Essential Oils as Green Pesticides “Neem Oil”

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What is Green Pesticides ?

Green pesticides, also known as **ecological pesticides**, are pesticides derived from **organic sources** that are considered **environmentally friendly**. They cause **less harm to human and animal health**, habitats, and the ecosystem compared to synthetic pesticides. These pesticides include those derived from **natural sources**, such as **biological pesticides** or **botanical insecticides**, and are often used in **organic farming**

Sources of Essential Oils

- Leaves
- Flowers
- Peel
- Seeds
- Wood
- Berries
- Bark
- Resins
- Rhizomes
- Roots

Characteristics of Essential Oils

- **Distinct from fatty oils**: Essential oils are volatile and aromatic, unlike fatty oils.
- **Functions in plants and humans**:
  - Fight infections.
  - Initiate cellular regeneration.
  - Act as a chemical defense against fungi, viruses, and predators.
- **Hormone-like compounds**: They contain substances that mimic hormones.
- **Compatibility with human physiology**: Their chemical structure is similar to certain compounds found in blood and tissues, making them physiologically compatible

Insecitcidal Activity

- Essential oils from plants in the Myrtaceae, Lamiaceae, Asteraceae, Apiaceae, and Rutaceae families have shown activity against insect orders such as Lepidoptera, Coleoptera, Diptera, Isoptera, and Hemiptera

Mode of Action of Essential Oils

- **Insecticidal Action**:
  - **Linalool**: Affects the insect nervous system by interfering with **ion transport** and the release of **acetylcholine esterase**.
  - **Octopamine**: Acts as a neurotransmitter in insects, interacting with **octopamine receptors** (I & II).
  - **Toxicity Mechanism**: Disruption of the **octopaminergic system** leads to a breakdown of the insect nervous system.
  - **Mammalian Selectivity**: Vertebrates lack octopamine receptors, making essential oils safer for mammals.
  - **Eugenol**: Mimics octopamine, increasing **intracellular calcium** levels, and acts through **octopamine receptors** to exert insecticidal effects.
  - **Geraniol**: Does not mediate toxicity via octopamine receptors.
- **Repellent Action**:
  - Repellents interact with **female mosquito olfactory receptors**, blocking their sense of smell.
  - **Oleic acid** and **linoleic acid** are involved in **death recognition and aversion** (necromone) in cockroaches
  - **Repellent Potential**: Essential oils possess strong repellent properties due to their volatile nature and distinct scent
- **Fumigant Action**:
  - **Essential oils** like **Artemisia annua**, **Anethum sowa**, **Curcuma longa**, and **Lippia alba**, as well as compounds like **d-limonene** and **1,8-cineole**, are used as **fumigants**.
  - These oils work **via the vapor phase** through the insect's **respiratory system**, though the exact mode of action is not fully understood

Synergistic Formulations

- **Definition of Synergists**:
  - Also called **activators** or **adjuvants**.
  - Derived from the Greek word "synergid," meaning cooperation (syn = together, ergon = work).
- **Role of Synergists**:
  - **Synergists** enhance the toxicity of insecticides, even though they have little to no insecticidal activity on their own.
  - They allow for the use of **lower doses** of insecticides, reducing the risk of **resistance development** and **environmental pollution**.
- **Types of Synergistic Formulations**:
  - **Pest-repellent products**: Includes homemade herbal teas, plant extracts, fermentation products (e.g., vinegar), and industrial products like **kaolin** (clay and rock powders).
  - **Decline of Homemade Products**: The use of homemade formulations is decreasing due to the availability of **standardized industrial products**.
- **Example**:
  - Control of **bollworm** (**Helicoverpa armigera**) damage on cotton by combining conventional insecticides at **50% of the recommended concentration** with extracts of **Azadirachta indica**, **Khaya senegalensis**, and **Hyptis sauveolens**.
  - This combination is more **effective** than the insecticide alone

Extraction Methods

- Maceration
- Expression Method
- Cold Pressing
- Distillation Method
  - Hydro Distillation
  - Steam Distillation
  - Turbo Distillation
- Cold Fat Extraction (Enfleurage Method):
- Extraction with Volatile Solvent
- Supercritical Carbon Dioxide Extraction
- Solvent-Free Microwave Extraction (SFME)

