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Repellent activities of *Syzygium cumini* L. (Myrtaceae) extracts against *Callosobruchus chinensis* L. (Coleoptera: Bruchidae)

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Abstract The root, leaf, stem bark and seed were extracted into n-Hexane, acetone, chloroform and methanol from *Syzgium cumini* L and were used against *Callosobruchus chinensis* L. for the repellent activities. All the tested extracts showed repellent activities against adult beetles of *C. chinensis* at concentrations of 251.50, 125.70, 62.86, 31.43 and 15.72 µg/cm^2 on filter paper. The chloroform extracts of all plant parts showed the best repellency at 0.01% level of significance, except the leaf (chloroform) extract which was found active at 0.1% level of significance. According to the intensity of repellency the result could be arranged in a descending order: leaf (chloroform extract) >stem bark (chloroform extract) >root (methanol extract) > seed (methanol extract) and in all the cases significant differences were observed.

Key words: *Syzygium cumini* extracts, *Callosobruchus chinensis*, repellency

Introduction

Pulses are important and rich sources of several amino acids; containing 20-30% protein which is almost three times higher than the protein content of cereals (Doharey *et al*., 1990). These grains also contain minerals and certain vitamins, and provide high energy. Pulse legumes are infested by several bruchid species (Arora, 1977) of which *Callosobruchus* species are notorious and cosmopolitan during both pre-and post-harvest periods. The major pests of pulses are *Callosobruchus chinensis* L. and *C. maculatus* (F.). The infested pulses loss the seed quality and viability, and the market value is decreased accordingly (Caswell, 1980).

Synthetic chemical pesticides have been used for a long time to control stored legumes (Bhalla *et al*., 2008). However, over use of chemical insecticides led a number of problems including hazards to human health and destruction of the ecosystem balance (Shaheen & Khaliq, 2005). Plant based pesticides were found to be potent candidates for insect pest control in stored legumes (Rajapakse & Ratnasekera, 2008).

In Bangladesh presence of both species of *Callosobruchus* have been recorded from infested pulses at both field and storage systems, of which *C. chinensis* is the commonest.

Syzygium cumini L. is a common, large evergreen fruit tree of Bangladesh, commonly known as 'Jamun' or 'Jam' which belongs to the family Myrtaceae. The original home of *S. cumini* is India or the East India and have been successfully introduced into many other tropical countries (Kirtikar & Basu, 1975). The plant extract has been frequently used by a number of researchers and they reported that the plant possesses insecticidal activity.

However, there is a lack of information on the insect management potentiality of *S. cumini* against the stored-product insects, especially against *C. chinensis*. Therefore, the present research was designed to determine the repellent effect of the extracts of root, leaf, stem bark and seed of *S. cumini* against *C. chinensis* under laboratory condition.

Materials and Methods

Plant collection: The plant *S. cumini* was collected from the University of Rajshahi campus.

Test insect: Adults of *C. chinensis* were collected from the lentil infested stock cultures maintained for five years at the Control Temperature room (CT Room: 30 ± 0.5^{0}C and 70-80% RH) with photoperiod (12h L: 12h D) of the Entomology and Insect Biotechnology Laboratory, Institute of Biological Sciences, University of Rajshahi. The fresh lentil seeds was used as food medium for the sub-cultures of *C. chinensis*.

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Preparation of extracts: Root, leaf, stem bark and seeds were dried in shade and stored separately in cotton bags. Prior to experimental set up the dried plant parts were powdered individually with the help of a grinder. Each ground material (500 g) was soaked in 500 ml n-Hexane, acetone, chloroform and methanol separately for 24-72 h and filtered through Whatman no 1. The filtrate was then allowed to vaporize in rotary evaporator until completely dried up which was kept in a refrigerator at 4^0C with proper labelling. Hundred dried extract were dissolved in 10 ml of each of the solvents. The concentration of the final extract thus was 100 μg/10 μl for each solvent of each plant part.

Preparation of concentrations: The concentration 100 µ/10 µl was considered as the stock solution, and then the final concentrations were made by serial dilution of the same solvent at the proportion of 1:2. From this solution of each extract 12.5, 10.0, 6.25 and 3.125 were taken into separate vials and dissolved in requisite amount of the respective solvent and spread equally on the filter paper placed at the bottom of separate petridish (90 mm). Now the concentrations were attained as 251.5, 125.7, 62.86, 31.43 and 15.72 mg of extract per 0.01 cm of the petri dish. The concentration controlling light and humidity was calculated by measuring the dry-weigh of the crude extracts applied in petri dish divided by surface area of respective petri dish. The petri dishes were then dried at room temperature. Such five concentrations were prepared for each four extracts of each part (root, seed, leaf and stem) of *S. cumini*.

