Journal of Pharmacognosy and Phytochemistry 2019; 8(4): 59-62

Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(4): 59-62
Received: 28-03-2019
Accepted: 30-04-2019

Rashmi Joshi
Research Scholar, Deptt of Entomology, College of Agriculture, GBPUA&T, Pantnagar, Uttarakhand, India

Dr. SN Tiwari
Professor, Deptt of Entomology, College of Agriculture, GBPUA&T, Pantnagar, Uttarakhand, India

Correspondence
Rashmi Joshi
Research Scholar, Deptt of Entomology, College of Agriculture, GBPUA&T, Pantnagar, Uttarakhand, India

Fumigant toxicity and repellent activity of some essential oils against stored grain pest *Rhyzopertha dominica* (Fabricius)

Rashmi Joshi and Dr. SN Tiwari

Abstract
Grain storage is an integral component of post-harvest management practices. In India approximately 10.0 per cent of food grain is lost during storage half of which is accounted for insect pests which may go up to 40% losses in case of some insects. *Rhyzopertha dominica* (F.) (lesser grain borer, Coleoptera: Bostrichidae) is major pest of stored grain in India, it may cause up to 40% of grain loss as compared to other stored grain pests. Although there have been certain insect management practices like use of synthetic pesticides but due to increasing concern of pesticide residue in grains has encouraged researchers to look for some other alternatives. In one such attempt fumigant toxicity and repellent activity of some essential oils derived from *Murraya koenigii*, *Callistemon citrinus*, *Citrus limetta*, *Curcuma longa* and *Pinus roxburghii* were tested against *R. dominica*. Insect was allowed to breed and feed for one month and then the number of adults emerged were counted. It was found that there was almost 100% inhibition against this pest in all the essential oils when used in 0.1% concentration. Different combinations were also prepared from these essential oils and then also it was observed that not less than 99.05 % inhibition was observed. High repellency was observed falling under class 4 and 5 when insect was tested against all the essential oils used in study. Thus the results observed indicates that these essential oils may revolutionize post-harvest management technology of grain storage by providing quality food and environmental friendly approach.

Keywords: Fumigant, *Rhyzopertha dominica*

Introduction
Insect pests cause serious losses to food grain during storage, reducing the quantity and or/quality of the stored product [3]. *Rhyzopertha dominica* (F.) (lesser grain borer, Coleoptera: Bostrichidae) is major pest of stored grain in India. Both adults and larvae of *R. dominica* feed primarily on stored cereal seed including wheat, maize, rice, oats, barley, sorghum and millet. In India approximately 10.0 per cent of food grain is lost during storage half of which is accounted for insect pests [8]. *R. dominica* may cause upto 40% of grain loss as compared to other stored grain pests i.e. *Sitophilus oryzae*, *Tribolium castaneum* and *Ephestia cautella* causing nearly 19%, 14% and 10% damage respectively. Direct-feeding damage by insects reduces grain weight, nutritional value, and germination of stored grain. Infestations also cause contamination, odour, mold, and heat-damage problems that reduce the quality of the grain and may make it unfit for processing into food for humans or animals. Commercial grain buyers may refuse to accept delivery of insect contaminated grain, or may pay a reduced price. Insects consume and contaminate grains with their metabolic by products and body parts. By their metabolic activities' insect produce heat and moisture that lead to the development of microflora in grains. Heavily infested wheat is unfit for seed purpose and its products are unsuited for human consumption. For the control of stored grains insect pests, various synthetic pesticides in the form of fumigant, sprays and dusts have been used in the past. But in the recent past insects started showing resistance against these synthetic pesticides, also some of them were degrading the environment. Concerns over health and environmental problems associated with synthetic insecticides currently in use in agriculture have led to an intensification of efforts to find safe, effective and viable alternatives. In this regard plant-based insecticides (PBIs) as described by Rosenthal can be less toxic to man, readily biodegradable, suitable for use by small scale farmers and yet capable of protecting crops from attack by a wide range of insect pests [10]. In recent years essential oils have received much attention as pest control agents because of their insecticidal, repellent or antifeedant properties.

Material and Method

The experiments were conducted in Post-Harvest Laboratory in Department of Entomology, College of Agriculture, GBPUA&T, Pantnagar.

