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Repellent Activity of Certain Plant Extracts (Clove, Coriander, Neem and Mint) Against Red Flour Beetle

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Abstract

Various insect acts as pests for crops and storage grains that cause lot of damage and economic losses. Common control agents are synthetic compounds that are unsafe for humans and environment. Certain parts of plants and herbs are historically used for their repellent activity against insects for grain storage and tree protection. In this context, this study was planned to investigate the repellent activity of extracts of clove, coriander, neem and mint against red flour beetle that cause damage to storage grains and other crops. Insect repellency was tested using multiple concentrations of the extracts. Results of this study demonstrated that these plant extracts proved to have effective repellent activity against the insect. The most effective extract was coriander followed by mint in various concentrations. 1.5 % concentration was found to be most effective. It is concluded from the results that these plants are natural sources of repellent material and hence are a potential source of natural / biological insect repellents.

Keywords: insect repellency; plants extracts; red flour beetle.

1. Introduction

Insects cause huge damage and loss of storage grains, crop wastage, and also affect plants and trees causing significant economic losses [1, 2]. Common remedial measures include use of synthetic compounds / agents to repel or kill the pests. These chemical compounds have their own damaging effects on the crops, stored grains and also on human health and environment. Biological control methods have their own benefits like lesser losses, minimum bad effects on crops/ material and less damaging for health [3, 4]. Plants and herbs are commonly used for their repellent properties against various insects particularly in storage of food crops. Leaves of neem (*Azadirachta indica*) are used in Asia for repelling insects from stored crops [5, 6].

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Clove (*Syzygium aromaticum*) and coriander (*Coriandrum sativum*) are also known to have repellent activity against insects. Material may be oil or extract; clove oil is reported to have repellent activity against mosquitos [7, 8]. Mint (*Mentha sp.*) is also aromatic and used for its insect repellent properties [9]. Insects cause huge amount of losses to crops and stored food. Red flour beetle (*Tribolium castaneum*) is one of the most important insect pest and model organism for food safety studies [9]. This inset is commonly found in stored foods and cause huge amount of losses. It is one of the most important pest of rice grain storage. Different chemical compounds are used to deal with the insect which pose a risk to human health and environment. Neem leaves and other plant parts and extracts are historically used by the farmers to protect their crops and stored food materials which give an idea of having these compounds tested for their efficacy as repellents [9]. The present study was planned in the context above to estimate and compare repellent activity of four plant extracts (clove, coriander, neem and mint) against red flour beetle.

2. Materials and Methods

2.1 Insect collection and identification

The insects (red flour beetles) were isolated from rice bought from a local store. These were kept in rice at room temperature in rice for the study period.

2.2 Plant Collection

Neem leaves were collected from a Neem tree in Kinnaird College, Lahore. Mint, coriander, and clove were obtained from local spices vendor in Badian Road, Lahore.

2.3 Extract preparation

Plant extracts were prepared using methods reported by Parekh and his colleagues 2005 and Onyeagba and his colleagues 2004 [12, 13]. Methods were optimized to our lab conditions to obtain results. The plant materials (clove, neem, mint and coriander leaves) were washed thoroughly with water to remove any contamination and air dried. Two kinds of extracts were prepared; one with the help of water (aqueous extract) and the other with the help of ethanol (ethanolic extract).

a. Aqueous extract: Aqueous extracts were prepared by following method: Ten (10) grams of crushed plant materials in 100 ml of distilled water were treated with slow heat for six (6) hours. Every two (2) hours, it was filtered through eight (8) layers of muslin cloth and centrifuged at 5000 rpm for 15 minutes and supernatant was collected for further processing. After 6 hours (3 centrifugations), supernatant was collected and concentrated to $1/4^{th}$ of original volume. It was then autoclaved at 121°C (15 lb/in^2 pressure) and stored at 4°C before use (25).

b. Ethanolic extract: Ten (10) grams of crushed plant material was kept in 100 ml of ethanol for 24 hours. Thereafter, it was filtered through eight (8) layers of muslin cloth and centrifuged at 5000 rpm for 15 minutes. The supernatant was collected and the solvent was evaporated to make the final volume $1/4^{th}$ of the original volume. It was stored in an air-tight bottle at 4°C (25).

