Egyptian Journal of Biological Pest Control, 18(1), 2008, 149-154
Proceeding of 2nd Arab Conference of Applied Biological Pest Control, Cairo, Egypt, 7-10 April 2008

Toxicity and repelency of *Trigonella foenum* L. and *Curcuma longa* L. extracts to *Sitophilus oryzae* (L.) and *Rhizopertha dominica* (Fab.) (Coleoptera)

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ABSTRACT

Different extracts of fenugreek (*Trigonella foenum- graecum* L.) and Rhizomes of *Curcuma longa* L. (turmeric) extracts were tested in the laboratory for their toxicity, reduction of Fl progeny and repellency effects against adults of the grain stored insects *Sitophilus oryzae* (L.) and *Rhizopertha dominica* (F.). Data showed that surface treatment of wheat seeds with acetone and chloroform extracts of *T. foenum* at the 4% concentration level caused 72.2 & 71.2% mortality of *S. oryzae* adults after 14 days, respectively. On the other hand, at the same concentration, all tested extracts of *T. foenum* showed various toxicities to *R. dominica* adults. Acetone extract scored the most efficient extract as it gave 83.3% mortality. Data showed that surface treatment of wheat seeds with extracts of *C. longa* were not effective in causing mortalities among adults of *S. oryzae* except petroleum ether extract which gave low mortality percentage (20.4%) at 4.0% concentration. Also, the same extract concentration gave highest effect (90.8%) against adults of *R. dominica*. Regarding the latent effect, acetone, petroleum ether and chloroform extracts of *T. foenum* reduced significantly the F_1 progeny of *S. oryzae*. The reductions reached (100, 85.9 and 84.0%) at 4.0% concentration level, respectively. The corresponding reductions in case of *R. dominica* were 90.7, 66.7 and 68.4%. Petroleum ether and diethyl ether extracts of *C. longa* showed noticeable reduction in F_1 progeny of *S. oryzae* especially at the high concentration level (4.0%) being (36.0 and 33.6 %), respectively, while all extracts of *C. longa* except diethyl ether extract showed obvious reductions in F_1 progeny of *R. dominica*. Petroleum ether extract gave complete protection while acetone extract gave 85% reduction in F_1 progeny. Diethyl ether extract of *T. foenum* and petroleum ether of *C. longa* at (4.0%) concentration level scored the best repellent ones causing 98.3 and 73.3 % repellency, respectively, on the second day post-treatment of adults of *R. dominica*.

KeyWords: *Trigonella foenum-graecum*, Fenugreek, *Curcuma longa*, turmeric, *Sitophilis oryzae*, *Rhizopertha dominica*, Repellency.

INTRODUCTION

Use of chemical insecticides for controlling major pests has created important problems such as pollution of environment and pest resistance. Therefore, it has become necessary to look for safe insecticides. Recently, attention has been given to the isolation and identification from plant sources for various botanical compounds possessing insecticidal properties. Several attempts have been made to monitor the insecticidal activity and other insecticidal effects in extracts of different plant species against various insects (Barakat *et al.*,1985 and Ahmed, 1993). Plant crude extracts were utilized in pest control (Ramadan, 1987 and Soliman *et al.*, 2003). Chemical components of the seeds and leaves of fenugreek (*Trigonella foenum graecum* L.), an annual herb, were studied for nutritive and medicinal values (Sood, 1975; Varshny & Beg, 1978 and Varshny & Jain, 1979). Fenugreek oil was used for protecting the stored seeds from infestation by stored product insects (El-Degwi and El-Orabi, 1997). Certain toxicological and biological effects of plant extracts and oils were studied by Radwan *et al.* (2002). Rhizomes of turmeric are a common practice in some southern Asian countries, *i.e.*, India and Pakistan, to store rice or wheat by mixing 2% turmeric powder with it (Chatterjee, 1980). Turmeric is known to contain pungent odoriferous oils and oleoresins (coloring matter). The oleoresins consist of curcumin and other related compounds (Lubis, 1968 and Krishnamurthy *et al.*, 1976). The main components of turmeric oil are sesquiterpene ketones in the form of turmerone and ar-turmerone (Mima, 1959).