Grain preparation & Insect culture - Pure culture of test insects were developed in the control room maintained at 27 ±1°C temperature and 70±5% relative humidity. The adults of *R. dominica* were reared on the grain of wheat variety PBW-343. Before use, grain was disinfested in the oven at 60° C for 12 hrs. After disinfestations the moisture content of the grain was measured and raised to 13.5 per cent by mixing water in the grain. The quantity of water required to raise the moisture content was calculated by using following formula as described by Pixton [9].

$$\text{Quantity of water to be added} = \frac{W_1(M_2 - M_1)}{100 - M_2}$$

Where,

W_1 = Weight of grain

M_1 = Moisture content

M_2 = Require moisture content

The grain was then filled in plastic jars and 50 adults were released in each jar after which it was kept in incubator. First generation adults (0-7 days old) were used for experimental purpose.

Procurement of oils- Oils selected for the study (Table 1) were extracted from the locally available plants by Cleavenger Apparatus in Post-harvest Entomology Laboratory, Department of Entomology, Pantnagar.

Table 1: Common and scientific name of plants the essential oils, used in study:

S. No.	Essential oils	Botanical name	Conc. Per cent of oil
1.	Curry leaf oil	*Murraya koenigii*	0.05, 0.1
2.	Bottle brush oil	*Callistemon citrinus*	0.05, 0.1
3.	Sweet lime	*Citrus limetta*	0.05, 0.1
4.	Turmeric leaf oil	*Curcuma longa*	0.05, 0.1
5.	Pine oil	*Pinus roxburghii*	0.05, 0.1

Experimental details

i. Fumigant toxicity of essential oils

The experiment was conducted under controlled conditions at 27 $\pm$ 1 ^{0}C temperature and 70 $\pm$ 5 percent relative humidity. Fifty gram wheat grains of variety PBW-343 (moisture content 13.5 percent) was filled in each plastic vial. Untreated grain was used as control. Different set was prepared for each insect.

Ten adults of *R. dominica* (0-7 days old) were released in each vial. After 24 hrs of releasing the insects measured quantity of oil was poured on the absorbing mat, which was then placed inside the vial in the centre. Insects were then allowed to feed and breed for one month. The insects emerging in the F1 generation were counted till the emergence of the last insect or until the grain was spoiled. All the experiments were conducted two times to confirm the bio-efficacy of essential oils.

ii. Repellent activity of essential oils

Repellency test was conducted following the method of Talukdar and Howse [12] and Amin *et al*. [2]. Petri dishes 9cm in diameter were used to confine insects during experiment. The essential oils were diluted in ethanol to different concentrations (0.5%, 1.0%, 1.5%, 2.0%, 2.5%, and 3.0%) and absolute ethanol was used as control. Filter paper with a 9cm diameter was cut in half and 1ml of each concentration was applied separately to one half of the filter paper as uniformly as possible with a micropipette. Another half (control) was treated with 1ml of absolute ethanol. Both the treated half and the control half were then air dried to evaporate the solvent completely. Twenty insects were released in the centre of each filter paper disc and cover was placed over the petri dish. Counts of the insects present on each half were made after every half an hour and upto fifth interval. Percent repellency of each oil was calculated by using the following formula from Abbott [1]:

$$\text{Percent Repellency} = \frac{A - B}{A} \times 100$$

Here,

A = Average number of insects present on untreated portion

B = Average Number of insects present on treated portion

The percentages of repellency were then categorized according to the following scale by the method of B. Roy *et al* and R. Amin *et al*. [2, 11]:

Class	Repellency Rate (%)
0	>0.01-0.10
I	0.10 to 20.00
II	20.10 to 40.00
III	40.10 to 60.00
IV	60.10 to 80.00
V	80.10 to 100.00