2.4 Repellent Material Preparation (apparatus and the extract disks)

Repellency testing

For repellency testing filter paper disks were prepared following the method of MsDonald and his colleagues 1970 [14]. Whatman filter paper disks (9 cm in diameter) were prepared and divided into two halves. Extracts (1 ml) of specific concentrations were uniformly applied on the half disks and then air dried at room temperature. Other half was left blank. Both halves were joined with cellotape. The disks were placed in petri dishes. Then 5 insects were released on the strips carefully. Insects were free to move on the both halves. Repellent behavior was observed after every hour for five (5) hours.

3. Results

Results of the study demonstrated that both aqueous and ethanolic extracts proved to be effective in repelling insects of all the three types.

Table 1: Repellency shown by red flour beetle by 0.5% concentration of aqueous and ethanolic extracts of clove (Aq = aqueous, Et = ethanolic).

Extract % of Original Extract	**Number of insects repelled**									
	1hr		**2hrs**		**3hrs**		**4hrs**		**5hrs**	
Extract Solvent	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**
0.5%	4	3	4	4	5	5	5	5	5	5
0.5%	4	4	4	4	4	5	5	5	5	5
0.5%	4	4	5	3	5	5	5	5	5	5

Data in Table 1 shows that aqueous extract of clove at 0.5% concentration repelled red flour beetle effectively with no revisit rate of the area by the insects. After three (3) hours, all insects were repelled (100% repellency) was observed. Observations till 5th hours had shown the same result. Ethanolic extracts have shown the same result. No statistically significant difference was found among aqueous and ethanolic extracts.

Table 2: Repellency shown by red flour beetle at 1 % concentration of aqueous and ethanolic extracts of clove (Aq = aqueous, Et = ethanolic).

Extract % of Original Extract	**Number of insects repelled**									
	1hr		**2hrs**		**3hrs**		**4hrs**		**5hrs**	
Extract Solvent	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**
1%	4	4	5	5	4	5	5	5	5	5
1%	4	4	4	5	4	5	5	5	5	5
1%	5	4	5	5	5	5	5	5	5	5

Table 2 shows that at 1 % concentration most of the insects were repelled after 3 hours and did not revisit the area. Ethanolic extract of clove repelled all the insects (red flour beetle) in 2 hours and there was no revisit.

Table 3: Repellency shown by red flour beetle by 1.5 % dose of aqueous and ethanolic extracts of clove (Aq = aqueous, Et = ethanolic).

Extract % of Original Extract	**Number of insects repelled**									
	1hr		**2hrs**		**3hrs**		**4hrs**		**5hrs**	
Extract Solvent	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**
1.5%	5	4	5	5	5	5	5	5	5	5
1.5%	5	5	5	4	5	5	5	5	5	5
1.5%	5	4	5	5	5	5	5	5	5	5

Table 3 shows that at 1.5% concentration showed that all insects were repelled after 2 hours with no revisit of the treated area. There was no statistically significant difference between aqueous and ethanolic extracts.

Table 4: Repellency shown by red flour beetle at 0.5% concentration of aqueous and ethanolic extracts of coriander (Aq = aqueous, Et = ethanolic).

Extract % of Original	**Number of insects repelled**									
	1hr		**2hrs**		**3hrs**		**4hrs**		**5hrs**	
Extract Solvent	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**
0.5%	4	4	4	5	4	5	5	5	5	5
0.5%	5	4	4	5	4	5	5	5	5	5
0.5%	4	4	4	5	5	5	5	5	5	5

Table 4 shows that coriander's extract showed a high repellency rate. At 0.5% concentration, ethanolic extract repelled all insects at 2nd hour while aqueous extract repelled all insects at 4th hour. At 5th hour both extracts showed a 100% repellency result.

Table 5: Repellency shown by red flour beetle at 1% concentration of aqueous and ethanolic extracts of coriander (Aq = aqueous, Et = ethanolic).