The present study was conducted to determine the repellency and toxicity of extracts derived from fenugreek and turmeric against the adults of the grain stored insects; *Sitophilus oryzae* (L.) and *Rhizopertha dominica* (F.)

MATERIALS AND METHODS

1- Source and rearing of test insects

The rice weevil, *S. oryzae* and the lesser grain borer *R. dominica* were brought from infested stores in Kalyobia governorate. They were reared under laboratory conditions of 25±1° C and 60±5 % R.H. at the

Pests and Plant Protection Department, National Reserch Centre, Giza, Egypt.

2- Plants used

1- Seeds of fenugreek plant (*Trigonella foenum graecum* L.), Family: Leguminasae.
2- Powdered rhizomes of turmeric (*Curcuma longa* L.) Family: Zingiberiaceae.

3- Extraction procedure

Series of solvents were used to extract different substances from fenugreek seeds and powdered rhizomes of turmeric according to polarity starting with petroleum ether, diethyl ether, chloroform, acetone and ethyl alcohol, 50g of the seeds powder was soaked in 100ml of petroleum ether in 250ml flask for 48 hours with stirring for 3-4 hours daily using magnetic stirrer. The homogenate was filtered. The filtrate was evaporated under vacuum using rotary evaporator in water bath at 45-55°C and then the crude extract was kept in a refrigerator till use. The residue was undergoing the same procedure with the next solvent.

4- Entomocidal effects

Crude extracts of *T. foenum* and *C. longa* were dissolved in acetone to obtain various concentrations namely, 0.25, 0.50, 1.00, 2.00 & 4.00% (v/v) & or (w/v). 10 gm of sterilized wheat grains in about 250ml. jar were treated with 1ml. of each-diluted extract, mixed well and air - dried to evaporate the solvent. Batches of 20 adult insects (1-2 week old) of either *S. oryzae* or *R. dominica* were introduced per each jar containing the treated wheat. Three replicates for each concentration level were used, while wheat treated only with acetone served as control, the jars were kept at the same rearing conditions. Mortality counts were recorded after 2, 5, 7 and 14 days and corrected using Abbott's formula (1925).

5- Effects on progeny

The jars were kept under the same conditions and examined for F1 emerged adults at three intervals, 6th, 8th and 10th weeks post treatment and the numbers of adult insects emerged from different treatments were recorded. No readings were recorded after the 10th week to avoid F2 progeny. Reduction percentage in the progeny of F1 adults as compared with the check was calculated in each case.

6- Repellency effects

Repellency tests were conducted using 2.00 & 4.00% (v/v) & or (w/v) concentrations of the same extracts according to the method described by Su (1989) with slight modifications by El-Lakwah *et al.* (1992) and Ignatowicz *et al.* (1994). A metallic ring (6cm diameter x 1cm height) was placed on a filter paper in the centre of a Perti-dish (15cm diameter). Five grams of the treated wheat kernels with 20 adult insects (1-2 weeks old) of either *S. oryzae* or *R. dominica* were placed on the ring. Repellency was examined after 2 days according to the number found inside and outside the ring. Three replicates for each concentration were used and for control as well.

7- Germination tests

Ten grams of wheat seeds treated with different tested materials were stored for 7 days at 25±1° C and 60±5% R.H. Thirty seeds were selected from each treated group and the control as well and distributed in 3 Petri-dishes 10/each, the seeds were placed on cotton pieces moistened with ample amount of water. The germination ratios were recorded after 2, 3 and 7 days from planting.

8- Statistical analysis

Obtained data were subjected to statistical analysis using One Way Anova (F-test) and the least significant difference (L.S.D.) through the Computer program, Microstat ver. 2.0.

