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## Chapter

# Botanical Insecticides Are a Non-Toxic Alternative to Conventional Pesticides in the Control of Insects and Pests

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## Abstract

Insect control for crops is one of the most critical global concerns. Pest management is an economic and ecological problem worldwide due to the human and environmental risks raised by most synthetic pesticide products. Botanical insecticides have resurfaced in popularity due to their low cost and low environmental impact, rather than their negative effects on human health. Botanical insecticides destroy only the insects they are meant to kill, leaving no residue on food or in the environment. Botanicals have long been used to combat pests. The compounds have many environmental advantages. However, as opposed to other bio-control pests and pathogens, their use was minimal during the twentieth century. In developing countries, botanical insecticides are well adapted for use in organic food production. Nonetheless, they may play a far bigger role in developed countries' food production and post-harvest food protection. Consequently, the current chapter briefly addresses botanicals with active ingredients with insecticidal, antifeedant, or repellent properties.

**Keywords:** insect, crop protection, active constituents, insecticides, natural products, action mechanism

## 1. Introduction

Insects are the world's most abundant animal species, and they can be found in any ecosystem. Pest insects account for fewer than 0.5 percent of all insect species, and just a few are dangerous to humans. Certain insects can be dangerous to entire countries or groups of countries [1]. Crops are continuously at risk of being infested or infected. Since pesticides are cheap and easily applied, farmers typically use fast pest control measures like synthetics to protect their animals and crops from infestation. Synthetic pesticides can tend to select

more pesticide-tolerant ones in the population, but it does lead to developing pesticide-resistant pests. To oversimplify and misuse synthetic pesticides in agriculture can damage human health and the environment, even damaging biodiversity. Research suggests that constant consumption of synthetic pesticides can cause human illnesses and diseases [2–4]. Furthermore, most synthetic pesticides are not biodegradable, causing soil and groundwater contamination and ozone depletion in the atmosphere. The negative consequences of misuse and overuse of synthetic pesticide have prompted alternative pest control solutions [5–7].

Plants containing bioactive chemicals have been shown to effectively treat a variety of crop pests and human illnesses [8, 9]. Plants like pyrethrum (*Tanacetum cinerariifolium*) and anemone (*Anemone Brizo*) have been shown to have pesticide and malaria-control properties in their insect repellent abilities. Human management of plant problems was practiced, and pesticides were gradually phased out by humans, rather than being replaced by technology and newer, more toxic, but more effective pesticides. They had great success in combating serious plant diseases such as rust and blight, where they are more effective and less toxic, and they became very popular [10]. As a result, natural plant-based products were gradually phased out until recently, when synthetic pesticides threatened human health and the environment [11]. Today, people want food grown with pesticide-free and naturally derived treatments. At the same time, detection of toxic pesticide residues in food and a heightened interest in food safety has prompted agriculture-organic bans of certain chemicals [12, 13].

Continued usage of synthetic insecticides has caused environmental damage, health problems, and loss of species diversity, contamination and biodiversity problems, and an increase in exposure to danger to hazards [14]. Synthetic pesticides have harmed farmers in the export trade, especially in the horticultural sector [15]. Both farmers and exporters in developing countries have lost market and profits if banned pesticides are detected above-defined tolerable level. Alphadime® (alpha-cypermethrin + dimethoate) and Demeton®, for example, are no longer allowed to be used on fresh produce exported to other countries [16, 17].

All the aspects that contribute to the value of botanical pesticides are efficacy, biodegradability, various modes of action, low toxicity, and the accessibility of the source materials. Pre- and pre-harvest times are frequently small [18]. In organic agriculture, where organic food attracts higher costs, botanical pesticides are extensively used [19]. As a result, botanical insecticides are becoming popular since they are safe in crops cultivated for human consumption, and customers willing to pay an organically cultivated premium are more demanded [20]. Many investigations have been carried out with known and still to be utilized species of plants having pesticide characteristics [21, 22]. The commercially available botanical pesticides are examples of pyrethrum (*Tanacetum cinerariifolium*), neem (*Azadirachta indica*), sabadilla, tobacco (*Nicotiana tabacum*) and ryania (*Ryania speciosa*) [23]. In post-harvest pest control, farmers have traditionally utilized plant protection agents, particularly for grain conservation, while they were storing.

The derivatives of plant products that repel, inhibit, or destroy pest are botanical pesticides [24]. Many studies have concentrated on managing pest populations using different botanical pesticides to control insects [25–29]. Plants with pesticide properties can deal with bacteria, fungi, and nematodes; likewise, toxins affect pests. This chapter features data on the chemical composition of botanicals, their pest-control mechanisms, the problems of their use, and the need for them.

