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An Overview towards Botanicals from Medicinal Plants in Stored Insects

Shalini Jiwan Chahande [a], Mahendra Kumar Yadav [b++], P. Amrutha Lakshmi [c#], Muneeshwar Sharma [d†], T. Sampathkumar [e‡], T. Rani [f^], Parul Dhar [g], Lalit Upadhyay [h##] and G.Malathi [i#^*]

[a] *Department of Biochemistry, Seth Kesarimal Porwal College of Arts and Science and Commerce, Kamptee, Affiliated to Rashtrasant Tukadoji Maharaj Nagpur University, Maharashtra, India.*
[b] *School of Agriculture, RNB Global University, Bikaner, Rajasthan-334601, India.*
[c] *Government College (A), Ananthapuramu, Andhra Pradesh-515002, India.*
[d] *KVK Jammu, SKUAST-Jammu, India.*
[e] *Agricultural College and Research Institute, Madurai – 625104, India.*
[f] *Cotton Research Station, Tamil Nadu Agricultural University, Veppanthattai, Perambalur (Dist.), India.*
[g] *Department of Life Sciences, Rayat Bahra University, Mohali, 140103, India.*
[h] *Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu, India.*
[i] *Horticultural Research Station Yercaud Salem, Tamil Nadu, India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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[++] *Assistant Professor;*
[#] *Lecturer in Botany;*
[†] *SMS Plant Protection;*
[‡] *Assistant Professor (Agronomy);*
[^] *Assistant professor (Entomology);*
[##] *Scientist Agroforestry;*
[#^] *Associate Professor and Head;*
**Corresponding author: Email: malathihort@gmail.com;*

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ABSTRACT

The use of synthetic chemical insecticides is not allowed or is used restrictively because of the problem of residues and the health risks of consumers. With this in mind, plants are needed that can provide potential alternatives to the currently used insecticides, as they are a rich source of bioactive molecules. Available literature indicates that the plant could be a source of new insecticides. Preventing food loss during post-harvest storage is of the utmost economic importance. Integrated pest management is now a widely accepted pest management strategy, including post-harvest pest management using chemical insecticides with disinfectants. Therefore, there is great potential for insecticidal compounds derived from plants. This article focuses on the current status of botanical insecticides as grain protectors and how they work. The control of this insect is highly dependent on the use of synthetic insecticides and disinfectants. But its widespread use has created serious problems. The increasing resistance of stored product insects to conventional synthetic pesticides, along with growing concerns over environmental and human health impacts, has spurred interest in alternative pest management strategies. Botanicals derived from medicinal plants have emerged as promising candidates due to their diverse bioactive properties and eco-friendly nature. This review provides a comprehensive overview of the current knowledge on the use of botanical extracts for controlling stored insects. It discusses the various modes of action, including repellency, toxicity, and growth inhibition, and highlights the most effective plant species and their phytochemical constituents.

Keywords: Medicinal; plants; disinfectant; insecticide; health risks; compounds; dependent.

1. INTRODUCTION

“The loss of grain due to insect attacks during storage is a serious problem, especially in developing countries. Insect losses are more than direct losses. High content of insect remains preserved cereals that are not fit for human consumption and food loss and in terms of quality and quantity. Changes caused by infection of insects during storage, the environment can cause hot, wet "hot spots" that suitable storage conditions for mushrooms that cause additional losses. It is estimated that more than 20,000 types of fields and storage pests destroy about a third of the world food production worth more than $ 100 billion a year of which the largest losses (43%) in developing” [1-2]. “Natural products from plants are shown as powerful two-rational alternatives to synthetic insecticides for integrated management of insects after the harvest. Pesticide plants, as an alternative to synthetic pesticides, are known for their non-cytotoxicity, their ease of biodegradation and their modeling of host metabolism. Pesticide compounds grow quickly, making them greener than synthetic compounds” [3-5]. “In India, there is a high availability of plants that have been characterized by their efficiency, growth, proliferation and low availability” [6,7]. “In the 1960s, their negative impact on the environment and human health became apparent. The reasons for using synthetic pesticides are their direct impact on pests, which eventually led to trade in agricultural products with pesticide residues. More than 600 species are considered pests of stored products. Among insects, the main pests are roaches, ticks, and beetles. Beetles are the largest taxon of insects and the number one order of stored product pests” [8]. “In addition, this group of insects is often resistant to insecticides and can survive in dry conditions and absorb water from poorly hydrated products. Therefore, their population is difficult to control in food storage areas. Different groups of insecticides are used against pests of coleopterans (cockroaches and ulcers), such as synthetic insecticides, fungal substances and substances of plant origin (for example, essential oils or alkaloids). Natural products make up a small percentage of the currently used insecticides” [9-11]. In some cases, we have not fully discussed some active compounds due to inconsistencies in the available data. However, if necessary, a brief overview was provided. We are also trying to discuss possible methods of using bio insecticides to protect stored crops, as well as future use of plant compounds in the future to protect stored crops. During severe infestations, skin and submerged bodies accumulate in fluffy masses which can explode. He is an ordinary resident of household dust and is very allergic [12-15]. A vacuum cleaner is required if the sites are severely infected. These signs indicate that the storage conditions are too humid. Contaminated materials should be

