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Toxicological Effects of *Dryopteris filix-mas* Against the Ontogeny of Rice-moth, *Corcyra cephalonica* (Staint)

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Abstract: Laboratory studies on the larvicidal and pupicidal effects of *Dryopteris filix-mas* (root and rhizome) aqueous extract was made on the third instar larvae of *Corcyra cephalonica* (Staint.). The observation revealed that 0.16% (a.i.) v/w dose level of *Dryopteris filix-mas* caused 100% larval mortality indicating absolute toxicity to the pest.

Key words: *Dryopteris filix-mas* · Toxicity · *Corcyra cephalonica* · Ontogeny

INTRODUCTION

Rice-moth, *Corcyra cephalonica* is a major pest of stored cereals and cereal commodities in India as well as in other tropical and subtropical regions of the world. Its larval stages cause appreciable loss to rice, sorghum, maize, currants, gram, groundnuts, cocoa beans, peanuts, cotton seeds, linseeds, raisins, chocolates, army biscuits, nutmeg and milled products [1-8].

Sufficient knowledge exists on the nutritional and reproductive physiology of this lepidopterous pest [9-17]. In addition, influence of insecticidal agents like organochlorines, organophosphates and a few synthetic pyrethroids have also been reported against the ontogeny as well as larval biochemistry of this lepidopterous pest [18-28].

The use of organophosphorus and organochlorine insecticides pose problems such as poisoning in man and other animals (Pichet and Philongene) [29], pest resistence to pesticides (Ramesh Chand and Pratap Birthal) [30], the risk of user's contamination, injurious to non-target organisms and even cause pollution to our own environment and thus disturbing the ecosystem. Hence, there is an urgent need to develop safe alternatives to conventional insecticides for the protection of grain and grain products against insect infestations.

Plant products, which show diverse biological activities, may be useful for this purpose. Higher plants are a rich source of novel natural substances that can be used to develop environmental safe methods for insect control [31]. Plant materials with insecticidal properties have been used traditionally for generations throughout the world [32]. Botanical insecticides compared to synthetic ones may be safer for the environment, are generally, less expensive, easily processed and used by farmers and small industries [32]. Since these insecticides are often active against a limited number of species, are often biodegradable to non-toxic products and are potentially suitable for use in integrated pest management. They could lead to the development of new classes of safer insect control agents [33].

Earlier findings reveal that the rhizome and young shoots (fiddleheads) of the male fern (*Dryopteris filix-mas*) have deworming properties that have long been recognized in Europe against tapeworms (Taenia). The ferns are effective in arresting embryonic development in insects. The extracts of pteridophytes have toxic effects on *Spodoptera littura* and *Helicoverpa armigera*. Filicin, which isolated from the rhizome of *Dryopteris filix-mas,* is a potential insecticide.

The aim of the present study was to investigate the toxicological effects of *Dryopteris filix-mas* to control the rice-moth, *Corcyra cephalonica*. Hence, as an objective of such programme the present work, for the first time, has been designed and conducted to investigate the influence of *Dryopteris filix-mas* against the ontogeny of rice-moth, *Corcyra cephalonica*. Such knowledge may be regarded as one of the objective criteria permitting an assessment of effectiveness of botanical control measures against *Corcyra cephalonica* in particular and lepidopterous pests in general.

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MATERIALS AND METHODS

Insects: A rich standard culture of this insect was maintained in the laboratory on normal dietary medium composed of coarsely ground jowar (*Sorghum vulgare*) mixed with 5% (w/w) yeast powder inside a glass containers (150 mm diameter, 200 mm height) at 26±1°C and 93± 5% relative humidity (R.H.).

Collection of Plant Material: *Dryopteris filix-mas* plants were collected from adjacent areas in Gorakhpur and neighbour districts of U.P. INDIA.

Preparation of Aqueous Extract: The fresh *Dryopteris filix-mas root* and rhizome were washed in tap water, cut into small pieces and then air dried at room temperature, crushed in an electric grinder, homogenized in distilled water (1gm/ml) for 5 minutes and centrifuged at 1000g for 10 minutes. The supernatant was used as water extract for the toxicological experiments.