Repellency test: Half filter paper discs (Whatman No. 40, 9 cm diam) were prepared and selected concentrations of all the n-Hexane, acetone, chloroform and methanol extracts separately applied onto each of the half-disc and allowed to dry out as exposed in the air for 10-15 minutes. Each treated half-disc was then attached lengthwise, edge-to-edge, to a control half-disc (without any extract) with adhesive tape and placed in a Petri dish (9 cm diam), the inner wall of which was smeared with glu on to prevent insects escaping. Ten adult insects (3-5d old) were released in the midline of each filter-paper. Insects that settled on each half of the filter paper discs were counted after 1 h and then at hourly intervals for 5 h. No significant difference was detected between the repellency of only solvent impregnated and untreated filter papers in tests designed to check for any possible influence of solvents. Each test was repeated five times. The average of the counts was converted to percentage repellency (PR) using the formula of Talukder & Howse (1995):

$$PR = (N_c - 5) \text{ X } 20$$

Where, N_c is the percentage of insects on the untreated half of the disc. Positive values expressed repellency and negative values for attractant activity.

Statistical analysis

The PR data was further transformed into arcsin values for the calculation of Analysis of Variance (ANOVA).

Results and Discussion

All the test extracts of leaf, seed, stem bark and root of *S. cumini* collected in n-Hexane, acetone, chloroform and methanol showed repellency by contact action against the adult *C. chinensis* at concentration levels 251.50, 125.70, 62.86, 31.43 and 15.72 µg/cm^2 on filter paper.

All the extracts (n-Hexane, Acetone, Chloroform and Methanol) at all concentrations, except the lowest ones, showed repellent action against the adult *C. chinensis* (Tables 1-4). The 3-67% repellency were recorded in acetone, chloroform and methanol extracts of root in higher concentrations. The highest 93.32% repellency was recorded in chloroform and methanol extracts of leaf and seed in higher concentrations (Tables 2 and 4). The lowest concentrations showed the lowest repellency.

Adults showed significantly different levels of repulsion at different concentrations of each extract of all parts of *S. cumini* (Table 5). However, the repellent effect did not vary with exposure time. The acetone and chloroform extracts of leaf were found to be comparatively less repellent than the other parts (Table 5). Among the tested chloroform extracts all the rest offered repellency at 0.01% level of significance ($P<0.001$) except the leaf (chloroform) extract which was found active at 0.1% level of significance ($P<0.01$) (Table 5). According to the intensity of repellency the result could be arranged in a descending order: leaf (chloroform extract)>stem bark (chloroform extract)>root (methanol extract)>seed (methanol extract) and in all the cases significant differences were observed.

Table 1. Repellency effect of root extracts of different solvents of *S. cumini* against *C. chinensis* adults (N=10).

Solvents	Conc. (µg/cm^2)	Distribution of adult in treated area/hour					Percent repulsion (PR)				
		1	2	3	4	5	1	2	3	4	5
n-Hexane	251.5	6.67	7.00	7.33	7.00	6.33	33.32	40.0	46.66	40.0	26.66
	125.7	6.0	5.67	6.33	5.33	5.67	20.00	13.32	26.66	6.6	13.56
	62.86	5.33	5.67	5.67	5.67	5.33	6.66	13.32	13.32	13.32	6.66
	31.63	4.67	4.67	4.33	4.33	3.67	-6.68	-6.68	-13.34	-13.34	-26.68
	15.72	3.0	2.33	3.33	3.33	2.33	-40.0	-53.34	-33.34	-33.34	-53.34
Acetone	251.5	8.33	8.0	7.67	7.33	7.67	66.66	60.0	53.32	46.66	53.32
	125.7	7.67	7.0	6.33	6.33	6.67	53.32	40.0	26.66	26.66	33.32
	62.86	6.33	6.0	5.67	5.33	5.67	26.66	20.0	13.32	6.66	13.32
	31.63	5.67	5.33	5.33	4.67	5.33	13.32	6.66	6.66	6.68	6.66
	15.72	5.33	4.0	4.0	3.33	4.67	6.66	-20.0	-20.0	-33.34	-6.68
Chloroform	251.5	8.33	8.0	7.67	7.33	8.0	66.66	60.0	53.32	46.66	60.0
	125.7	7.33	7.33	6.33	6.67	6.33	46.66	46.66	26.66	33.32	26.66
	62.86	6.33	6.0	5.67	6.0	5.67	26.66	20.0	13.32	20.0	13.32
	31.63	5.33	5.33	5.33	5.0	4.0	6.66	6.66	6.66	0.0	-20.0
	15.72	4.33	4.0	4.0	3.67	3.0	-13.34	-20.0	-20.0	-26.56	-40.0
Methanol	251.5	5.67	5.33	5.67	5.67	4.33	13.32	6.66	13.32	13.32	-13.32
	125.7	8.0	7.67	8.0	7.67	7.0	60.0	53.32	60.0	53.32	40.0
	62.86	7.68	6.67	6.33	6.67	6.33	53.32	33.32	26.66	33.32	26.66
	31.63	6.33	5.67	6.33	5.67	5.33	26.66	13.32	26.66	13.32	6.66
	15.72	5.67	5.33	5.67	5.67	4.33	13.32	6.6	13.32	13.32	-13.32