## 2. Background history

Plants have been used as pesticides since humans discovered that some plants defend themselves better than others. Before using any other pesticides, people used botanicals to combat pests. They are recorded in hieroglyphic, Chinese, Roman, and Greek antiquities. In India where the neem tree of the Veda, a collection of handwritten archeological Sanskrit written at least 4000 years old, has been mentioned Neem (*Azadirachta indica* Juss.; Meliaceae). Plant compositions for controlling insect pests were mentioned in various writings of the 18th century. In the late 19th century, poisonous plants or minerals were often applied such as oils, tars, sulfocalcic sprinklers, hot water and other technologies [30]. Plant extracts were created as a result of combining empirical and scientific findings.

The first pesticides were made with readily available botanicals and allelochemicals. Since pest insects are easier to identify, they were targeted rather than pathogens. Biopesticides of plant origin have been studied in many recent books and chapters [31, 32].

Plant development as pesticides has two sources of development: First, there are historical and existing uses of plants and their plant constituents in cattle and crop protection methods; and second, the analysis of plant extracts for active ingredients and plant protection. Nicotine activity obtained from tobacco *Nicotiana tabacum*, *Derris elliptica*, and rotenone from *Leguminosae Lonchocarpus* fall into this group. (ii) systematic sampling of plant families obtained in searching campaigns to detect active molecules, accompanied by biological tests. Such prospecting was done in the 1940s with the help of Rutgers University and Merck, and the outcome was Ryanodine, an alkaloid derived from *Ryania* sp. that was first sold in the United States in 1945 [31].

Four major compounds were widely used before WWII: Alkaloids and *nicotines*, *rotenone*, *pyrethrins*, and vegetable oil. *Nicotines* and alkaloids The usage of these compounds waned due to their toxicity to nicotine organisms or molecular instability (pyrethrum), while chemically synthesized pesticides were marketed during WWII (organochlorides, organophosphates, and carbamates). Their management was cheaper and easier. Until the 1960s, this condition persisted [31].

However, a resurgent interest in botanicals was shown by several demonstrations that the widespread use of chemical pesticides can adversely impact non-target creatures and environmental hazards. Even though a great effort was made in the second half of the twentieth century to search for and produce newly synthesized pesticides, research was conducted on plant-based Biopesticides to increase their stability or discover novel compounds and molecules. An excellent illustration of this is the syntheses of pyrethroids, pyrethrum-derived synthetic compounds, and neem (*Meliaceae*) in the 20th century.

## 3. Botanical pesticides sources

Some botanical pesticides were obtained from plants extracts essential oils, or combinations. Certain plants are known to be used as botanicals. Rhizomes, bark, leaves, nuts, cloves, fruits, and stems are ingredients. In this context, the application of the plant component would rely on which bioactive compounds are utilized and their levels of abundance within the target cells. Botanical insecticides are mainly found in the following plant families: *Myristicaceae*, *Rutaceae*, *Caesalpinaceae*, *Apiaceae*, *Caesalpinaceae*, *Sapotaceae*, *Cupressaceae*, *Piperaceae*, *Solanaceae*, and *Zingiberaceae* [33–35]. Dried and pulverized plant parts are extracted using solvents

that promote extraction. After the extraction, the potency is distilled, standardized, and tested in a laboratory or field. Other examples of viable and profitable botanical pesticides have included the neem herb *azadirachtin* (*Azadirachta*) and the insect repellent pyrethrum (*Tanacetum cinerariifolium*). Many other plants have pesticide properties like Garlic (*allium sativum*), Turmeric (*Curcuma longa*), Rosemary (*Rosmarinus officinalis*), Ginger (*Zingiber officinale*), peppermint, (*Mentha piperita*), and Thyme (*Thymus vulgaris*) [36, 37].

#### 4. Factors that affect botanical pesticides

1. Supply of raw materials.
2. Botanical extract standardization containing the dynamic combination of active ingredients.
3. Types of solvents, plant organisms, and plant parts.
4. Quick decomposition and Environmental factors.
5. Market prospects for botanical pesticides.
6. State registration.

Some factors that influence the usage of synthetic botanical pesticides include the pesticide's composition, the active ingredient, method, time, and the quantities used in the mixtures of pesticides, climatic conditions and the time of year of application [38].

Thus, an investigation must also consider possible environmental exposure, indicators of health, and other aspects of risk assessment such as an individual's residency and work background, clinical history, and the prevalence, in the area in which populations are examined of pesticides analyzed in drinking water, land, atmosphere and fresh and processed food. The length of time spent each day, the number of years spent conducting the activity, the type of exposure, the use of protecting facilities, and their geographical closeness to agricultural fields can increase exposure [39].

