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LABORATORY EVALUATION OF SOME VEGETABLE OILS AS PROTECTANTS OF STORED PRODUCTS

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Twelve vegetable oils were tested for their repellent activities against red flour beetle, *Tribolium castaneum* (Herbst) and their toxic effect against lesser grain borer, *Rhyzopertha dominica* (Fabricius) for a period of eight weeks. The best repellent activity (Class V) was found in the oil of neem, *Azadirachta indica* (Antoine de Jussieu). Methi dana, *Trigonella foenumgraecum* (Linnaeus) and nutmeg, *Myristica fragrans* (Maarten Houttuyn) showed Class IV repellency while oils of black pepper, *Piper nigrum* (Linnaeus), Kalongi, *Nigella sativa* (Linnaeus) and turmeric *Curcuma longa* (Linnaeus) showed Class III repellency. The oils of *M. fragrans* (calyx), *A. indica* and *P. nigrum* showed the maximum toxic effects at 0.25% w/w by surface treatment of wheat grains.

Key words : Antifeedants, Repllents, *R. dominica, T. castaneum.*

Introduction

The control of certain stored-product insects by vegetable oils and essential oils has been described by many authors [1-7]. Don-Pedro [8] reported appreciable toxicity of ground citrus peels particularly orange peel. *Citrus sinesis* (Linnaeus) against *Callosobruchus maculatus* (Fabricius) and to a lesser extent *Dermestes maculatus* (Degeer). Mixing oils obtained from locally available plants with pulses has been an ancient Indian method of protection against bruchid attack. More recently a number of vegetable oils have been screened experimentally to determine their effectiveness.

Some oils have been reported to have repellent and antifeedant properties, while others have been used against a variety of insects especially to kill dormant eggs. Some authors [3,9] have described the effect of vegetable oils on oviposition, egg hatch, growth rate [10] and the emergence of stored grain insects. To aid in the protection of stored products from insect attack, there is a continuing need for repellents and antifeedants that are more effective, more economical than the existing synthetics available.

The objective of the present work was to test the repellent and toxic properties of vegetable oils obtained from some locally available plant parts against *T. castaneum* and *R. dominica* respectively.

Materials and Methods

Seven seeds, one calyx, one bud, two fruits of eleven plants and turmeric powder were purchased from local market, these plant parts were ground to fine powder and extracted with *n*-hexane in Soxhlet extractor for eight hrs. The solvent was removed under reduced pressure.

The cultures of test insects, *T. castaneum* and *R. dominica* were maintained on wheat flour with 5% yeast and whole wheat grains respectively. Insect cultures were maintained at 29°±1° and 60±5% RH.

The repellency method followed is that of Malik and Naqvi [11] with certain modifications. Filter papers (Whatman No.1) 8x8cm were treated with 1ml of 1% (w/v) oil in acetone and dried at room temperature. Acetone treated papers served as control. Untreated papers were joined on both sides of treated papers with scotch tape on reverse sides. Two glass rings (4.5cm in height and 8cm in diameter) were placed over these matched papers. Ten 2-3 week old *T. castaneum* adults were released into each ring and the number of insects on treated and untreated halves were observed twice daily for five days. Oils showing more than 50% repellency during first week were selected for further studies over a period of 8 weeks after the initial treatment with new batch of insects on 2nd, 4th and 8th week. Each treatment was replicated eight times. Average insect count for each 5 day period were converted into percentage. The percent repellency was assigned a class by using the following scale [12].

Class I = 0.1 - 20%, Class II =20.1 - 40%, Class III =40.1 -60%, Class IV =60.1 - 80%, Class V =80.1 - 100%.

Plant oils showing Class III-IV repellency upto eight weeks were selected to evaluate their grain protecting properties against *R. dominica*. In each experiment, a known quantity of each oils was dissolved in acetone to make suitable dilutions. Aliquots of these solutions were added to 30 g wheat grain so as to obtain a range of 0.25-1% concentration (w/w). In addition, samples of acetone treated grains were used as control. After complete evaporation of acetone, the treated grains were divided into three equal portions of 10g and placed in bottles after counting their numbers. Ten, 1-2 week old *R. dominica* adults were released into each bottle. Mortality of insects observed weekly for one month and total surviving

adults, number of damaged and undamaged grains were counted after two months.

