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Insecticidal, antifeedant and growth regulatory efficacies of flower extract of *Quisqualis indica* (Linn.) against *Corcyra cephalonica* (Stainton)

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Abstract
Flower extract of *Quisqulis indica* in acetone with four concentrations i.e., 25, 50, 75 & 100 % were tested to record persistent toxicity for 60 days on the Life cycle of rice moth, *Corcyra cephalonica* (Stainton) until the adult emergence of the second generation. Observations were made to determine mortalities and detrimental effects at various stages of the life cycle. The potential of this extract was evaluated on rice moth development by measuring the average developing duration & growth index and ultimately tallying the percentage of seed protection. It drastically reduced the adult emergence, controlling the rice moth population up to 90%. The timeframes for rice moth growth were dramatically accelerated by the application of various doses. Significant reduction in grain damage was observed, showing a 75.75 percent increase in seed protection compared to the control. This extract adversely affected fecundity and fertility of F1 generation adults as showed 45% reduction in egg laying and 30-40% eggs were non-viable. In order to control the population of this stored grain pest, *Quisqualis Indica's* combined toxic, mild growth-regulatory, and sterilant effects were identified in the current investigation.

Keywords: *Corcyra Cephalonica*, *Quisqualis indica*, toxicity evaluation, antifeedant, growth regulatory activity, sterilant

Introduction

Corcyra cephalonica (Stainton), rice moth, a prominent pest of stored rice, also attacks wheat, maize, sorghum, groundnuts, cotton seeds, coffee, spices, and cocoa beans, especially in areas with tropical and subtropical climates [1]. The insect pest has primarily been documented from continents like Europe, Africa, Asia, and North America [2], while it is still spreading to other parts of the world via the transit of infected grains and commodities [3]. The larvae feed inside silken webs, causing harm to the grain. When infestation levels are severe, the entire grain supply may become a webbed mass, which eventually develops a distinctive bad odor [4]. Consumer acceptance and, thus, the market value of the products are decreased by contamination with larval faeces, webbings, exuviae, and corpses. *C. cephalonica* has spread throughout the world through the trade of rice and it is reported to be severely infested in Himachal Pradesh, India, during the rainy season [5].

Because of the intensive and indiscriminate use of chemical pesticides, which has led to residual issues and the development of resistance to many common insecticides including pyrethroids, carbamates, and organophosphates, there is a constant need for the search of environmentally benign insecticides from natural sources, particularly plants. Many scientists are presently working to create novel means of controlling insect populations, including secondary plant metabolites, such as alkaloids, glycoalkaloids, terpenoids, organic acids, and alcohols, which have the potential to be employed in plant defense. These substances can have an impact on insects at many levels of biological structure, but they typically impair cellular and physiological functions. *Quisqualis indica (Linn.)* (Combretaceae), often referred to as Rangoon Creeper, is a superb vine for outdoor gardens. It is found everywhere in the world, but it is particularly prevalent in China, the Philippines, Bangladesh, Myanmar, India, and Malaysia. Important chemical components found in *Quisqualis indica* (Linn.) include tannins, flavonoids, steroids, carbohydrates, protein, amino acids, saponins, and phenolic compounds [6]. Bairagi VA et. al. (2012) extracted phytoconstituents i.e., terpenoids (sitosterol and lupeol), flavonoids (Quercetin and rutin), and tannins (gallic acid) from the leaves and flowers of this plant [7]. These substances have demonstrated a range of pharmacological effects, including antimicrobial [8], anti-fungal [9], cytotoxic [10], insecticidal [11], anthelminthic [12], immunomodulatory [13], anti-inflammatory [14], antioxidant properties. The goal of the current study was to determine the toxicity and adverse effects of acetone extract of the flowers of *Q. indica* on various phases of the rice moth's life cycle in order to manage its population.

