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DEVELOPMENT OF ORGANIC LIQUID PESTICIDES FROM HERBS: A SUSTAINABLE ALTERNATIVE TO SYNTHETIC CHEMICALS

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ABSTRACT

Insect pests, including mealy bugs, aphids and trips, pose significant threats to crops, traditionally controlled by synthetic chemical pesticides. However, these chemicals contribute to environmental pollution, health risks and the development of pest resistance. The extensive use of synthetic pesticides results in bioaccumulation, soil biodiversity loss and runoff contamination, posing serious health hazards to farmers and consumers alike. Consequently, there is a growing emphasis on developing environmentally benign pest management alternatives.

This study explores the development of organic liquid pesticide formulations derived from herbs. The insecticidal efficacy of these formulations was evaluated *in vitro* against mealy bugs, a common pest. The findings demonstrate the potential of these herbal-based pesticides as effective, eco-friendly alternatives to synthetic chemicals. This approach not only reduces the environmental footprint but also advances sustainable crop protection practices.

Key words : Organic liquid pesticides, Herbal insecticides, Eco-friendly pest management.

Introduction

Insecticides are chemicals designed to kill insects and are widely used in medicine, agriculture, and industry. However, their application can profoundly impact ecosystems and pose significant risks to both animals and humans. Insects play a critical role in nature, serving various functions from pollination to decomposition. While some insects are beneficial, others can be harmful and their presence can directly affect human health and environmental stability.

Insecticides, whether natural or synthetic, aim to manage insect populations in agricultural fields, animal houses, and residential areas. Various brands and types of insecticides are available, but many have been banned in certain regions due to their detrimental environmental effects. For example, pesticides used to enhance crop yield can affect wildlife, water quality and air quality. Notably, the decline in bee populations due to pesticide exposure poses a significant threat to food pollination and crop yields.

The problem of pesticide resistance is exacerbated by the rapid reproduction rates of insects. They can produce new generations every 3 to 4 weeks, leading to quicker development of resistance to insecticides. This resistance not only undermines pest control efforts but also increases the risk of pesticide toxicity to humans and wildlife. Chemical pesticides can contaminate water sources through drift, leaching, or runoff, harming aquatic life and terrestrial predators. Historical examples, such as the banning of DDT in the US due to its adverse effects on predatory birds, highlight these concerns.

Recent scrutiny over the health risks associated with chemicals like glyphosate has further emphasized the need for safer alternatives. Organic pesticides offer a viable solution to these issues. They are designed to manage pests and pathogens without negatively impacting soil health or the environment. Organic pesticides are safer for humans and pets, reduce respiratory problems, improve indoor air quality, and lower the risk of allergic reactions.

In this investigation, we explore the formulation of organic liquid pesticides derived from various plant sources and test their efficacy against mealy bugs on Hibiscus plants. Mealy bugs, small, slow-moving insects covered in white, cottony wax are a common pest. They can infest all parts of plants, including roots, and cause damage such as stunting, chlorosis, defoliation, and wilting. Their feeding produces honeydew, a sticky substance that supports sooty mold fungi, potentially impairing photosynthesis if present in large amounts. Mealy bugs lay up to 600 yellow eggs in protective cottony masses, making them a challenging pest to control.

This study aims to develop and evaluate organic liquid pesticides as a safer and more sustainable alternative to conventional chemical insecticides, advancing eco-friendly pest management strategies.

Materials and Methods

Materials required

Plant sources

Tobacco (*Nicotiana tabacum*): Tobacco is an herbaceous plant known for its leaves, which contain nicotine—a potent insecticide. Nicotine acts as a fast-acting nerve toxin that causes tremors, convulsions, and paralysis in insects. Nicotine kills the insects rapidly within an hour causing intensive tremors, convulsions and then paralysis (Kanamani, 2021).

Neem (*Azadirachta indica*): Neem is a broad-leaved evergreen tree with significant pest control properties. Its seeds and leaves contain bioactive compounds such as azadirachtin, which act as repellents, antifeedants and insecticides (Rosemery *et al.*, 2018).

Chili (*Capsicum annuum*) : Chili peppers contain capsaicin, an alkaloid with broad-spectrum insecticidal activity. Capsaicin is effective against various insect pests including beetles, weevils, and aphids. According to reports, capsaicin has broad-spectrum insecticidal activity against many species of insects, e.g., stored product beetles *Sitophilus zeamais* and *Tribolium castaneum*, (Ho *et al*., 1997) rice grain insects *Sitotroga cerealella* (Prakash *et al*., 2006), *Alfalfa weevil* (Al-Doghairi *et al*., 2003), *Myzus persicae* (Liu *et al*, 2003), *Bemisia tabaci* (Zhao *et al*., 2012) .

Garlic (*Allium sativum*) : Garlic contains sulphur and allicine, garlic essential oil was demonstrated to possess insecticidal activity against *Blattella germanica* Linnaeus. Blattodea:Blatellidae (Tunaz *et al*., 2009), *Lycoriella ingénue* Dufour Diptera: Sciaridae (Park *et al*., 2006), *Reticulitermes speratus* Kolbe Isoptera: Rhinotermitidae (Park *et al*., 2005).

