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Role of essential oils in plant diseases protection: A review

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Abstract

Essential oils of many plants demonstrate a wide variety of activity against plant pathogenic fungi and pest insects including oviposition avoidance, repellent, growth regulatory, antifeedant, antivector, insecticidal activities. The essential oils are also used in the defense of accumulated foodstuffs. Modern research evaluated that in insects, nervous system of octopaminergic holds up the chemical components of essential oils. Few of these oils and their essential components are extensively used in beverages and foods as flavoring agents. This particular dogmatic condition jointly with the essential oils broad accessibility from the fragrance and flavor production, has made it promising to fast way of commercialization of pesticides which are based on essential oils. However the "green pesticides" may also prove valuable for organic food production particularly in agriculture, and are also used to inhibit the garden and home pests.

Key words: Green Pesticides, Plants, Disease Protection, Essential oils, Antimicrobial

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1. Introduction

In recent years the overuse of pesticides caused the environmental problems which have been the matter of concern for both public and scientists. It has been projected that in each year, approximately 2.5 million tons pesticides have been used on crops and the pesticides caused global spoil of about $100 billion per year. This is because of the non-biodegradable properties and high toxicity of pesticides in the water resources, residues in soil, and crops which influence public health. Thus, on the one hand, one needs to search the biodegradable and new highly selective pesticides to solve the problem of long term toxicity to mammals and, on the other side, one must study the environmental friendly pesticides and develop techniques that can be used to decrease the pesticidal use though maintaining crop yields. Natural products are tremendous alternative to synthetic pesticides as a means to lessen the negative impacts to human health and the environment. The move toward the processes of green chemistry and the ongoing need for increasing new crop protection tools with original modes of acts makes discovery and commercialization of natural products as green pesticides an attractive and commercial pursuit of striking consideration.

The concept of "Green Pesticides" refers to all types of nature-oriented and useful pest control materials that can contribute to lessen the pest population and increase the production of food. They are ecofriendly and safe. They are friendlier to the environmental components than synthetic pesticides [1]. Consequently the present conception of green pesticides, have made some coherent attempts to contain materials like, hormones, toxins, plant extracts and pheromones from organic source and include several characteristics to control pest such as secondary metabolites, plant derivative pesticides, entomophagous nematodes, pheromones and microorganisms are used to alter the crops which resist the pests. In pest management semisynthetic and biodegradable synthetic products have been measured to comprise the sunshade of green pesticides [2-5]. Here we will highlight some modern advancement in which essential oils have predictable as commercially reasonable and safe green pesticides among some modern viable advancements beside their constraints and potential.

Essential oils are hydrophobic, volatile and aromatic compounds that give scent, flavor or characteristic odor to a plant. These are usually considered as volatile plant secondary metabolites and they are by-products of plant metabolism. The essential oils are present in secretary opening of cell wall of plants or glandular hairs and these survive as fluid droplets in roots, stems, leaves, bark, flowers, and fruits in various plants. Essential oils offer a variety of functions for the plants together with (i) protecting themselves from heat or cold, (ii) attracting or repelling insects; and (iii) using chemical ingredients in the oil as defense equipment. Most of the essential oils have been used as resins, as flavorings agent, food additives, components of perfumes, cosmetics, plastics and soaps. Generally at room temperature, these oils are liquid and, at room or slightly higher temperature they acquire gaseous state without undergoing breakdown. There is about 0.01 to 5% of essential oil found in most plants. For example, trees of orange make various contents of essential oils in their leaves, citrus fruits and blossoms. In *Ocimum basilicum* (basil) methyl chavicol amounts to 75% of the oil, in *Acorus calamus* rhizomes β-asarone amounts to 70–80%, in the range of 50– 60% linalool is found in coriander leaf and seed oils obtained from various localities at different time periods and is the major component followed by limonene, terpinene, *p*-cymene and camphor. Interestingly decanal and 2-decenol was the prime components in leaf oil [6]. However, there is no single constituent in other species which is in the majority. Nearly all essential oils consist of monoterpenes in addition to sesquiterpenes that are hydrocarbons consist of 15 atoms of carbon. As small component, higher terpenes may also be present. The chief groups are cyclic compounds with an aromatic system or unsaturated or saturated hexacyclic. Acyclic (linalool, citronellal) and bicyclic (1, 8-cineole) examples also make the essential oils components. Though in chemical composition intraspecific variability can exist, that is relative to chemotypic races and ecotypic variations or populations.

