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Pyrethrum Extraction to Produce Pyrethrin

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ABSTRACT: The production of Pyrethrin as an insecticide from Chrysanthemum cineraria folium flowers. The crude active compound extracted using organic solvents. The flowers extract showed active biological effect against various insects. The use of pyrethrin can be used by as medicinal use for killing various household along with insects in farm which can led to better growth of crops. Obviously, the ideal economic procedure would be one by which the pyrethrin and any other biologically valuable ingredients present in fresh flowers can be converted into concentrated, purified and colorless or practically colorless extract without loss of pyrethrin content or loss of biological activity, and at a reasonable economic cost. The purpose of this research is to extract Pyrethrin from cineraria folium in order to produce insecticide from natural product as a substitution to synthetic products in order to overcome the problem.

I. INTRODUCTION

Many insects cause damage to the crop. To solve this problem, many pesticides were investigated. Those chemicals can kill the target insects and non-target organisms like beneficial insects. Accumulation of chemicals on food can cause diseases in humans. In addition, the insects will have the ability to resist some types of pesticide. Hence, there is a need to evaluate the materials from natural sources as bio-pesticides since it is safe for humans and the environment. The Man-made form of Pyrethrin is called Pyrethroid which is toxic, adheres to substances, and does not dissolve in water.

II. LITERATURE REVIEW

Pyrethrin is most commonly used as a pesticide and has been used as a pesticide since the 1900s. In the 1800s, it was also known as "Persian powder", "Persian pellitory", and "zacherlin" as common names of pesticides. Pyrethrin has been used as a pesticide for thousands of years. It is also believed that the Chinese crushed chrysanthemum plants and used the powder as a pesticide in early 1000 BC. It was widely known that the Chou Dynasty in China widely used pyrethrin for its pesticide properties. Also, the use of pyrethrum as a pesticide was a well-kept secret by ancient Persians, for the health of their crops, but its use is documented from around 400 B.C. Japan was known as the leading producer of pyrethrum before World War II, and later African countries began the production. Because of their pesticides and insect-repellent effect, pyrethrin has been very successful in reducing insect pest populations that affect humans, crops, livestock, and pets, such as ants, spiders, lice, mosquitoes, fleas, and ticks. This crop is grown mainly in Nakuru, Nyandarua, Uasin Gishu, Kericho, Kisii, Kiambu, and Narok districts and provides livelihoods to about 8,000 farmers. Here are the steps and considerations involved in pyrethrum cultivation:

1. **Climate and Location:** Pyrethrum thrives in regions with temperate climates. It requires cool temperatures during the growing season and a frost-free period for flowering and seed development. Optimal temperatures for pyrethrum cultivation typically range from 15°C to 24°C (59°F to 75°F).

2. Soil Preparation: Pyrethrum prefers well-drained, sandy loam soils with good organic matter content. Conduct soil tests to assess nutrient levels and pH and make any necessary soil amendments to ensure optimal growing conditions.

3.Variety Selection: Choose pyrethrum cultivars that are well-suited to your local climate and soil conditions. Different varieties may have varying pyrethrin content and yield potential.

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4. Planting: Pyrethrum is typically propagated from seeds or cuttings. Seeds can be sown directly in the field. Plant pyrethrum in rows, with a recommended spacing of about 30 cm (12 inches) between plants and 60 cm (24 inches) between rows. Ensure that the planting depth is appropriate for the seeds or cuttings being used.

5. Watering and Irrigation: Pyrethrum requires consistent moisture throughout the growing season. Adequate irrigation is essential, especially during dry periods.

6. Fertilization: Apply balanced fertilizers based on soil test recommendations to provide essential nutrients to the plants.

7.Weed Control: Keep the cultivation area free from weeds to reduce competition for nutrients and moisture. Use appropriate control methods, including manual weeding or herbicides if necessary.

8. Pest and Disease Management: Monitor for pests and diseases that can affect pyrethrum plants, such as aphids, leafhoppers, and various fungal infections. Integrated pest management (IPM) strategies may include the use of beneficial insects, cultural practices, and if needed, botanical or chemical treatments.

9. Flowering and Harvesting: Pyrethrum plants typically start flowering about 70-90 days after planting. Harvest the pyrethrum flowers when they are in full bloom. The flowers should be picked by hand or using mechanical harvesters, depending on the scale of cultivation.

10. Drying and Processing: Dry the harvested flowers quickly to preserve the pyrethrin content. Solar drying or mechanical drying methods are commonly used. After drying, the flowers are processed to extract the pyrethrin compounds.

