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Preliminary Assessment of Insect-Repellent Activity of *Curcuma amada* and *Curcuma aromatica* Rhizome Peel Extracts through Field Application

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Abstract: ***The increasing demand for eco-friendly and sustainable insect control agents has led to the exploration of plant-derived bioactive compounds that possess repellent properties. In this study, the insect-repellent potential of peel Curcuma amada (mango ginger) and Curcuma aromatica (wild turmeric) rhizomes peels using simple direct-area applications under open or semi-open conditions was carried out. Ethanol extracts were applied to exposed surfaces and plant leaves, and repellency was assessed against mosquitoes (Culex spp.), Drosophila melanogaster, and aphids (Aphis craccivora). Both extracts exhibited prompt repellency responses, ranging from initial application upto 10 min, depending on the insect species tested. However, C. aromatica peel extract consistently showed a longer duration of repellent effect across all three insect types, lasting up to 30 h in the case of aphids. C. amada also exhibited significant activity but with shorter persistence. These results highlight the potential of exploring rhizome peels, typically considered agricultural waste, as effective, low-cost botanical repellents. This study emphasizes a practical, real-environment approach to testing without the use of containers or enclosures, thus mimicking field conditions. These findings support further phytochemical and formulation research for the development of natural insect-repellent products using Curcuma peels.***

Keywords: Repellent, Efficacy, Curcuma, Drosophila melanogaster, Aphis craccivora

I. INTRODUCTION

Insect pests remain a major concern in agriculture and public health. Mosquitoes are well-known carriers of deadly diseases like malaria, dengue, and chikungunya, while pests such as *Drosophila melanogaster* (fruit flies) and *Aphis craccivora* (aphids) inflict considerable harm on fruit crops and leguminous plants [1].

The extensive application of synthetic insecticides and repellents has led to several adverse effects, including the emergence of insect resistance, ecological imbalance, and harm to non-target species, including humans [2,3]. As a result, there is an increasing interest in plant-based alternatives that are environmentally friendly, biodegradable, and sustainable. Plants generate a range of secondary metabolites with recognized insect-repellent and insecticidal properties, such as alkaloids, terpenes, flavonoids, and essential oils [4]. Among the plants examined, species from the genus *Curcuma* (Zingiberaceae), like *Curcuma amada* (mango ginger) and *Curcuma aromatica* (wild turmeric), have been noted for their broad-spectrum biological activities, including antimicrobial, antioxidant, and insect-repellent effects [5,6].

While most research focuses on the rhizomes or essential oils, the rhizome peels often discarded as waste which contain significant amounts of bioactive compounds such as curcuminoids, sesquiterpenes, and volatile oils that could enhance repellent activity [7]. Utilizing these waste materials aligns with sustainable and cost-effective pest control strategies. In this study, the insect-repellent properties of ethanol extracts from the peels of *C. amada* and *C. aromatica* were assessed using a field evaluation in open or semi-open settings, avoiding the use of laboratory containers or cages.

The extracts were applied directly to surfaces and leaves to test their effectiveness against mosquitoes, *Drosophila melanogaster* and *Aphis craccivora*. This practical approach simulates real-world exposure and allows for a more accurate evaluation of repellent behavior in semi-natural conditions. The results may aid in developing new botanical repellents from agricultural waste, promoting both pest management and environmental sustainability.

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II. MATERIALS AND METHODS

A. *Plant Material and Extraction*

Fresh rhizomes of *Curcuma amada* and *Curcuma aromatica* were collected from local market and authenticated by a qualified botanist. The rhizomes were thoroughly washed with tap water to remove soil and debris. Peels were manually separated from the rhizomes, shade-dried at room temperature for 7–10 days, and then finely powdered using a mechanical grinder.

Extraction was carried out using the infusion method, a form of hot water extraction widely used for herbal preparations [8]. Approximately 50 g of powdered peel was infused in 500 mL of boiling distilled water for 30 minutes. The mixture was allowed to cool, filtered through Whatman No. 1 filter paper, and the aqueous extract was concentrated under reduced pressure using a rotary evaporator. The semi-solid extract was stored at 4 °C until further use.

B. *Preparation of the Extract for Repellency Studies*

For the repellency tests, the concentrated extract was mixed with absolute ethanol in a 1:1 (v/v) ratio to enhance volatility and facilitate spraying. The formulation was transferred into clean, labelled spray bottles and used for field application to study the repellentproperties.

C. *Repellency Testing Procedure*

The repellent potential of *Curcuma amada* and *Curcuma aromatica* peel extracts was evaluated against three insect species such as mosquitoes (*Culex* spp.), *Drosophila melanogaster* (fruit flies), and *Aphis craccivora* (aphids). The study employed field application in semi-open or open environmental conditions to mimic natural exposure, without the use of enclosed chambers or laboratory containers.