Extract % of Original	**Number of insects repelled**									
	1hr		**2hrs**		**3hrs**		**4hrs**		**5hrs**	
Extract Solvent	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**
1%	5	5	4	5	5	5	5	5	5	5
1%	4	5	5	5	5	5	5	5	5	5
1%	5	5	4	5	5	5	5	5	5	5

Table 5 shows that coriander's extract showed even higher repellency rate. At 1% concentration, ethanolic extract repelled all insects at 1st hour while aqueous extract repelled all insects at 3rd hour. At 5th hour both extracts showed a 100% repellency result. No significant difference was found between aqueous and ethanolic extracts.

Table 6: Repellency shown by red flour beetle at 1.5 % concentration of aqueous and ethanolic extracts of coriander (Aq = aqueous, Et = ethanolic).

Extract % of Original	**Number of insects repelled**									
	1hr		**2hrs**		**3hrs**		**4hrs**		**5hrs**	
Extract Solvent	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**
1.5%	5	5	5	5	5	5	5	5	5	5
1.5%	5	5	5	5	5	5	5	5	5	5
1.5%	5	5	5	5	5	5	5	5	5	5

Table 6 demonstrates repellency by 1.5 % concentration of coriander extract which is showing 100 % repellency by both aqueous and ethanolic extracts.

Table 7: Repellency shown by red flour beetle due to different doses of aqueous and ethanolic extracts of neem (Aq = aqueous, Et = ethanolic).

Extract % of Original	**Number of insects repelled**									
	1hr		**2hrs**		**3hrs**		**4hrs**		**5hrs**	
Extract Solvent	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**
0.5%	3	4	5	5	4	4	4	5	5	5
0.5%	5	4	4	4	3	5	4	5	5	5
0.5%	5	4	5	5	5	4	5	5	5	5

Table 7 demonstrates repellency by 0.5 % concentration of neem leaves extract which is showing 100 % repellency by both aqueous and ethanolic extracts at 5th hour. It was observed that till 4th hour a few insects revisited.

Table 8: Repellency shown by red flour beetle due to different doses of aqueous and ethanolic extracts of neem (Aq = aqueous, Et = ethanolic).

Extract % of Original	**Number of insects repelled**									
	1hr		**2hrs**		**3hrs**		**4hrs**		**5hrs**	
Extract Solvent	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**
1%	5	5	4	5	5	5	5	5	5	5
1%	5	5	4	5	5	5	5	5	5	5
1%	4	4	5	5	5	5	5	5	5	5

Table 8 shows the repellency by 1 % concentration of neem leaves extract which is showing 100 % repellency by both aqueous and ethanolic extracts at 3rd hour. It was observed that till 2nd hour a few insects revisited.

Table 9: Repellency shown by red flour beetle due to different doses of aqueous and ethanolic extracts of neem (Aq = aqueous, Et = ethanolic).

Extract % of Original	**Number of insects repelled**									
	1hr		**2hrs**		**3hrs**		**4hrs**		**5hrs**	
Extract Solvent	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**
1.5%	4	5	4	5	5	5	4	5	5	5
1.5%	5	5	4	5	3	5	4	5	5	5
1.5%	5	5	5	5	5	5	4	5	5	5

Table 9 shows the repellency by 1.5 % concentration of neem leaves extract which is showing 100 % repellency by ethanolic extracts at even 1st hour. But in aqueous solution insects revisited till 4th hour.

Table 10: Repellency shown by red flour beetle at 0.5 % concentrations of aqueous and ethanolic extracts of mint (Aq = aqueous, Et = ethanolic).

Extract % of Original	**Number of insects repelled**									
	1hr		**2hrs**		**3hrs**		**4hrs**		**5hrs**	
Extract Solvent	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**
0.5%	5	5	5	5	5	5	5	5	5	5
0.5%	5	5	5	5	5	5	5	5	5	5
0.5%	5	5	4	5	5	5	5	5	5	5

Table 10 shows the repellency by 0.5 % concentration of mint extract which is showing 100 % repellency by ethanolic extracts at even 1st hour. But in aqueous solution insects revisited till 2nd hour.

Table 11: Repellency shown by red flour beetle at 1 % concentration of aqueous and ethanolic extracts of mint (Aq = aqueous, Et = ethanolic).

Extract % of Original	**Number of insects repelled**									
	1hr		**2hrs**		**3hrs**		**4hrs**		**5hrs**	
Extract Solvent	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**
1%	5	5	5	5	5	5	5	5	5	5
1%	5	5	5	4	5	5	5	5	5	5
1%	5	5	4	5	5	5	5	5	5	5

Table 11 shows the repellency by 1 % concentration of mint extract which is showing 100 % repellency by both aqueous and ethanolic extracts at even 1st hour, but insects revisited till 2nd hour.

