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In Vitro Antifungal Efficacy of Some Essential Oils Against Storage Pests

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ABSTRACT: Antifungals are medicines that kill or stop the growth of fungi (the plural of fungus) that cause infections. They are also called antimycotic agents. Essential oils are the extracted and distilled oils of different plants. These oils contain the chemical compounds that characterize and support the life cycle of the plant. Essential oils are natural substances with powerful properties. The essential oils of herbs and spices are some of the most powerful antimicrobial Trusted Source essential oils. Thyme, cinnamon, oregano, clove, and mint are all examples of these kinds of oils. Citronella, geranium, lemongrass, eucalyptus, and peppermint, among others, have been tested Trusted Source specifically against fungi and found to be effective antimicrobials for that purpose. Tea tree oil is another essential oil that has demonstrated Trusted Source antifungal capabilities. Native Australians conventionally used tea tree oil as an antifungal and antibacterial, and it's used today for the same purposes.

KEYWORDS: antifungal, essential oils, storage pests, in vitro, antimycotic, infections, storage, pests

I. INTRODUCTION

Coconut oil has both microbial and antifungal properties. Turmeric has numerous health benefits, including antibacterial and anti-inflammatory properties. It's also an effective antifungal that inhibits growth. Aloe vera has long been used as a natural remedy for both bacterial and fungal infections, and ringworm is no exception. Oregano essential oil may be a more powerful antifungal than other commercial products that are available. Lemongrass oil extract, and to a slightly lesser extent lemongrass tea, both have antifungal properties. Licorice has strong antimicrobial properties, and research has found that the extracts of licorice could be used as alternative treatment for fungal infections.[1,2]

A variety of essential oils have been shown to have antifungal properties, and some are particularly recognised for their usefulness in treating fungal infections and preventing the growth of bacteria. They can be used for health purposes and may have other uses too, such as preventing diseases in agriculture.

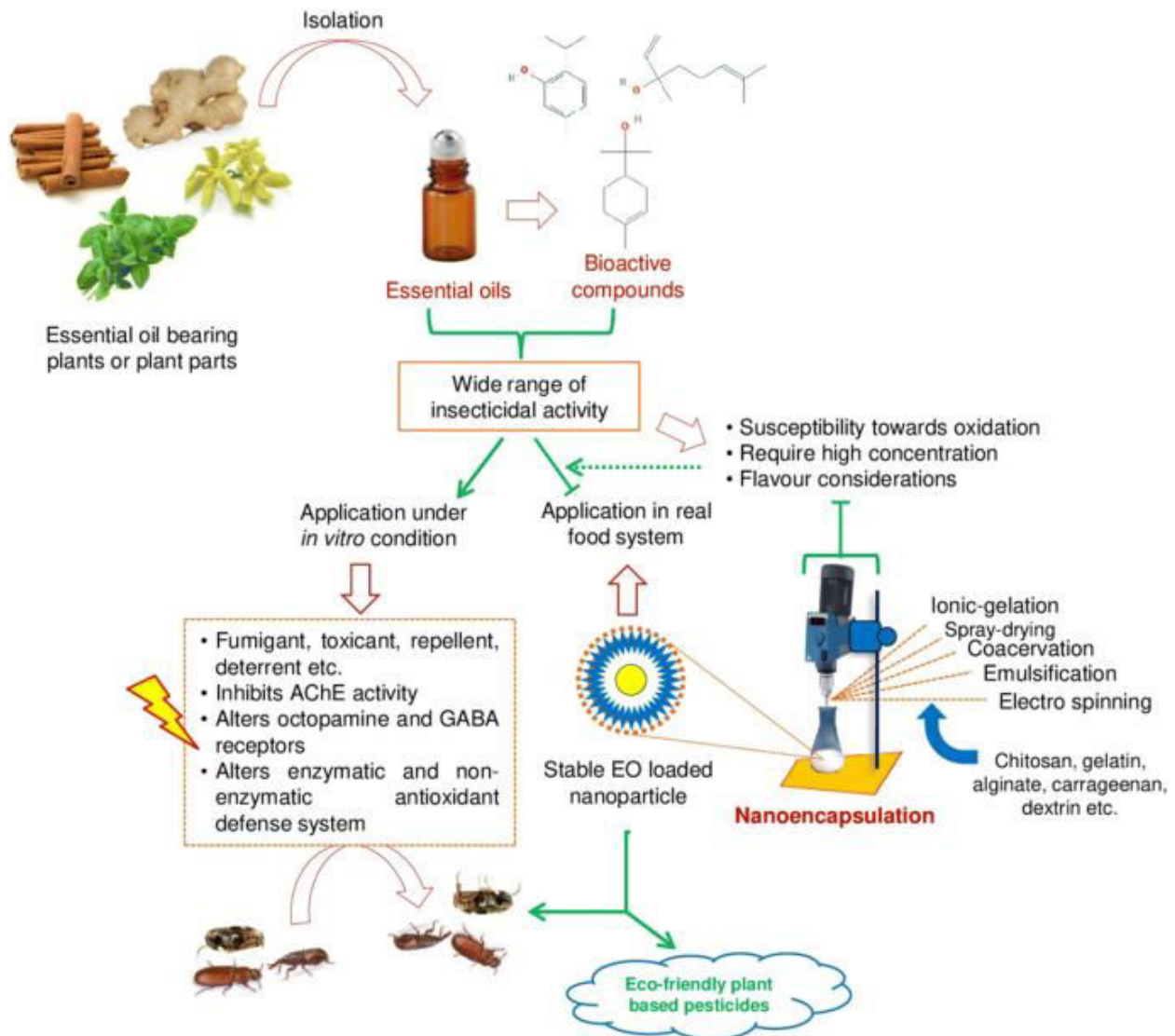
- Thyme oil – thyme oil is rich in thymol and carvacrol, which have been shown to help combat fungal growths and infections. Other related oils from the same plant family include oregano oil and rosemary oil.
- Tea tree oil – tea tree essential oil has anti-inflammatory and antibacterial effects, and can also be used for antifungal purposes. Eucalyptus oil, coming from the same plant family, can also be used against fungi.[3]
- Peppermint oil – peppermint is known for a number of medicinal qualities and has been proven to have antifungal properties too.
- Clove oil – clove is used as pain relief and an antibacterial, often for dental problems, but its antifungal ability has also been shown to be effective.