Clove (*Syzygium aromaticum*) : Clove essential oil has been widely studied for its insecticidal and repellent activities against many species of pests (Chaieb *et al*, 2007; Kafle *et al*., 2013; Cortés-Rojas *et al*., 2014); such as fire ants (Appel *et al*., 2004), aphids (UshaRani *et al*, 2005; Kareem, 2012) weevils (Ho *et al*, 1994; Kerdchoechuen *et al*., 2010) and moths (Mbonu, 2010 and Ajanta *et al*, 2010).

Turmeric (*Curcuma longa*) : Turmeric contains essential oils and oleoresins with insecticidal, repellent, and antifeeding activities, particularly effective against stored product insects (Su *et al*, 1982). Jilani *et al*. (1988) also observed the repellent and growth-inhibiting effects of the essential oil of Turmeric on rust red flour beetle.

Additional materials

Cow urine : Cow urine has many beneficial properties particularly in the area of agriculture. Organic agriculture is now becoming the new boom all over the world. The noteworthy aspects of cow urine are its eco-friendly nature, easy accessibility and multiple uses. Cow urine contains 95% water, 2.5% urea, minerals, 24 types of salts, hormones and 2.5% enzymes. It also contains iron, calcium, phosphorus, carbonic acid, potash, nitrogen, ammonia, manganese, iron, sulfur, phosphates, potassium, urea, uric acid, amino acids, enzymes, cytokine and lactose. The uric acid in the urine acts as fertilizer and hormone. Cow urine has antibacterial, antifungal, antiviral properties; Due to high content of urea in it which is toxic to the pests. It will not attack the leaves and buds of the crop plants. Due to pungent and bad smell of the extract, most of the pests and insects, which are attracted due to nectar and fragrance, get repelled, from the plant. (Bhadauria, 2002).

Comparative agents : Distilled water, isopropyl alcohol, and liquid detergent are used for comparative

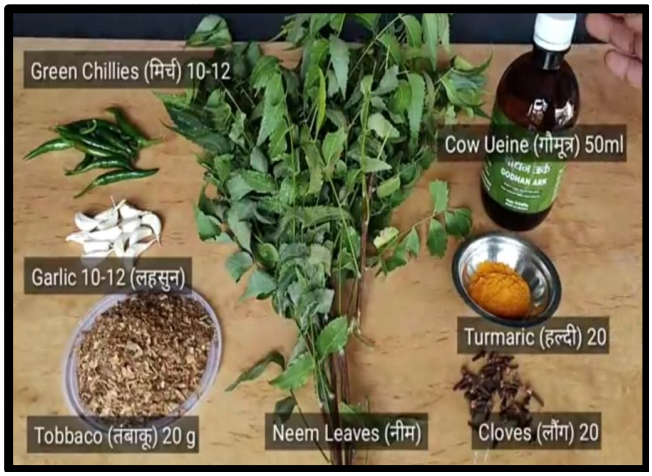

Plate 1 : Material used for preparation of Organic liquid pesticide.

Plate 2 : Mealy bugs infestation on Hibiscus.

studies to evaluate the efficacy of the organic pesticide formulations.

Method of preparation of Organic Liquid pesticide

Ingredients Preparation

- **Weighing:** Accurately weigh the following quantities of each ingredient:
  - Dried and course powder of Tobacco leaves (*Nicotiana tabacum*): 20 g
  - Dried and course powder of Neem Leaves (*Azadirachta indica*): 20 g
  - Chopped Green Chilies (*Capsicum annuum*): 20 g
  - Crushed Garlic (*Allium sativum*): 10 g
  - Clove powder (*Syzygium aromaticum*): 10 g
  - Turmeric powder (*Curcuma longa*): 10 g
  - Cow Urine: 50 ml

Preparation of Organic liquid pesticide formulations

- **Formulation F_1:** 1) Take a medium-sized pot suitable for boiling. 2) Add 2 liters of water into the pot. 3) Add the ingredients according to the formulation described in Table 1. 4. Stir the mixture thoroughly with a spoon to ensure even distribution of the ingredients. 5) Boil the mixture on a medium flame until the water reduces to half its original volume. 6) During the boiling process, the mixture will release a strong odor. To manage this, place the pot in an open kitchen area or ensure proper ventilation by opening doors or windows. 7) Once the water has reduced to 1 lit, remove the pot from the heat and let the solution cool. 8) Strain the cooled solution using a strainer to remove solid residues, ensuring a clear liquid. 9) Transfer the strained solution into an airtight glass bottle for storage.
- **Formulation F_2**
  - Water: Add 500 ml of water to a container.
  - Isopropyl Alcohol: Add 50 ml of isopropyl alcohol to the water.
  - Mixing: Stir well to mix the water and isopropyl alcohol. This serves as a comparative control for the organic pesticide formulation.
- **Formulation F_3**
  - Water: Add 500 ml of water to a container.
  - Liquid Detergent: Add 50 ml of liquid detergent to the water.
  - Mixing: Stir well to mix the water and liquid detergent. This formulation is used as a comparative control for the organic pesticide formulation.

