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Evaluation of vegetable oils as grain protectants against *Rhyzopertha dominica* (Fabricius) on maize under storage condition

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Abstract
Laboratory trials were carried out at Department of Agricultural Entomology, B. A. College of Agriculture, AAU, Anand for evaluating vegetable oils as grain protectants against *R. dominica* in stored maize. Among the nine oils used, castor, neem and pongam oils (1%) gave higher mortality at different storage periods of maize, whereas coconut and groundnut oils (1%) were least effective against *R. dominica* in maize. The half-life value was 2.5 to 3 months in neem, castor and pongam oil, whereas it was below 2 months in groundnut oil. Gross persistency value was between 3100 and 4550 in mahua, pongam, neem and castor oils (1%), whereas the value was lowest (>2000) in groundnut oil. Castor, neem and pongam oils were found highly effective as less number of adults emerged. Groundnut and coconut oils were less effective with higher adult emergence. On the basis of percent loss in germination, neem, castor and pongam oils had lower germination loss, while groundnut and coconut oils had higher germination loss.

Keywords: Lesser grain borer, maize, vegetable oils

Introduction
Maize, *Zea mays* Linnaeus, family Graminae is the most versatile crop with wider adaptability in varied agroecologies. In India, maize is the third most important food crop after rice and wheat. It is cultivated in 7.27 million hectare with a production of 15.86 million tonne [1]. Grain produced should be stored to meet home consumption and for sale. Insect pests are causing enormous losses in terms of quality, quantity and germination of seeds. Under storage conditions, maize grains suffer heavy loss due to rice weevil, khapra beetle, lesser grain borer and angoumois grain moth [2]. *R. dominica* along with *Sitophilus spp*. ranks as the most important pest of stored cereals worldwide [3]. Lesser grain borer appears to be most closely associated with stored products in the storage environment. The grub and adult cause damage to grains by feeding inside them [4]. Smearing or mixing of vegetable oils is an easy, cheap and safe method to protect grains like maize, milled rice, wheat and pulses stored particularly for domestic consumption and it is traditional practice in rural and urban areas of India.

Materials and Methods
Laboratory trials were carried out at Department of Agricultural Entomology, B. A. College of Agriculture, AAU, Anand for evaluating vegetable oils as grain protectants against *R. dominica* in stored condition. Five edible and 4 non-edible oils all at 1 percent (v/w) level were evaluated based on periodical mortality, half-life, gross persistency, population growth and germination loss.
Each oil was applied to 500 g previously sterilized maize grains (cv. GM 6) by smearing @ 1percent. An untreated and sterilized bulk of 500 g maize grains was kept as control treatment. All the 10 bulks (each of 500 g) of maize grains were stored in an air tight plastic bottle at room temperature and utilized for further experimentation.

Evaluation based on adult mortality
For the purpose, three samples of treated maize each of 50 g (one sample for one repetition) were drawn from each bulk of treatment. Each experiment was carried out at 15 days interval. The samples were filled in plastic tube (6 cm height and 5 cm diameter) individually. Twenty adults (5 to 10 days old) of *R. dominica* obtained from laboratory culture were released into

each of the plastic tube and each plastic tube was covered with a piece of two-fold muslin cloth which will be held in position with rubber band. The observations on number of dead adults out of total adults were made after 7 days of adult release and percent mortality was worked out. The periodical data on percent mortality was corrected using Abbott's formula [5].

Evaluation based on half-life and gross persistency

Half-life

The vegetable oils were also evaluated for their efficacy as grain protectants based on mortality half- life in days. It was worked out using the formula used by Kher [6].

Gross persistency

The gross persistency of different oils tested as mortality of *R. dominica* was worked out using formula given by Pawar and Yadav [7].

Evaluation based on population growth

An experiment was carried out using same bulks of maize grain under different treatments. Mortality percent was also worked out on the basis of total adults developed after 3 and 6 month storage periods. The data on percent mortality was first corrected using Abbott's formula [5].

Organoleptic test

Studies were undertaken to see the presence or absence of disagreeable smell or flavour in maize seeds smeared with non-edible oils. For the purpose, 3 samples each of 100 g of maize seeds were drawn from the bulk of seeds treated with different non-edible oils *viz*., neem, pongam, mahua and castor oil all at 1 percent v/w. The samples were drawn after 6 months of storage period. The samples were made into flour using grinder. A chapatti was made from each sample. Five persons were asked to smell and taste different chapattis under different treatments. They were also asked to give the marks (1 to 10) on the basis of smell and taste. The more the disagreeable smell and taste the less mark was given for that treatment.

Evaluation based on germination loss

The number of grains germinated was counted after 7 days of incubation. Based on germination counts, the percentage of germination before and 6 months after adult release were calculated repetition-wise. Based on percent germination before and 6 months after adult release, percent loss in germination was worked out repetition-wise for each treatment.

Results and Discussion

Evaluation based on adult mortality

The data on corrected percent mortality of *R. dominica* obtained is presented in Table 1. Castor oil (71.48%) was significantly superior to other treatments in the experiment. Neem (67.41%), pongam (55.66%) and mahua (51.33%) oils differed significantly to each other in their descending order in controlling the pest. Anand *et al*. [8] reported that neem oil even at 10 ppm reduced population of *R. dominica* in paddy. Kathirvelu and Ezhilkumar [9] noted that neem and pongam oils @ 30 ml/ kg were effective in paddy against *R. dominica*. Palm (48.17%) and mustard (44.44%) oil were equally effective against *R. dominica* in maize storage, the latter oil treatment was at par with sesame oil (41.06%). Shukla *et al.* [10] found that sesame and mustard oils (1%) provided mortality of *R. dominica* in wheat. The lowest (32.88%) mortality was obtained in groundnut oil and it was at par with coconut oil (36.20). Shukla *et al*. (1992) reported that coconut oil (1%) had no effect on *R. dominica* in wheat. There was significant difference among mean mortalities obtained at different period.