Various packaging options are available for essential oils to make their storage and application simple. Some of the packaging types that are suitable include glass dropper bottles, rollette bottles, and roller balls in plastic and metal. These different options each offer advantages to make essential oils a convenient treatment and prevention tool for fungal infections.

Metal roller balls offer the benefit of both soothing the skin with the cool metal while applying the essential oil formula. Sprays and rollers give you control over application and make it quick and easy to use essential oils. Glass dropper bottles are ideal for pure essential oils, which can then be mixed with carrier oils for easier delivery.[4,5]

Antifungal essential oils can be formulated and packaged in multiple ways to provide consumers with the best experience.

Given the worldwide use of essential oils in various industries, oils from many species are available in abundance. Their major constituents are either well-characterized or are themselves available in a relatively high degree of purity. Thus, the major barrier to their use as pesticides may be government approval, but in the United States, several plants and their derivatives are exempt from registration owing to their widespread use in foods. This chapter discusses the chemistry of plant essential oils, their biological activities in arthropods and fungi, and their potential as botanical pesticides in commercial practice. Pesticides based on plant essential oils or their constituents have demonstrated efficacy against a range of stored product pests, domestic pests, blood-feeding pests, and certain soft-bodied agricultural pests as well as against some plant pathogenic fungi responsible for pre- and post-harvest diseases. They may be applied as fumigants, granular formulations, or direct sprays with a range of effects from lethal toxicity to repellence and/or oviposition deterrence in insects.[6,7]



II. DISCUSSION

A storage pest is an insect or other animal that damages or destroys stored food or other stored valuable organic matter.^[1] Insects are a large proportion of storage pests with each type of crop having specific insects that gravitate towards them such as the genus *Tribolium* that consists of insects such as *Tribolium castaneum* (red flour beetle)



or *Tribolium confusum* (confused flour beetle) which damage flour crops primarily. Crops can be completely destroyed or even partially damaged affecting the quality of the crop and the ability to germinate new ones, by decreasing the protein content and removing the seeds from the grains. There are two types of grain insect pests, primary and secondary pests.[8]

Primary pests

Primary grain pests attack the whole grain. The eggs are laid inside the grain, before the larvae mature inside the grain and then chew their way out. Some of these pests include the Lesser grain borer, Granary weevil (*Sitophilus granarius*, the Wheat weevil) and Rice weevil (*Sitophilus oryzae*).^[3]