Table 2. Repellency effect of leaf extracts of different solvents of *S. cumini* against *C. chinensis* adults (N=10).

Solvents	Conc. (µg/cm^2)	Distribution of adult in treated area/hour					Percent repulsion (PR)				
		1	2	3	4	5	1	2	3	4	5
n-Hexane	251.5	8.67	9.0	8.33	8.67	8.67	73.32	80.0	66.66	73.32	73.32
	125.7	7.67	7.33	7.67	7.67	7.67	53.32	46.66	53.32	53.32	53.32
	62.86	6.33	6.67	6.33	6.67	6.67	26.66	33.32	26.66	33.32	33.32
	31.63	5.67	6.33	5.33	5.67	5.67	13.32	26.66	6.66	13.32	13.32
	15.72	5.0	5.67	4.33	4.33	4.33	0.0	13.32	-13.34	6.66	-13.34
Acetone	251.5	8.67	8.33	8.33	8.0	8.33	73.33	66.66	66.66	60.0	66.66
	125.7	7.67	7.33	7.67	7.33	7.67	53.32	46.66	53.32	46.66	53.32
	62.86	6.33	6.33	6.67	6.33	7.0	26.66	26.66	33.32	26.66	40.0
	31.63	6.0	5.33	6.33	5.67	6.0	20.0	6.66	26.66	13.32	20.0
	15.72	6.0	5.33	5.67	5.33	4.67	20.0	6.66	13.32	6.66	-6.68
Chloroform	251.5	9.67	9.33	9.0	9.0	9.67	93.32	86.66	80.0	80.0	93.32
	125.7	8.67	8.33	8.0	7.67	8.0	73.32	66.66	60.0	53.32	60.0
	62.86	7.33	6.67	7.0	6.67	6.67	46.89	33.32	40.0	33.32	33.32
	31.63	6.0	5.67	6.33	5.67	5.33	20.0	13.32	26.66	13.32	6.66
	15.72	5.67	5.33	5.67	5.33	4.67	13.32	6.66	13.32	6.66	-6.68
Methanol	251.5	8.67	7.33	8.0	8.0	9.67	92.32	83.33	80.0	80.0	93.32
	125.7	8.67	7.33	8.0	7.67	8.0	73.32	66.66	60.0	53.32	60.0
	62.86	7.33	6.67	7.0	7.67	6.67	46.89	33.32	40.0	33.32	33.32
	31.63	5.0	5.67	6.33	5.67	5.33	20.0	13.32	26.66	13.32	6.66
	15.72	5.67	5.33	6.67	5.33	4.67	13.32	6.66	13.32	6.66	-6.68

Table 3. Repellency effect of stem bark extracts of different solvents of *S. cumini* against C. *chinensis* adults (N=10).

