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Comparative toxicological analysis of different plant leaf extracts from diverse families targeting rice moth, *Corcyra cephalonica* (Lepidoptera: Pyralidae)

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Abstract

The advent of life on the planet Earth is manifested and mastered by various species of class Insecta. Although all the species of insects are not harmful as a large group of them is responsible for pollinating the plants but some like rice moth, *Corcyra cephalonica* are notorious pests. The present study investigates the effect of different plants leaf derived extracts onto the larvae and adults of rice moth in terms of anti-feeding potential assessment and also explores the repellency potential of these plant leaf extracts against adults of rice moth. A significant observation was recorded deciphering the toxicity of different extracts in their varying percentage concentrations of 25, 50, 75 and 100. Percent seed protection over control and repellency percentages for plant extracts were calculated with sorghum and brewer's yeast used to feed during insect rearing. In near future, more emphasis should be laid on plant derived bio-control means so as to attain the goal of sustainable agriculture.

Keywords: Insect pests, sustainable agriculture, olfactometer, biochemicals, insect bioassays

Introduction

Insect infestation in storage facilities remains a critical challenge in agriculture. Insects contribute to 5% of the total 10% grain damage caused by pests annually ^[1], resulting in substantial financial losses ^[2]. While chemical pesticides remain in use, growing concerns about food safety have prompted the development of eco-friendly pest management approaches ^[3, 4]. These alternative strategies include plant-derived insecticides, biological control agents such as *Bacillus thuringiensis* (Bt), entomopathogenic fungi, natural enemies, and semiochemicals for controlling *C. cephalonica* and similar stored product pests ^[5-9].

The stored grain pest *Corcyra cephalonica* (Stainton), commonly known as the rice moth, belongs to the order Lepidoptera. The pest has established its presence across Europe, Africa, Asia, and North America ^[10], with ongoing spread to new territories through grain trade and transportation of infested products. The larvae cause significant damage by feeding on broken and damaged cereal grains, creating characteristic silk webbing that eventually forms dense masses, binding the infested products together ^[11]. The infestation not only damages the grain but also reduces its commercial value due to contamination with insect waste, silk webs, shed skins, and dead insects.

Despite its significant impact, the destructive potential of *C. cephalonica* is often undervalued ^[12]. Enhanced understanding of this pest's impact and biology is crucial for developing effective management strategies. Additionally, the simplicity and cost-effectiveness of rearing *C. cephalonica* in laboratory conditions make it an attractive option for producing biological control agents. This aspect is particularly relevant for developing nations where the high costs often limit the implementation of biological control programs ^[13].

The present investigation deals in exploring the biocontrol potential of plant botanicals belonging to 12 different families viz., Sapotaceae (*Achras sapota*, Sapota), Annonaceae (*Annona squamosa*, Custard apple), Umbelliferae (*Annethumsowa*, Dill) Chenopodiaceae (*Chenopodium album*, Lamb's quarters), Euphorbiaceae (*Euphorbia nerifolia*, Palsetia), Moraceae (*Ficus indica*, Banyan and *Ficus religiosa*, Peepal), Rutaceae (*Murrayakoenigii*,

Curry leaf tree), Combretaceae (*Quisqualisindica*, Ragoon creeper), Myrtaceae (*Syzygiumcumini*, Black plum), Apocynaceae (*Tabernaemontanalivariante*, Chandani) Caesalpiniaceae (*Tamarindusindica*, Tamarind tree)) and Papilionaceae (*Trogonellafoenum-graecum*, Fenugreek) against larvae of *C. cephalonica* (Stainton) in an experimentation designed for analysis of toxicological studies including anti-feeding and repellent action.

Materials and Methods

Culturing and Rearing of Insects

The culture of the experimental insect *C. cephalonica* was obtained from Agricultural Research Station, Durgapura, Jaipur. In laboratory, the stock culture was maintained in transparent glass jars. These jars were pre-sterilized by keeping them at 60 °C for 24 hours in an oven. The rearing of insects was done on artificial diet comprising sterilized half-crushed sorghum at 50-60 °C for a period of 2 days with 10% of brewer's yeast added to the diet mixture.

Collection of Plant Botanicals

The experimentation was devised in two phases. During first

phase the botanicals were collected from open fields of Agricultural Research Station, Durgapura, Jaipur. The fresh leaves were collected, dried and solvent extracted in soxhlet assembly ^[14], with a mantle heating temperature of 50 °C. The thimble comprised of Whatmann filter paper No. 80 holding 30 gram powdered sample of each of the plant extract. The running time was standardized to a period of 11 hours.

