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Effect of *Ricinus communis* leaf extract on the Development and Population build-up of *Callosobruchus chinensis* (Linn.)

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Abstract:
Ricinus communis leaf extract was assayed for its various toxic properties (repellent, oviposition deterrent, ovicidal and loss in food consumption) against Callosobruchus chinensis, a severe stored pest. Acetone extract of R. communis leaf found effective to repel the pest and to reduce oviposition and seed loss by the pulse pest.
Keywords: *Callosobruchus chinensis, Ricinus communis, Repellent, Ovipositional deterrent, Ovicidal.*

I. Introduction:

Agriculture pest problems are as old as the beginning of crop cultivation. Among all the crops cultivated pulses exhibit biological value due to rich protein level. Pulses are severely damaged by the bruchid pests during storage (Mookherjee et al ,1970; Sharma,1984; Giga,1990). Use of botanical products and vegetable oils for the protection of stored grains is in practice since time immemorial in India. Vegetable oils found effective repellent and seed protectant on pulses and cowpea (Mummugatti et al, 1977; Singh et al, 1978 and Ali et al,1983). Botanical pesticides are assayed as alternative to the synthetic pesticides due to their safer and non-residual, non-toxic effects on non-target organisms and on the environment. Excessive use of synthetic pesticides not only contaminates the food (WCS, 1980) but adversely affects the environment and has residual toxic effects on non target organisms.

Plant products have been found effective against various stored pests (Garcia,1990; Giga et al 1990; Su,1985,1986,1991; Dwivedi & Kumari,2000; Dwivedi and Garg,2000). Ofuya (1990) used Bark powder to reduce the oviposition and hatching in *Callosobruchus maculatus.* The present study is an attempt evaluates the efficacy of *R. communis* leaf extract in Acetone as repellent, oviposition deterrent, ovicidal and reduction in food consumption by the grubs.

II. Materials and Methods:

To run the experiment culture of the test insect, *C. chinensis* (L.) was reared in the laboratory in the pre sterilised glass jars. Sterilised cowpea seeds were used as food source in the jars. Optimum conditions of Temperature and Humidity 25±^{o}C and 70±10 R.H. are maintained in the culture jars with the help of lamp and KOH pellets in the Petri dish respectively (Smith, 1966 and Singh and Sharma, 1981). The grains were conditioned at room temperature for 24 hrs. before use. 50 pairs of *C. chinensis* were released in the jars to obtain eggs. To set the experiments freshly emerged insects were obtained from mother culture.

Leaves of *Ricinus communis* (Euphorbiaceae) were collected and were washed, shade dried and then powdered in the grinder. The extract of leaf powder is prepared by Soxhlet method using Acetone as a solvent. (Luque de Castro and García-Ayuso,1998). The prepared extract was used as 100 % Stock solution. The desired concentrations i.e., 25, 50 and 75% of the extract were prepared by diluting the Stock solution with the solvent.

Repellency:

For repellency experiment, freshly emerged insects of 0-24 hrs. were taken from mother culture. To evaluate repellent action of the extract 'Y' shaped Olfactometer was used (Read et al,1970 and Ahmed and Eapen,1986). A cotton ball soaked in 1 ml. of stock solution (100 %) of the extract was plugged in the experimental arm, whereas control arm plugged with the cotton ball soaked in the same amount of the solvent (Acetone). Newly emerged insects were placed in the centre of the Olfactometer from the Base arm for 30 minutes and after that, number of beetles in the Experimental, Control and Base arm were counted. The experiment was run three times. Repellency results were statistically analysed by calculating Standard Deviation (S.D) and Chi square test (x^2).