Results & Discussion

Fumigant toxicity of essential oils

The experiment was conducted two times to confirm the efficacy of oils. Comparison of the efficacy of first and second screening (Table 2) results indicated that *C. citrinus* at 0.1 per cent, *C. longa* at 0.1 percent, *P. roxburghii* at 0.1 per cent, *C. citrinus* at 0.05 per cent alone while treatment number *C. limetta*+ *C. longa* at 0.05 per cent each, *C. limetta*+ *P. roxburghii* at 0.05 per cent each and *C. limetta*+ *C. longa* at 0.025 per cent each were found highly effective and resulted in 100 per cent inhibition with no progeny development of insects in both screenings. Kumar *et al*. [7] reported that oil of *M. koenigii* and C. reticulata at 0.2% *M. koenigii*+*C. reticulata*, *M. koenigii*+*C. longa*, *C. reticulata*+*C. longa* at 0.1% each and *M. koenigii*+*C. reticulata*+*C. longa* at 0.07% each were found highly effective against *R. dominica*. Also, Gangwar and Tiwari [4] found in their studies that adults of *R. dominica* were most susceptible to fumigant action of all fractions of *C. longa* leaf oil at 0.1% and 0.05% concentration.

Table 2: Fumigant toxicity of some essential oils and their combinations against *R. dominica*

S. No.	Treatment	Conc. % (v/v)	Combination per cent	Ist screening		IInd screening	
				Total no of adults emerged	Percent inhibition	Total no of adults emerged	Per cent inhibition
1	*M. koenigii*	0.1	-	0.67 (0.37)*	99.02	0.00(0.00)*	100
2	*C. citrinus*	0.1	-	0.00(0.00)*	100	0.00(0.00)*	100
3	*C. limetta*	0.1	-	1.30(0.54)*	98.08	0.00(0.00)*	100
4	*C. longa*	0.1	-	0.00(0.00)*	100	0.33(0.23)*	99.92
5	*P. roxburghii*	0.1	-	0.00(0.00)*	100	0.00(0.00)*	100
6	*M. koenigii*	0.05	-	0.67 (0.37)*	99.02	0.33(0.23)*	99.92
7	*C. citrinus*	0.05	-	0.00(0.00)*	100	0.00(0.00)*	100
8	*C. limetta*	0.05	-	3.33 (1.09)*	95.10	0.00 (0.00)*	100
9	*C. longa*	0.05	-	0.33(0.23)*	99.51	0.00 (0.00)*	100
10	*P. roxburghii*	0.05	-	5.33(1.34)*	92.16	0.33(0.23)*	99.92
11	*M. koenigii + C. citrinus*	0.1	0.05E	1.00 (0.59)*	98.53	0.00 (0.00)*	100
12	*M. koenigii + C. limetta*	0.1	0.05E	1.00 (0.59)*	98.53	0.00 (0.00)*	100
13	*M. koenigii + C. longa*	0.1	0.05E	0.33(0.23)*	99.51	0.00 (0.00)*	100
14	*M. koenigii + P. roxburghii*	0.1	0.05E	7.67(1.68)*	88.74	0.00 (0.00)*	100
15	*C. citrinus + C. limetta*	0.1	0.05E	0.33(0.23)*	99.51	0.00 (0.00)*	100
16	*C. citrinus + C. longa*	0.1v	0.05E	0.33(0.23)*	99.51	0.00 (0.00)*	100
17	*C. citrinus + P. roxburghii*	0.1	0.05E	0.67(0.37)*	99.01	0.00 (0.00)*	100
18	*C. limetta + C. longa*	0.1	0.05E	0.00 (0.00)*	100	0.00 (0.00)*	100
19	*C. limetta + P. roxburghii*	0.1	0.05E	0.00 (0.00)*	100	0.00 (0.00)*	100
20	*C. longa + P. roxburghii*	0.1	0.05E	0.33(0.23)*	99.51	0.00 (0.00)*	100
21	*M. koenigii + C. citrinus*	0.05	0.025E	1.67(0.77)*	97.55	0.00 (0.00)*	100
22	*M. koenigii + C. limetta*	0.05	0.025E	8.67 (1.93)*	87.26	1.00(0.46)*	99.76
23	*M. koenigii + C. longa*	0.05	0.025E	31.67 (2.20)*	53.44	0.00(0.00)*	100
24	*M. koenigii + P. roxburghii*	0.05	0.025E	30.00 (2.69)*	55.88	1.67(0.69)*	99.61
25	*C. citrinus + C. limetta*	0.05	0.025E	0.67 (0.37)*	99.01	4.00 (0.85)*	99.05
26	*C. citrinus + C. longa*	0.05	0.025E	1.33 (0.54)*	98.08	0.00 (0.00)*	100
27	*C. citrinus + P. roxburghii*	0.05	0.025E	11.33 (1.19)*	83.34	0.00 (0.00)*	100
28	*C. limetta + C. longa*	0.05	0.025E	0.00 (0.00)*	100	0.00 (0.00)*	100
29	*C. limetta + P. roxburghii*	0.05	0.025E	11.33 (1.68)*	83.34	0.00 (0.00)*	100
30	*C. longa + P. roxburghii*	0.05	0.025E	41.00 (1.58)*	39.70	0.00 (0.00)*	100
31	*M. koenigii + C. citrinus + C. limetta*	0.1	0.04E	0.33(0.23)*	99.51	0.00 (0.00)*	100
32	*M. koenigii + C. citrinus + C. longa*	0.1	0.04E	0.33(0.23)*	99.51	0.00 (0.00)*	100
33	*M. koenigii + C. citrinus + P. roxburghii*	0.1	0.04E	1.67 (0.59)*	97.55	0.33(0.23)*	99.92
34	*C. citrinus + C. limetta + C. longa*	0.1	0.04E	0.00 (0.00)*	100	0.00 (0.00)*	100
35	*C. citrinus + C. limetta + P. roxburghii*	0.1	0.04E	1.00 (0.69)*	98.52	0.00 (0.00)*	100
36	*C. limetta + C. longa + P. roxburghii*	0.1	0.04E	14.00 (1.25)*	79.41	0.00 (0.00)*	100
37	*M. koenigii + C. citrinus + C. limetta + C. longa*	0.1	0.03E	0.33 (0.23)*	99.51	0.00 (0.00)*	100
38	*M. koenigii + C. citrinus + C. limetta + P. roxburghii*	0.1	0.03E	0.33 (0.23)*	99.51	0.00 (0.00)*	100
39	Untreated control			68.00 (3.64)*		421.00(6.02)*	
	S Em. ±			(0.62)*		(0.19)*	
	CD at 5%			(1.73)*		(0.52)*	