Table 12: Repellency shown by red flour beetle 1.5 % concentration of aqueous and ethanolic extracts of mint (Aq = aqueous, Et = ethanolic).

Extract % of Original	**Number of insects repelled**									
	1hr		**2hrs**		**3hrs**		**4hrs**		**5hrs**	
Extract Solvent	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**	**Aq**	**Et**
1.5%	5	5	5	5	5	5	5	5	5	5
1.5%	5	5	5	5	5	5	5	5	5	5
1.5%	5	5	5	5	5	5	5	5	5	5

Table 12 shows the repellency by 1.5 % concentration of mint extract which is showing 100 % repellency by both aqueous and ethanolic extracts at even 1st hour. No insects revisited in this experiment.

4. Discussion

Herbs and plants are used historically to repel insects. This is considered to be a safer way to repel insects in comparison to synthetic compounds which have their own risks. In the present study many plants and their parts were used to make extracts and then tested by standard methods to find out their repellency potential against insects. In all the four plant extracts used in different concentrations, it was observed that all of these showed strong repellent activity against red flour beetle. These results are in coordination with the reported work in India in particular [9] which is a very probable result as India and Pakistan share geographical location. Ahmad and his colleagues 2018 also showed that many plant extracts have strong insect repellency against red flour beetle [16]. Among all the extracts used in this study, most effective extract was of coriander followed by mint. Coriander extract in both water (aqueous extract) and ethanol was proved to be effective against red flour beetle. Ethanolic extract however was strongest as it has shown 100 % repellency from beginning (first hour). This result of the present study coincides with the results reported by Lopez and his colleagues 2008 that coriander contain toxic compound against stored rice pests [15].

Mint was also proved to be very strongly active against red flour beetle in this study and repelled all insects and in particular at 1.5% concentration repelled 100% insects (showed 100% repellency). Clove was proved to be least effective in all these extracts in all concentrations. These results are also shows that the aroma probably is also an important factor as it was observed that strongest aroma led towards strongest repellency. Tirpathi and his colleagues (2009) also reported that aroma is an important factor in insect repellency and more strong odour is related with strong repellent activity [17].

Neiro and his colleagues (2010) explained that plant essential oils individually and their mixtures are good source of insect ontrol and this is safer than the synthetic compounds [18]. Overall, ethanolic extracts were stronger in their repellent activity in comparison to aqueous extracts in these plants.

5. Conclusion

It was observed concluded that all of these plants have strong repellent activities against red flour beetle which is an important pest of storage crops. Coriander and mint had shown strongest repellent activity among all the four extracts while clove proved to be least effective. 1.5 % concentration was the most effective concentration but even at 1% concentration, these were proved to be very effective. Overall, these plant extracts shows strong repellent activity and these are a potential source of safe biological insect repellents in future.

6. Recommendations

Based upon the results of this study, plant extracts proved to be effective. These could be used for further studies individually or in combination. These could be used against more insects to find further efficiency. More solvents could also be used to prepare extracts to investigate their potential further.

References

[1]. S. Padin, G. Dal Bello and M. Fabrizio. (2002). “Grain loss caused by Tribolium castaneum, Sitophilus oryzae and Acanthoscelides obtectus in stored durum wheat and beans treated with Beauveria bassiana”. Journal of Stored Products Research. 38(1), p. 69-74.

[2]. E. Shaaya, M. Kostjukovski, J. Elberg, and S. Sukprakarn. (1997). “Plant oils as fumigants and contact insecticides for the control of stored-product insects”. Journal of Stored Products Research. 33(1), p. 7-15.

[3]. P. Nicolopoulou-Stamati, S. Maipas, C. Kotampasi, P. Stamatis and L. Hens. (2016). “Chemical Pesticides and Human Health: The Urgent Need for a New Concept in Agriculture”. Frontiers in Public Health. 4, 148. doi 10.3389/fpubh.2016.00148.

[4] D.J. Ecobichon (2001). “Pesticide use in developing countries”. Toxicology. 160(s 1–3), p. 27-33.