S.D. = $\sqrt{\Sigma d^2/N-1}$

Where: d= X - $\bar{X}$

Chi square test: $(O-E)^2/E$

Where:
E= Expected Value
O= Observational Value

Ovipositional Deterrency:

To assay the oviposition deterrent property of the extract three replications of 100 % concentration and control (solvent only) were run simultaneously. 5 grams of cowpea seeds treated with 1 ml. leaf extract of *R. communis* and solvent were kept in the pre-sterilised plastic vials. Three pairs of freshly emerged (0-24 hrs.) insects were released in the experimenting vials. Results were recorded by counting the number of eggs laid by the insects on the treated seeds. Percent reduction in the oviposition and Deterrent quotient was calculated by the formula given by Messina and Renwick,1983.

Percent reduction in oviposition:

$$= \frac{\text{No. of eggs on control seeds – No. of eggs on treated seeds}}{\text{Total No. of eggs on control seeds}} \times 100$$

Deterrent quotient: DQ

$$= \frac{\text{No. of eggs on control seeds – No. of eggs on treated seeds}}{\text{Total No. of eggs (control + Treated seeds)}}$$

DQ ranges from -1 (eggs on treated seeds) to + 1(eggs on control seeds)

Ovicidal Action:

Ovicidal action of the extract was assessed at four concentrations i.e., 25,50,75 and 100 %. These dose levels were prepared by diluting the stock solution (100 %) with varying proportion of the solvent. 20 eggs on cowpea seeds were treated with different doses by dipping method. Seeds with treated eggs were shifted to the vials after evaporation of the solvent. Vials were covered with muslin cloth. Three replication of each dose is run along with control treated only with Acetone. Results were recorded after last egg hatching. Percent corrected mortality of eggs was calculated by using Abbott's formula (Abbott, 1987):

$$= \frac{\text{\% kill in treated - \% kill in control}}{\text{100 - \% kill in control}}$$

III. Results and Discussion:

Leaf extract of *R. communis* (in Acetone) exhibited the repellent action against *Callosobruchus chinensis*. Results documented in Table.1 clearly indicate that 16.67 % beetles moved in treated arm as compared to the control arm (36.67 %).

Table.1: Repellent Action of *Ricinus communis* in Acetone against *Callosobruchus chinensis (L.)*

S. No.	No. of Insects in Base Arm	No. of Insects in Control Arm (A)	No. of Insects in treated Arm (B)	% Of (A)	% of (B)
1	8	7	5	35	25
2	8	8	4	40	20
3	12	7	1	35	5
Mean± S.D.	9.33 ± 2.3098	7.33 ± 0.9966	3.33±2.0816	36.67± 2.8867	16.67± 10.4083

Leaf extract of *R.communis* potentially killed the eggs in treated groups. Egg mortality showed gradual increase with the concentration of the extracts. Even S/25 dose level exhibited more than 50 % egg mortality and in 100 % dose level it rose up to 81.65 %. Table.2 clearly indicates that in control no egg mortality took place in the same conditions.

Table.2: Ovicidal Action of *Ricinus communis* in Acetone against *Callosobruchus chinensis (L.)*

S. No.	Dose Level	Average no. of hatched eggs	% of eggs hatched	Egg mortality	Percent egg mortality	Percent Corrected Mortality
1	S/25	6.67	33.35	13.33	66.65	66.65
2	S/50	6	30	14	70	70
3	S/75	4.33	21.65	15.67	78.35	78.35
4	S/100	3.67	18.35	16.33	81.65	81.65
5	Control	20	100	00	00	00

Freshly emerged beetles released on the seeds treated with the leaf extract of *R.communis* in the acetone shown effective reduction in the oviposition. Only 85 eggs were laid by the female beetles on the treated seeds as compared to 219 eggs on the seeds treated with acetone only. 100 % dose level of the extract potentially reduced the oviposition by 61.18 % with 0.44 DQ value. Results were significant at 0.001 level of P-value.