#### 5. Botanical insecticides made from plants are used in agriculture

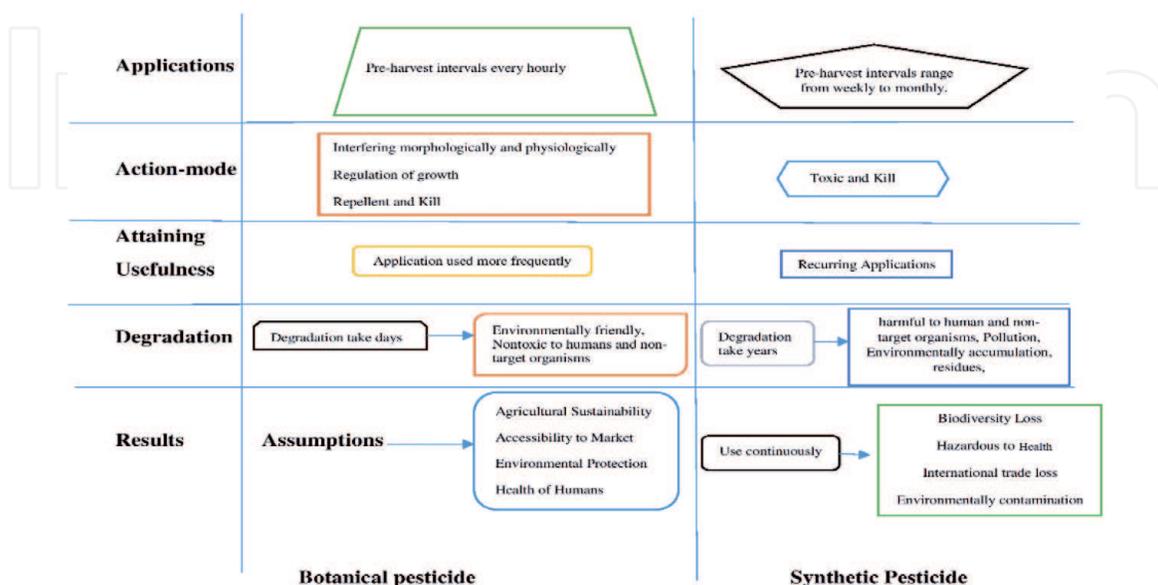
This class of plants is of prime importance as botanical pesticides, herbs, or ornamental plants, can be found in the environment, and a lot of them serve several purposes such as medicines, foodstuffs, accessories, and livestock. They are widely available, and thus very economical, and thus can be easily adopted into agricultural practices. Neem, pyrethrum, and several other non-target species, commercially sold pesticides, are the least harmful, such as insects and fish to none target organisms. They are healthy for both human use and the climate. The relationship between plant-derived pest-control products and pests is based on a biochemical process, which will decrease the likelihood of resistance. Essential oils and essential extracts have a derivative focus on target-specific properties, which help protect bees and other non-target beneficial species from a plant-based risk. Has no or little allelopathic impact on botanical crops Its effectiveness depends

on the plant species, whether the extract is used dry or liquid, solve concentrations, and extraction methods. They have a variety of modes of action including insect resistance, population control, toxicity, and crop modification to meet a variety of different pests' requirements. They interact with behavioral activity, metabolic processes, anatomy, biochemical activities, and certain physiological functions. For example, the terpenoids interfere with phenology on moth phenology cells (**Figure 1**) [40–49].

Some scientists have critically examined the acceptance, adoption, and use of botanical pesticides. There must be enough knowledge and proof of the chemistry and effectiveness of botanical pesticides before they can be approved for general use. These provide details on the composition, degradation, durability, and toxicity of the substances [50].

Food safety is enhanced due to the integration of botanicals in agricultural systems, particularly in greenhouses, production; crop productivity is improved through increased and greater market accessibility thanks to that, along with higher prices due to lower pest densities; and guaranteed market access. A certain subset of the consumer population is willing to pay more for organically grown foods, and this opens the door for the botanical pesticides that are profitable for the farmers to expand their market share of that population. **Figure 1** shows the various pathways that can be followed when considering both synthetic and botanicals. Synthetic pesticides contribute to agriculture have the benefit of reducing crop damage and cutting the number of money farmers have to spend on pesticides and increases in sales and profits on their produce. At the same time, these methods must be used judiciously and by skilled staff should be implemented. IPM systems that incorporate botanical pesticides will eliminate the overuse of synthetic pesticides instead of the more common practice of using either of the two. For these reasons, small farmers and family farmers need to take proper precautions and ensure both human and environmental protection; [51, 52].

In this chapter, we'll look at using botanical products to control insects in crop production. From a chemical standpoint, we offer a summary of botanical insecticides and classify their effects on insects.



**Figure 1.** Differences between botanical and synthetic pesticides with respect to mode of action, use, persistence and effect on ecosystem.