Table 1. List of grain pests and their life cycle

Pest Name	Common Host Grains	Life Cycle Stages	Duration of Life Cycle	Key Characteristics
Rice Weevil	Rice, Wheat, Maize	Egg, Larva, Pupa, Adult	26-32 days	Females lay eggs inside the grain kernel; larvae feed inside the grain.
Lesser Grain Borer	Wheat, Barley, Rice	Egg, Larva, Pupa, Adult	30-45 days	Highly destructive; bore holes in grains during larval and adult stages.
Red Flour Beetle	Wheat, Maize, Processed Grains	Egg, Larva, Pupa, Adult	20-25 days	Feeds on broken or damaged grains; thrives in stored grain products.
Sawtoothed Grain Beetle	Oats, Corn, Processed Grains	Egg, Larva, Pupa, Adult	30-50 days	Flattened body allows it to penetrate tight spaces in grain storage.
Granary Weevil	Wheat, Barley, Corn	Egg, Larva, Pupa, Adult	35-40 days	Adults cannot fly; larvae feed entirely within the grain kernel.
Indian Meal Moth	Maize, Rice, Processed Grains	Egg, Larva (Caterpillar), Pupa, Adult	28-35 days	Caterpillars create silk webs in stored products, contaminating food.
Angoumois Grain Moth	Wheat, Corn, Barley	Egg, Larva, Pupa, Adult	4-6 weeks	Eggs are laid on grain surface; larvae bore into kernels to feed.
Khapra Beetle	Rice, Wheat, Barley, Maize	Egg, Larva, Pupa, Adult	4-6 months	Highly resistant to starvation and desiccation; major quarantine pest.
Maize Weevil	Maize, Wheat, Barley	Egg, Larva, Pupa, Adult	30-45 days	Infests whole grains; adult weevils are capable of flight.
Confused Flour Beetle	Wheat, Corn, Barley	Egg, Larva, Pupa, Adult	26-35 days	Feeds on damaged grains and processed products; common in flour mills.

Source: Shadia 2011 [7]