Plants offer an alternative source of insect-control agents because they contain a range of bioactive chemicals, most of which are selective and have little or no harmful effect on the environment and the non-target organisms. Due to the multiple sites of action through which the plant materials can act, the probability of developing a resistant population is very low [1]. Botanical insecticides degrade rapidly in air and moisture and detoxification enzymes break them readily. This is very important because rapid breakdown means less persistence in the environment and reduced risks to non-target organisms. Among natural products certain highly volatile essential oils currently used in the cosmetic, perfume, food, pharmaceutical and agricultural industries demonstrate guarantee for controlling insect peat, mainly in limited environments such as granaries or greenhouses. As the essential oils are potential sources of commercial insect control agents, much attempt has been focused on plant essential oils. From the viewpoint of pest control, fumigant activity of essential oils against insects is one of the most valuable properties of essential oils, while it may involve their victorious use to control pests in storage without having to apply the compound directly to the insects. In this context, essential oils have received much attention as potentially useful bioactive compounds against insects showing a broad spectrum of activity against insects, low mammalian toxicity, degrading rapidly in the environment and local availability. Essential oils are secondary metabolites that plants produce for their own needs other than for nutrition. The aromatic characteristics of essential oils present a variety of functions for the plants together with repelling or attracting insects, utilizing chemical components in the oil as defense resources and protecting themselves from heat or cold. In general, they are complex mixtures of 20-60 organic compounds that give characteristic odor and flavor to flowers, barks leaves, seeds, fruits and rhizomes. In industrialized countries, essential oils could be useful alternatives to synthetic insecticides in production of organic food, whereas in developing countries; they may be a means of low cost protection. Bioactivity of these essential oils depends upon its chemical composition that varies with plant part used for harvesting time, extraction, nature of the soil, plant age and growth conditions. Essential oils are complex mixtures comprised of a large number of constituents in variable ratios. Essential oils hold natural fragrances and flavors assembled as aliphatic compounds (alkanes, ketones, alkenes, alcohols and aldehydes, acids), sesquiterpenes (oxygenated and hydrocarbons derivatives) and monoterpenes (oxygenated and hydrocarbons derivatives) that give typical scent. Many essential oils secluded from different plant species fit in to different genera; comprise a relatively higher amount of monoterpenes. Jointly or independently they may contribute to the protection of plants against herbivores, although some herbivores have counter adapted to them. Plant essential oils show wide and varied bioactivities against both medically important insect species and agricultural pests, ranging from toxicity with ovicidal, larvicidal, pupicidal and adulticidal activities to sublethal effects including oviposition deterrence, anti-feedant activity and repellent actions as well as they may influence on biological factors such as life span, growth rate and reproduction. Accordingly, the use of plant essential oils can lead to the identification of new bioinsecticides.

2. Essential Oils as Green Pesticides

Naturally green concept recommends the prevention of use of any pesticide. Actually, such programs favor the strategy of "prudent avoidance". A variety of steps recommended in these programs are grass cycle, slow release soil feeding, high mowing, deep root watering, compost spread, over seeding, core aeration, use of valuable organisms etc. This idea is very valuable for lawn, kitchen and additional household pest control policy. Utilization of essential oils or their constituents add to this natural perception owing to their instability, partial perseverance beneath the field situation and a number of them including exclusion under inflexible set of rules.

Essential oils are generally obtained from aromatic plants through steam distillation, especially those used as flavorings and fragrances in the food industries and perfumes, correspondingly, and more freshly as herbal medicines and for aromatherapy. Essential oils are extracted commercially from numerous botanical resources; a lot of them are mint family (Lamiaceae) member. Usually the oils are composed of complex mixtures of sesquiterpenes, monoterpenes and biogenetically associated phenols. For examples 1,8-cineole, the chief ingredient of oils from eucalyptus and rosemary; thymol from garden thyme; eugenol from clove oil; asarones from calamus; menthol from a variety of mint species; and linalool and carvacrol from numerous plant species. In the 1990s for protection of stored products especially in Southern Asia and in the Mediterranean region numerous source plants have been conventionally used, but significance in the oils was converted with rising display of their contact insecticidal and fumigant actions to a broad variety of pests [7]. The quick action in opposition to some pests is indication of a neurotoxic approach of action, and there is proof for hindrance with the neuromodulator octopamine created by some oils and others created with GABA-gated chloride channels [8]. The sanitized components of terpenoid essential oils are somewhat poisonous to mammals. However, with little exclusion, the essential oils and their resultant components which depend upon the oils are generally non-hazardous to birds, fish and mammals. Due to the instability of essential oils, partial determination below the ground position is needed. Actually, under field conditions effects are evaluated on natural opponents. For definite monoterpenoids latest proof for an octopaminergic mode of action, [9-10] joint with their comparative chemical simplicity point out that these natural products may thus find precious as direct structures for the innovation of latest neurotoxic insecticides by means of excellent selectivity of mammalian.