RESULTS AND DISCUSSION

Effects of *Trigonella foenum* and *Curcuma longa* extracts on *S. oryzae* and *R. dominica*

1. Entomocidal effects:

T. foenum different extracts had various toxicity levels to *S. oryzae* depending upon the kind of the solvent and the concentration of the solute. Diethyl ether at all used concentration levels, Petroleum ether below 4% concentration and chloroform or acetone extracts below 2% concentration even after 14 days of exposure showed either negligible or no toxic effects on *S. oryzae* adults. At 2% concentration level, chloroform extract proved to be the only one revealed reasonable mortality among treated *S. oryzae* adults (67.9%) after 14 days of exposure (Table 1). At 4% concentration level, the effects of petroleum ether and chloroform *T. foenum* extracts on adult mortality were early occurred. After 14 days of exposure, mortality percentages showed either slightly increase to 18.9% in case of petroleum ether or highly significant increase

reaching 71.2% in case of chloroform. Acetone extract of *T. foenum*, however achieved the highest mortality percentages among *S. oryzae* adults (72.2%) after 14 days of exposure (Table 1). Statistical analysis of the data revealed that acetone and chloroform extracts at 4% concentration had significant effect at 5% level of probability on the percentage mortality in comparison with the other extracts of *T. foenum* (Table 2).

T. foenum seeds extracted by petroleum ether, diehyl ether, chloroform and ethyl alcohol at concentrations less than 4% and 14 days exposure showed negligible effects to *R. dominica* adults. Their mortality percentages at 4% concentration level and 14 days of exposure were 19.6, 25.9, 19.3 and 31.6%, respectively. Acetone extract scored the best effects; achieved mortality after 14 days of exposure for 1- 4% concentration levels ranged between 38.9-83.3% (Table 1). Statistical analysis of the data proved that acetone extract of *T. foenum* at 4% concentration caused significant difference in the percentage mortality in comparison with the other extracts. Also, percentage mortality from treated group with ethyl alcohol extract at 4% concentration indicated significant difference from that treated with petroleum ether and chloroform extracts (Table 2).

Surface treatment of wheat seeds with different extracts of *C. longa* were not effective in causing mortalities among adults of *S. oryzae* except petroleum ether extract which gave low mortality percentage (20.4%) at 4.0% concentration. The same extract at 4% concentration gave highest effect (90.8%) against *R. dominica* adults followed by ethyl alcohol extract (31.6%) and acetone extract (19.4%) (Table 3). Statistical analysis showed no significant difference in the percentage mortality of *S. oryzae* among different extracts (Table 4). Also, indicated that petroleum ether extract of *C. longa* at 4% concentration had a significant effect in the percentage mortality of *R. dominica* in comparison with the other extracts. Mortality percentage of adults in treatment with ethyl alcohol extract at 4% concentration revealed significant difference from those treated with diethyl ether and chloroform extracts (Table 4).

The present results agree with that obtained by Su (1985) who showed that acetone extract of *Anethum graveolens* seeds was toxic to *S. oryzae*. El-Lakwah *et al.* (1994) reported that petroleum ether and acetone extracts of *Melia azedarach* fruits proved high mortality percentage against adults of *R. dominica* and *S. oryzae*.

Table (1): Corrected cumulative mortality percentages after two weeks from treatment and reduction percentages of *S. oryzae* and *R. dominica* adults in F1 progeny from *Trigonella foenum* treated seeds.