Toxicological Studies

The toxicological studies were done by assessing the anti-feeding and larvicidal action. For the assessment of anti-feeding action of plant extracts, the insect diet (5 gram sorghum) was treated with 1 ml extract having four different concentrations (25, 50, 75 and 100%) with three replications of each concentration tested against *C. cephalonica* larvae. The solvent was itself used as control deprived of plant extracts in plastic vials used for experimentation. A total of twenty 3rd instar larvae were utilized under each concentration for a 20 day observation period. The loss in seed weight of sorghum was compared with control diet calculated by C- value ^[15].

$$\text{Percent seed protection over control} = \frac{\% \text{ seed protection in treated} - \% \text{ seed protection in control}}{100 - \% \text{ seed protection in control}} \times 100$$

$$\text{Preference C Value Index} = \frac{2A}{M + A}$$

Where, A is average loss in seed weight in experimental trial and M is average loss in seed weight in control

$$\text{Repellency Percentage} = \frac{\text{Insects in control arm} - \text{Insects in experimental arm}}{\text{Insects in control arm}} \times 100$$

The petroleum ether and acetone were used as solvents destined for control.

Results

The highest anti-feeding potential was recorded for *A. squamosa* against *C. cephalonica* with a 87.80% of percent seed protection @100% concentration while least anti-feeding potential was recorded with *Q. indica* (56.91% @ 25% concentration) among 9 different plants (Table 1).

The repellent action of plant leaf extracts against *C. cephalonica* was assessed using two different solvents, represented in Table 2. The least effect was observed for *T. indica* petroleum ether extract and highest effect was observed for *T. livariante* petroleum ether extract.

Discussions

The results in the current finding are in consonance with the observations recorded by previous research groups. It is observed that neem plant extract exhibited highest anti-feeding property against *Perical liaricini* and *Selepadocilis* ^[18]. Three new flavonoid have been isolated from the roots

The repellent properties were estimated using Y- shaped olfactometer ^[16]. The 20 newly emerged adults were released in the center of olfactometer through the base arm. The repellency percentage was calculated ^[17].

of *Tephrosia emoroides* and reported their anti-feeding activity against the larvae of spotted borer, *Chilo partellus* ^[19]. Also, 4 neem products (azadirachtin, azadirachtin-iodine, neem seed oil cake and neem oil) has been evaluated and found that all exhibited potent anti-feeding activity against rice moth, *C. cephalonica* ^[20]. Phago deterrent action of *M. koenigii*, *A. sapota* and *A. sowa* leaf extract were evaluated ^[21]. They registered 84.26, 62.44 and 51.86% seed protection @ 100% concentration respectively with the above mentioned plant leaf extracts. These findings for anti-feeding potential are in agreement with the present investigation. Similarly, for repellent potential, the present investigation withholds to the previous studies ^[22], where they reported 100 percent repellency of *C. cephalonica* when adults were subjected to citrus clean oil formulation. Highest repellent properties of *C. album* (petroleum ether extracts) against tobacco cutworm, *Spodoptera litura* larvae has been found ^[23]. The results obtained ^[24], also in accordance with the present investigation where they reported high repellent potential of *A. sowa* against *Tribolium castaneum*.

Table 1: Efficacy of plant extracts as seed protecting against larvae of *C. cephalonica*

Plant extract	Solvent Used	Concentration (% dil of SS)	% Loss in seed weight	% Seed Protection	% Seed Protection over control	C- Value
<i>Annona Squamosa</i>	Acetone	25	16.70	83.3	59.583	0.575
		50	14.45	85.55	65.029	0.518
		75	14.05	85.95	65.997	0.507
		100	9.00	91	78.218	0.357
		Control	41.32	58.68	-	-
	Petroleum ether	25	23.20	76.8	34.352	0.792
		50	17.00	83	51.895	0.649
		75	15.75	84.2	55.432	0.616
		100	13.70	86.3	61.233	0.558
		Control	35.34	64.66	-	-
<i>Anethumsowa</i>	Acetone	25	44.10	55.90	10.073	0.946
		50	40.57	59.43	17.271	0.905
		75	37.70	62.3	23.123	0.869
		100	24.42	75.5	50.203	0.664
		Control	49.04	60.85	-	-0.925
	Petroleum ether	25	34.20	65.8	13.853	0.768
		50	24.80	75.20	37.531	0.681
		75	20.50	79.50	48.362	0.638
		100	18.62	60.30	53.098	-
		Control	39.70	58.9	-	-
<i>Chenopodium album</i>	Acetone	25	25.04	74.96	24.578	0.859
		50	24.10	75.90	27.409	0.841
		75	22.20	77.80	33.132	0.801
		100	18.55	81.45	44.126	0.716
		Control	33.20	66.80	-	-
	Petroleum ether	25	35.10	64.90	23.695	0.865
		50	24.50	75.50	46.739	0.709
		75	23.70	76.30	48.478	0.679
		100	10.20	89.80	77.826	0.362
		Control	46.00	54.00	-	-
<i>Euphorbia neriifolia</i>	Acetone	25	28.70	71.30	30.170	0.822
		50	25.75	74.25	37.347	0.770
		75	14.10	85.90	65.693	0.510
		100	12.20	87.80	70.316	0.457
		Control	41.10	58.90	-	-
	Petroleum ether	25	36.45	63.55	8.875	0.953
		50	30.00	70.00	25.00	0.857
		75	26.55	73.45	33.625	0.797
		100	24.90	75.10	37.750	0.767
		Control	40.00	60.00	-	-
<i>Murraya koenigii</i>	Acetone	25	34.05	65.95	8.835	0.953
		50	27.30	72.70	26.907	0.844
		75	25.65	74.35	31.325	0.814
		100	22.95	77.05	38.554	0.761
		Control	37.35	62.65	-	-
	Petroleum ether	25	31.52	68.48	21.980	0.876
		50	26.50	73.50	34.405	0.792
		75	23.05	76.95	42.945	0.726
		100	18.00	82.00	55.445	0.616
		Control	40.40	59.60	-	-
<i>Quisqualis indica</i>	Acetone	25	43.09	56.91	7.927	0.958
		50	40.56	59.44	13.333	0.928
		75	37.30	62.70	20.299	0.887
		100	32.70	67.30	30.128	0.872
		Control	46.80	53.20	-	-
	Petroleum ether	25	30.40	69.60	18.279	0.899
		50	28.45	71.55	23.521	0.867
		75	22.87	77.13	38.325	0.761
		100	22.42	77.58	39.731	0.752
		Control	37.20	62.80	-	-
<i>Tabernaemontana livaricate</i>	Acetone	25	32.20	67.80	6.259	0.967
		50	31.05	68.95	9.606	0.949
		75	23.85	76.15	30.560	0.819
		100	23.35	76.65	32.023	0.809
		Control	34.35	65.65	-	-