Solvents	Conc. (μg/cm²)	Distribution of adult in treated area/hour					Percent repulsion (PR)				
		1	2	3	4	5	1	2	3	4	5
n-Hexane	251.5	9.67	9.0	9.33	9.67	9.0	93.32	80.0	86.66	93.32	80.0
	125.7	8.33	7.67	8.0	8.33	7.0	66.66	53.32	60.0	66.66	40.0
	62.86	7.0	6.33	6.33	7.33	5.67	40.0	26.66	26.66	46.66	13.32
	31.63	6.0	6.0	5.33	6.33	5.33	20.0	20.0	6.66	26.66	6.66
	15.72	5.33	5.67	5.33	5.0	4.0	6.66	13.32	6.6	0	-20.0
Acetone	251.5	8.67	9.0	8.67	8.67	9.0	73.32	80.0	73.32	73.32	80.0
	125.7	7.67	8.0	8.33	8.0	8.0	53.32	60.0	66.66	60.0	60.0
	62.86	6.67	6.67	7.0	6.67	6.67	33.32	33.32	40.0	33.32	33.32
	31.63	5.67	6.0	5.67	5.33	5.33	13.32	20.0	13.32	6.66	6.66
	15.72	5.33	4.67	4.33	4.33	3.67	6.66	-6.68	-13.35	-13.34	-26.68
Chloroform	251.5	8.33	8.0	7.67	8.0	7.67	66.66	60.0	53.32	60.0	53.32
	125.7	7.67	7.0	7.0	7.0	6.33	53.32	40.0	40.0	40.0	26.66
	62.86	6.33	5.33	6.0	6.33	5.33	26.66	-6.66	20.0	26.66	6.66
	31.63	5.67	4.33	5.33	5.67	4.67	13.32	-13.34	6.66	13.32	-6.68
	15.72										
Methanol	251.5	8.33	7.67	8.33	7.33	8.0	66.66	53.32	66.66	46.66	60.0
	125.7	6.67	7.33	7.0	6.67	7.0	33.32	46.66	40.0	33.32	40.0
	62.86	6.0	6.33	6.67	5.67	6.0	20.0	26.66	33.32	13.32	20.0
	31.63	5.67	5.33	6.33	5.33	5.67	13.32	6.66	26.66	6.66	13.32
	15.72	5.33	4.33	5.33	4.33	4.67	6.66	-13.34	-13.34	6.66	-6.68

Table 4. Repellency effect of seed extracts of different solvents of *S. cumini* against *C. chinensis* adults (N=10).

Solvents	Conc. (μg/cm²)	Distribution of adult in treated area/hour					Percent repulsion (PR)				
		1	2	3	4	5	1	2	3	4	5
n-Hexane	251.5	7.67	7.33	7.0	7.67	7.33	53.32	46.66	40.0	53.32	46.66
	125.7	6.33	6.67	6.0	6.33	6.67	26.66	33.32	20.0	26.66	33.32
	62.86	6.33	5.67	5.33	5.67	5.67	26.66	13.32	6.66	13.32	13.32
	31.63	6.33	5.67	5.33	5.67	5.67	26.66	13.32	6.66	13.32	13.32
	15.72	4.33	4.33	4.0	3.33	4.0	-13.34	-13.34	-20.0	-33.34	-20.0
Acetone	251.5	8.67	8.67	8.33	8.0	8.33	73.32	73.32	66.66	60.0	66.66
	125.7	8.0	7.67	7.33	7.0	6.67	60.0	53.32	46.66	40.0	33.32
	62.86	6.67	6.33	6.0	5.67	5.67	33.32	26.66	20.0	13.32	13.32
	31.63	6.0	5.67	5.33	4.33	5.33	20.0	13.32	6.6	13.34	6.66
	15.72	4.67	5.0	3.67	3.0	4.33	-6.68	0.0	-26.68	-40.0	-13.34
Chloroform	251.5	6.67	7.33	6.67	7.0	7.33	33.32	46.66	33.32	40.0	46.66
	125.7	6.33	6.0	6.33	6.0	6.33	26.66	20.0	26.66	20.0	26.66
	62.86	5.67	5.33	5.67	5.33	5.67	13.32	6.66	13.32	6.66	13.32
	31.63	4.67	4.33	5.33	4.33	4.0	-6.68	-13.34	-6.66	-13.34	-20.0
	15.72	3.33	3.67	4.0	3.33	3.0	-33.34	-26.68	20.0	33.34	40.0
Methanol	251.5	9.67	9.33	9.0	8.67	9.0	93.32	86.66	80.0	73.32	80.0
	125.7	8.67	8.0	8.0	7.33	8.0	73.32	60.0	60.0	46.66	60.0
	62.86	7.33	6.67	7.0	6.33	6.67	46.66	33.32	40.0	26.66	33.32
	31.63	6.0	5.67	6.33	5.33	5.67	20.0	13.32	26.66	6.66	13.32
	15.72	5.33	4.67	5.67	4.33	4.0	6.66	-6.68	13.32	-13.34	-20.0

Table 5. ANOVA on repellent action of *S. cumini* extracts against *C. chinensis* by contact.