There are numerous essential oils examples resembling to patchouli (*Pogostemon patchouli*), rose (*Rosa damascene*), geranium (*Pelargonium graveolens*), lavender (*Lavendula officinalis*), sandalwood (*Santalum album)*, etc. which are famous in fragrance and perfumery industry. Further essential oils, for example, rosemary (*Rosemarinus officinalis*), *Eulcalyptus globulus*, clove (*Eugenia caryophyllus*), thyme (*Thymus vulgaris*), lemon grass (*Cimbopogon winteriana*) and vetiver (*Vetiveria zizanoides*) are identified due to their properties to control pests. Whereas peppermint (*Mentha piperita*) keeps away moths, ants, lice and flies; pennyroyal (*Mentha pulegium*) repels mosquitoes, fleas, ticks, lice, moths and ants. Basil (*Ocimum basilicum*) and spearmint (*Mentha spicata*) are also efficient in warding off flies. In the same way, essential oil comprising plants like *Mentha piperita, Lavandula angustifolia, Melaleuca leucadendron*, *Pelargonium roseum*, *Juniperus virginiana* and *Artemesia vulgaris*, are also efficient together with a variety of fungal pathogens and insects [11]. Studies carried out on the property of *Mentha* species explosive oil components are extremely efficient adjacent to *Callosobruchus maculatus* and the ordinary stored particle pests [12]. Lemongrass and eucalyptus essential oils have been proved efficient as antifeedants, miticides, antimicrobial and insecticides products; accordingly discovery use as microbiocides, purifier, disinfectants, fungicides, bacteriostats and various have completed the control in defending the household property.

The essential oils of *Cymbopogon citratus*, *Tanacetum vulgare*, *Foeniculum vulgare*, *Rabdosia melissoides*, *Cinnamomum zeylanicum*, *Acorus calamus*, *Gaultheria procumbens*, *Abelmoschus moschatus*, *Ocimum* spp., *Eugenia caryophyllata*, *Cuminum cymium*, *Lavandula angustifolia* syn. *L. officinalis, Bunium persicum, Cedrus* spp. *Trachyspermum ammi* and *Piper* species are also famous for their diverse pest arrange properties. Essential oil of citronella (*Cymbopogon nardus*) has been used for above fifty years both as an animal and insect repellent. To keep away the indoor insect pests, mixing the few drops of essential oils, each of lemon (*Citrus limon*), lavender, citronella, basil and rose (*Rosa damascena*) in one litre distilled water is very useful. Citronellal, the key component of monoterpenes, is found as main reason of larvicidal action of citronella oil [13]. Essential oil of Vetiver (*Vetiveria zizanioides*) extracted by steam distillation contains oxygenated sesquiterpenes in abundance. This oil is used to guard the dresses and other precious materials from attack of insects when found in drawers, cabinet and box. Essential oil of Catnip (*Nepeta cateria*) is extremely efficient to keep away bees, flying insects and mosquitoes. The most dynamic ingredient in catnip has been recognized as nepetalactone. It is exceptionally operational in opposition to *Aedes aegypti* mosquito. *Trachyspermum* sp. oil is also parricidal beside southern house mosquito, *A. aegypti* and *Culex quinquefasciatus* pronounce (LC50 = 93.19–150.0 ppm) [14]. In the same way, *Ocimum sanctum* essential oils caused about 20% mortality to 3rd instars *S. litura* larvae. At a relevant amount of 100 μg/ larvae, essential oils of *Thymus serpyllum, Origanum creticum* (LD50 = 48.4 to 53.4) and *Satoreja hortensis* were useful to 3rd instars *S. litura* and > 90% larval transience has been notified. Similar studies were reported by Sharda and his fellows where *Ageratum conyzoides* essential oil caused mortality of about 43.0 to 68.75% at the concentration of 0.025 to 0.25 μl. Tripathi *et al*. (2003) investigated the toxic effect of *Aegle marmelos* essential oil via applying tropically to *S. litura* larvae among LD50 = 116.3 μg/ larvae. *Lippia alba* essential oil bring growth retardation (GI50 = 6.9 to 11.0 mg/g diet), in which feeding and relative growth rates of *S. litura* both were evidently decreased. Essential oil extracted from dill plant (*Anethum sowa*) is a richest resource of carvone. Dillapiole is the chief component of *A. sowa* which is famous for insecticide synergistic properties of *A. sowa*. It also found in *Anethum graveolens* seed oil to the extent of about 40–60% and in spearmint oil (*Mentha spicata*) it occurs at the amount of more than 51%. The leaves of turmeric (*Curcuma longa*), yields oil on hydrodistillation which contains upto 70% α-phellandren. This α-phellandren containing oil stimulates larval fatality and growth retardation of *Spilosoma obliqua*. This oil is also nymphicidal and ovicidal to *Dysdercus koenigii* and stimulate effect of reasonable reduction of *T. castaneum*. Ginger and Curcumene oil with the 0.2% concentration stimulates 86% reduction of the mycelia growth of fungus *Rhizoctonia solani*. Consequently, combined consideration of essential oil effectiveness like a green pesticides recommended that a number of oils are appreciably extra vigorous than others. Though, more experimental assessment of dynamic compound by using extensive display of pest variety would expose particular biological behaviors.