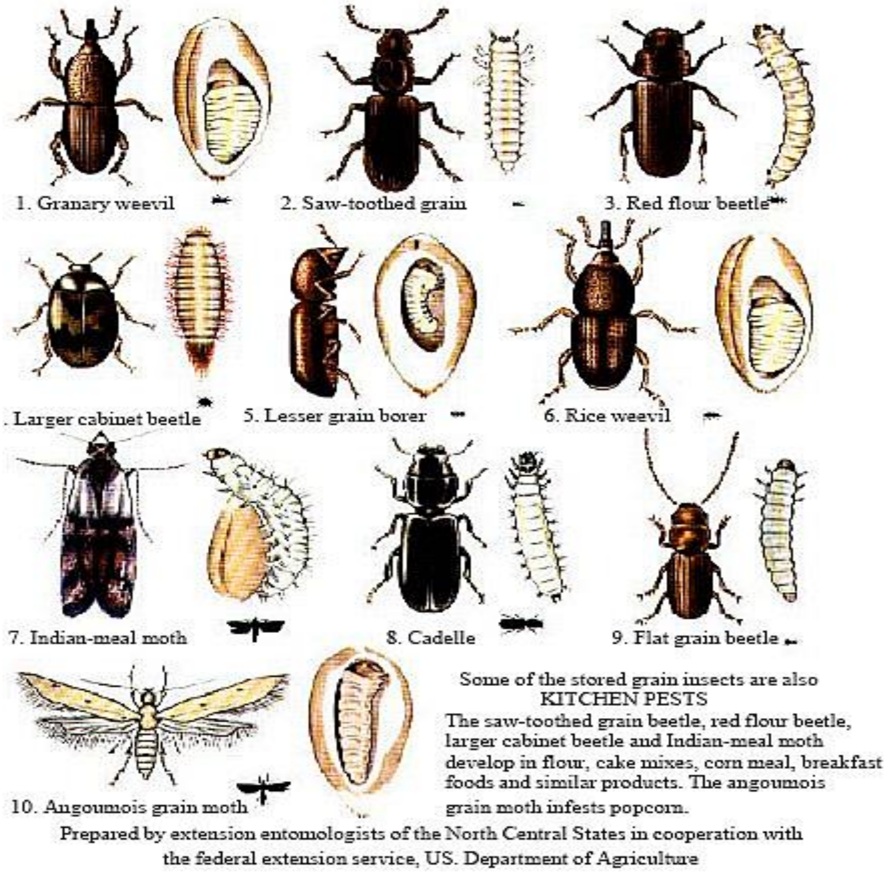

Fig. 1. Microphotographs of kitchen pests

removed and contaminated areas should be thoroughly cleaned. Botanical insecticides currently play only a minor role in insect control and plant protection; increasingly stringent legal requirements in many jurisdictions have prevented a handful of botanists from entering the market in North America and Europe for the past 20 years [16-19]. However, public health requirements and regulations create opportunities for the use of plant products in industrialized countries, in situations where human and animal health is critical, to combat pests in and around homes and gardens, commercial kitchens, and storage. food and meal. in pets [20-23].

2. USES OF BOTANICALS FOR STORED INSECTS

“The biological nature of botanical pesticides accelerates their degradation and therefore does not accumulate in the environment, for example in water and soil, thereby eliminating contamination risks” [24]. “Vegetables have been used since time immemorial to protect stored food from common pests. They act as repellents, antioxidants, toxins and act as natural defenders of grains, acting as chemo stimulants / reproduction inhibitors or inhibitors of insect growth and development” [25,26]. “The concept of using natural sources to a store of various household items has been around for centuries. When modern means were not available. Here evidence of ash, sand, herbs, and herbs used in ancient civilization that was used for expansion shelf life of many foods. Many of these practices they find their confidence even in the modern era, as these methods they are profitable and sustainable. The main activity is due to the presence of volatile lipophilic essential oils secondary metabolites. Many spices and herbs and their extracts are known to have insecticidal properties, which often present in the essential oil fraction” [27-31].

3. TRADITIONAL METHODS FOR STORED INSECTS

“Only some other plant materials show a decrease in commercial use as insecticides, as the wood of the Caribbean tree *Ryania speciosa* (Salicaceae) contains a number of unique alkaloids that block neuromuscular compounds. Shredded stem wood containing Al% ryanodine and its alkaloid analogs was used to produce organic fruits. *Quassia amara* (Simaroubaceae), a small tree from Brazil, contains bitter triterpenoids. The wood chips and bark of the land of this species and the associated tree Ailanthus altissima have traditionally been used as an insecticide. Sabadilla is a powder based on ground seeds of *Schoenocaulon officinale* (Melanthiaceae), a plant from South America. Pure active substances, the steroid type alkaloids, are quite toxic to mammals, but, like rotenone, the concentration of alkaloids in powdered seeds is quite low, which provides a margin of safety for the user" [32-35].

a. Pyrethrum: Pyrethrum is the most widely used botanical insecticide in the world and is known as a rapidly disintegrating household spray.
b. Pyrethroids: It is synthetic materials designed to imitate natural pyrethrum but are much more toxic and long lasting.
c. Rotenone: Rotenone is an isoflavonoid obtained from the roots or rhizomes of tropical legumes in the genera Derris, *Lonchocarpus* and *Tephrosia*.
d. Nicotinoids: They have been previously referred to as nitro-guanidines, neonicotinyls, neonicotinoids, chloronicotines and more recently as the chloronicotinyls.