Plant parts	Extracts	Factors	F-value	P-value (df=4)
Root	n-Hexane	Concentrations	253.296***	3.03
		Exposure Time	2.95	0.0526
	Acetone	Concentrations	51.036***	6.55
		Exposure Time	6.778	0.002
	Chloroform	Concentrations	54.435***	4.07
		Exposure Time	3.901	0.021
	Methanol	Concentrations	43.044***	2.27
		Exposure Time	5.447	0.0057
Seed	n-Hexane	Concentrations	83.589***	1.63
		Exposure Time	3.835	0.023
	Acetone	Concentrations	64.509***	1.15
		Exposure Time	5.669	0.005
	Chloroform	Concentrations	75.793***	3.43
		Exposure Time	1.4005	0.278
	Methanol	Concentrations	50.394***	7.19
		Exposure Time	4.244	0.016
Leaf	n-Hexane	Concentrations	37.389***	6.26
		Exposure Time	9.653	0.0003
	Acetone	Concentrations	28.478**	4.24
		Exposure Time	5.453	0.006
	Chloroform	Concentrations	17.687**	1.01
		Exposure Time	0.722	0.589
	Methanol	Concentrations	63.545***	1.29
		Exposure Time	7.798	0.001
Stem bark	n-Hexane	Concentrations	121.978***	9.03
		Exposure Time	2.953	0.0527
	Acetone	Concentrations	70.1196***	6.16
		Exposure Time	1.604	0.222
	Chloroform	Concentrations	41.638***	2.89
		Exposure Time	7.299	0.0015
	Methanol	Concentrations	67.354***	8.34
		Exposure Time	1.86	0.167

Note: *=** Highly significant, ** = Significant

Repellency by the n-Hexane, acetone, chloroform, and methanol extracts of *S. cumini* against *C. chinensis* adults was very much promising, while all the extracts found to repel at 0.01% level of significance (P<0.001) except the leaf (chloroform) extract which was found active at 0.1% level of significance (P<0.01). The repellency record triggers a hope for the use of *S. cumini* extracts as repellent to manage *C. chinensis* in stored pulses.

Nattudurai *et al*. (2015) investigated insecticidal and repellent activity of *Toddalia asiatica* (L.) Lam. (Rutaceae) leaf and fruit extracts (hexane, diethyl ether and methanol) against *Callosobruchus maculatus* (F.), *Sitophilus oryzae* (L.) and *Tribolium castaneum* (Herbst.) adults and found that all the extracts of both leaf and fruits had the mortality and repellency against the tested insects in a concentration dependent manner. They found *C. maculatus* was the most susceptible. Lethal concentrations for 50 percent mortality (LC_{50}) of *C. maculatus*, *S. oryzae* and *T. castaneum* were recorded as 39.19, 44.13 and 61.10 μl/L respectively. They concluded diethyl ether fruit extract exhibited 100% repellent activity against *C. maculatus* and *S. oryzae* and 92% against *T. castaneum* adults at 20 μl/L concentration. They concluded that diethyl fruit extract of *T. asiatica* could be used as ecofriendly and repellent against *C. maculatus*, *S. oryzae* and *T. castaneum*. Badshah *et al*. (2015) studied repellency evaluation of some selected indigenous plant materials against *Rhyzopertha dominica* and found the tested insect was exposed for ten days to five plant extracts (distilled water) viz. *Mentha longifolia*, *Momordica charantia*, *Luffa aegyptica*, *Carum copticum* and *Curcuma longa* at the concentrations of 25%, 50% and 75%. The results depicted that dose rate and exposure period had significant effects on the repellency. They reported that the repellency increased with increasing dose and exposure periods. *M. longifolia* was found to be the most effective repellent followed by *M. charantia*, *L. aegyptica*, *C. copticum* and *C. longa*. They concluded that complete repellency was achieved with *M. longifolia* while minimum repellency was recorded with *C. longa* at 75% and 25% dose rates respectively. Repellency and feeding deterrency of *S. oryzae* of three distributed plants extracted in ethanol, chloroform and hexane were performed by Viglianco *et al*. (2008) in Argentina. The studied plant species were *Aloysia polystachia* (Griseb) Moldenke, *Solanum argentinum* Bitter et Lillo and *Tillandsia recurvata* (L.) L. Percentual repellency (PR) was determined for each extract. A moderate repellent effect of *S. argentinum* and *A. polystachia* on *S. oryzae* was observed; however, the hexane extract of *S. argentinum* was the one with strongest repellent (Class 4). Abdullah *et al.* (2011) assessed the mortality and repellency of the chloroform extracts of different parts of *Urena sinuate* on *T. castaneum* adults. The root and stem extracts showed significant repellent effect on the beetles but the fruit and leaf extracts produced no repellency at all. Talukder & Howse (1995) tested MeOH extract of pitraj (*Aphanamixis polystachya* (Wall.) against *T. castaneum* and reported 100% repellency. Mondal *et al*. (2011) assessed the repellent activity of *Derris indica* extracts against *T. castaneum* adults. The fruit shell, leaves, seed and stem bark extracts also showed repellent activity.

