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Symposium: Plants, as Factories of Natural Substances, Edible and Essential Oils

Influence of plant extracts and essential oils in modern plant protection

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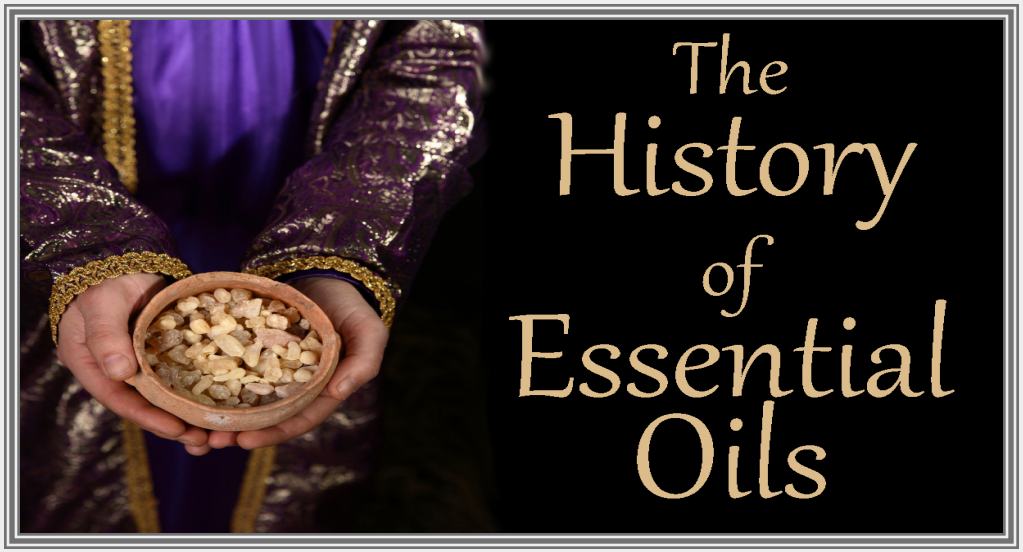


- The benefits of essential oils have been recognised for thousands of years
- Their use is described in the New Testament of the Bible
- In the pre-insecticide era, 2500 BC, herbs and oils were used to protect seeds and stored grain
- A Hindu book from 2000 BC refers to the Neem tree and other plants being used for pest control
- The first botanical insecticide dates back to the 17th century when nicotine from tobacco leaves was used to control plum beetles

Commercial use of botanical pesticides began in the 20th century with the introduction of:

- azadirachtin from seeds - *Azadirachta indica*

- nicotine from plant - *Nicotiana tabacum*

- pyrethrum from flowers - *Chrysanthemum cinerariifolium*

- rotenone from roots - *Lonchocarpus sp*.

- derris dust from roots - *Derris elliption*

Research on botanical pesticides was actively undertaken in the 1980s-90s

Negative effects on non-target species and environmental risks resulting from the massive use of chemical pesticides created:

- renewed interest for botanicals
- research into the development of new synthesized pesticides

Global impact of pests and diseases

- about 2.5 million tonnes of pesticides are used on crops each year
- annual crop lost: 20-25% of potential world yield
- one-third of global production, valued at several billion dollars, is destroyed annually by over 20,000 species of pests in field and storage
- *Botrytis cinerea* and *Colletotrichum spp.* fungi attacks the flowers, fruits, leaves and stems of more than 200 plant species, causing both pre- and post-harvest diseases

Plant protection plays an extremely important role in increasing the production of horticultural crops for our growing populations

Today control of pests and diseases continues attract interest and requires a high level of attention

- quality and quantity; sustainable crop production

- environmental protection of ecosystems and biodiversity

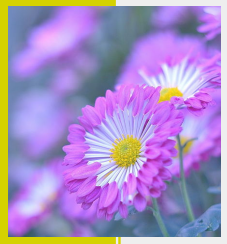
Interest has increased in the use of oils and plant extracts to replace conventional chemical pesticides in pest control

Around 800 plant species exhibit biocidal activity

Some plant products are recommended:

- control pests and diseases post-harvest and in the field
- suppressing soil-borne plant diseases

Why consider botanicals?