Pest	% Conc.	Extracts at different concentrations									
		Petroleum ether		Diethyl ether		Chloroform		Acetone		Ethyl alcohol	
		Mor.%	Red.%	Mor.%	Red.%	Mor.%	Red.%	Mor.%	Red.%	Mor.%	Red.%
S. orayzae	0.25	0.0	-	3.6	9.1	0.0	12.0	0.0	31.4	0.0	8.8
	0.50	0.0	-	3.6	5.0	0.0	13.3	0.0	46.4	0.0	-
	1.00	1.7	19.5	1.7	-	3.4	40.9	7.4	81.4	0.0	5.4
	2.00	5.1	21.4	0.0	12.1	67.9	75.6	12.8	99.2	0.0	26.0
	4.00	18.9	85.9	3.6	15.5	71.2	84.0	72.2	100	3.7	-
R. dominica	0.25	3.5	-	3.7	12.3	12.3	-	22.2	21.4	0.0	7.6
	0.50	3.6	0.0	18.4	50.9	12.2	15.2	11.1	62.1	1.8	12.5
	1.00	1.7	2.3	18.5	61.3	12.2	27.8	38.9	73.6	5.3	1.1
	2.00	5.3	44.2	20.3	65.0	14.1	62.0	61.1	78.6	5.3	-
	4.00	19.6	66.7	25.9	67.5	19.3	68.4	83.3	90.7	31.6	3.8

Mor. = Mortality; Red. = Reduction.

Table (2): Entomocidal effect of *Trigonella foenum* extracts on adult mortalities of *S.oryzae* and *R.dominica.*

Extracts	Concentration= 4%	
	% Total mortality after14 days of exposure	
	S. oryzae	*R. dominica*
Petroleum ether	18.9^{b}	19.6^{cd}
Diethyl ether	03.6^{b}	25.9^{bc}
Chloroform	71.2^{a}	19.3^{cd}
Acetone	72.2^{a}	83.3^{a}
Ethyl alcohol	03.7^{b}	31.6^{b}
F-value	33.692^{**}	46.178^{**}
L.S.D. at 5%	18.028	11.783

Values followed by the same letter within a column are not significantly different at 5% level of probability

Table (3): Corrected cumulative mortality percentages two weeks post treatment and reduction percentages of *S. oryzae* and *R. dominica* adults in the F1 progeny from *Curcuma longa* treated seeds.

Pest	% Conc.	Extracts at different concentrations									
		Petroleum ether		Diethyl ether		Chloroform		Acetone		Ethyl alcohol	
		Mor. %	Red. %	Mor.%	Red. %	Mor.%	Red. %	Mor.%	Red. %	Mor.%	Red. %
S. orayzae	0.25	1.8	0.0	0.0	-	0.0	-	1.8	-	0.0	0.0
	0.50	3.8	-	7.1	-	0.0	-	5.4	0.0	0.0	-
	1.00	9.3	-	8.9	-	7.3	4.1	5.4	-	3.4	-
	2.00	9.2	-	7.1	-	7.4	21.6	5.4	-	3.5	18.2
	4.00	20.4	36.0	8.9	33.6	7.3	-	5.4	-	6.9	-
R. dominica	0.25	0.0	44.1	0.0	-	3.4	-	10.5	24.8	19.4	-
	0.50	0.0	45.5	0.0	-	3.3	-	15.9	27.1	19.4	-
	1.00	1.8	51.4	1.8	6.2	3.0	43.1	22.8	32.3	17.7	6.2
	2.00	48.1	90.9	0.0	-	10.0	59.6	22.9	39.8	28.1	85.0
	4.00	90.8	100	8.7	15.5	10.0	59.6	19.4	54.9	31.6	85.0

Mor. = Mortality; Red. = Reduction

Table (4): Entomocidal effect of *Curcuma longa* extracts on adult mortalities of *S.oryzae* and *R.dominica.*

Extracts	Concentration = 4%	
	% Total mortality after 14 days of exposur	
	S. oryzae	*R. dominica*
Petroleum ether	20.4[a]	90.8[a]
Diethyl ether	08.9[a]	08.7[cd]
Chloroform	07.3[a]	10.0[cd]
Acetone	05.4[a]	19.4b[c]
Ethyl alcohol	06.9[a]	31.6b
F-value	2.666	46.183**
L.S.D. at 5%	---	14.901

Values followed by the same letter within a column are not significantly different at 5% level of probability

2- Effects on progeny

Reduction in F1 progeny of *S. oryzae* adults developed from seeds treated with diethyl ether or ethyl alcohol *T. foenum* extracts at all concentration levels as compared with the check were found insignificant. Acetone extract scored the highest significant reduction on F1 progeny. Reduction percentages reached 81.4, 99.2 and 100 % when acetone extract was used at 1,2 and 4% concentration levels, respectively, followed by chloroform extract which revealed significant reductions in F1 progeny. 40.9, 75.6 and 84.0 % at the same concentration levels, respectively. Petroleum ether *T. foenum* extract achieved high significant reduction (85.9 %) only when used at 4% level (Table 1).