Essential oils, as stated above, are composite mixture of naturally existed organic compounds. These are primarily consist of terpenes such as terpinene, pinene, α-phellandrene, β- phellandrene, myrecene, limonene, *p*-cymene etc.; and terpenoids for example monocyclic alcohols (4-carvomenthenol, menthol, terpineol, borneol, carveol,), bicyclic alcohol (verbenol), acyclic monoterpene alcohols (linalool, geraniol), aromatic phenols (thymol, eugenol, safrol, carvacrol,), aliphatic aldehydes (citronellal, citral, perillaldehyde), acids (citronellic acid), monocyclic ketones (pulegone, menthone, carvone), cinnamic acid, esters (linalyl acetate) and bicyclic monoterpenic ketones (verbenone, thujone, fenchone). Some essential oils may also consist of sulphur containing constituents, methyl anthranilate, oxides (1,8- cineole), coumarins, etc. Curcumene, zingiberene, nerolidol, farnesol, termerone, sesquiphellandrene, etc. are the sesquiterpenes (C15) which separated from essential oils. Sesquiterpenoide essential oil components are produced by the concentration of isopentenyl pyrophosphate component. In essential oils diterpenes are generally not present but these are sometimes come across as side-product.

3. Growth Inhibitors and Insecticides

Mostly components of essential oils are lipophilic in nature, which acts like oviposition deterrents, feeding deterrents and toxins to a broad range of insect pests. Several monoterpenoids have insecticidal characteristics for the southern corn root-worm, red flour beetle, and houseflies have been notified. While several monoterpenoids possess insecticidal characteristics, the extent of toxicity of distinct compound for one species deviates significantly. Cornelius and his fellows investigated the monoterpenoids toxicity against *Coptotermes formosanus.* They found eugenol as most efficient termiticide. They also found that it was also efficient as feeding deterrent and as a fumigant. It is also documented as poisonous for Asian armyworm, granary weevil, *Spodoptera litura* Fabricius, western corn root worm, *Sitophilus granaries* (Linnaeus), *Musca domestica* Linnaeus, common house fly and *Diabrotica virgifera* Lee Conte, (LD50 = 2.5–157.6 μg/insect) [15]. According to Raina and his fellows [16] citrus peel essential oil which contain ~92% *d*- limonene caused 68 and 96% death of *Coptotermes formosanus* Shiraki and Formosan subterranean termite within five days and considerable decrease in feeding in contrast to controls at 5 ppm (v/v) concentration was found. It was also found that the termites did not pass through glass tubes which are fitted with 0.2 to 0.4% extract of orange oil treated sand. *Nepeta cataria* essential oil and its two main constituents *Z, E*-nepetalactone, *E, Z*- nepetalactone monoterpenes caused 100% mortality to Formosan subterranean termite at 40 mg/cm^2, while 97% mortality was attained by *E, Z*-nepetalactone at 20 mg/cm^2 within 7 days which also describes its repellent activity via putting off termites to channel through a glass tube of 60 mm filled with sand and treated with 200 ppm concentration [17].

Turmeric essential oil is also valuable for controlling of pest. Leaves and used parts of turmeric, produce oil via hydrodistillation which contains a rich amount of 2-phellandrene which reduce the growth of *Plutella xylostella* (Linnaeus), diamond back moth and *S. obliqua* at the concentration of 1.0 % [18-19].