- Reduce use of chemicals
- Extend useful life of chemicals
- Resistance management
- Safer to use (plants and human)
- Less phytotoxicity (crop safety)
- Sustainable solutions in agriculture
- Reduce crop losses
- Eco-friendly
- Easily bio-degradable
- Organic farming
- Integrated Pest Management

Most popular herbs that repel insects

Sweet Basil (*Ocimum basilicum*)
Bay Laurel (*Laurus nobilis*)
Lavender (*Lavandula augustifoli*)
Common Tansy (*Tanacetum vulgare*)
Wormwood (*Artemisia absinthium*)
Citronella grass (*Cymbopogon nardus*)

Plants used for pest control experimentally and traditionally in different parts of world:

Allium sativum (Garlic)
Anacardium occidentalis
Annona cuneata Annonaceae
Azadirachta indica (Neem)
Capsicum frutescens (chilli)
Cassia spp. Leguminosae
Eucalyptus spp.
Euphorbia tirucalli (milk bush)
Melia azedarach (Persian lilac)
Ocimum spp. (Basil)
Rhuspyroides
Solanum nigrum (blackpepper)
Tagetes spp. (Marigold)

Orange oil (*Citrus sinensis*)
Lemon oil (*Citrus Medica limonum)*
Mustard oil (*Brassica juncea*
Cashew (*Anacardium occidentale)*
Pepper (*Pimenta dioica)*
Thai ginger (*Alpinia galangal*)
Indian Catmint (*Anisomeles indica*)
Curcuma longa (Turmeric)
Carica papaya (Papaya)
Annona squamosa (Custard Apple)
Vitex negundo (Vitex)
Calotropis gigantea (Calotropis)
Allium cepa (Onion)
Aloe barbedensis (Aloe)

10,000 secondary metabolites have been chemically identified

The major classes of plant compound important for plant chemical interactions:

- **Nitrogen containing compounds**- alkaloids, glucosinolates
- **Phenolics -** simple phenols, flavonoid
- **Terpenoids** - monoterpenes, sesquiterpenes, limonoids

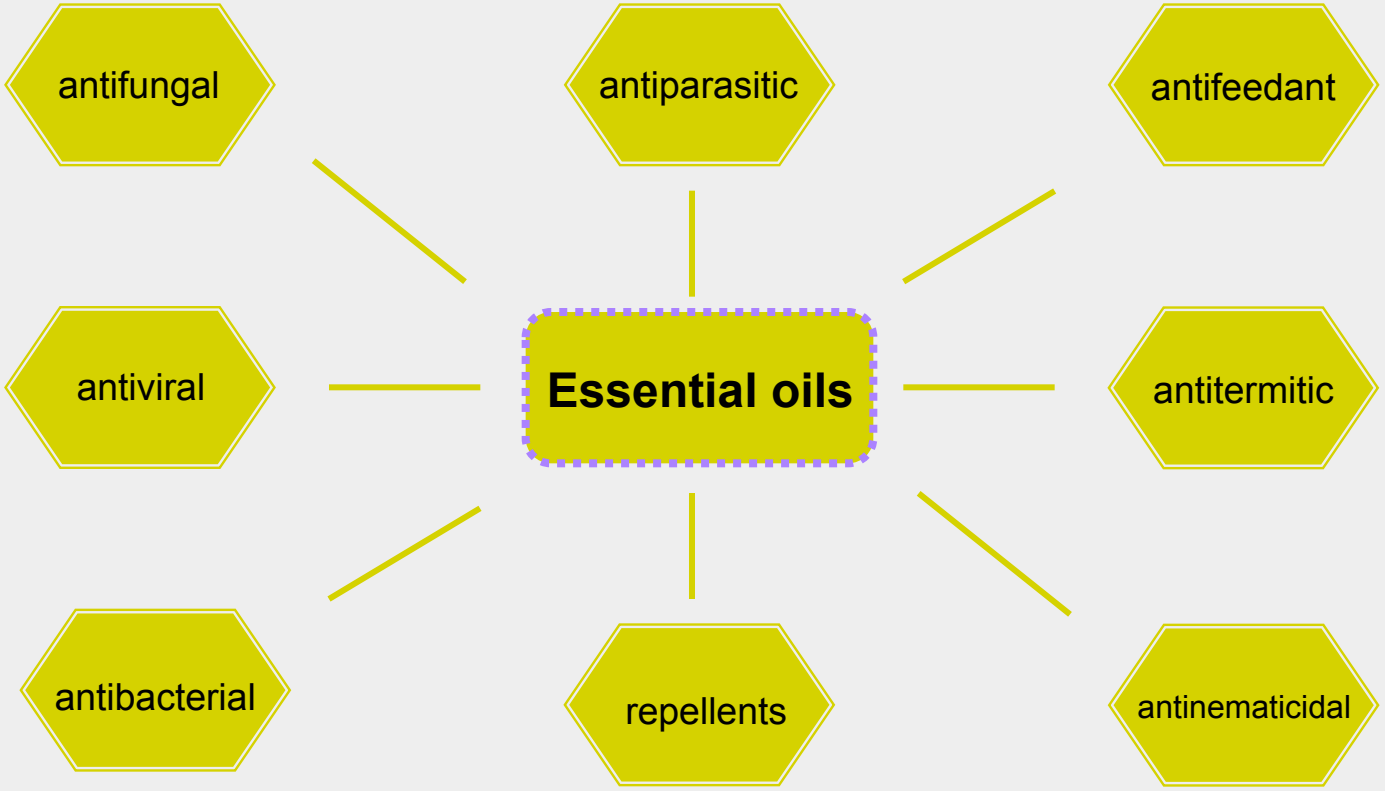
Natural plant oils have many modes of action