11. Pest Management and Storage: Properly store the dried pyrethrum flowers to protect them from pests and moisture, which can degrade the pyrethrin. Keep the pyrethrum in a cool, dry place until it is ready for processing or sale.

12. Crop Rotation and Management: Consider crop rotation to prevent soil depletion and reduce the risk of pests and diseases. Follow good agricultural practices to maintain soil health and ensure the sustainability of pyrethrum cultivation.

13. Market and Sales: Identify potential buyers or markets for your pyrethrum products, whether it's dried flowers or extracted pyrethrin. Comply with any regulatory requirements and quality standards for pyrethrum products.
Pyrethrum is a tufted, slender, pubescent perennial 12 to 30 inches high with daisy-like flower heads 11/2 inches across, on long slender stems. It is adapted to a temperate climate with 45 to 50 inches of rainfall. Pyrethrum is a certain plant species of the ester family whose aromatic flower heads, when powdered, constitute the active ingredient in the pesticides called pyrethrin. They are a mixture of six chemicals that are toxic to insects that are Pyrethrin I, II; Cinerin I, II; Jasmolin I, II. Among these compounds, pyrethrin I and pyrethrin II are the most predominant and active. The extraction yields of each pyrethrin ester depend on extraction conditions (temperature, solvent) but their relative proportions do not vary significantly. The flower contains about 1-2% pyrethrin by dry weight, but approximately 94% of the total yield is concentrated in the seeds.

III. METHODOLOGY OF PROPOSED SURVEY

Pyrethrin, though insoluble in water, is soluble in many organic solvents. Several extraction methods with different organic solvents have been reported which are being used for the large-scale production of pyrethrum. Among these Pyrethrum is still the classical organic solvent extracted using hydrocarbon solvents such as hexane or petroleum ether is being commonly used.

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1. Firstly, the pyrethrum flowers are picked and dried in sunlight for two to three days to make them perfectly dry.
2. The flowers are also oven-dried to make the fast-drying of the flowers. The oven is maintained at a temperature of around 50 degrees. As the pyrethrum is temperature temperature-sensitive element, excess heating can reduce its efficiency.so, temperature should be strictly monitored.
3. The dried flowers along with solvent i.e. Hexane are passed into the extraction vessel. The vessel is provided with Pressure and temperature transmitters to monitor the operating conditions.
4. The process is under a vacuum of 280 mm hg, as the pyrethrum is temperature sensitive. It cannot be treated to a temperature > 60 deg C.
5. The extract includes a Pyrethrum + Hexane mixture.
6. In the extractor the temperature is maintained at 40 deg C and atmospheric pressure, and the extraction process takes place.
7. The extracted content is filtered and later fed to the Falling Film Evaporator.
8. After filtration, FFE is used to recover solvent and produce high-quality extract.
9. Wet residue cake is collected and sent to ATFD (Agitated Thin Film Dryer) where the temperature is 40 deg and 280 mm Hg pressure and the leaves are dried. The dried product can be used again in the continuous process.
10. Again, from FFE 1 the concentrate is passed to the WFE (Wiped Film Evaporator). WFE is used for concentrating and distilling heat-sensitive products.
11. Finally, from WFE distilled hexane is separated, and the residue containing Product-99.9% and Hexane- 0.1% is obtained. And remaining impure hexane from FFE & WFE is sent for hexane recovery so that it can be reused for the next batch.

Choice of solvent:

Theoretically any solvent which dissolves the readily oil-soluble pyrethrin can be used. Practical commercial usage in recent years has centered on low-boiling hydrocarbon solvents, such as hexane, for two reasons. First, such a solvent, which should be free from naphthalene and unsaturated hydrocarbons, is selective to a degree and will extract the pyrethrin without removing too high a percentage of other natural constituents, such as fats, coloring matter, waxes, etc., the presence of which would complicate the subsequent purification procedures. Second, such a solvent, being volatile at reasonable temperatures, facilitates the removal procedure which is essential to concentration.

Hexane is a common solvent used for pyrethrum extraction, and it offers certain advantages compared to other solvents. Here's why hexane is often preferred.

Selectivity: Hexane is a non-polar solvent, which means it has a strong affinity for non-polar compounds like pyrethrin's, the active insecticidal compounds in pyrethrum. This selectivity helps in efficiently extracting pyrethrin's while leaving behind polar impurities and water- soluble compounds.