4. Antifeedants

Antifeedant chemicals can be describe as being either suppressant, or repellent, or disincentive from nourishing once contact has been made with insects. Bioefficacy of essential oils obtained from *Luvanga scandans* and *Eucalyptus camaldulensis* var. *obtusa* also found as larvicidal for *S. litura*. Biogenically associated monoterpenoids, linalool from *Luvanga scandans* species and the 1, 8-cineole from *Eucalyptus camaldulensis* variety *obtusa* were determined to be most active separate from these plants through current applications. 1, 8-cineole (LD50 = 126.6 μg/larva) was less active than linalool (LD50 = 85.5 μg/ larva). A variety of well-known monoterpenoids have been tested for synergy and used as binary mixtures, by feeding and toxicity reticence constraint. The data recommended that *trans*-anethole and thymol synergized the property of linalool, however with 1, 8-cineole, thymol showed only preservative effect and so was the case with combination of linalool and terpineol. A specific synergism was also noticed in case of isolated compounds which were obtained from two different plant species, i.e. linalool with 1, 8-cineole [20].

Koschier and Sedy evaluated the antifeedant effect of rosemary (*Rosemarinum officinalis*) and majoram essential oil in opposition to onion thrips (*Thrips tabaci* Lindeman) at concentration of 0.1 to 1.0%. Essential oils extracted from *Ocimum basilicum, Ocimum sanctum, Vitex negundo, Callistemon lanceolatus* and *Cymbopogon winterianus* caused 100% nourishing anticipation with concentration of 10%. Substantial nourishing reticence (70.21 to 80.21%) was verified for *S. obliqua* 3rd instars when subjected at concentration of 0.4% of *Juglans regia* var. *kumaonica and Artemisia nilagarica* oils, whereas these oils induced feeding anticipation at 0.3% of 63.11 to 83.76% along with 5th instars of *S. litura* [21]. *Elsholtzia incise, E. densa*, and *E. piulosa* essential oils also demonstrate important antifeedant action against 3rd instars of *S. litura*. Uppermost feeding anticipation of 76.5% was determined in *H. armigera* with *Aegle marmelos* essential oil [22].

5. Repellents

A. aegypti and other mosquitoes caused vector-borne diseases which have develop into worldwide health problem. Although, thousands of different plants have been experienced as prospective resource of insect repellents but a small number of plant consequent compound tested to date express the wide usefulness and extent as fine as DEET. In recent times, the analysis of botanical phytochemicals with mosquitocidal prospective has been published, showing recognition of narrative efficient mosquito killing compound from botanicals consisting vigorous phytochemicals. This review present the latest situation of information on botanical ovicides, screening methodologies, plant species which have larvicidal properties, phytochemicals which inhibit growth and reproduction, residual capacity, extraction processes, additive, antagonistic and synergistic combined achievement resistance, effects of mixtures and their effects on non-target organisms and confers shows potential proceed made in phytochemical research for vector control.

6. Antifungal Agents

Essential oils and their constituents also been evaluated for their antifungal behavior and found valuable against *Botrytis cinerea, Monilinia fructicola* [23], R*hizoctonia solani, Fusarium moniliforme* and *Sclerotinia sclerotiorum, F. oxysporum, Cymbopogon nardus* [24], *Aspergillus niger, F. solani, A. flavus, Penicillium digitatum, Pythium ultimum, R. solani,* and *Alternaria* *padwickii*, *Bipolaris oryzae*, *Colletotrichum lindemuthianum*, and peanut fungi [25-26]. In contrast to insects, various species of fungus illustrates extra reliable outcomes. Carvacrol and thymol are certainly dynamic in opposition to the majority of fungal species experienced [21]. The pathway of activity of these complexes against fungi is unidentified but may be interrelated to their general capability to soften or otherwise dislocate the reliability of cell membranes and cell walls [1].

Many experiments have been carried out greenhouse to investigate the efficiency of essential oils of the plants like fumigants for soil to control bacterial sag in tomatoes. In greenhouse experiments, soil (potting mixture) diseased with *R. solanacearum* and was preserved at 400 mg and 700 mg/ liter of soil with the essential oils. Just before and 7 days after treatment population densities of the *R. solanacearum* were determined. Treatment with lemongrass, thymol oil and palmarosa oil shows the populations reduction to unnoticeable points at both concentrations, while oil of tea show no influence. Transplantation of seedlings of tomato in the soil which was treated with 700 mg per liter of lemongrass oil, 700 mg per liter of thymol, 700 mg per liter of palmarosa oil resulted in seedlings free from bacterial sag and thymol action resulted in 100% reduction of *R. solanacearum* in plants [27].