Knowing mode of action is integral to improve quality and sustainability of a product

A group of compounds classified as allomones show a broad spectrum of activity against pathogenic fungi and pest insects

Effectiveness of these substances has resulted in development of new botanical pesticides

Essential oils and plants extracts properties




Published papers on botanical pesticides:
To 1980 - 61 articles
1980-2014 - more than 1250 articles

Fumigant

• essential oils and their compounds tested as fumigants include clove, thyme, mint, oregano, lemongrass, cinnamon, rosemary and others

• the mode of action of some oils as fumigants is unknown, but oils mainly act in the vapor phase via the respiratory system.

• essential oils and their constituent compounds are not as active as commercial fumigants

• no established natural fumigants are in use against pests attacking grains, dry stored food and other horticultural products

Antifungal

Plant extracts and essential oils have been indicated for potential control of fungal diseases

• a number of scientific investigations have highlighted the importance and the contribution of many plant families i.e. *Asteraceae, Liliaceae, Apocynaceae, Solanaceae, Caesalpinaceae, Rutaceae, Piperaceae, Sapotaceae*

• only limited data is available on the antifungal activity of essential oils

• need further investigation against fungal diseases in *vitro*, post-harvest and in field conditions

Antiviral

Anti-viral proteins have been extracted from:

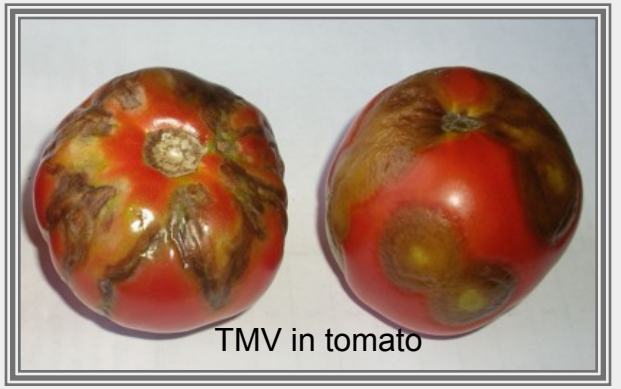
- Great bougainvillea and Chilean Mesquite, effective in reducing sunflower necrosis virus (SFNV) in cowpea & sunflower plants

- Artemisia and Lemongrass, effective in reducing tobacco mosaic virus (TMV) in tobacco plants under greenhouse conditions

- need further investigation against viral diseases in greenhouse and field conditions


SFNV in cowpea


TMV in tobacco


TMV in tomato

Antinematicidal

Plant extracts produce a significant reduction in the nematode population

• the mode of action of most nematicidal phytochemicals is unknown

• development of new nematicides is a difficult task

• commercial nematicides based on plant essential oils have not yet appeared on the market

• need further investigation against nematodes in field conditions

Antitermitic

Fennel *(Foeniculum vulgare)*
Syrian Rue *(Peganum harmala)*
Mint *(Mentha spp.)*
Basil *(Ocimum basilicum)*
Endod *(Phytolacca dodecandra)*

- activity shows promising capability in termite control *in vitro Microterms spp.* and *Odontotermes obesus*

- need further investigation against termites in field conditions

Termites killing Coconut trees in Micronesia

Sugar cane damaged by termite attack

Maize stem damaded by termite *Odontotermes obesus*

Herbicides

Match EX (50% lemongrass oil)
WeedZap (45% clove oil+cinnamon oil)
Matratec (50% clove oil)

The potential of manuka oil as a preemergent treatment that makes it an attractive option for developing a new natural herbicide.