* Data in parentheses indicate log (x+1) transformed values, E= Each

Repellent activity of essential oils

By comparing performance (Table 3- Table 7) of curry leaf oil (*M. koenigii*), Bottle brush oil (*C. citrinus*), Musammi peel oil (*C. limetta*), Turmeric oil (*C. longa*), Pine oil (*P. roxburghii*) against *R. domonica* at 0.05, 1.00, 1.5, 2.00, 2.5, 3.00 per cent concentrations, it was found that all the studied oil concentrations were either placed in repellency class 5 or in class 4 when both the evaluations were taken together.

Table 3: Repellency of different concentrations of *C. limetta* against *R. dominica*

Essential oil	1st screening		2nd screening	
Concentration (%)	Mean Repellency Rate	Repellency Class	Mean Repellency Rate	Repellency Class
0.5	80.10	5	71.89	4
1	81.37	5	74.32	4
1.5	82.95	5	76.24	4
2	87.86	5	81.37	5
2.5	89.86	5	86.54	5
3	92.51	5	89.82	5

Table 4: Repellency of different concentrations of *M. Koenigii* against *R. dominica*

Essential oil	1st screening		2nd screening	
Concentration (%)	Mean Repellency Rate	Repellency Class	Mean Repellency Rate	Repellency Class
0.5	68.65	4	52.56	3
1	71.17	4	62.06	4
1.5	72.16	4	72.69	4
2	77.97	4	76.02	4
2.5	80.90	5	81.47	5
3	83.48	5	81.76	5

Table 5: Repellency of different concentrations of *C. citrinus* against *R. dominica*

Essential oil	1st screening		2nd screening	
Concentration (%)	Mean Repellency Rate	Repellency Class	Mean Repellency Rate	Repellency Class
0.5	70.23	4	85.9	5
1	73.26	4	88.21	5
1.5	73.85	4	88.22	5
2	75.28	4	89.77	5
2.5	84.73	5	90.48	5
3	92.75	5	93.04	5