## 6. Botanical insecticides types

### 6.1 Fatty acids and esters

The single application of allyl cinnamate can result in highly toxic effects in the *S. littoralis* larval stages of the cabbage whitefly and onion maggot. Ethyl (E, Z, E)-2-decent (Zeder's) was confirmed to be an effective insecticide against the Cimex, while Schmidt et al. [53] were unable to obtain an example for testing. Studies on fat-metered homogenate suggested that fat methyl esters (derived from *Solanum chlamygnidense*) have larvicidal properties for the cinque feed vector, *Culex. quinquefasciatum* [54]. Studies show that saturated and polyunsaturated acids (particularly C8, C9, and C10) work against houseflies, horn flies, and stable flies, respectively a fatty acid mixture (C8910) has shown to be both toxic and refractive to an insecticide-resistant *Anopheles* mosquito strain. In the literature by Youssef et al. [55], it was found that the larvicidal activity of linoleic acid was active against *S. littoralis*, and the larval weight was reduced.

### 6.2 Glycosides

In general, plants use cyanogenic glycosides in defense against their herbivores, although some species have been observed to use them for purposes of protection as well as for damage by certain pests. Velu et al. [54], discovered that the digitized glycoside (purple root), sourced from *Digitalis purpurea*, *calotropis procera*, was effective against both larval and adult stages of the camel tick ticks, as well as against *Azadirta andneemidos* genuses, while "kinds, in combination with *hyaliqueinul* bearing Neem oil and *Proxeebrin acedra* on a bioassay, showed digitoxin from *purpurean digitalids* could hold against various species of camel, while proven in addition to all lar and adult stages of *Hyommadrromesis rajene* had the proper concentration. Additionally, it discovered that Viscin-2 and Vtsin, which serve as growth-inhibiting photo plastic herbicides for insects, also prevent the larva of the cotton aphid species from gaining weight. Have acridglycides (from Bothidae and Mucroneidae), they do not possess the protein insect binding of gypsophilla (*L. dispar*, *N. coenia*, and, to be more precise, juneids (*Lymriidae* and *Mucranidae*) do). Since cyanogenic glycosides are found in cassava or other plants, it's also believed that they are components of these plants' plant defense mechanisms. Like most stored-product insecticides, they are effective against: they are effective against both pests and infestations. Cyanohydroarilase has pesticide properties to the lepidozinans (particularly in indoor areas), which means that it is useful as alternative pest control and can be applied to the soil as fumarate [55]. This was discovered by (in this study) on species from the genus of ants of Cassia, which possess a *malathion peroxide* (antimalaria) and are frequently used in malarious regions as antimalarial/ insecticidal activity. The larvae found in *A. gigas*, chinch Bugs from *Glycinequa* have larvicide activity against chinch and malaria visas vectors. The effectiveness of juvenile hormone treatments in pest control is outstanding in recent experiments [56].

### 6.3 Flavonoids

Flavonoids have the potential to be effective in pest-control measures. Flavonoids are important in protecting plants from insect pests and herbivores that feed on plants. Plants are protected from insect pests by flavonoids and isoflavonoids, influencing their behavior, growth, and development. *Pinus banksiana's rutin* and quercetin-3-glucoside inhibit the growth of *Lymantria. dispar* and increase its mortality. Tobacco armament (*Spodoptera litura*) death rates of peanuts enriched in quercetin and rutin glycosides increased. In *Nilaparvata lugens* and herbivores,

three flavone glucosides present in rice impede insect digestion [55]. Insecticide activity against *Callosobruchus maculatus* grubs, flavonoid glycosides derived from *Tephrosia purpuria* were exhibited. Two further forms of flavonoids protecting plants against insects are isoflavonoids and proanthocyanidins. For instance, *naringine procyanidine* suppresses *Aphis craccivora* and herbivores' growth [55]. Quercetin/azadirachtin insecticide can be a safe, efficient insecticide that increases the functioning and non-toxicity of *Euphaedra orientalis* [57]. It is also less environmentally damaging because it is quickly biodegradable. *Acyrtosiphone pisum* was identified by Goawska, Sprawka, Ukasik and Goawski [58], as polyphene-naringenin flavonol (*flavanone naringenin* and *flavonol quercetin*) as a pesticide against Pea aphid. (Aphididae, Hemiptera.). *Tagetes erecta* and *Tagetes patula* contain toxic plant chemicals (flavonoids) that can support their usage in the form of natural insecticides. Quercetin, Kaempferol and RCO, tricin, apigenin + RCO, apigenin and apigenin are efficient insecticides.