[5]. M. Cheraghi Niroumand, M. H. Farzaei, E. Karimpour Razkenari, G. Amin, M. Khanavi, T. Akbarzadeh, and M. R. Shams-Ardekani. (2016). “An Evidence-Based Review on Medicinal Plants Used as Insecticide and Insect Repellent in Traditional Iranian Medicine”. Iranian Red Crescent Medical Journal, 18(2), e22361. doi:10.5812/ircmj.22361.

[6]. G. Jilani, R.C. Saxena and B.P. Rueda (1988). “Repellent and Growth-Inhibiting Effects of Turmeric Oil, Sweetflag Oil, Neem Oil, and “Margosan-O” on Red Flour Beetle (Coleoptera: Tenebrionidae)”. 81(4), p. 1226-1230.

[7]. Y. Trongtokit, Y. Rongsriyam, N. Komalamisra, C. Apiwathnasorn (2005). “Comparative repellency of 38 essential oils against mosquito bites”. Phytotherapy Research. 19(4), 303-309.

[8]. E. Deletre, T. Martin, P. Campagne, D. Bourguet, A. Cadin, C. Menut, R. Bonafos and F. Chandre

(2013). “Repellent, irritant and toxic effects of 20 plant extracts on adults of the malaria vector Anopheles gambiae mosquito”. PloS one, 8(12), e82103.

[9]. M.F. Maia and S. J. Moore (2011). “Plant-based insect repellents: a review of their efficacy, development and testing”. Malaria Journal, 10 Suppl 1(Suppl 1), S11. doi:10.1186/1475-2875-10-S1-S11.

[10]. K. Chakraborty, A. Sarkar and P. Nandi (2015). “Incidence of Mango Mealy Bug, Droschia Mangiferae (Coccidae: Hemiptera) in the agro-climatic conditions of the upper Gangetic plain Of West Bengal, India”. International Journal of Science and Nature. 6, p. 568-575.

[11]. L.D. Hansen, R.D. Akre, K. WILDEY and W. ROBINSON (1993). Urban pest management of carpenter ants. In Proceedings of the first International Conference on Urban Pests. (pp. 271-279).

[12]. J. Parekh, D. Jadeja and S. Chanda (2005). “Efficacy of aqueous and methanolic extracts of some medicinal plants for potential antibacterial activity”. Turkish Journal of Biology. 29, p. 203-210.

[13]. R.A. Onyeagba, O.C. Ugbogu, C.U. Oleke and O. Iroakasi (2004). “Studies on the antimicrobial effects of garlic (Allium sativum Linn.), ginger (Zingiber officinale Roscoe) and lime (Citrus aurantifolia Linn.)”. African Journal of Biotechnology. 3(10), p. 552-554.

[14]. L.L. Mcdonald, R.H. Guy And R.D. Speirs (1970). “Preliminary evaluation of new candidate materials as toxicants, repellents and attractants against stored product insects” 1. USDA Marketing Respectively. Report, 882 pp.

[15]. M.D. López, M.J. Jordán and M.J. Pascual-Villalobos (2008). “Toxic compounds in essential oils of coriander, caraway and basil active against stored rice pests”. Journal of Stored Products Research. 44(3), p. 273-278.

[16]. F. Ahmad, N. Iqbal, S.M. Zaka, M.K. Qureshi, Q. Saeed, K.A. Khan, H.A. Ghramh, M.J. Ansari, W. Jaleel, M. Aasim, M.B. Awar (2018). “Comparative insecticidal activity of different plant materials from six common plant species against Tribolium castaneum (Herbst) (Coleoptera: Tenebrionidae)”. Saudi Journal of Biological Sciences. https://doi.org/10.1016/j.sjbs.2018.02.018.

[17]. A.K. Tripathi, S. Upadhyay, M. Bhuiyan and P.R. Bhattacharya (2009). “A review on prospects of essential oils as biopesticide in insect-pest management”. Journal of Pharmacognosy and phytotherapy. 5, p. 52-63.

[18]. L.S. Neiro, Oliveroverbal, J. Stashenko, E (2010).”Repellent activity of essential oils – a review”. Bioresource Technology, 101, p. 372-378.