4. FUMIGATION

The currently used fumigants, phosphine, methyl bromide, This is consequence, there is an increasing necessitates for development of safe alternative that could replace the toxic fumigation against stored product insecticides. *Sitophilus zeamais* is and the red-flour beetle, *Tribolium castaneum* and demonstrates both repellent and fumigant properties. The exact mode of action of these oils as fumigant is unknown but the oils mainly act in the vapor phase via respiratory system. Alkaloids isolated from *Annona squamosa* have shown larvicidal growth-regulating and chemosterilant activities against *Anopheles stephensi*, *Callosobruchus chinensis*, causing nearly 100% sterility at a concentration of 1.5%. Fumigation plays a major role in insect pest elimination in stored products. Currently, phosphine (from metal phosphide preparations, cylinderized formulations and on-site generators) and methyl bromide (available in cylinders and metal cans) are the two common fumigants used for stored-product protection world over.

The following areas of research need attention for the exploitation of these natural products as alternative fumigants for stored-product insect control:

1. Stability of plant products as fumigants.
2. Screening of plant essential oils/compounds for fumigant toxicity must include egg and pupal stages, diapason larvae or mixed-age cultures of target insect species
3. Validation of mixtures containing carrier gases or adjuvants for essential oils.
4. Sorption and tainting aspects must be addressed for potent essential oils/components with different types of food commodities
5. Fumigant toxicity of essential oils/constituents to *C. cephalonica*, *A. fasciculatus*, *C. serratus*, *Cryptolestes* spp. and insect pests of animal products (except D. maculatus).
6. Fumigant action of compounds from neem seed or oil, seaweeds and other marine natural products needs to be investigated [36-39].

5. FUTURE OF BOTANICALS

Vegetables are useful in the case of documented resistance of the diamond moth to *Bacillus thuringiensis* and spinosad because of. Plants are useful in case of documented resistance to diamond moths against *Bacillus thuringiensis* and spinosad due to overuse [40]. Vegetables help prevent the discharge of thousands of tons of pesticides to Earth; they are safer for the user and for the environment because they decompose by microorganisms and decompose into harmless compounds in a matter of hours or days in the presence of sunlight.

6. INSECTICIDAL ACTIVITY

The percentage of variation in the sensitivity of stored grain insect pests is high in response to toxicity of volatile compounds, currently control of stored-product insects of cereals in store were ... In this work extended to the search of insecticidal activity are observed are, *Morinda lucida*, *Callosobruchus maculatus*, rice weevil, *Sitophilus zeamais* Motschulsky., *Sitophilus oryzae* L., *Callosobruchus maculatus*, *S. oryzae*, *R. dominica*, *P. interpunctella*, So, we recommended using botanical insecticidal and being promoted and research is being conducted to find new sources of botanical insecticides. Some recent publications are cited in the ascending order which covers the studies on Botanicals from Medicinal Plants in Stored Insects, case studies, research and review communications are as follows:

7. CONCLUSION

The fact that small holder farmers have the knowledge of using pesticide plants which they hardly use, there is a need of a research based solution on better ways to make the knowledge useful. Practical research based in field situation and that directly involve small scale farmers is important to put into practice experts' understanding. There have been many laboratory studies of plant products as fumigants against insect pests of stored foods. In addition to toxicity tests, special attention was paid to elucidating the way it acts on insects. For some natural compounds, the effect on food quality, germination and seedling growth was studied. However, the following research areas require special attention to study these natural products as alternative fumigants for controlling insects in stored foods.the utilization of botanicals derived from medicinal plants presents a promising and sustainable approach to managing stored insect pests. These natural compounds offer a safer alternative to synthetic pesticides, reducing the risk of environmental contamination and human health hazards. The diverse modes of action exhibited by botanical extracts, such as repellency, toxicity, and growth inhibition, contribute to their effectiveness in pest control. However, to fully realize the potential of botanicals, further research is needed to identify the most potent plant species, optimize extraction methods, and understand the mechanisms underlying their insecticidal properties. Additionally, the development of standardized formulations and field trials will be crucial for the successful integration of botanicals into pest management programs. By continuing to explore and harness the bioactive properties of medicinal plants, we can enhance sustainable agricultural practices and ensure food security in the face of increasing pest pressures.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors hve declared that no competing interests exist.

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