	Petroleum ether	25	39.64	60.36	23.029	0.869
		50	33.85	66.15	34.270	0.793
		75	25.35	74.65	50.776	0.659
		100	23.25	76.75	54.854	0.622
		Control	51.50	48.50	-	-
<i>Tamarindus indica</i>	Acetone	25	30.20	69.80	60.574	0.909
		50	26.20	73.80	27.624	0.839
		75	26.10	73.90	27.900	0.837
		100	22.30	77.70	38.397	0.762
		Control	36.20	63.80	-	-
	Petroleum ether	25	27.90	72.10	31.280	0.814
		50	22.50	77.50	44.581	0.713
		75	20.60	79.40	49.261	0.673
		100	17.90	82.10	55.911	0.611
		Control	40.60	59.40	-	-
<i>Trigonella foenum-graecum</i>	Acetone	25	37.50	62.50	11.137	0.941
		50	35.90	64.10	14.928	0.919
		75	32.65	67.35	22.630	0.872
		100	23	77	45.497	0.705
		Control	42.20	57.80	-	-
	Petroleum ether	25	33.40	66.60	10.215	0.946
		50	28.70	71.30	22.849	0.871
		75	26.00	74.00	30.107	0.822
		100	24.95	75.05	32.930	0.802
		Control	37.20	62.80	-	-

Table 2: Repellent action of plant leaf extracts against *C. cephalonica*

S. No.	Plant Extract	Repellency Percentage (Petroleum ether)	Repellency Percentage (Acetone)
1.	<i>T. livaricate</i>	83.01	81.25
2.	<i>C. album</i>	72.25	68.61
3.	<i>A. squamosa</i>	71.84	72.54
4.	<i>M. koenigii</i>	70.71	68.35
5.	<i>T. foenum-graecum</i>	69.99	63.19
6.	<i>Q. indica</i>	68.22	61.78
7.	<i>E. nerrifolia</i>	66.66	59.47
8.	<i>A. sowa</i>	64.88	60.50
9.	<i>S. cumini</i>	58.84	60.65
10.	<i>F. religiosa</i>	57.11	50.00
11.	<i>A. sapota</i>	48.24	35.72
12.	<i>F. indica</i>	45.45	44.50
13.	<i>T. indica</i>	42.30	37.11

Conclusion

The 3rd instar larvae of *C. cephalonica* were treated with different concentrations (25, 50, 75 and 100%) of plant extracts for their anti-feeding activity assessment. Results indicate that acetone extract of *T. livaricate* (87.22%), *M. koenigii* (84.04%), *C. album* (83.34%) and *T. foenum-graecum* (81.14%) displayed sorghum seed protection response in evidence of anti-feeding potential. The repellency percentage of *T. livaricate* (83.01 and 81.25 for both extracts), *A. squamosa* (71.84 and 72.54%) was found to be agents of strong repellent potential in addition to other plant leaf extracts used in this study. In near future the emphasis should be on these plant derived safe to environment biochemicals so as to attain the goal of sustainable agriculture. Moreover, the Gas-Chromatography (GC-MS) analysis and High Performance Liquid Chromatography (HPLC) studies are required so as to decipher the biochemistry of the metabolites responsible for insect deterring potential.

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