The percentage loss of grains was calculated from the following formula [13]:

$$\text{Percent weight loss} = \frac{(UNd) - (DNu)}{U \times (Nd + Nu)} \times 100$$

where: U = Weight of undamaged grains, D = Weight of damaged grains, Nd = Number of damaged grains, Nu = Number of undamaged grains.

Results and Discussion

Table 1 shows the parts of the plants used for extraction of oils. The experiments on the repellent activity of the oils showed Class V repellency in case of *A. indica* while oils of *M. fragrans* and *T. foenumgraecum* showed Class IV repellency. Oils of *P. nigrum*, *C. longa* and *N. sativa*, on the other hand, showed moderate repellent property (Class III) *Carum bulbocastanum* (P. Koch), *Eugenia aromatica* (C.P. Thunberg) and *Papaver somniferum* (Linnaeus) lost their repellent activity within the test period of eight weeks (Table2).

TABLE 1. PLANTS INVESTIGATED FOR REPELLENT PROPERTIES AGAINST *TRIBOLIUM CASTANEUM*..

S.No.	Scientific name of plants	Family	Common name	Parts used
1.	*Azadirachta indica* (A. Juss.)	Meliaceae	Neem	Seeds
2.	*Myristica fragrans* (Houtt.)	Myristicaceae	Nutmeg	Calyx
3.	*Myristica fragrans* (Houtt.)	Myristicaceae	Nutmeg	Fruits
4.	*Trigonella foenumgraecum* (L.)	Papilionaceae	Methi dana	Seeds
5.	*Piper nigrum* (L.)	Piperaceae	Black pepper	Dry fruits
6.	*Curcuma longa* (L.)	Zingiberaceae	Turmeric	Rhizomes
7.	*Eugenia aromatica* (Thunb.)	Myrtaceae	Cloves	Buds
8.	*Nigella sativa* (L.)	Ranunculaceae	Kalonji	Seeds
9.	*Papaver somniferum* (L.)	Papaveraceae	Opium	Seeds
10.	*Carum bulbocastanum* (Koch)	Umbelliferae	Seah zeera	Seeds
11.	*Amomum subulatum* (Roxb.)	Zingiberaceae	Elaichi	Seeds
12.	*Carum copticum* (Benth & Hock. F.)	Umbelliferae	Ajwain	Seeds

The toxic effects of seven oils and % loss of grain due to insects are presented in Table 3. During a period of one month all the oils produced 100% mortality of the test insects at 1% concentration except *N. sativa* which showed 70% kill.

The order of toxicity, calculated by analysis of variance and Duncun's Multiple rang test, is as follows:

M. fragrance (calyx oil)> *A. indica* = *P. nigrum* > *C. longa* > *M. fragrans* (fruit oil) > *T. foenumgraecum* > *N. sativa*.

The application of oils of *M. fragrans* (calyx) and *A. indica* gave satisfactory protection of grains upto two months at 0.25% concentration. The oils of *P. nigrum* and *C. longa*, on the other hand, showed a moderate activity at comparable dose (Table 3).

This work has shown that *A. indica*, *M. fragrans*, *P. nigrum* and *T. foenumgraecum* oils can give protection to stored wheat from *R. dominica* and *T. castaneum* for a period of 60 days. The protective action of oils was observed due to the accumulative effects of their repellent and toxic nature (Tables 2 & 3), The repellent and toxic properties of these oils depended on their application rate. These findings are in line with the observation of Jilani and Saxena [14] who studied these properties in turmeric, sweetflag, *Acorus calamus* (Linnaeus) and neem oils against *R. dominica*.

The candidate oils produced toxic and repellent effects resulting in the reduction of progeny of *R. dominica*. Such control of various stored-product insects by vegetable oils and essential oils have been noted previously. Some authors [3,9]

TABLE 2. REPELLENCY OF PLANT OILS AGAINST *TRIBOLIUM CASTANEUM* (HERBST.) FOR A PERIOD OF EIGHT WEEKS.