Plate 3 : Method of Preparation of Organic Liquid Pesticide

Plate 4 : Efficacy of organic pesticide against mealy bugs.

Table 1 : Preparation of Pesticide Formulations.

S. no.	Ingredient for Preparation of F1 Organic pesticide	Ingredient for preparation of F_2 pesticide	Ingredient for preparation of F_3 pesticide	Ingredient for preparation of F_4 Pesticide
1	Dried course powder of Tobacco leaves (20 g)	Water (500 ml)	Water (500 ml)	Water (500 ml)
2	Dried course powder of Neem Leaves (20 g)	Isopropyl alcohol (50 ml)	Liquid Detergent (50 ml)	Neem oil (50 ml)
3	Chopped Green chilies (20 g)			
4	Crushed Garlic (10 g)			
5	Clove powder (10 g)			
6	Turmeric powder (10 g)			
7	Cow Urine (50 ml)			
8	Water (2 liters)			

- **Formulation F_4**
  - Neem Oil: Add 50 ml of neem oil to a container.
  - Water: Add 500 ml of water.
  - Mixing: Stir well to mix the neem oil with the water. This formulation serves as another comparative control.

By following this method, we prepared and evaluate the efficacy of various organic liquid pesticide formulations compared to standard controls.

Application of Organic Pesticide

To improve quality, safety, and efficacy, dilutes the stored pesticide solution before application. In a spray bottle, add 500 ml of water. Then add 50 ml of the prepared organic pesticide to the water. Mix the solution well and let it sit for 5 minutes. Spray Application: Use a hand sprayer to apply the diluted pesticide solution. Apply the pesticide to the Hibiscus plants infested with mealy bugs. Ensure thorough coverage of all plant parts, especially where mealy bugs are present. Treatment Schedule: Apply the pesticide to each of the five Hibiscus plants twice, with a 3-day interval between applications.

Results and Discussion

Observations and Monitoring : After application, we observed the plants for changes in pest activity and overall plant health and recorded change in mealy bug infestation and noted observations related to plant condition.

The results from Table 2 indicate the effectiveness of various pesticide formulations in controlling mealy bugs on hibiscus plants. Here's a summary of the findings:

- **Water (Control):** No mealy bugs were killed; all pests remained unaffected.

Table 2 : Efficacy of different formulations of pesticide against mealy bugs on Hibiscus plants in Garden.

	Application number	No. of live Mealy bugs /plant	No. of dead Mealy bugs/ plant after application	% Reduction of Mealy bugs
Control (Water)	1	55	-	00
	2	65	-	00
F_1	1	70	66	94.28
	2	4	4	100.00
F_2	1	65	55	84.61
	2	10	9	90.00
F_3	1	45	28	62.22
	2	17	11	64.70
F_4	1	48	33	68.75
	2	15	11	73.33

- **F_1 Organic Pesticide:** 100% of mealy bugs were eliminated after the second application, showing the highest efficacy among the tested formulations.
- **F_2 Pesticide**: 90% of mealy bugs were killed after the second application, making it the second most effective option.
- **F_4 Pesticide**: 73.33% of mealy bugs were killed, indicating moderate effectiveness.
- **F_3 Pesticide:** 64.70% of mealy bugs were killed, showing the least effectiveness among the tested pesticides.

In summary, F_1 organic pesticide proved to be the most effective in eradicating mealy bugs, followed by F_2, F_4 and F_3.

Conclusion

Multiple applications of organic pesticides can indeed offer efficient control of mealy bug pests while also contributing to improved plant health.

- *Enhanced Pest Control:* Repeated applications ensure that any mealy bugs that survive an initial treatment are targeted in subsequent ones. This helps to control the pest population more effectively, reducing their numbers over time.
- *Reduced Pest Resistance:* Regular application of organic pesticides can help prevent the development of pest resistance. By using different formulations or varying the timing, pests are less likely to adapt and develop resistance.
- *Improved Plant Health:* Organic pesticides are often formulated with natural ingredients that can be less harmful to plants compared to synthetic chemicals. This can lead to better overall plant health as these pesticides may not cause the same level of stress or damage as some synthetic alternatives.
- *Soil and Environmental Benefits:* Organic pesticides typically break down more quickly and do not leave harmful residues, which can benefit the soil and surrounding environment. Healthier soil contributes to stronger plants and better resistance to pests.
- *Sustainable Practices:* Using organic methods aligns with sustainable agricultural practices, promoting long-term plant health and ecosystem balance.

Overall, while organic pesticides can be very effective, their success often depends on proper application timing and technique. Multiple applications, combined with good cultural practices and regular monitoring, contribute to maintaining a healthy and pest-free garden.

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