## 6.4 Alkaloid

Alkaloids are vital to insect control as they are among the most effective natural insecticides in nature. The authors concluded that pyridine alkaloids from castor bean proved effective against the malaria-carrier mosquito species *Anopheles gambiae*. The oil extracted from the leaves of *Ruta chaloedermis* powder and quinone herbals had larvicidal and antifedi parasiticidal activity against caterpillars such as the larvae of the coastal *Helio thopygea* butterfly. Antifeedant and larvicidal effects were found in the perularia root alkaloids extract, that regular antifeedant and larvicide did Praline and piperidine alkaloids have activity against mosquito larvae *Arachis hypogaea* alkaloid has a larvicidal function [58, 59].

## 6.5 Nicotine

Nicotine, the addictive component of tobacco, is a tranquilizer in tobacco plants (*Nicotiana Tobacco*) and other *Nicotiana* species. Heavy doses because of respiratory paralysis are also exceedingly toxic. Nicotine is a ganglion cholinergic agonist with a wide spectrum of pharmacological effects mediated via autonomy, supranational medulla, neuromuscular crossover, and brain bonding to receptors [60].

## 6.6 Essential oils

Regnault-Roger and Philogne [61] state that natural chemical pesticides are plant extracts that are excellent alternatives to biological or synthetic pesticides. Additionally, chemical pesticides are difficult to use because of insect resistance to synthetic compounds, which has resulted in billions of dollars of food production losses annually. In addition, the United States Food and Drug Administration (FDA) accepted that botanical pesticides (essential oils), which are protected from non-target and cross-and multi-resistant to insects, are more likely to cause ozone depletion, neurotoxicity, carcinogenicity, teratogenicity, and mutagens [61].

The rising use of plant-based insecticides by organic growers has increased aromatics in essential oils extraction due to the rise in plant-based products and health-conscious consumers. These ingredients are used to kill and repel insects [60–62]. According to some researchers, essential oils are effective against bedbugs, ants, moths, and particularly the predatory, voracious, and especially larvae of the Gypsy moth, some types of insects. One observes that Peppermint oil is effective against Ants, Flies, Nips, and *Varroa most stumptica*; additionally, proves that it is effective against Both *Callospora*, *Tribrix*, and *Varrota* powdery locust. *Trichosomyia of uremia*

larvae has Larvicide effective against *Aedes aegypti* mosquitoes and *C. Quinquemaculatus* [58, 61–64].

Nepetalactone is a very good active element for the repellent of mustaches, bees, and other flying insects in Catnips (*Nepeta cataria*). In repelling mosquitoes, it is more effective than DEET. The *Aedes aegypti* mosquito, which distributes the yellow fever virus, is highly effective. In contrast, *Zingiber* Official Rhizome and *Piper Cubeba* berries oil exhibited insecticide and anti-favoring activities in *Tribolium castaneum* and *Sitophilus oryzae*. *Tagetes* species oil exhibits an anti-insect effect against *Ceratitidis capitata* and *Triatoma infestans*. *Melaleuca alternifolia*'s fumigant toxicity to *Sitophilus spp.* Healthy cockroach repellents are rosemary, oregano, yarrow, eucalyptus and mint oil. *Supella longipalpa* is an oregano oil-killing parasite. It detected that insecticidal in larvae from the pine procession moth, *Thaumetopoea pityocampa*. *Laurus nobilis* essential oil has also been discovered toxic against *rhyzopertha dominica*, and *T. castaneum*. *Lavandula hybrida*, *Rosmarinus bureinalis* and *Eucalyptus globulus* have killed the adults of *Acanthoscelid obtectos*. *Tagetes minuta* essential oil has also been Acaricidal and repellent for *cochliomyia macellaria*. Basil oils contain eugenol, a potent anti-mosquito, and linalool, a harmful substance to *Bruchid zabrotes fasciatus* and other pests. *Lasioderma serricorn* repels *zingiber zerumbet*'s essential oil. *Juniperus procera* essential oil has been proven to help repel *Anopheles arabiensis* malaria mosquito. All of the instances include terpinene-4-ol, 1,8-cineol, verbenone, and field horn. Anti-piling insects, insecticides and mosquito bites in adults were prevented by Eucalyptus oil, *Aedes aegypti* larvae have poisonous substances of *Eucalyptus globules*. Burning *Eucalyptus citriodorica* sheets are used as a mosquito repellent in Africa. Moreover, the CDC (Centers for Disease Control and Prevention, USA) advocated utilizing the West Nile virus to protect it from neurological disease and even from death and transmitted by mosquitoes using the lemon *eucalyptus* oil (p-menthane-3,8-diols, PMD, as an active ingredient) [51–54, 58, 60, 62, 65–68].

## 6.7 Spinosads

Spinosad was originally insular in Actinomycete soil, the *Saccharopolyspora spinosa*, and combines the spinosyns A and D. *Spinosads* can be used against a large variety of moths, leaf miners, and foliage-feeding beetles. Spinosads possess novel target sites, which are distinct from other insecticides' nicotinic acetylcholine receptors, which leads to dysfunction of the neuromuscular system, which disrupts the acetylcholine neurotransmission [69, 70].