Lesser grain borer (Rhyzopertha dominica)

The lesser grain borer has a dark coloured cylindrical structure with the head concealed.^[4] When lesser grain borer eggs are laid, they are laid outside the grain, however they mature inside the shell of the seed which can take up to 6 weeks if the temperature is cooler, with the adult borers not living for longer than two months. This species is known to damage stored wheat, maize/corn and other cereal crops with the seeds becoming hollowed out husks. Products with small infestations should be discarded however the grains can be treated with smaller amounts of spray. However, large infestations require more control, including complete fumigation.

Rice weevil (Sitophilus oryzae)

The adult rice weevil has an orange-black exoskeleton and lays up to 450 eggs in pores of the damaged grains with each hatched egg further damaging the grain from the inside. Similarly to the lesser grain borer, maturation also happens inside the grain with the matured adult rice weevil eating through the husk of the grain to get out. The life cycle is similar to that of the lesser grain borer in summer months (approximately one month) and adult weevils live up to 8 months after the experience their life cycle.^[3]

Secondary pests

Secondary grain insects feed on broken grain and any powder products left as a result of the broken grain. These pests include the genus *Tribolium*, beetle species and moth species.

Rust-red flour beetle (Tribolium castaneum)

The Red flour beetle or Rust-red flour beetle is a red-brown beetle with an exoskeleton that darkens in colour as the beetle increases in age, with the maximum adult age being a year. Unlike primary pests, Rust-red flour beetles can produce up to 1000 eggs and lay them inside the damaged grain with parts of the larvae able to use the damaged grains and cereal as their food source.^[3]

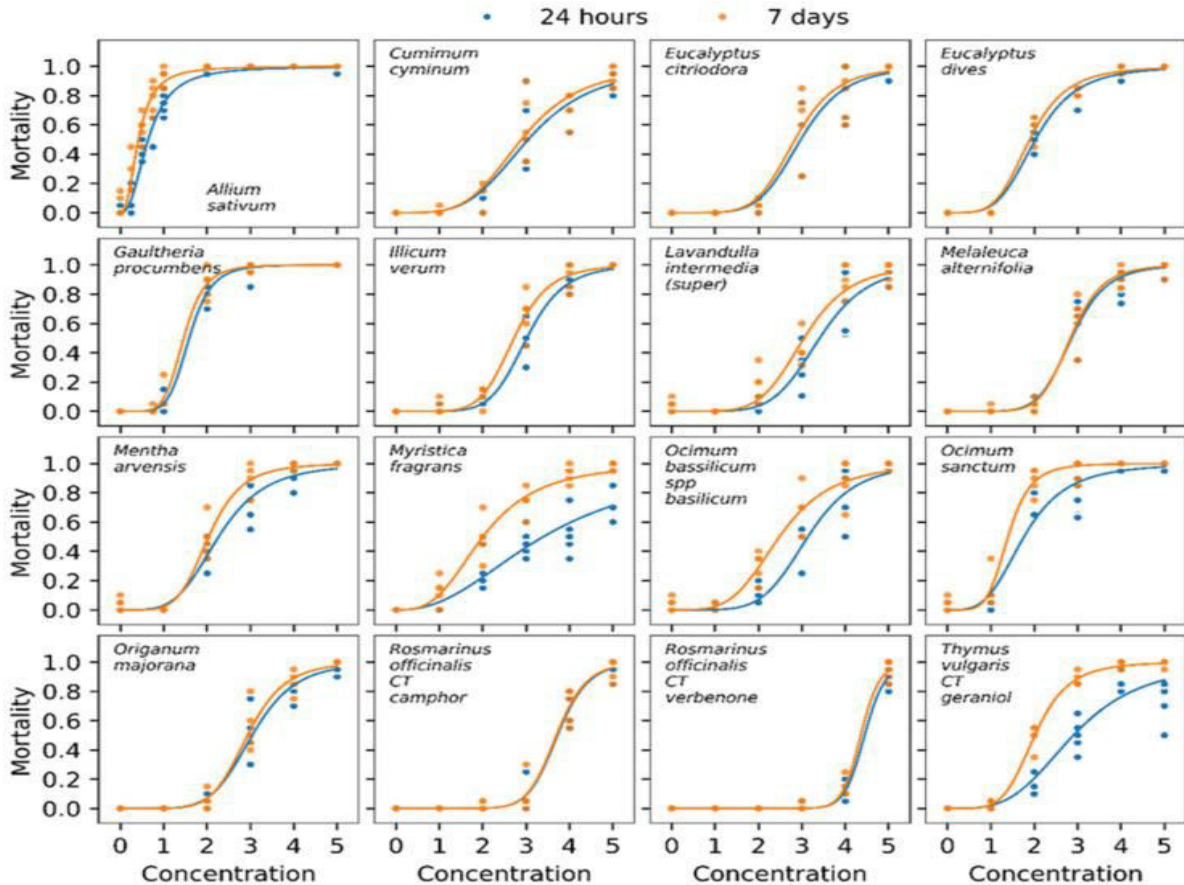
Warehouse moth (Ephestia elutella)