Material and Methods

A pure culture of rice moth was obtained from Durgapura Agriculture Research station, Jaipur and was kept in glass jars that were two-thirds full of sterilized, crushed sorghum grains & 10% Brewer's yeast powder at 28 ± 2º temperature and 65 ± 5% relative humidity, respectively.

The freshly emerged adults were moved to an upside-down funnel enclosed in a mosquito net to allow mate and produce eggs. For testing, recently deposited eggs (0–24 hours) were gathered.

Locally procured *Quisqualis indica* fresh flowers were dried in the shade and processed into a fine powder using a mechanical grinder. The extraction was carried out using the Soxhlet method with acetone as the solvent [15]. The powdered materials (30 g) were placed in the Soxhlet thimble, and acetone (300 ml, Merck) extraction were conducted until exhaustion (48 hrs), after which they were filtered through Whatman's No. 1 filter paper. The purified extract served as the stock solution (SS) and refrigerated at

4ºC. By further diluting the extract with solvent, three concentrations of extract—25, 50, and 75% were created. Each experiment had three replications, four sub-treatments (25, 50, 75, and 100%), and a control group that received only acetone. In each treatment, 50 freshly laid eggs were added to a vial holding 20 grams of grains that had been treated with 2 ml of desired conc. of extract. They were allowed to grow in a treated environment, and observations were taken to determine mortality at various stages of the life cycle until the adult emergence of the following generation. By generating the "t-test" value at the 0.001 significant level, the data were statistically examined. According to Abbott's formula, the percent corrected mortalities of the different life-stages of rice moth were computed [16].

$$\text{Abbott's corrected mortality:} = \frac{\%\text{ Kill in Treated - \% kill in Control}}{100 - \%\text{ kill in Control}} \times 100$$

After adult emergence, larvae, pupae, frass and excreta were removed and unconsumed food was weighted. The formula proposed by Kogan and Goeden, 1970[17], was used to compute the percentage of seed protection compared to control and the Preference (C-value0 index.

$$\text{Percent Seed Protection Over Control:} = \frac{\%\text{ Seed protection in Treated - \% Seed protection in Control}}{100 - \%\text{ Seed protection in Control}} \times 100$$

$$\text{Preference (C-value) Index:} = \frac{2A}{(M+A)}$$

Where: A= Av. loss in seed weight in treatment
M= Loss in seed weight in control group

Total time taken by newly hatched larvae till they attained adulthood was taken and Growth index was calculated by the following formula [18].

$$\text{Growth index} = \frac{\text{Percentage of adult emergence}}{\text{Av. developmental period}}$$

Results

Mortality data (Table-1) for the rice moth at different stages of its life cycle shows that the extract is most hazardous to eggs, followed by larvae, while pupae were less vulnerable. Strong ovicidal effects were observed, with egg mortality reaching 47.34, 53.34, 62.68, and 65.34% at 25, 50, 75, and 100% conc., respectively, compared to only 8% in the control. Excellent larvicidal activity was seen in the following ratios: 61.56% larval mortality over control (10.86%) at 100% conc., followed by 42.28, 30, and 22.78% at 75, 50, and 25% conc. Although all combinations of extracts increased pupal mortality compared to control, pupae toxicity was determined to be statistically non-significant. In all treatment conc., the total amount of adult emergence was greatly reduced, and this reduction was found to be inversely proportional to dose levels. At 25, 50, 75, and 100% conc., it showed only 38, 30, 16, and 10% adult emergence, compared to 78% in the control group.

Table 1: Toxicity of *Quisqualis indica* (Linn.) flower extract to different life stages of *Corcyra cephalonica (*Stan.)