## 6.8 Sabadilla

Sabadilla is a Venezuelan seed and is a source of schistocyanatelenene. It is among the most dangerous recorded botanicals, with a 5,000 mg/kg LD50 for mammals. Sabadilla assists in getting a smooth surface but can also act as a stomach poison. Reinforced insecticides are similar to the other type of botanical insecticides in that they are long-lasting, but they have less residual action in sunlight and break down quickly (rainfall). Sabadilla impairs sensory, motor, and respiratory nerve functions paralyze and kills [71]. Caterpillars, leafhoppers, thrips, stink bugs, and squash bugs are all susceptible to it.

## 6.9 Rotenone

It is derivable from the two plants' roots. Both are legumes from East India, Malaya, and Southern America, *Lonchocarpus* sp. and *Derris* sp. The toxic botanical

insecticides of rotenone are moderately toxic and the DL50 to mammals is 132 mg/kg [66]. Indeed, rotenone, two widely used synthetic derived insecticides, is more harmful to mammals than carbaryl and malathion. Also, fish is highly toxic to rotenone [53]. The botanical insecticide is a poison of the stomach and touch. It takes several days to destroy pests, but the pests avoid feeding almost instantly. Rotenone acts slower than most other botanic insecticides. The air and sunlight decay quickly. Rotenone prevents the breathing of complex I by electron transport. In many insects and mite pests, Rotenone exhibits a wide range of behavior, such as feeding beetles, caterpillars, lice, mosquitos, fleas and flames [72].

### 6.10 Ryania

Ryania's active ingredients come from the roots and woody stems of the Trinidadian plant *Ryania* species [71]. *Ryania* is a low-toxicity mammalian pathogen with a median lethal dose (LD50) of 750 mg/kg that acts as a touch and stomach poison. Among the botanical insecticides, it has a long residual effect. This botanical insecticide works by binding to calcium channels in the sarcoplasmic reticulum, which especially affects muscles. Calcium ions flood the cells, resulting in rapid death [72]. *Ryania* is most effective against caterpillars (such as the codling moth and corn earworm). But, it is also effective against various other insects and mites, including the potato beetle, lace bugs, aphids, and squash bug [73].

## 7. Repellents

A botanical pesticide has a repulsive quality to prevent an insect pest from the treated materials and protect a crop with a minimal environmental impact. Since it promotes olfactory or other receptors to remove the insect pest from the treated materials. Botanical pesticides are considered safe in pesticide control since they do not leave any pesticide residue and make it safe for humans, the climate, and the ecology. Essential *Ziziphora tenuior*, *Myrtus communis*, *Achillea wilhelmsii* and *Mentha. piperita* oils have repellent effects on human floats. Due to the repellent activity of essential oils on *Tribolium confusum*, their efficacy in organic food safety for *M. piperita*, *Rosemary officinalis* and *Coriandrum sativum* oils. It found that *T. castaneum* and *L. serricumis* essential oils, both of which can remain dormant for several years, were susceptible to pesticides with good residual activity. One repellent's efficacy is to one variety of insect is likely attributable to the non-persistent insect oil sample, and the other is too different ones may be due to anti-insect mechanisms. Essential oils of *Cymboplocnsus* and *Tmesisohia* were effective in attracting Phlebotomcous mosquitoes, and an Arsenophon were unsuccessful in keeping them away from their target different types of repellents influence the efficacy, dosage, use of differing concentrations, human health and attractiveness as targets, insect species, and repellent qualities and insect response vary, as a lot, all of which affect the amount of perspiration loss, and abrasion as well as sensitivity, and insects have numerous alternatives to make it hard to get rid of also had a noticeable activity to repel the mosquitos, namely *Amblyomma celtisagrus* *Origanum* had more that *Origanum* no doubt recognized as an adjuvant activity, I wonder if these studies were conducted under similar conditions (L.). Carvacrol and thyme were used to ward off infections caused by Americanum and Americanum treated rats could avoid infections. Since carvone and thymol in Carvacrol-rich essential oil is associated with reduced mosquito and tick abundance, it may have potential as a pest control substance [70, 71].

Different natural fatty acids with certain acetylcholinesterase and octopaminergic receptor effects have insecticide characteristics. A saturated mixture of fatty acids made up of octanoic acid (also called caprylic acid), nonanoic acid, and decanoic acid (sometimes referred to as capric acid) were repelled from Horn Flies, known together to be 'C8910 acids' (C8, C9, and C10 mixture). C8910 acids, which dissuade horn from feeding by more than 85%, strongly repelled the pest. More than 50 percent of the animals have shown C8910 acids to elicit feeding deterrent and anti-feeding. Cuminy alcohol, cuminaldehyde and  $\alpha$ -phellandrene Monoterpenoids as well as oleic, linoleic and methyl oleate naturally occurring synergized with DEET and cuminy alcohol, cuminaldehyde and phellandrene Monoterpenoids and [72, 73].

