Citrus aurantium* EO have been found to be effective against *Erwinia amylovora* and *Agrobacterium tumefasciens*. Many researchers claim that EOs can also be helpful in managing serious pathogens such as *Fusarium* spp. and *Botrytis cinerea*. EO from fennel has been found effective against *B. Cinerea*. EO extracted from lemongrass, clove, oregano were effective against *Aspergillus* sp. *Phytopthora infestans* have been shown to be affected by *Citrus sinensis*, *Citrus Lemon* and *Citrus bergamis* EO. Mentha piperita EO has been found to be effective against *Rhizoctonia solani* and *Microphomina phaseolina* (Abdolahi *et al.,* 2011).

In some European countries, various plant derived EOs have been registered as biocidal such as *Juniperus Mexicana*, *Mentha arvensis*, *Piper nigrum*, *Cinnamomum zeylanicum*, *Citrus aurantifolia* and *Ferula galbaniflua*. Some of the commercial products available in European countries are- BIOXEDA (Clove EO), BIOX-M (*Mentha spicata* EO) and ESSEN'CIEL (Sweet orange EO).

Mode of Action Essential Oil

Studies conducted by many researchers suggest that EOs act on the cell membrane of the pathogens which cause leakage of macromolecules and ions resulting into lyses of the pathogen (Bakkali *et al.,* 2008). Many EOs restrict the spore germination and mycelia growth of fungal pathogens to prevent its further infection. The lipophilic nature of the many bioactive components present in EO might interfere with plasma membrane of fungi resulting in lyses of hypha. Further studies have confirmed its role in inhibiting cell wall formation, inhibiting cell division, affecting mitochondria functions, inhibiting ergosterol synthesis and protein synthesis.

Limitations of Essential Oil

The exact mechanism of interaction between pathogens and EO is still not fully understood. This creates a suspicion on its activity. EOs exhibit phytotoxic effects on some plants. The symptoms include - chlorosis, stunting and leaf burning. Studies suggest that EO interfere with the mitosis, respiration, ion exchange and chlorophyll synthesis. The stability of EO in the field condition is also major hindrance towards its adoption. Limited research is available regarding its field performance. They are known to degrade easily under light and temperature. Registering a commercial green pesticide require many time consuming and costly studies on its effect on environment and health which also hinders its commercialisation. Long term effect on non target organism is still unknown.

Future Prospects

More focus should be given to establish EO as reliable, safe and efficient alternative of synthetic chemicals. New technologies should be tested such as - micro encapsulation or nano encapsulation to increase its stability and long lasting effects. Research related to its long term effect on human health and environment should be encouraged. Farmers should be assured of its effectiveness and encouraged to adopt non-synthetic chemical control methods.

Conclusion

The properties of EO have fascinated many researchers to explore its possibilities in diverse areas. EOs has shown interesting results *in-vitro* condition. However still more researches are needed to show its efficiency in field condition but initial results suggests that it could become a potential alternative of synthetic chemicals in agriculture.

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