IV. RESULT AND CONCLUSION

Extraction results using Methanol:

Description	70% w/w Methanol	60% w/w Methanol	50% w/w Methanol
First extract (1L)	1.118	1.089	0.840
Second Extract (1 L)	0.073	0.076	0.221
Third Extract (500 ml)	0.027	0.029	0.069

(Table 1. Extraction result using Methanol)

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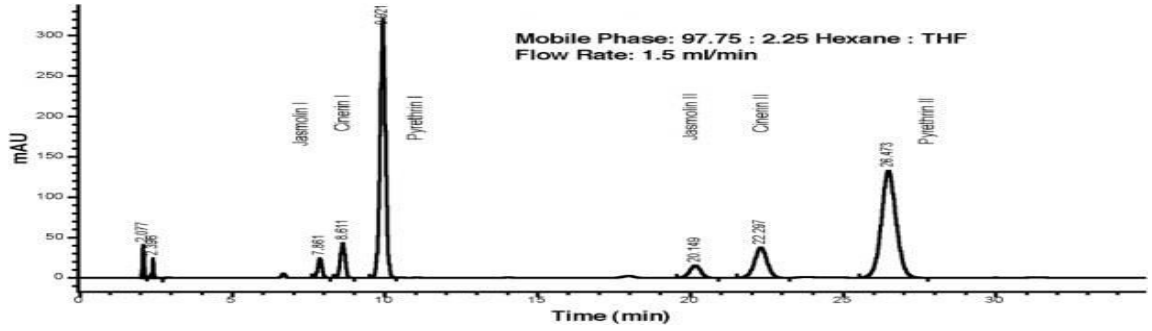
Extraction results using Hexane:

Description	70% w/w Hexane	60% w/w Hexane	50% w/w Hexane
First extract (1L)	1.2	1.09	0.9
Second Extract (1 L)	0.09	0.078	0.19
Third Extract (500 ml)	0.03	0.032	0.05

(Table 2. Extraction result using Hexane)

HPLC technique is used to detect the quality of the Pyrethrin in crude extract. The mobile phase components used were acetonitrile (solvent A) and water (solvent B) Most HPLC quantification methods use a commercial pyrethrum mixture with an estimated amount of 25% of total pyrethrin as a standard solution. The amount of total pyrethrin in the assayed sample was estimated by calculating the sum of measured peak areas of individual pyrethrin. The calibrating curves for total pyrethrins and each pyrethrin were obtained from the prepared standard mixtures. The calibrating intervals covered the range of occurrence of all six compounds in the analyzed sample. Typically, pyrethrins are detected at a wavelength between 200 nm and 300 nm, with 275 nm being a common choice.



Sample	Identification	% Jasmolin 1	%Cinerin 1	% Pyrethrin 1	% Jasmolin 2	%Cinerin 2	% Pyrethrin 2
1	98/9.1	2.46	4.62	20.83	2.52	5.17	17.14
2	98/8.1	2.66	6.06	21.05	2.52	5.11	15.38
3	98/7.5	2.57	4.1	19.86	3	5.27	17.91
4	98/6.1	2.67	3.77	20.75	2.65	4.12	15.92
5	98/3.9	2.84	4.76	22.1	2.74	5.04	16.5
6	98/2.2	2.43	5.27	20.81	2.43	5.04	14.98
7	98/1.5	2.36	9.48	25.96	1.4	3.76	9.85
8	97/9.1	2.48	5.1	22.82	2.55	5.63	17.85
9	97/7.1	2.57	8.24	25.64	1.48	3.45	9.85
10	97/5.5	2.66	4.12	21.99	2.31	3.78	14.12

(Table 3. Pyrethrum Concentration)

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Pyrethrum Concentration	Incubation time	Sample Volume	Killing Percent	Insects No
20%	24 hrs	50 ml	50%	50 Nos
30%	24 hrs	50 ml	77%	50 Nos
40%	24 hrs	50 ml	100%	50 Nos

(Table 4. Concentrated Pyrethrum Extraction Results)

The pyrethrin market is expected to continue growing as the demand for organic and sustainable pest control solutions increases. Research into novel formulations, encapsulation technologies, and synergistic combinations with other natural compounds may drive innovation in the industry. The market may be influenced by developments in biotechnology and genetic modification for improved pyrethrin production. Please consult more recent sources, industry reports, and market analyses to get the most current information on the pyrethrin market, as it may have evolved since my last knowledge update in 2021. Market dynamics can change due to factors like regulatory shifts, technological advancements, and consumer preferences.

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