From the laboratory maintained culture on ground jowar mixed with 5% (w/w) yeast powder, newly emerged males and females were transferred to oviposition glass chambers (35 mm diameter, 200 mm height). Eggs laid by the females were collected and then placed in glass chambers (consisting of 250 ml beakers) for hatching. Freshly hatched larvae of *Corcyra cephalonica* were allowed to feed on a normal dietary medium mixed with 5% yeast powder (w/w) kept inside 250ml beakers for exactly 15 days. On the 16th day of larval hatching, 25 third instar larvae were transferred to each similar rearing chambers (250ml beakers) containing 50gms of dietary medium mixed and treated separately with 9 different known dose levels of *Dryopteris filix-mas* i.e. 0.01%, 0.02%, 0.04%, 0.06%, 0.08%, 0.10%, 0.12%, 0.14% and 0.16% (a.i.) v/w, using 5 replications of each treated as well as normal dietary media as control. For the preparation of different dose levels of *Dryopteris filix-mas* in dietary media, a stock solution of extract was prepared by dissolving it in distilled water and then adjusted via serial dilution to achieve its required concentration. Now 50 ml of this required concentration of *Dryopteris filix-mas* was soaked in 100gms of coarsely ground jowar (*Sorghum vulgare*) mixed with 5% yeast powder (w/w). Then after this soaked food was fully mixed to obtain homogenous mixture of the *Dryopteris filix-mas* extract. After one hour, this treated wet dietary media was dispersed on polythene sheets and air dried to eliminate the excess of water at room temperature. In a similar way, control dietary media was prepared in distilled water rather than application of *Dryopteris filix-mas* extract. On the completion of life-cycle number of adults emerged and dead pupae were recorded to calculate percent pupation and percent larval mortality. The values have been expressed as the mean ± S.D. of five replicates. Straight line regression equation was applied between different concentration of *Dryopteris filix-mas extract* and their corresponding percent larval death/percent pupation /percent pupal death and percent adult emergence to observe the significant correlation.

RESULTS

Results presented in Table 1 and Fig. 1 revealed that a significant larval mortality was obtained with the increase of *Dryopteris filix-mas* root and rhizome aqueous extract dose levels. At 0.01% dose level of *Dryopteris filix-mas* larval mortality was only 15.2 ± 1.78% while 100% larval mortality was observed at 0.16% dose level of *Dryopteris filix-mas*. As the *Dryopteris filix-mas* dose levels increase a significant reduction in pupation and a significant enhancement in pupal death occur. 84.8 ± 1.78% pupation was recorded at 0.01% dose level which decreased to 12 ± 2.82 at 0.14% dose level of *Dryopteris filix-mas.* At the same time, 5.40 ± 1.78% pupal death was recorded at 0.04% of dose level of *Dryopteris filix-mas*, which increased to 100% at 0.14% dose level of *Dryopteris filix-mas*. A significant reduction in adult emergence was recorded following exposure of increased dose levels of *Dryopteris filix-mas*. At 0.01% dose level of *Dryopteris filix-mas* 84.8 ± 1.78% was recorded that decreased to 15.2 ± 5.21 at 0.14% dose level of *Dryopteris filix-mas*.

DISCUSSION

The toxicity of this botanical extract increases significantly with the increase in its dose level on each developmental stage. i.e. larva, pupa and adults (Table1, Fig.1). On the basis of % larval death, % pupation, % pupal death and % adult emergence, at different dose levels of *Dryopteris filix-mas* root and rhizome aqueous extract it is possible to categorise the relative effectiveness of their dose levels (Fitzpatrick and Dowell) [34]. The data demonstrate that 0.16% dose level of *Dryopteris filix-mas* extract may be considered as extremely toxic to the pest, as no pupation occurred at this dose level indicating 100% larval mortality. At dose level of 0.14% *Dryopteris filix-mas* pupation took place but there was no emergence of any single adult.