## 8. Antifeedant/deterrents for feeding

Botanical pesticides make the treated materials unattractive or unpalatable to insects, preventing or disrupting feeding. Insects dwell on the treated material indefinitely until they die of starvation [73] found that *M. alternifolia* oil and its chemical compounds had *helicoverpa armigera* Hubner antifeedant capabilities. *Dinoderus porcellus* may have been caused to die by tannins, saponins, flavonoids, steroids, and alkaloids in the leaf extract *Khaya senegalensis*. The primary constituent of neem, azadirachtin, was discovered as the main insecticide element. It operates as an antimicrobial, repellent, and repulsive, making insects sterile by blocking oviposition and inhibiting the formation of males' sperm. It observed that the impact of 1,8-cineol on termites in Galangal is antifeedant, repellent and poisonous. *Gliricidium sepium* methanol excerpts are rich in terpenoids, coumarins and phenols. That indicates that some of the plant's active components prevent larvae from feeding, while others damage the hormonal balance or make the meal taste terrible. These active chemicals can prevent eating by acting directly on the chemosensilla larvae.

## 9. Toxicity

Some botanical pesticides are poisonous to stored-product insects, resulting in their demise. Since mitochondrial poison blocks the electron transport chain and inhibits energy production, rotenone is classified as a toxic substance. Since it must be consumed to be effective as an insecticide, it is a stomach poison. Against granary weevil adults, the essential oil of *Lavandula angustifolia* showed strong fumigant and contact toxicity. Furthermore, granary weevil orientation to an enticing host substrate can be disrupted by heavy repellent action. Fumigant toxicity was demonstrated against the stored grain pest *Callosobruchus Chinensis*. Cinnamon, clove, rosemary, bergamot, and Japanese mint essential oils all showed promise as potential natural fumigants or repellents for pulse beetle control. Adult and egg mortality for head lice was linked to the use of (geraniol, citronellol, 1,8-cineole, linalool,  $\alpha$ -terpineol, nonyl alcohol, thymol, menthol, carvacrol, and eugenol) essential oils. *Thymus vulgaris* essential oil was found to have important activity against *Culex pipiens*. It found that the essential oil of *Echinops grijsii* roots and isolated thiophenes have a lot of potential for controlling *Aedes albopictus*, *Anopheles sinensis*, and *C. pipiens pallens* larvae and could be used in the hunt for fresh, safer, and more efficient natural larvicides. Toxicity and repellent activity of the zerumbet (*L.*) Smith (Zingiberaceae) essential oil that contains caryophyllene component against cigarette beetles (*L. serricornis*). Extracts from *Heracleum platytaenium*

and Humulus, as well as insecticides, have great potential in the administration of *Leptinotarsa decemlineata* larvae. The toxicity of limonene, linalool, and pinene on adult Mediterranean fruit flies. DNA damage caused by altering enzyme systems (acetylcholinesterase, acid phosphate, alkaline phosphate, lactate dehydrogenase and phenol) was identified after treatment with essential oils *Citrus aurantium*, *Eruca sativa*, *Z. officinale* and *Origanum majorana*, *R. Dominica*, *T. vulgaris* oil has the highest insecticidal toxicity, followed by *R. graveolen*, *C. aurantium*, *L. petersonii* and *A. millefolium* oils. The insecticidal toxicity to *P. shantung* geneses nymphs of *T. Vulgaris* oil has been 1,3 times greater compared to adults of *P. shantung genesis*. The difference in plant-derived oils insecticidal toxicity may be further clarified by species-specific reactions to plant species, plant compounds, adult and height *P. shantung genesis* and nymph weights [61, 63, 64, 66–68, 72].

## 10. Development inhibitors and growth retardants

Botanical pesticides harmed insect growth and development, decreasing the weight of larvae, pupae, and adults and lengthening the stages of development. Plant derivatives also reduce the survival rate of larvae and pupae, and adults. Azadirachtin and neem seed oil both showed an 80 and 77% increase in aphid nymph mortality while the development time of those who survived in adulthood was increased. Many botanical insecticides have demonstrated an impact on the development, growth and adult growth of insects [15, 20, 25, 30].