F1 progeny of *R. dominica* adults developed from different *T. foenum* extracts treated seeds showed significant reductions, only when acetone and diethyl ether extracts were used at 0.5, 1,2 and 4% concentration levels. Ethyl alcohol extract at all concentration levels did not affect F1 Progeny. On using extracts at 4 % level, the reduction percentages in a descending order were; acetone (90.7) > chloroform (68.4 %) > diethyl ether (67.5 %) > petroleum ether (66.7 %) (Table 1).

The effect of *C. longa* on adult progeny of *S.oryzae* and *R dominica* developed from adults emerged from treated seeds with Petroleum ether and diethyl ether extracts of *C. longa* showed noticeable reduction in F_1 progeny of *S. oryzae*, especially at the high concentration level (4.0%) being (36.0 and 33.6), respectively, (Table 3). While all extracts of *C. longa* except diethyl ether extract showed obvious reductions in F_1 progeny of *R. dominica*. Petroleum ether extract gave complete protection (100%), chloroform extract (59.6%), acetone extract (54.9%) and ethyl alcohol extract gave (85%) reduction in F_1 progeny (Table 3).

The present results coincide with those of Sharma (1985) who reported that extracts of the flowers of *Calotropis procer* decreased adult emergence of *R. dominica,* Su (1989) found that acetone extract of dill seed provided complete protection to the wheat seeds aginst *S. oryzae* and gave 68.13% reduction in Fl progeny. El- Lakwah *et al.* (1994) reported that petroleum ether and acetone extracts of *M. azedarach* fruits proved reduction in Fl progeny of *R. dominica* and *S. oryzae.*

Table (5): Repellency of *Trigonella foenum* extracts to *S. oryzae* and *R. dominica*.

Extracts	% Average adult repellency after 2 days of exposure			
	S. oryzae		*R. dominica*	
	Concentration 2%	Concentration 4%	Concentration 2%	Concentration 4 %
Petroleum ether	01.7[a]	03.3[a]	40.0[b]	70.0[b]
Diethyl ether	03.3[a]	03.3[a]	36.7[b]	98.3[a]
Chloroform	03.3[a]	06.7[a]	56.7[a]	68.3[b]
Acetone	08.3[a]	10.0[a]	13.3[c]	16.7[c]
Ethyl alcohol	03.3[a]	06.7[a]	20.0[c]	25.0[c]
F-value	1.083	1.443	15.911**	74.535**
L.S.D. at 5%	---	---	12.579	11.673

Values followed by the same letter within a column are not significantly different at 5% level of probability

Table (6): Repellency of *Curcuma longa* extracts to *S. oryzae* and *R. dominica*.

Extracts	% Average adult repellency after 2 days of exposure			
	S. oryzae		*R. dominica*	
	Concentration 2%	Concentration 4%	Concentration 2%	Concentration 4 %
Petroleum ether	05.0_a	06.7_b	66.7_a	73.3_a
Diethyl ether	03.3_a	05.0_b	21.7_c	40.0_b
Chloroform	06.7_a	06.7_b	33.3_{bc}	35.0_b
Acetone	06.7_a	20.0_a	06.7_d	10.0_c
Ethyl alcohol	05.0_a	03.3_b	03.3_d	03.3_c
F-value	0.369	3.432*	36.125**	23.396**
L.S.D. at 5%	---	10.483	11.860	15.829