Table 1: Toxicological effects of *Dryopteris filix-mas* against the ontogeny of rice-moth, *C.cephalonica.*

% *Dryopteris filix-mas* root and rhizome aqueous extract dose levels in food enriched with 5% (w/w) yeast powder	Percent* larval death	Percent* pupation	Percent* pupal death	Percent* adult emergence	Acute toxicity to the pest
Control	0	100	0	100	
0.01	15.2±1.78	84.8±1.78	0	84.8±1.78	Poorly toxic
0.02	21.6±3.57	78.4±3.57	0	78.4±3.57	Moderately toxic
0.04	40.8±1.78	59.2±1.78	5.40±1.78	56.0±2.82	Moderately severe
0.06	52.8±1.78	47.2±1.78	11.86±1.78	42.4±2.19	Moderately severe
0.08	62.4±2.19	37.6±2.19	12.76±1.78	32.8±3.34	Severely toxic
0.10	69.6±2.19	30.4±2.19	15.78±1.78	25.6±3.57	Severely toxic
0.12	79.2±1.78	20.8±1.78	26.92±3.57	15.2±5.21	Severely toxic
0.14	88.0±2.82	12.0±2.82	100		Extremely severe
0.16	100				Extremely toxic

*Values have been expressed as the mean ± S.D. of five replicates.

Straight line regression equation was applied between different dose levels of *Dryopteris filix-mas* root and rhizome aqueous extract and their corresponding percent larval death/percent pupation/percent pupal death/percent adult emergence to observe the significant correlation:

Percent larval death y = 10.566 + 580.73x; r = 0.98 P< 0.001

Percent pupation y = 90.116 - 597.62x; r = - 0.98 P< 0.001

Percent pupal death y = - 11.890 + 490.75x; r = 0.77 P insignificant

Percent adult emergence y = 91.316 - 686.81x; r = - 0.98 P< 0.001

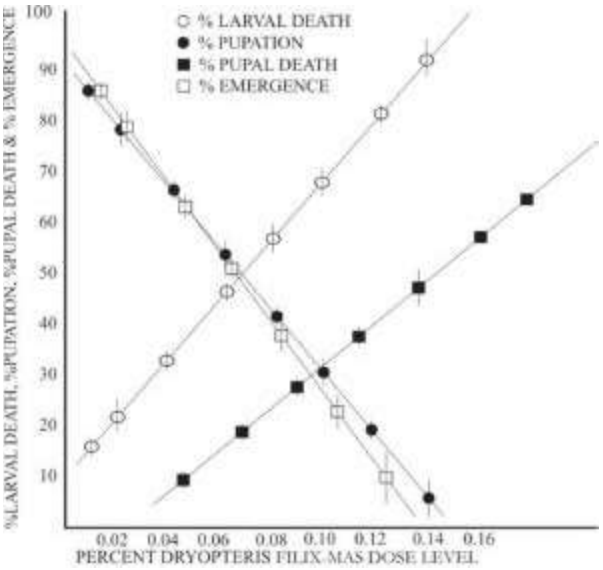

Fig. 1: Graphic representation of % larval death, % pupation, % pupal death & percent emergence of rice-moth, *Corcyra cephalonica* at various dose levels of *Dryopteris filix-mas* (Mean ± S.D.).

This dose level is considered as extremely severe. At 0.12, 0.10 and 0.08% dose levels of *Dryopteris filix-mas* the average emergence was 15.2 ± 5.21%, 25.6 ± 3.57% and 32.8 ± 3.34% respectively. These dose levels are regarded to be severely toxic. A moderately severe toxicity is accounted at dose levels of 0.06% and 0.04% of this botanical as the average emergence at these dose levels was 42.4 ± 2.19% and 56.0 ± 2.82%, respectively. At 0.02% dose level of *Dryopteris filix-mas* the average emergence was 78.4 ± 3.57%. This dose level is moderately toxic to the pest. The average emergence, at dose level of 0.01% of *Dryopteris filix-mas* was 84.8 ± 1.78%. This dose level is poorly toxic to the pest.

Previous findings reveal that extract of seeds of *Annona squamosa*, aerial parts of *Tephrosia purpurea* and rhizome of *Acorus calamus* caused similar toxic effects to the larvae of *Corcyra cephalonica,* the larvae became black and resulted in to death, Sandhya Jadhav, [35]. Saxena *et al.* Bhattacharya, Senguttuvan *et al.* Saxena *et al.* Patel *et al.* and Jaswanth *et al.* have studied the effect of different plant extracts on insect pests and found several to be toxic to different insects [36-41]. Thus, in the present investigation, it is concluded that 0.14% and 0.16% dose levels of *Dryopteris filix-mas*, is efficient for the effective control of *C. cephalonica* in particular and lepidopterous pest in general.

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