7. Essential Oil as Antiviral Agents

Unstable oils and pure isolates of plants have been pointed out as consisting material which hinder or inhibit viral diseases. In a research the essential oils, *Melaleuca alternifolia*, at 100, 250, 500 ppm concentration found useful in diminishing local abrasion caused by TMV on *Nicotiana glutinosa* plant. In the same way, essential oils of *Callistemon lanceolatus*, *Peperomia pellucid*, *Ageratum conyzoides*, *Carum copticum*, *and Ocimum sanctum* have been estimated for inhibitory action against mung bean mosaic virus (MBMV), cowpea mosaic virus (CPMV), southern bean mosaic virus (SBMV) and bean common mosaic virus (BCMV). At 3000 ppm, *Ocimum sanctum* showed the best reticence of 88.2%, 90, 89.6, and 92.7, against SBMV, MBMV, CMV and BCMV, respectively. Inhibitory actions were also shown in other oils in opposition to other viruses. Another statement has revealed 62% retardation against tobacco mosaic virus. By GLC and TLC the fresh carrot leaves on hydrodistillation yield essential oil upto 0.07%. By mass spectra, IR, and NMR components were acknowledged. Twenty nine different compounds were recognized and the main components were found linalool (14.90%), sabinene (10.92%), carvone (8.76%), linalyl acetate (8.36%). The essential oil extracted from *Tagetes minuta* found vigorous in opposition to carnation vein mottle viruses (CaVMV), carnation ring spot (CaRSV). The constituents namely ocimene and dihydrotagetone present in the oil were found to have improved antiviral affect aligned with two carnation virus. The bioactive component present in oil or the oil as such may be used as ecofriendly and natural antiviral products on commercial scales.

Tomato spotted sag virus (Thrips-vectored) is one of the most destructive tomato affecting pest compounds. Different field experiment were performed to find out the properties of volatile essential oils which are extracted from kaolin-based elements films and plant on the occurrence of *Frankliniella* thrips population dynamics and tomato spotted sag. Tea tree (*Melaleuca alternifolii*) oil, lemongrass (*Cymbopogon flexuosus*) oil and geraniol were contrasted with an untreated control and a standard insecticide treatment. When the three essential oils, in combination with kaolin, evaluated in contrast to the controlled treatment show the decrease in tomato spotted sag virus occurrence from 32 to 51% and 6 to 25% in 2005 and 2006, respectively. These three essential oils, when applied with kaolin, produced results like to the standards of insecticide [28]. Hence, to control viruses and reduce utilization of insecticidal products on tomatoes, naturally occurring products such as essential oils and kaolin could be used effectively.

8. Ovicides and Oviposition Inhibitors

Application of majoram and 1, 8 cineole compact ovipopsition rate at 1.0% concentration, in contrast to unprocessed controls. In Egypt, at level of 0.1% essential oil of *A. calamus* prohibited oviposition of *C. maculatus*. In another experiment, garlic oil (an oviposition restraint) found to be extremely poisonous to *P. xylostella* eggs and 99.4% decline in hatching of eggs has been estimated in *S. oblique* by using essential oil of *Aegle marmelos* at 250 mg oil/50 eggs [21]. Carveol, fenchone, linalool, carvacrol, menthol, pulegone, thymol, geraniol, carvones, menthone, terpineol, citral, verbenone, verbenol, thujone, cinnamaldehyde, cinnamic acid and citronellal have been investigated as homicides against *M. domestica* eggs. These researches express that the monoterpenoid ketones are extensively more efficient than structurally alike alcohols (verbenol versus verbenone; menthol versus menthone etc).

Guerra and his fellows [29] evaluated that the harmful pest of potato in stores is potato tuber moth. They investigated the defensive outcome of local species of Minthostachys (Lamiaceae) against tuber invasion by the potato tuber moth in Peru, Cusco. They enclosed potato tubers with *Minthostachys glabrescens* and *Minthostachys spicata* dried shoots and measure up to tuber damage with a direct treatment of maize straw. The number of eggs which have been laid by mated moths on filter paper were treated with essential oils of each of the three species. Finally, they tested for variations in oviposition prevention between five full-sib potato tuber moth families which increased under alike conditions. They found that chopped, dried flowers and leaves of Minthostachys species decreased the percentage of tuber spoil in stores in comparison with the control (5% vs. 12%). The natural concentrations of essential oils have been depressed moth oviposition and plummeting the number of eggs. Finally, during the detection among family deviation on filter papers treated with essential oils, there was no difference in the number of eggs laid on control compounds.