Table 6: Repellency of different concentrations of *C. longa* against *R. dominica*

Essential oil	1st screening		2nd screening	
Concentration (%)	Mean Repellency Rate	Repellency Class	Mean Repellency Rate	Repellency Class
0.5	64.18	4	94.80	5
1	75.21	4	95.54	5
1.5	86.15	5	96.32	5
2	92.44	5	96.29	5
2.5	95.51	5	97.54	5
3	98.20	5	97.63	5

Table 7: Repellency of different concentrations of *P. roxburghii* against *R. dominica*

Essential oil	1st screening		2nd screening	
Concentration (%)	Mean Repellency Rate	Repellency Class	Mean Repellency Rate	Repellency Class
0.5	75.73	4	71.15	4
1	76.64	4	73.44	4
1.5	77.71	4	74.86	4
2	79.08	4	75.78	4
2.5	87.80	5	88.21	5
3	89.78	5	88.73	5

The repellent activity of some essential has been proved against *R. dominica* by Joshi and Gaur [6] and found them highly effective against the insect. Geetanjaly *et al* [5] reported that at v0.2 and 0.1% concentrations oils extracted from *Citrus sp* were highly effective against the insect.

Conclusion
It can be concluded from the fumigant toxicity and repellent activity studies of five essential oils and their combinations that these oils were highly effective against *R. dominica* and could be a better management option in near future.

Acknowledgment
We hereby express our deep gratitude to the G B Pant University of Agriculture & Technology for providing us the facilities for smooth functioning of research and members of advisory board *viz.* Dr. Neeta Gaur and Dr. P C Srivastava for their continuous support and motivation.

References

1. Abbott WS. A method of computing the effectiveness of an insecticide. J. Econ. Entomol. 1925; 18:266-267.
2. Amin MR, Shahjahan M, Eltaj HF, Iqbal TMT, Alamgir M, Hossain Bangladesh J Entomol. 2000; 10(1 & 2):1-13.
3. Evans DE. Stored products. In: Burn, AJ, Coaker TH, Jepson PC. (Eds.), Integrated Pest Management. Academic Press, London, UK, 1987, 425-461.
4. Gangwar Pooja, Tiwari SN. Insecticidal Activity of Curcuma longa Essential Oil and its Fractions against *Sitophilus oryzae* L. and *Rhyzopertha dominica* F. (Coleoptera), Int. J Pure App. Biosci. 2017; 5(3):912-921.
5. Geetanjly, Rahul Chandel, Vijay Kumar Mishra, Tiwari SN. Comparative efficacy of eighteen essential Oil against *Rhyzopertha domi0nica* (F.), IJAEB, 2016; 9(3):253-360.
6. Joshi Rashmi, Gaur Neeta. Repellent Activity of Essential Oil from Tulsi Plant against Lesser Grain Borer, *Rhyzopertha dominica* (Fabricius) (Coleoptera: Bostrichidae) and Red Rust Flour Beetle, *Tribolium castaneum* Herbst, (Coleoptera: Tenebronidae), Int. J Curr. Microbiol. App. Sci, 2018; 7(2):157-160.
7. Kumar Ranjeet, Tiwari SN, Pandey PS. Fumigant toxicity of essential oils and their combinations on population buildup of three stored product coleoptera in stored wheat and effect on quality of wheat, 2th International Working Conference on Stored Product Protection (IWCSPP) in Berlin, Germany, October, 2018, 7-11.
8. Narang DD. Banish the pests feeding on our grain. In: The Tribune. September. Chandigarh, India, 2002, 23.
9. Pixton SW. Moisture content-its significance and measurement in stored product. J. Stored Product Res. 1967, 3:35-37.
10. Rosenthal GA. The chemical defence of higher plants. Scientific American Journal, 1986, 94-99.
11. Roy B, Amin R, Uddin MN. Leaf extracts of Shiyalmutra (*Blumea lacera*) as botanical insecticides against lesser grain borrer and riceweevil. J. Biol. Sci. 2005; 5(2):201-204.
12. Talukdar FA, Howse PE. Deterrent and insecticidal effect of extract of pithraj, Aphanamixis polystacha against Tribolium castaneum. J Chem. Ecel. 1993; 19:2463-2471.