S. No.	Conc. (% dilution of SS)	% Egg mortality	% Egg corrected mortality	% Larval mortality	% Corrected larval mortality	%Pupal mortality	% Corrected pupal mortality	% Adult emergence	% Control of population
1.	25	47.34	42.76	22.78	13.37	6.54	1.75	38	62
2.	50	53.34	49.28	30	21.47	8.14	3.43	30	70
3.	75	62.68	59.43	42.28	35.24	25.02	21.18	16	84
4.	100	65.34	62.32	61.56	56.87	25.03	21.19	10	90
5.	Control	8	-	10.86	-	4.87		78	22
6.	t-test value	11.733 S		3.304 S		2.176 NS		8.195	

By extending the incubation period, the larval period, the pupal period, and shortening the adult lifespan, acetone extract of *Quisqualis indica* shown strong growth regulatory activity in proportion to conc. against rice moth. (Fig.1). At 100% conc., the incubation period was lengthened by 2.5 days. In contrast to the control, the larval period was between 31.5 and 40.5 days and had a rising trend and continuous gradient. In compared to the control (11days), pupal length was prolonged by 2, 4, and 6 days at 25, 50, and 100% conc. Overall, the rice moth's average developmental period rose dramatically, going from 44 days in the control group to 47.4, 51.5, 57.5, and 64 days at 25, 50, 75, and 100% conc., respectively. It displayed a severe fall in the growth index at all contexts, corroborating a slowdown in rice moth growth (Fig.2).

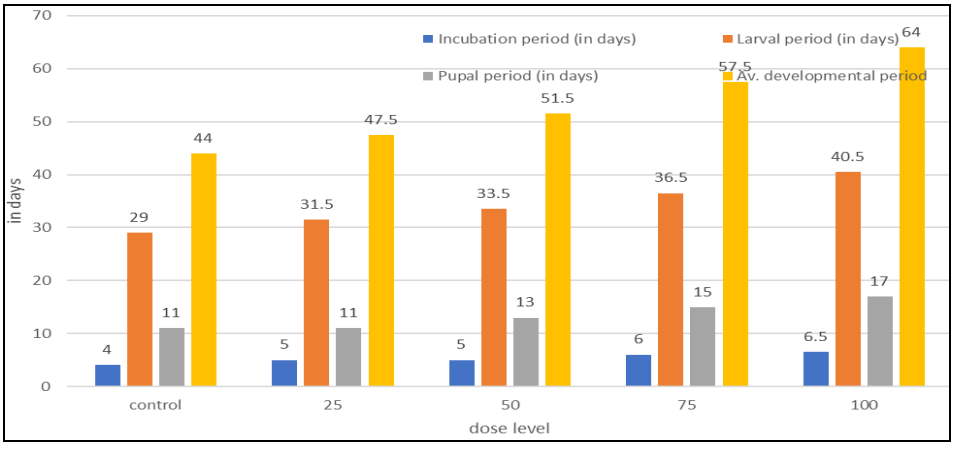

Fig 1: Effect of acetone extract of *Quisqualis Indica* flower on developmental period of rice moth