Values followed by the same letter within a column are not significantly different at 5% level of probability

3- Repellency effects

All tested extracts of *T. foenum* did not show any repellent effects to *S. oryzae* adults along all exposure periods at all tested concentrations (Table 5). On using *R. dominica*, diethyl ether, petroleum ether and chloroform extracts of *T. foenum* produced marked repellency effect ranged between 36.7 and 56.7% at 2% concentration level and between 68.3 and 98.3 at 4% conc. level. While ethyl alcohol and acetone possessed low to moderate repellency effects (13.3 -25.0%) (Table 5). In case of *C. longa* all used extracts did not show any repellent effects on *S. Oryzae* except acetone extract which caused (20.0 %) repellency at 4% concentration level. For *R. dominica*, at the same concentration level, petroleum ether, dierhyl ether & chloroform extracts produced marked repellency (73.3, 40.0 &-35.0%), respectively (Table 6). The repellency increased with increasing the concentration and the repellency percentage decreased as the post treatment period increased; this is due to the loss of some volatile components or various unstable components present. Ediz and Davis (1980) reported that both water-soluble and ether–soluble phenolic compounds of tower and candle rapeseed exhibited repellency values for *T. confusum* and *T. castaneum,* Su (1985 & 1989) found that acetone seed extracts of *Anethum graveolens*. Mace &. Nutmeg were strongly repellent to S. oryzae and El-Lakwah *et al.* (1994&1995) reported that petroleum ether and acetone extracts of *M. azedarach* fruits proved higher repellency against adults of *S. oryzae* and *R. dominica.*

4- Germination tests

Germination of wheat seeds treated with different tested extracts of, *T. foenum* and *C. longa*, in liquid form, at the same concentration levels used in the corresponding experiments were similar to that of the control after 7 days of storage.

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الملخص العربى

التأثير السام والطارد لمستخلصات نبات الحلبة و ريزومات الكركم على سوسة الأرز وثاقبة الحبوب الصغرى

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تضمنت الدراسة تقدير كفاءة المستخلصات المختلفة لبذور نبات الحلبة وريزومات الكركم المستخلصة باستخدام مذيبات مختلفة على البارد كمركبات لمكافحة الحشرات الكاملة لكل من سوسة الارز وثاقبة الحبوب الصغرى وتأثيرها على نسبة الخفض فى تعداد الجيل الأول وتقليل اصابة الحبوب المعاملة؛ بالاضافة الى التأثير الطارد للحشرات الكاملة وذلك عند تعرض الحشرات الكاملة للأفتين موضوع البحث لحبوب القمح المعاملة سطحيا بالمستخلصات المختلفة وبتركيزات مختلفة. اتضح من النتائج المتحصل عليها أن مستخلص الأسيتون لنبات الحلبة أكثر فاعلية على سوسةالأرز وثاقبة الحبوب الصغرى حيث كانت نسبة الموت ٧٢,٢، ٨٣,٣% على التوالى. كما أنه أعطى حماية للحبوب المعاملة من الاصابة بالأفتين بنسبة ١٠٠، ٩٠,٧% على التوالى. كما تبين أن أعلى نسبة تأثير طارد كانت لمستخلص اثير ثنائى الايثيل ٩٨,٣% ضد ثاقبة الحبوب الصغرى. كما تبين من النتائج أن مستخلص الايثر البترولى لريزومات الكركم أكثر اماتة لسوسة الأرز وثاقبة الحبوب الصغرى حيث كانت نسب الموت ٢٤,٤ ٩٠,٨% على التوالى. كما أعطى كلا من مستخلص الايثر البترولى واثير ثنائى الايثيل انخفاض فى تعداد الجيل الأول عند التركيز العالى لسوسة الأرز بينما أعطت كل المستخلصات حماية بنسبة ١٠٠% من الاصابة بثاقبة الحبوب الصغرى. كما وجد أن مستخلص الايثر البترولى له أفضل تأثير طارد لثاقبة الحبوب الصغرى.