The result of the present study showed that all the tested concentrations of the extracts have considerable repellent activity against adult *C. chinensis*. An unpleasant pungent smell was present in the extracts due to the presence of certain highly volatile chemical components, which caused the repellency to the test insect.

It may be concluded that *S. cumini* possess chemicals, which are repellent to insects and therefore are potential against *C. chinensis*. The results thus provide important tools for further development of Integrated Pest Management (IPM) Program.

References

Abdullah, M.P.K.A.K., Saleh, D.K.M.A., Khan, A.R., Islam, R. & Islam. N. 2011. Insecticidal and repellent activities of the chloroform extracts of *Urena sinuata* L. against *Tribolium castaneum* (Herbst) adults. *Univ. j. zool. Rajshahi Univ.* **30**: 25-28.

Arora, G.L. 1977. Taxonomy of the Bruchidae (Coleoptera) of North-West India, Part I adults. *Oriental Insects* **7**: 1-32.

Badshah, T., Saeed, M., Khan, I., Khan A., Khan, G.Z., Farid, A. & Khan, S.M. 2015. Repellecny evaluation of selected indigenous medicinal plant materials against *Rhyzopertha dominica* (Herbst) (Coleoptera: Tenebrionidae). *J. Entomol. Zool. Studies* **3** (1): 65-68.

Bhalla, S., Gupta, K., Lal, B., Kapur, M.L. & Khetarpal, R.K. 2008. Efficiency of various non-chemical method against pulse beetle, *Callosobruchus maculatus* Fab. *ENDURE International Conf*. Diversifying Crop Protection, Oct. 12-15, France p.4.

Caswell, G.H. 1980. A review of the work done in the entomology section. Institute of Agriculture Research. *Pests of stored grain. Samaru Miscellan* **99**: 12

Doharey, R.B., Katiyar, R.N. & Singh, K.M. 1990. Comparative efficacy of some edible oils for the protection of green gram (*Vigna radiata* L.) Wilczek against pulse beetle *Callosobruchus chinensis* (L.) and *Callosobruchus maculatus* (F.). *Bull. Grain Tech*. **28**: 116-119.

Kirtikar, K.R. & Basu, B.D. 1975. *In Indian Medicinal Plants*. Periodical Experts, New Delhi, **Vol. II**, pp. 1052-1053.

Mondal, O.A., Islam, H., Biswas, S. & Islam, N. 2011. Repellent activity of *Derris indica* extracts against *Tribolium castaneum* (Herbst.) adults. *J. Life earth Sci., Rajshahi Univ*. **6**: 113-115.

Nattudurai, G., Irudayaraj, S.S., Paulraj, M.G., Baskar, K & Ignacmuthu, S. 2015. Insecticidal and repellent activities of *Toddalia asiatica* (L.) Lam. extracts against three major stored product pests. *Entomol, Ornithol Herpetol* **4**: 148 doi: 104172/2161.0983. 1000/48

Rajapakse, R.H.S. & Ratnasekera, D. 2008. Pesticidal potential of some selected tropical plants against *Callosobruchus maculatus* (F.) and *Callosobruchus chinensis* (L) (Coleoptera: Bruchidae). *Trop. Agr. Res. Extension* **11**: 69-71.

Shaheen, F.A. & Khaliq, A. 2005. Management of pulse beetle, *Callosobruchus chinensis* L. (Coleoptera: Bruchidae) in stored chickpea using ashes, red soil powder and two pentine oil. *Pak Entomol.* **27**: 19-24.

Talukder, F.A. & Howse, P.E. 1995. Evaluation of *Aphanamixis polystachya* as a source of repellents, antifeedants, toxicants and protectants in storage against *Tribolium castaneum* (Herbst). *J. stored. Prod. Res.* **31**(1): 55-61.

Viglianco, A.I., Novo, R.J., Cragnolini, C.I. & Cavallo, M.N.A. 2008. Antifeedant and repellent effects of extracts of three plant from Cordoba (Argentina) against *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae). *BioAssay* **3**: 4.

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