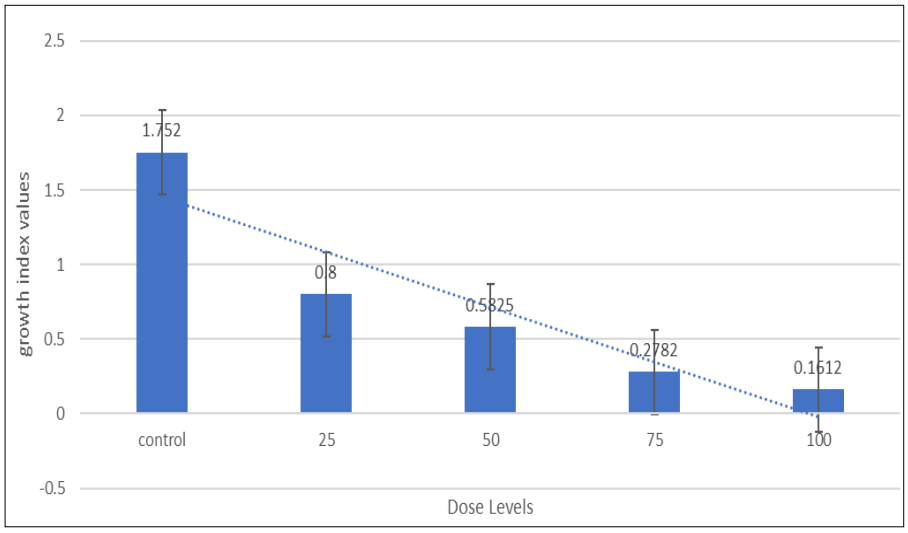

Fig 2: Effect of acetone exract of *Quisqualis inidica* flower on Growth index of rice moth

It was possible to significantly reduce the percentage loss in seed weight. In the control group, seed weight loss was 49.94%, whereas it was only 36.26, 31.88, 19.59, & 12.11% at 25, 50, 75, & 100% conc. (Table.2). Thus, by exercising its phago-deterrent properties, this extract significantly protects the grain seeds.

Table 2: Effect of *Quisqualis indica* Linn flower acetone extract on seed protection against attack by larvae of *Corcyra cephalonica (*Stan.)

S. No.	Conc. (% dilution of SS)	% Loss in seed weight	% Seed protection	% Seed protection over control	C-value
1.	25	36.26	63.74	27.39	0.841
2.	50	31.88	68.12	36.16	0.779
3.	75	19.59	80.41	60.77	0.563
4.	100	12.11	87.89	75.75	0.390
5.	Control	49.94	50.06	-	-

Around 15-20% malformed adults were emerged out with elevated and crumpled wings folding back themselves (Fig. 3). The majority of deformed females were incapable of breeding. These females occasionally laid a small number of eggs that were not viable. Even 10–40% of the eggs deposited by females with normal morphology were discovered to be non-viable and expressing ovicidal effectsin the following generation. When compared to controls, viable eggs demonstrated delayed hatching at higher conc. (6–9 days). Larvae, pupae, and adults of the following generation did not experience any notable mortalities or negative impacts; nevertheless, the average developmental period was somewhat lengthened at higher concentrations.

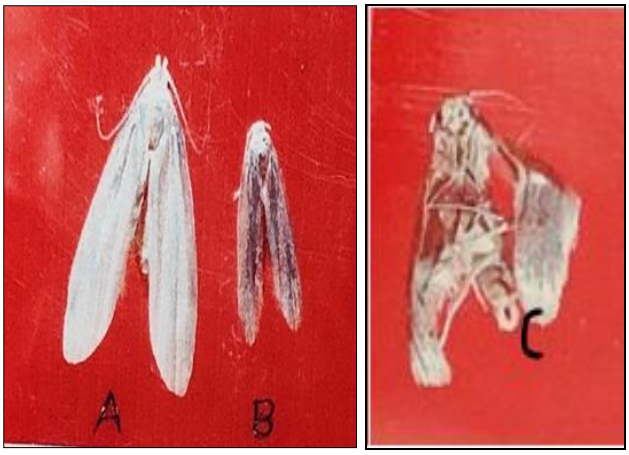

Fig 3: A. Normal female, B. Normal male C. Abnormal female showing crumpled wings (emerged in treated sample)

Discussion

Commonly occurring plant species i.e., *Quisqualis indica* (Linn.) chosen as the plant material of choice since it was easy and affordable to obtain and had a high likelihood of possessing insecticidal characteristics. Thus, *Quisqualis indica* sp. is a widespread aesthetic plant in India that can be cultivated naturally in hedges and rural areas. For thousands of years, it has been regarded as a brilliant source of therapeutic compounds. This plant's biologically active components have always attracted a lot of attention. In the present work, the acetone extract of flowers of *Q. indica* was screened for their insecticidal efficacy against a serious stored grain pest, rice moth, *Corcyra cephalonica* Stant. and it showed promising insecticidal effects in term of population management of rice moth.