Weeds have a greater negative impact on crop yields than any other agricultural pests

Botanical pesticides research in China since 1930s

Botanical pesticides registered in China

- Matrine - insecticide/fungicide
- Eugenol - fungicide
- Azadirachtin - insecticide
- Rotenon - insecticide
- Pyrethrins - insecticide
- Cnidiadin - insecticide /fungicide
- Vertrine - insecticide
- Nicotine - insecticide
- Celastrus angulatus - insecticide
- Camphor (d-camphor) -insecticide
- Da Huang Su Jia Ni - fungicide
- Eucalyptol - insecticide
- Carvacrol - fungicide
- Ethylicin - fungicide

Botanical pesticides in Europe

- Rotenone -withdrawn
- Nicotine -withdrawn
- Neem (azadirachtin)-never registered / approved
- Natural pyrethrins - approved

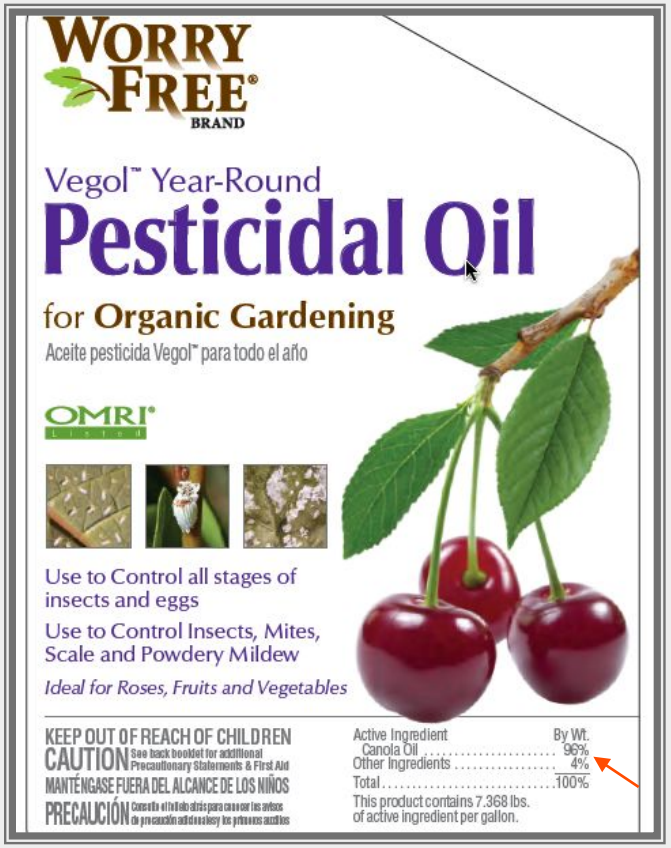
Botanical insecticides approved for use in specific countries

Country	**Pyrethrym**	**Rotenone**	**Nicotine**	**Neem**	**Others**
Australia	x	x	-	-	Citrus oil
New Zealand	x	x	-	x	
India	x	x	x	x	Ryania
Philippines	x	-	-	-	
Hungary	x	-	-	-	Quassia
Denmark	x	x	-	-	Lemon grass Eucalyptus oil Clove
Germany	x	-	-	x	
Netherlands	x	-	-	-	
United Kingdom	x	x	x	-	
South Africa	x	-	-	-	
Brazil	x	x	-	x	Garlic
Unated States	x	x	x	x	Specified EOs Ryania, Sabadilla
Canada	x	x	x	-	Specified EOs
Mexico	x	x	-	x	Garlic, Capcicum
China	x	x	x	x	

Vegetable oil in pest control : An oil derived from seeds soybeans, canola, cottonseed