9. Conclusions

Essential oils are naturally occurring phytochemicals. They are famous throughout the world for the cure of many diseases and possess many applications. There are few facts that documented these essential oils and extracts. Essential oils offer an alternative source of insect-control agents because they contain a range of bioactive chemicals, most of which are selective and have little or no harmful effect on the environment and the non-target organisms. Increasing demand for safe and effective natural products and interest in natural control of human infectious fungal pathogens are the factors which require the more numerical data on plant oils and extracts and it could direct to a new natural antifungal products. These new natural antifungal products could provide the utilization of the plant to cure various infectious diseases in human, plants and animals.

Reference:

[1] Isman, M.B. and C.M. Machial. 2006. Pesticides based on plant essential oils: from traditional practice to commercialization. *In* M. Rai and M.C. Carpinella (eds.), *Naturally Occurring Bioactive Compounds*, Elsevier, BV, pp 29–44.

[2] Koul, O., G.S. Dhaliwal, S.S. Marwaha and J.K. Arora. (2003). Future perspectives in biopesticides. *In* O. Koul, G.S. Dhaliwal, S.S. Marwaha and J.K Arora (eds.), *Biopesticides and Pest Management.*, Vol.1, Campus Books International, New Delhi, pp. 386–388.

[3] Koul, O. (2005). *Insect Antifeedants*. CRC Press, Bota Racon, FL.

[4] Dhaliwal, G.S. and O. Koul. (2007). *Biopesticides and Pest Management: Conventional and Biotechnological Approaches*. Kalyani Publishers, New Delhi.

[5] Koul, O. (2008). Phytochemicals and insect control: An antifeedant approach. *Crit. Rev. Plant Sci.*, 27:1–24.

[6] Lawerence, B.M. and R.J. Reynolds. 2001. Progress in essential oils. *Perf. Flavour*, 26:44–52.

[7] Isman, M.B. (2000). Plant essential oils for pest and disease management. *Crop Prot.*, 19:603–608.

[8] Priestley, C.M., E.M. Williamson, K.A. Wafford and D.B. Sattelle. (2003). Thymol, a constituent of thyme essential oil, is a positive allosteric modulator of human GABA receptors and a homo-oligomeric GABA receptor from *Drosophila melanogaster*. *Br. J. Pharmacol.* 140:1363–1372.

[9] Bischof, L.J. and E.E. Enan. (2004). Cloning, expression and functional analysis of an octopamine receptor from *Periplaneta americana*. *Insect Biochem. Mol. Biol.*, 34:511–521.

[10] Kostyukovsky, M., A. Rafaeli, C. Gileadi, N. Demchenko and E. Shaaya, (2002). Activation of octopaminergic receptors by essential oil constituents isolated from aromatic plants: possible mode of action against insect pests. *Pest Manag. Sci.* 58:1101–1106.

[11] Kordali, S., Cakir, A., Mavi, A., Kilic, H. and Yildirim, A. (2005) Screening of chemical composition and antifungal activity of essential oils from three Turkish *Artemisia* species. *J. Agric. Food Chem*., **53**, 1408–1416.

[12] Tripathi, A.K., Prajapati, V., Aggarwal, K.K., Sushil Kumar, Prajapti, V., Kumar, S. Kukreja, A.K. Dwivedi, S. and Singh, A.K. (2000) Effects of volatile oil constituents of *Mentha species* against stored grain pests, *Callosobrunchus maculatus* and *Tribolium castanum. J. Med. Arom. Plant Sci.*, 22, 549–556.

[13] Zaridah, M.Z., Nor Azah, M.A., Abu Said, A. and Mohd. Faridz, Z.P. (2003) Larvicidal properties of citronellal and *Cymbopogon nardus* essential oils from two different localities. *Trop. Biomed.*, 20:169–174.

[14] Vrushali, T., Tare, V. and Shushil, K. (2001) Bioactivity of some medicinal plants against chosen insect pests/vectors. *In* K. Sushil, S.A. Hasan, D. Samresh, A.K. Kukreja, S. Ashok, A.K. Sharma, S. Srikant and T. Rakesh (eds.), *Proceedings of the National Seminar on the Frontiers of Research and Development in Medicinal Plants*, CIMAP, Lucknow, pp.