The Warehouse moth is a grey moth that remains on the surface of the grain with the female moth laying up to 200 eggs, however their life span is only 2 weeks long with a 4 week life cycle. Similarly to other secondary pests, the Warehouse moth eggs use the surface of the grain, although when the larvae hatch they leave a stream of silk that encapsulates the surface of the grain which can then be used as a cocoon for mature larvae.^[3]

In a study, the granary weevil *Sitophilus granarius* is a stored product pest found worldwide. Environmental damages, human health issues and the emergence of resistance are driving scientists to seek alternatives to synthetic insecticides for its control.[19] With low mammal toxicity and low persistence, essential oils are more and more being considered a potential alternative. In this study, we compare the toxicity of 25 essential oils, representing a large array of chemical compositions, on adult granary weevils. Bioassays indicated that *Allium sativum* was the most toxic essential oil, with the lowest calculated lethal concentration 90 (LC90) both after 24 h and 7 days. *Gaultheria procumbens*, *Mentha arvensis* and *Eucalyptus dives* oils appeared to have a good potential in terms of toxicity/cost ratio for further development of a plant-derived biocide. Low influence of exposure time was observed for most of essential oils. [9,10] The methodology developed here offers the possibility to test a large array of essential oils in the same experimental bioassay and in a standardized way. It is a first step to the development of new biocide for alternative management strategies of stored product pests.[17,18]

III. RESULTS

According to a study, Calculation of mortality curves was realized for 24 h and 7 days treatment (Fig.1) indicates the LC90 after 24 h and 7 days for these 16 essential oils tested.



Garlic essential oil has been identified as the most toxic oil with a LC90 two to four times lower than other EOs, probably because of its content in sulfur compounds.[11,12]

Toxicity on the target pests is a first step for any kind of new pesticide elaboration. However, in the perspective of a potential utilization of essential oils in an industrial context, it is also essential to focus on some other aspects, such as the price, the wheat deterioration or the mammal toxicity to determine their actual industrial potential. Concerning mammal toxicity, the WHO classification ranked compounds from “extremely hazardous”[15,16] to “unlikely to present acute hazard” based on the concentration in mg/kg that provoke 50% of mortality in rat (WHO, 2009). Concerning *A. sativum*, diallyl trisulfide is ranked as “unlikely to present acute hazard” while diallyl disulfide is considered as moderately hazardous with an oral LD50 (rat) of 260 mg/kg. Even if this toxicity is two to four times lower than deltamethrin currently used in granaries, it remains to be carefully considered in the case of a conception of healthy and ecofriendly alternatives to insecticide.[13,14]

IV. CONCLUSIONS

Experiments should also be carried out at a larger scale, such as experimental granaries, with the purpose of estimating the quantity of oil per ton of wheat needed and thus the practical applicability of these treatments. Indeed, under mass

storage conditions, the application of essential oils during the grain filing process in the silo is based on nano-drop pulverization which could greatly increase the evaporation of the product. Considering insecticidal effects, prices, availability and mammal toxicity of essential oils tested, *M. arvensis*, *E. dives* and *G. procumbens* can be considered as good potential alternatives to the synthetic pesticides presently used to control grain weevils. As essential oils are products of very variable composition, studies must be performed to clearly identify the compound(s) responsible of the insecticidal toxicity of these three essential oils to avoid variable responses to future treatments. More investigations need to be done on the mechanism of action of these oils, including the role of minor components, both on insects and mammals, to secure their industrial use.[20]

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