D. *Repellent activity against Mosquito*

Spray formulations of each extract were applied evenly to clean exposed surfaces in mosquito-active zones during evening hours. The number of mosquito landings or bite attempts was observed for 5–10 minutes post-application and repeated every 15 minutes until repellent activity ceased. A reduction in mosquito activity compared to untreated areas was recorded as positive repellence study.

E. *Repellent activity against Drosophila*

Paper strips treated with each extract was placed in open surfaces such as fruit baskets where *Drosophila* activity is prominently attracted. Fly attraction or avoidance behaviour was observed at 30-minute intervals for up to 12 hours. Control strips without extract were also placed nearby for comparison. Observations included the number of flies landing, time of return and clustering behaviour.

F. *Aphid Repellent Test*

To evaluate the repellent effect of the extracts against aphids (*Aphis craccivora*), field-relevant testing was carried out under natural conditions. The fresh leaf surfaces of mango (*Mangifera indica*) and the fruit-bearing branches of guava (*Psidium guajava*) trees were selected based on active aphid infestation.The prepared spray formulations of *C.amada* and *C. aromatica* peel extracts were directly sprayed to infested leaves and branches. Control leaves on the same trees were left untreated to serve as a reference. Observations were made at regular intervals (1 hour, 6 hours, 12 hours, 24 hours) to determine aphid repellance or reinfestation. Aphid count reduction or visible migration was considered evidence of repellency.

G. *Data Recording and Interpretation*

The time to initial repellence and complete loss of effect was recorded for each insect group. Observational data included insect repellents, delayed return, reinfestation, or landing behavior. No mortality assessment was performed in this preliminary repellent study.

III. RESULTS AND DISCUSSION

The present study evaluated the insect-repellent activity of *Curcuma amada* and *Curcuma aromatica* rhizome peel extracts through direct application to natural surfaces. The repellent effect was assessed against mosquitoes (*Culex* spp.), fruit flies (*Drosophila melanogaster*), and aphids (*Aphis craccivora*), focusing on real-world settings such as plant leaves and household surfaces, without the use of enclosed test chambers (Table-1).

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A. *Mosquito Repellent Efficacy*

Both extracts demonstrated immediate repellent activity upon application, with *C. aromatica* peel extract exhibiting a slightly longer duration of protection (60 minutes) compared to *C. amada* (45 minutes). Observations included reduced mosquito landings and bite attempts on treated skin-safe surfaces and filter papers. The difference in efficacy may be attributed to the higher content of monoterpenes and oxygenated sesquiterpenes reported in *C. aromatica*, such as ar-turmerone, α-curcumene, and curdione [5]. These compounds are known to interfere with mosquito olfactory receptors, thereby altering host-seeking behavior [1].

B. *Fruit Fly (Drosophila) Repellent Efficacy*

In semi-open area, *Drosophila melanogaster* exhibited strong avoidance behaviour within 5 minutes of exposure to both extracts. The effect of *C. aromatica* was more persistent, lasting up to 12 hours, while *C. amada* showed repellent activity for approximately 9 hours. Treated areas remained largely free of flies, suggesting the presence of volatile compounds that either deterred landing or disrupted sensory cues. Previous studies have shown that plant-derived volatiles, including curcuminoids and essential oils from the *Curcuma* genus, can exert neurotoxic and behavioural effects on dipterans [3,11].

C. *Aphid Repellent activity on Fruit Trees*

The application of the extracts to mango (*Mangifera indica*) and guava (*Psidium guajava*) tree leaf surfaces resulted in notable reductions in aphid infestation. *C. aromatica* extract showed sustained repellency up to 30 hours, with no reinfestation observed during the study period. In contrast, *C. amada* extract initially repelled aphids, but partial reinfestation occurred after 22–24 hours. The efficacy of *C. aromatica* may be due to its richer profile of bioactive terpenoids and phenolic compounds, which are known to influence insect behavior and interfere with feeding [6,7].These results support the hypothesis that rhizome peels typically discarded as agro-waste possess significant insect-repellent potential. Direct application to plant and household surfaces in natural conditions demonstrated practical utility without relying on laboratory containment methods, thereby aligning with sustainable pest management practices.

The enhanced repellent activity of *C. aromatica* across all insect species tested suggests its potential as a lead candidate for developing plant-based repellent formulations. However, further studies are warranted to isolate and characterize the specific bioactive constituents responsible for repellency and to evaluate the safety and efficacy under larger field conditions.