Higher mortality in egg & larval stage may be due to easy penetration of extract through egg membrane and delicate integument of younger larvae in comparison to subsequent stages. These results are in consonance with the studies of Ardana IBK et. al., 2017[19], who registered strong ovicidal ability of 10% ethanol extract of *Quisqualis indica* leaves towards eggs of *Fasciola gigantica* (85%) and *Paramphistomum* sp. (53.3%). On the basis of phytochemical screening, they confirmed the presence of alkaloids ((carpain and carpasemin), tannin in extract that caused damage of eggs due to their proteolytic property. Fowsiya J,2020 [20] reviewed insecticidal activity of plant derived alkaloids and stated that alkaloids affect insects through biological action such as disturbing the cellular and physiological process via redox imbalance and hormonal regulation.

Findings of Anusree SS et. al.,2018 [21] strongly supports present results, who evaluated crude methanol and ethyl acetate extracts of *Quisqualis indica* flowers for their antifeedant and insecticidal action against third instar larvae of *Spodoptera litura* (F.) and they noticed good antifeedant activity (45.62%) and highly strong larvicidal action (93.51%) of methanol extract. In agreement of significant antifeedant activity results in present study, Koul O, 2008 [22] explained mode of action of phytochemicals i.e., alkaloids, terpenes, saponins as antifeedant in insects that feeding deterrents may be perceived either by stimulation of specialized deterrent receptors or by distortion of the normal function of neurons, which perceive phago-stimulating compounds.

Song JS et. al., 2014 [23] tested insecticidal activity of hot water extracts of 7 herbal plants against different stages of black pine bast scale insect and recorded highest corrected mortality of 95.7% on intermediate nymph stage produced by *Quisqualis indica* extract. In another experiment, they successively fractionated the methanol extract of *Q. indica* using hexane, chloroform, ethyl acetate, butanol & water and checked their insecticidal activity against four Cocoidea species. They isolated main compounds of *Q. indica* i.e., alpha-pinene, methyl palmitate, eugenol, methyl myristate, phthalic acid mono (2-ethylhexyl) ester and palmitic acid by GC mass analysis. Among them, hexane fractionate of alpha-pinene exhibited maximum insecticidal efficacy. In current study, Extract has also been found to have growth regulating activity by prolonging developmental period of different stages of rice moth. According to Novak et al., 1966[24], the active components of this plant species may interfere with the neuroendocrine system, causing growth-regulating hormonal imbalance, inhibition of chitin synthesis during the moulting process, and developmental delay, which gives time to suppress the negative effects of toxic substances. Additionally, hormonal imbalance causes various pupal body parts to exhibit aberrant biometrical characteristics, which leads to malformed adults who are unable to breed and eventually die. Starved larvae's development may be interrupted as a result of delayed development brought on by inhibited eating [25].

Conclusion

Based on the results of the current investigation, it can be said that *Quisqualis indica* Linn. floral acetone extract against the rice moth, *Corcyra cephalonica*, (Stainton) had promising insecticidal effects in terms of population management, since considerable egg mortality, larval mortality, and minimum adult emergence were reported. It successfully reduced seed weight loss and significantly impacted the fecundity and fertility of the F1 generation, decreasing rice moth reproduction. It increased average developmental period of rice moth at the same time that adult emergence and longevity were declining. This extract worked well to manage rice moth because it has strong insecticidal, growth-regulating, sterilant, and phago-deterrent actions, which may prevent further infestations. There are very few reports about the plant *Q. indica's* insecticidal qualities, but it has a number of primary and secondary metabolites that are accountable for treating a variety of acute and chronic ailments. Numerous phytochemicals have been found in different parts of *Q. indica*, and it has been suggested that they may have insecticidal activity against both stored grained pests and crop pests. Thus, new avenues for research will be made possible by the current findings in the future.

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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