Table.3: Ovipositional Deterrent property of *Ricinus communis* in Acetone against *Callosobruchus chinensis (L.)*

S.No.	Avg. No. of eggs on control seeds	Avg. No. of eggs on treated seeds	% Reduction in oviposition	DQ[a]	P[b]
1.	219	85	61.18	0.44	0.62

R. communis leaf extract in acetone reduced the oviposition in treated groups. Only 32.33 eggs were counted at S/100 dose level while 161.5eggs were laid on the solvent treated seeds. Emergence is also lowered in treated groups and minimum 16.48 % emergence at S/100 dose level was registered as compared to 27.86 % in the control group.

Treated seeds were effectively protected in seed loss by weight. Results expressed 64.79 percent seed protection over control at 100% dose level of the extract. Only 19.48 percent seed loss is recorded at S/100 dose level of *R. communis*.

Food consumption per grub (FCPG) was found inversely proportionate to dose levels of the extract. It gradually decreases with the increase in the dose level. C-value increased continuously with decrease in the concentration.

Table.4: Antifeedant property of *Ricinus communis* in Acetone against *Callosobruchus chinensis (L.)*

S.No.	Dose Level	Average Oviposition	Percent Emergence	Percent loss in seed weight	Percent seed protection over control	FCPG (in mg)	C - Value
1	S/25	107.33	33.55	39.58	27.900	54.97	0.724
2	S/50	100.67	27.14	33.66	38.766	61.58	0.567
3	S/75	82.67	21.77	26.38	52.129	73.277	0.312
4	S/100	32.33	16.48	19.48	64.794	182.73	0.082
5	Control	161.5	27.86	54.48	------	60.53	----

IV. Discussion:

Ricinus communis belongs to the family Euphorbiaceae contains 300 genera and 7,500 family. Castor (*R. communis*) has medicinal value as laxative, purgative, fungicide, insecticide and larvicide and other many medicinal properties. Important phytochemical constituents like flavonoids, Saponins, Glycosides, alkaloids and steroids are reported by Jitendra et al,2012. Insecticidal, Ovicidal, Ovipositional deterrent and antimicrobial agents like flavonoids in *R. communis* also reported by Shripad et al, 2003 against *Callosobruchus chinensis*. Fumigant and repellent potential of *Ricinus communis* and *Mentha pulegium* essential oils against were studied by Salem et al 2017.They explained that stem essential oils of castor exhibited potent fumigant and repellent toxicities against Coleopteran (*Tribolium*) and Lepidopteran (*Lasioderma*) pests. Salem and co-workers extracted 2,4-bis (dimethyl benzyl)-6-t-butyl(phenol) as a main volatile compound in castor oil. It showed strong 80% repellency against stored pests and can be used as herbal insecticide over synthetic pesticides. Apart from flavonoids and alkaloids in *Ricinus,* a water-soluble glycoprotein Ricin is also reported by T A Kodjo et al,2011. It is studied that toxic effects of *Ricinus communis* is due the presence of Ricin. It is majorly present in the seed endosperm and other parts of the plant like stem, leaves and flowers. Ricin is found a very potent repellent, ovicidal and oviposition deterrent against diamond back moth, *Plutella xylostella* (L.). Presence of ricin and recinine in *R.communis* is also discussed by Ferry et al (2004) and Olaifa et al (2004) in their studies. They stated that the compound exhibited insecticidal potency and can be a molecular approach to insect resistance. Bigi et al (2004) studied the toxic effects of ricinine from *Ricinus* against leaf cutting ants *Atta rubropilosa* (Hymenoptera;Formicidae) and symbiotic fungus.

The conclusion of above studies strengthens the findings of the present experiments. The leaf extracts of *Ricinus communis* in Acetone significantly exhibited the repellent, ovicidal, oviposition deterrency and seed protection efficacy. Pungent smell and oil-based nature of the extract may be due to the presence of essential oils, glycoproteins (Ricinine), flavonoids and alkaloids.

Conflict of interest: The authors declare that they have no competing interests.

Author Contributions: Both the authors have equal contribution in this paper. They conceived the study, conceptualized the paper, prepared, critically read and revised the manuscript, and gave final approval for publication.

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