Table 1. Insect Repellency Observed via Direct Application

Insect	Plant Host / Surface	Treatment	Repellency Onset	Effect Duration	Key Observations	Reinfestation
Mosquitoes	Skin-safe or surface area	*C. amada* Peel Extract	Immediate	45 minutes	Reduced landings and bite attempts	Yes
		C. aromatica Peel Extract	Immediate	60 minutes	Stronger avoidance; prolonged effect	Yes, but reduced rate of reinfestation
		Control (untreated)	None	—	Normal mosquito activity and bites	Not applicable
Fruit Flies (*Drosophila*)	Bench/fruit-adjacent areas	*C. amada* Peel Extract	Within 5 minutes	9 hours	Avoidance behavior initially, slow return after 6 h	Yes
		C. aromatica Peel Extract	Within 5 minutes	12 hours	Sustained avoidance; very few flies even at 10–11 h	No
		Control (untreated)	None	—	Active clustering on untreated surfaces	Not applicable

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Aphids	Mango (*Mangifera indica*)	*C. amada* Peel Extract	Within 10 minutes	22 hours	Reduced aphid count, slight return after 24 h	Yes
		C. aromatica Peel Extract	Within 10 minutes	30 hours	Strong effect; no reinfestation for 1 day	No
	Guava (*Psidium guajava*)	*C. amada* Peel Extract	Within 10 minutes	22 hours	Partial repulsion; aphid return after 12–24 h	Yes
		C. aromatica Peel Extract	Within 10 minutes	30 hours	Consistent repellent action; aphid-free up to 1 day	No
		Control (untreated)	None	—	No behavioral change; infestation persisted	Not applicable

This consolidated table presents repellent efficacy onset, duration, and behavioral response across mosquitoes, fruit flies, and aphids.

Figure-1 Application and Insect Repellency Assessment of *Curcuma* Peel Extracts Against Mosquitoes, Aphids, and *Drosophila*

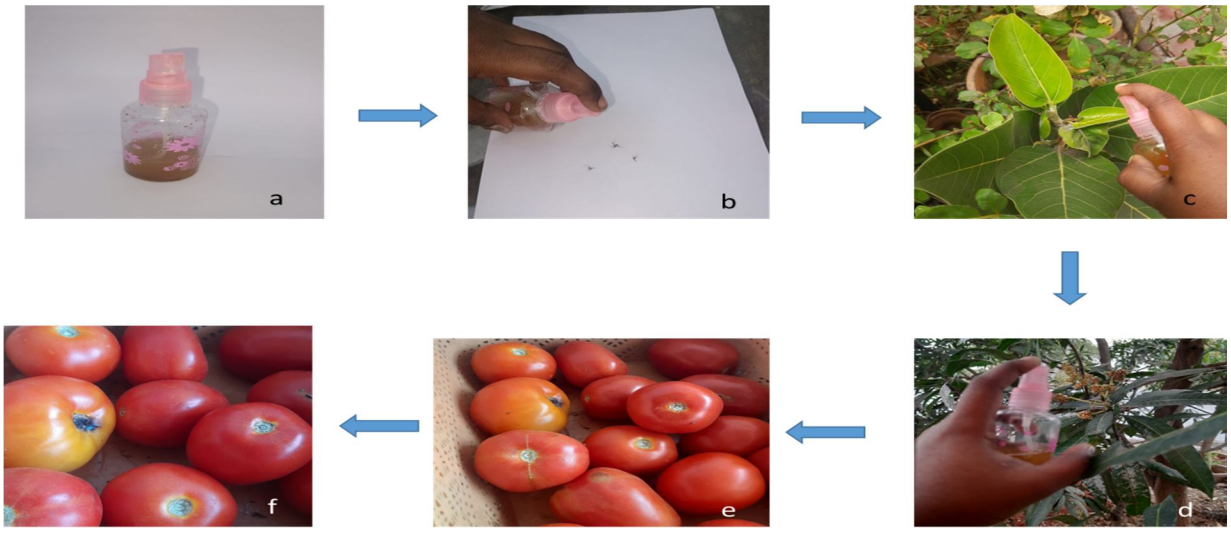


Figure-1 Stepwise application and evaluation of ethanol-based peel extracts of Curcuma amada and Curcuma aromatica against common insect pests.

1) Extract spray formulation in a pump bottle;
2) Spray tested against mosquitoes (Culex spp.) on a white test surface, showing immediate avoidance;
3) Application to guava (Psidium guajava) leaves infested with aphids (Aphis craccivora);
4) Field spraying on mango (Mangifera indica) branches during active aphid infestation;
5) Drosophila melanogaster activity observed on untreated tomato fruits (control group);
6) Reduced Drosophila activity and damage on tomato fruits after extract application.