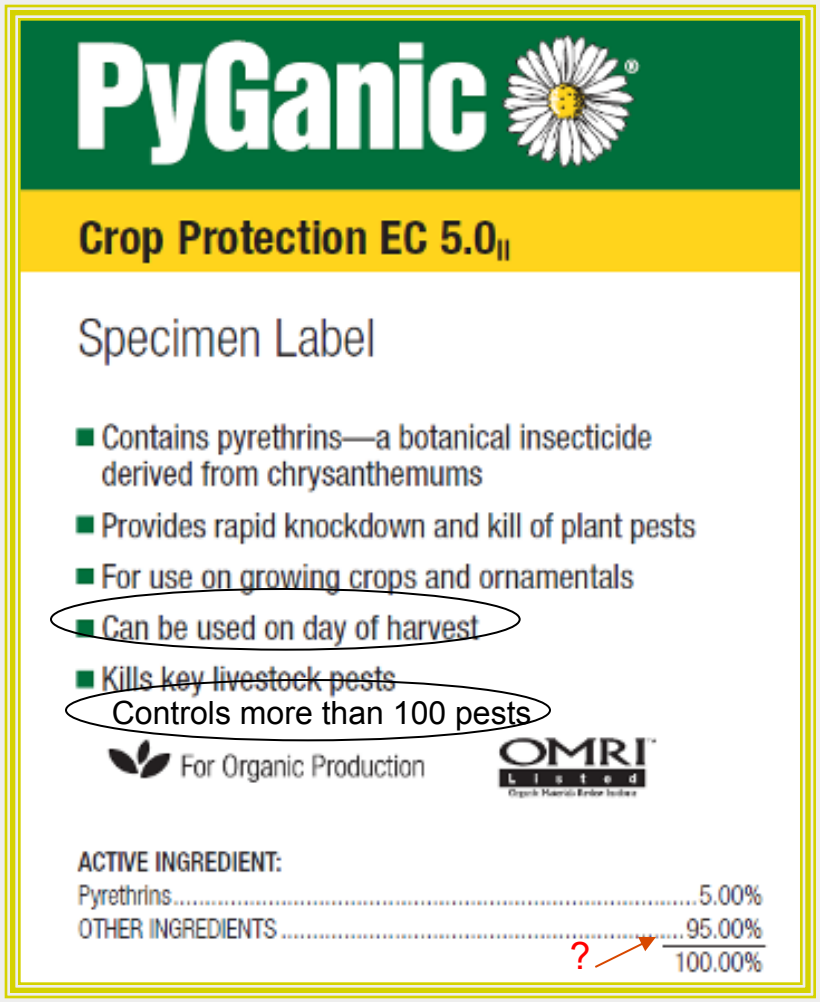
Canola oil for cooking

Natural News TV Canola Oil Pesticide Video
Canola Oil: Healthy Oil or Pesticide?



Canola oil for pest control
The label states “CAUTION: Avoid contact with skin or clothing.”

Organic botanical pesticides on market



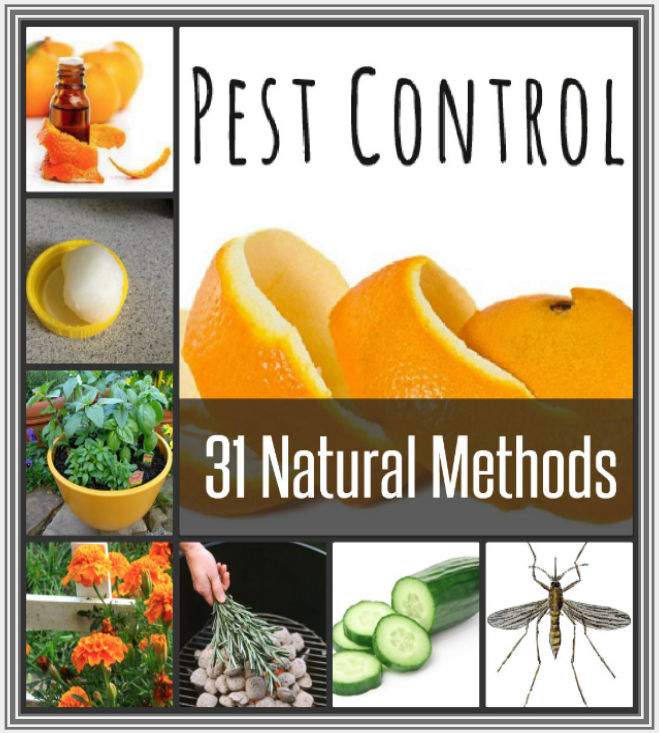
Limitations of botanicals for pest management

- extraction methods are not standardized
- rapid degradation
- most studies are in *vitro* efficacy
- need the development of formulations
- some chemical compounds are harmful to human, beneficial insects and plants
- less effective
- less availability formulations
- not all recommendations followed by growers have been scientifically verified
- there are no legal registrations establishing their use
- most of them have no established residue tolerances
- most of these products are not true pesticides, since many are merely insect deterrents and their effect is slow

- Botanical pesticides presently play only a minor role in pest management and crop protection
- Botanicals used as pesticides presently constitute only 1% of the world insecticide market

Gardeners are publishing how to make organic pesticides at home; organic bug spray recipes are appearing in books, and on Facebook, Twitter and Google

Instructions for how to make organic pesticides at home are providing many homemade, organic options for gardeners to turn to in the war against pests



Life consists not in living, but in enjoying health. Martial—Epigrams. Bk. VI.

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THANK YOU