Analysis Methods

- Gas Chromatography (GC)
- Thin-Layer Chromatography (TLC)
- High-Performance Liquid Chromatography (HPLC)

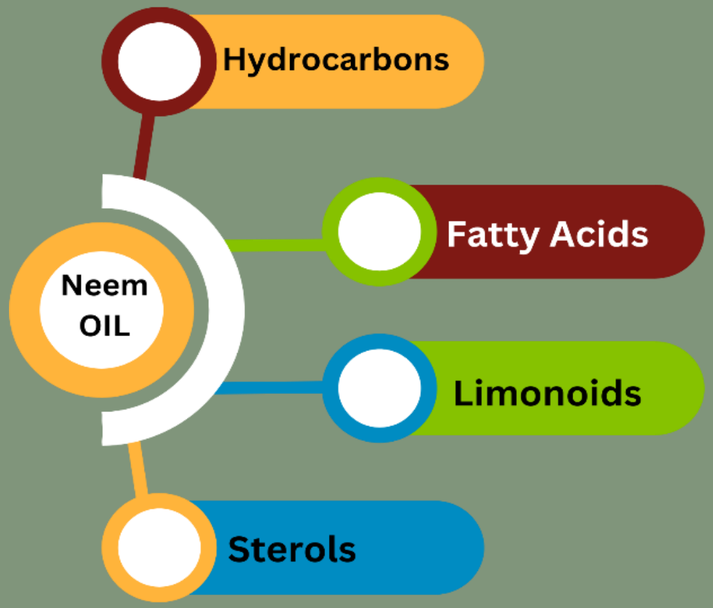
Advantages of Essential Oil–Based Pesticides

- Broad-spectrum pesticides possess insecticidal, antifeedant, repellent, oviposition deterrent, growth regulatory, and antivector activities.
- They are useful in foodstuffs and stored foods.
- Reduced-risk pesticides are nontoxic to mammals and fish.
- They are widely used as flavoring agents in beverages and foodstuffs.
- Commercialization is possible due to abundant availability.
- Green pesticides are largely used against home and garden pests.
- There is slow pest resistance due to complex mixtures of several compounds.
- There is a unique impact on integrated pest management.
- There is limited persistence and high volatility.
- There is no harm to predators, parasitoids, and pollinators

“Neem Oil”

Origin and Distribution: Neem (Azadirachta indica) belongs to the Meliaceae family. It is native to India and grows in tropical and subtropical areas such as Pakistan, Bangladesh, Sri Lanka, and Myanmar. The wild population is primarily found in the Siwalik hills and dry forests of Andhra Pradesh, Karnataka, and Tamil Nadu in India

Azadirachtin: A key active compound in neem oil, azadirachtin has insect-repellent, growth-disrupting, and anti-feeding properties. It is the most potent isomer in neem, crucial for controlling pests. Its content in neem oil varies, with concentrations ranging from 100–4000 ppm, depending on extraction methods and environmental factors



Advantages as a Pesticide

- **Environmental Safety:** Neem oil-based pesticides are safe, degradable, and eco-friendly. They do not harm soil, plants, or non-target organisms.
- **Low Toxicity:** Very low toxicity toward vertebrates and no significant adverse effects on ecosystems.
- **Human Safety:** Clinical studies show no side effects in humans (adults and children) after prolonged exposure to neem oil (1%).
- **FDA & EPA Recognition:** Considered "Generally Recognized as Safe" (GRAS) by the FDA and exempt from maximum pesticide limits on food products.
- **Biodegradable:** Components, including azadirachtin, degrade quickly in sunlight, water, and soil, leaving no harmful residue.
- **Resistance-Free:** Pests do not develop resistance to neem oil over time, as it alters their life cycle rather than killing them directly.
- **Selective Targeting:** Specifically targets pests like chewing and sucking insects without harming beneficial species, including pollinators and predators.
- **Soil Conditioning:** Neem oil can nourish and condition the soil, enhancing its overall health when used alongside other pesticides

Conclusion

Neem oil is a sustainable and eco-friendly solution for pest control, offering an effective alternative to synthetic pesticides. Its bioactive compounds, especially azadirachtin, provide targeted pest management without harming the environment, non-target species, or human health. Despite minor limitations, its potential in integrated pest management highlights its value in promoting greener agricultural practices

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Thank you

For your attention