The sequence represents a non-laboratory, open-field evaluation of insect repellency under practical conditions.

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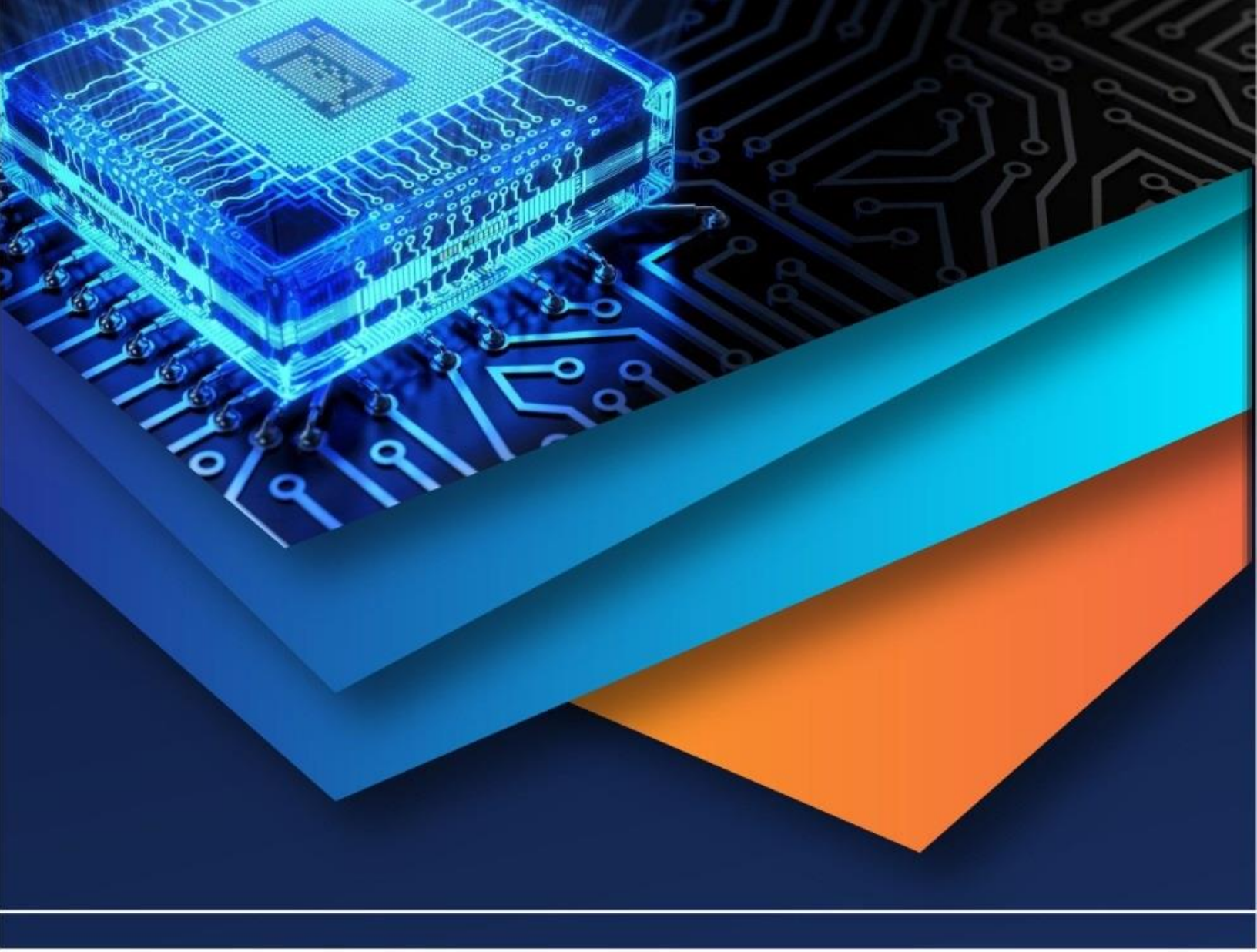
IV. CONCLUSION

This study demonstrated the insect-repellent potential of *Curcuma amada* and *Curcuma aromatica* rhizome peel extracts when applied directly to infestation prone surfaces. Both the extracts effectively repelled mosquitoes, fruit flies, and aphids. The peel extract of *C. aromatica* showed superior and longer-lasting activity, especially in reducing aphid infestation on mango and guava trees. The use of peel extracts, typically discarded as agro-waste, presents a sustainable approach to pest control. Unlike conventional lab-based assays, this study employed simple direct-area applications under open conditions, enhancing its real-world relevance. These results suggest that *Curcuma* peels may serve as low-cost, eco-friendly alternatives to synthetic repellents.

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