[15] Hummelbrunner, A. L. and Isman, M.B. (2001) Acute, sublethal, antifeedant and synergistic effects of monoterpenoid essential oil compounds on the tobacco cut worm (Lepidoptera: Noctuidae). *J. Agric. Food Chem.*, 49:715–720.

[16] Raina, A.K., J. Bland, M. Dollittle, A. Lax, R. Boopathy and M. Lolkins. (2007). Effect of orange oil extract on the formosan subterranean termite (Isoptera: Rhinotermitidae). *J. Econ. Entomol.*, 100:880–885.

[17] Chauhan, K.R. and A.K. Raina. (2006). Effect of catnip oil and its major compounds on the Formosan subterranean termite (*Coptotermes formosanus*). *Biopestic. Int*., 2**:**137–143.

[18] Govindaraddi, K. (2005) Antifeedant and insecticidal properties of essential oils of turmeric (*Curcuma longa* L.) and garlic (*Allium sativum* L.) against diamond back moth, *Plutella xylostella* (L). M.Sc thesis,CCS Haryana Agricultural University, Hisar.

[19] Walia, S. (2005) Allelochemicals as Biopesticide. *In* O. Koul, G.S. Dhaliwal, A. Shankar, D. Raj and V.K. Koul (eds.), *Souvenir Conference on Biopesticides: Emerging Trends*, Society of Biopesticide Sciences, India, Jalandhar, pp. 19– 32.

[20] Singh, R., P.J. Rup and O. Koul, (2008). Bioefficacy of 1, 8-cineole from *Eucalyptus camaldulensis* var. *obtusa* and linalool from *Luvanga scandans* against *Spodoptera litura* (Lepidoptera: Noctuidae) and combination effects with some other monoterpenoids. *J. Pest Sci.*, (in press)

[21] Tripathi, A.K., V. Prajapati and S. Kumar. (2003). Bioactivity of l-carvone, d-carvone and dihydrocarvone towards three stored product beetles. *J. Econ. Entomol.*, 96:1594–1601.

[22] Tsao, R. and T. Zhou, (2000). Antifungal activity of monoterpenoids against postharvest pathogens *Botrytis cinerea* and *Monilinia fructicola. J. Essential Oil Res*., 12:113–121.

[23] De-Billerbeck, V.G., C.G. Roques, J.M. Bessiere, J.L. Fonvieille and R. Dargent. (2001). Effects of *Cymbopogon nardus* (L) essential oil on the growth and morphogenesis of *Aspergillus niger*. *Can. J. Microbiol.* 47**:**9–17.

[24] Nguefack, J., S.K. Nguikwie, D. Fotio, B. Dongmo, P.H. Zollo, L.V. Amvam, A.E. Nkengfack, L. Poll. (2007). Fungicidal potential of essential oils and fractions from *Cymbopogon citratus*, *Ocimum gratissimum* and *Thymus vulgaris* to control *Alternaria padwickii* and *Bipolaris oryzae*, two seed-borne fungi of rice (*Oryza Sativa* L). *J. Essen. Oil Res.*, 19: 581–587.

[25] Krishna Kishore, G., Pande, S. and Harsha, S. (2007) Evaluation of essential oils and their components for broad-spectrum antifungal activity and control of late

leaf spot and crown rot diseases in peanut. *Plant Dis.*, **91**, 375–379.

[26] Pradhanang, P.M., M.T. Momol, S.M. Olson and J.B. Jones. (2003). Effects of plant essential oils on *Ralstonia solanacearum* population density and bacterial wilt incidence in tomato. *Plant Dis.* 87:423–427.

[27] Reitz, S.R., Maiorino, G., Olson, S., Sprenkel, R., Crescenzi, A. and Momol, M.T. (2008) Interesting plant essential oils and kaolin for the sustainable management of thrips and tomato spotted wilt on tomato. *Plant Dis*., 92:878–886.

[28] Dimetry, N.Z., M. Hafez and M.H. Abbass. (2003). Efficiency of some oils and neem formulations against the cow pea beetle, *Callosobruchus maculatus* (Fabricius) Coleoptera: Bruchidae). *In* O. Koul, G.S. Dhaliwal, S.S. Marwaha and J. K. Arora (eds.), *Biopesticides and Pest Management*, Vol. 2, Campus Books International, New Delhi, pp. 1–10.

[29] Guerra, P. C., I. Y. Molina, E. Ya´ bar and E. Gianoli. (2007). Oviposition deterrence of shoots and essential oils of Minthostachys spp. (Lamiaceae) against the potato tuber moth. J. Appl. Entomol. 131:134–138.