S. No.	Names of the plants	Period after treatment (weeks*) 1	2	4	8	Mean % repellency	Repellency class
1.	*Azadirachta indica*	98.1± 0.1	95.4± 2.1	85.9± 5.4	52.5± 3.0	92.9	V
2.	*Trigonella foenumgraecum*	96.1± 1.9	77.1± 4.8	70.0± 9.2	61.6± 4.0	76.2	IV
3.	*Myristica fragrans* (Calyx oil)	98.9± 0.8	76.1± 7.2	75.0± 4.3	35.6± 9.0	71.4	IV
4.	*Myristica fragrans* (Fruit oil)	97.9± 2.1	74.6± 5.8	61.4±12.4	39.1±14.6	68.3	IV
5.	*Piper nigrum*	64.7± 9.4	47.9± 7.0	45.4± 3.9	27.5±14.0	46.4	III
6.	*Nigella sativa*	58.6± 7.4	50.4± 3.3	35.0±11.0	27.0±18.5	42.7	III
7.	*Curcuma longa*	63.8± 5.3	47.9± 7.0	31.9± 7.1	19.6± 5.5	40.8	III
8.	*Carum bulbocastanum*	56.1± 7.3	38.6± 7.3	33.6± 8.1	22.5±16.0	37.7	II
9.	*Eugenia aromatica*	60.2±13.9	33.2± 8.3	30.4± 7.0	26.4±11.7	37.5	II
10.	*Papaver somniferum*	57.5± 6.1	40.6± 3.8	35.0± 8.5	-5.0±6.4	32.0	II
11.	Control	7.7± 4.9	9.0± 4.7	5.8± 3.3	-0.5± 7.4	5.5	I

* Average of eight replicates; ± S. E. of mean.

TABLE 3. TOXIC EFFECTS OF SEVEN VEGETABLE OILS AGAINST *RHYZOPERTHA DOMINICA* BY SURFACE TREATMENT OF GRAINS (AVERAGE OF SIX REPLICATES).

Source of oils	% Concentration (w/w)	Mean% mortality after one month	Mean No. of progeny after two months	%Reduction in progeny	%Weight loss of grain
Myristica fragrans	1.0	100 a	Nil	100	No loss
(Calyx oil)	0.5	100 a	Nil	100	No loss
	0.25	100 a	Nil	100	No loss
Azadirachta indica	1.0	100 a	Nil	100	No loss
	0.5	100 a	Nill	100	No loss
	0.25	80 bc	Nil	100	0.5 ± 0.1
Piper nigrum	1.0	100 a	Nil	100	No loss
	0.5	100 a	Nil	100	No loss
	0.25	80 bc	6	96.1	1.9 ± 1.1
Curcuma longa	1.0	100 a	Nil	100	No loss
	0.5	100 a	Nil	100	No loss
	0.25	65 c	28	81.9	6.6 ± 3.5
Myristica fragrans	1.0	100 a	Nil	100	No loss
(Fruit oil)	0.5	100 a	Nil	100	No loss
	0.25	60 cd	59	61.6	14.1 ± 6.6
Trigonella foenum-	1.0	100 a	Nil	100	No loss
graecum	0.5	80 bc	13	91.6	5.7± 1.0
	0.25	75 c	37	76.1	10.8 ± 5.2
Nigella sativa	1.0	70 c	Nil	100	2.9 ± 0.3
	0.5	43.3 e	74	52.3	10.6 ± 6.4
	0.25	23.3 f	99	36.1	20.5 ± 0.4
Control	-	10.0 g	155		40.3 ± 4.7

Mean % mortality followed by the same letters are not significantly different at 1% level of significance.

have reported the ovicidal activity of vegetable oils while others reported their toxic [1,8] action. There are reports [10] about the reduction of growth and emergence of insects as well due to the use of oils.

The results reported in this paper suggest that out of twelve oils tested, four vegetable oils *(A. indica, M. fragrans, P. nigrum* and *T. foenumgraecum)* can be developed as protectants for grains at village level. Howeve, there is need for further work to determine the toxicity of these oils, their effect on seed germination and their cost.

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