## 11. Attractants

Insect attractants are botanical chemicals that cause insects to travel in a direction toward their source. The effect is on gustating (smelling) and olfactory (smelling) receptors or sensors. Cruciferae seeds isothiocyanates, molasses, and bark terpenes, together with pheromones, are natural attractions for certain Cruciferaea insects and bark beets. *Psila rosae* and Lepidoptera draw from *Araujia serisoferae's* onion propyl mercapto N and *Araujia serisofera's* phenyl-acetaldehyde is derived from Araujia flowers. Insect attractants can be utilized for the monitoring of insects in three ways. In lustful insects, traps or poison apples are covered with insecticide and insects distract from the typical matching, food aggregations or oviposition. They do not damage insects and hence do not interfere with the ecology. They are employed due to mis-alimentation or the creation of unfertilized eggs, leading insecticide to improper oviposition sites, diminishing their population. It is not the only check measure utilized in an integrated control program [45].

## 12. Future role of botanicals insecticide

What function in plant defense and other uses will botanical pesticides play in the near future? Botanical products play a larger role than currently in developed countries; even in organic food processing, they are difficult to imagine. Organic production in Europe and North America is expected to increase by 8 to 15 percent annually (National Research Council 2000). Botanical products are among the least competitive in those markets. Microbial insecticides and spinosads have proved to be safe and cost-effective even there, however. Botanical products can be better positioned than assumed to be stand-alone items as items in crop protectors, especially since *Bacillus thuringiensis* and spinosad are resistant to diamond moth

abuse. Botanical products face tremendous competitive challenges in traditional agriculture for synthetic insecticides, such as 'reduced risk' neonicotinoids of the latest generation. Due to the decreased use of biopesticides (from 652 to 472 t) in California, the use of reduced-risk pesticides grew more than thrice between 1998 and 2003 (from 138 t to 483 t).

Botanicals are also declining, representing less than 1 percent of California's biopesticide use. Overall, the botanicals are hard to assume that they are best applied in wealthy countries in public health (mosquitoes and cockroaches) and consumers (home and garden). In underdeveloped nations, where farmers cannot afford conventional pesticides and where the traditional use of plants and plant derivatives to store the safety of products is well established, the true usefulness of botanical pesticides is more acknowledged. Although traditional pesticides (for example, through government aid) are available to farmers, a lack of literacy and protection equipment leads to thousands of poisonings every year.

Traditional West African plants that provide postharvest insect protection have received more attention. Some of the most effective plants employed are widely known for their active substances (e.g., *Tephrosia* rotenoids, *Nicotiana* nicotine, *Securidaca* methyl salicylate, and *Ocimum* eugenol), while others are volatile, which are a natural spray that destroys adult plagues and their descendants. Those materials are relatively stable in their current form, according to at least one evaluation.

Certain plants can effectively preserve grain against storage pests in developing nations. Many of these plants have a tropical spectrum and are possibly cultivable in underdeveloped nations. Pesticide efficacy in plant adoption is, however, only one element. The logistics of the processing, preparation, and consumption of botanical products will reduce their use [72]. Maybe, rather than screening new plants and insulate new bioactive compounds that pick up our interests, are not likely to be useful, this scientific community needs to focus its efforts on growing and applying existing botanicals.

### **13. Conclusion**

The natural environment offers a multitude of different plant species which have helped develop cures for human, animal, and plant sicknesses. The use of synthetic pesticides is often questioned on environmental health, strict regulation of their use, and strict control on pesticide residues in agricultural produce demand are all required precautions to ensure that must be taken. Pesticides produced synthetically are still hazardous to both environmental health, animals, and human beings subject to toxic or otherwise hazardous chemicals that remain on the ground or in the atmosphere after their use. Concerning their regenerative nature and contribution to human and environmental protection, botanicals must be reconsidered and their effectiveness in controlling crop pests.

Large-scale agriculture could be practiced in marginal lands where food is not in abundance to escape the competition with source plant extracts. The development of such crops in semi-arid areas could benefit communities. Rhizomes and herbaceous plants may be grown in areas under a tree canopy of shortness but with minimum disturbance to the trees. Biochemical compounds that have pesticide properties in plants are produced through biotechnological collaborations.

The natural presence of insect-based plant compounds, as a precious alternative to synthetic or chemical pesticides, are botanical insecticides used for the protection of crops from negative or side effects in conventional insecticides. The chemical features of botanical pesticides, notably repellents, feeding dissuasive

agents, toxicants, growth retardants and chemosterilants and attributes (essentials, flavonoids, alkaloids, glycoside, ester, and fatty acids), and their impact on insects in various forms. Instead of synthetic insecticides, botanical insecticides must be used, and organic cultivators in developed countries accept certain botanical insecticides. We, therefore, advocate the use and encouragement of botanical insecticidal products and research into new sources of botanical insecticides are being conducted.

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### **Conflict of interest**

The authors declare no conflict of interest.

### **Notes/thanks/other declarations**

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