Evaluation based on half-life and gross persistency

The efficacy of vegetable oils as grain protectants was also evaluated based on half-life and gross persistency values worked out replication-wise for different oils. The data on half-life in days and gross persistency values are presented in Table 1.

Half-life

The mortality half-life is the time in days required to reduce the mortality to half of its initial mortality. The half-lives ranged from 53.36 to 85.05 days among the various vegetable oils (Table 1). Neem oil recorded highest (85.05 days) value of half-life which indicated that the adult mortality of *R. dominica* reduced below 50 percent only after about 85 days of storage of maize grains treated with neem oil @ 1% (v/w). The half-life of castor oil (84.12 days) was at par with that of neem oil. Pongam oil (72.24 days) was at par with mahua oil (67.60). Palm and mustard oils were at par with mahua, coconut (58.73 days) and sesame (58.22 days) oils. Groundnut oil recorded lowest half-life of 53.36 days and it was at par with coconut and sesame oils. Deb [11] reported that neem, mahua and castor oils had higher (70 to 92 days) half-life values, while groundnut and coconut oils had less (54 to 58 days) half-life values in stored maize.

Gross persistency

Based on gross persistency value, all the oil treatments were differed significantly to each other. Castor oil (4540.32) was significantly superior over rest of the oils followed by neem (4358.20), pongam (3461.54) and mahua (3124.65). Palm, mustard, sesame, coconut and groundnut oils recorded gross persistency ranging from 1854.95 to 2893.64. Among the evaluated oils, groundnut oil had significantly lowest persistent value followed by coconut, sesame, mustard and palm oils. Deb [11] noticed that neem, castor, pongam and sesame oils were longer persistent and groundnut, palm and mustard oils were less persistent vegetable oils in maize.

Evaluation based on population growth

The data on number of adults developed by the initial release of twenty adults of *R. dominica* for 7 days are presented in Table 1. All oil treatments differed significantly from control (18.16). The lowest (3.00) number of adults was developed in castor oil and it was at par with neem oil (3.46). Pongam oil recorded population of 4.56 and it was at par with neem oil. Jilani and Saxena [12] reported that neem oil @ 200 µg/ cm^2 repelled the adults of *R. dominica*. Khaire *et al*. [13] found that neem oil and castor oil (1%) prevented adult emergence of *C. chinensis* in pigeon pea. Sharma [14] observed that neem oil (2%) reduced emergence of the storage pests in maize. Abdallah *et al*. [15] noticed that castor oil @ 12 ml/ kg eliminated progeny emergence of *R. dominica* in wheat. These treatments were significantly more effective than rest of the oils. Mahua and palm oil were found equally effective and they noted population of 7.85 and 8.50, respectively. Mustard oil (9.93) was at par with palm and sesame (10.86) oils. Among the oils groundnut oil registered highest (13.94) population of *R. dominica* and it was at par with coconut oil.

Organoleptic test

The analysis of data on organoleptic qualities after 6 months of storage (Table 2) indicated that the taste and smell of chapatti made from the maize grains treated with mahua oil and pongam oil was significantly more disagreeable than the chapatti made from the maize grains treated with neem and castor oils. Among the oils, castor oil was found to be organoleptically more acceptable and it was at par with neem oil. Kher [6] reported that among non-edible oils, castor oil was found organoleptically acceptable in wheat followed by pongamia and neem. Deb [11] observed that neem oil was organoleptically more acceptable followed by castor and pongam oils.

Evaluation based on germination loss

The data on percent loss in germination due to infestation are presented in Table 1. The germination loss after 6 months of storage due to infestation of *R. dominica* was lowest in neem oil (18.43%) and it was at par with castor (19.74%) and pongam oil (21.21%). Abdallah *et al*. [15] noticed that germination of wheat was not affected by treating with castor oil @ 12 ml/ kg. Khaire *et al*. [13] reported that castor (1%) had no adverse effect on germination of pigeon pea. Mahua and palm oil treatments recorded germination loss of 30.45 and 32.08 percent, respectively and the latter was at par with mustard oil (39.40%) also. Mustard, sesame (45.80%) and coconut (46.39%) oils had equal effect on germination loss. Among the oil treatments, groundnut oil had highest germination loss (54.20%) and it was at par with coconut oil and control (60.98%). Nikpay [16] reported that coconut oil 10 ml/ kg reduced viability of wheat grains.

Table 1: Effectiveness of vegetable oils as grain protectant against *R. dominica* based on adult mortality, half-life, gross persistency, population growth and germination loss during storage of maize grain

Treatments	Dose (%)	Adult mortality (%)**	Half-life (days)	Gross persistency	Number of adults emerged*	Loss in germination (%)**
Neem oil	1	55.19 (67.41)	85.05	4358.20	1.99 (3.46)	25.42 (18.43)
Pongam oil	1	48.25 (55.66)	72.24	3461.54	2.25 (4.56)	27.42 (21.21)
Mahua oil	1	45.76 (51.33)	67.60	3124.65	2.89 (7.85)	33.49 (30.45)
Castor oil	1	57.72 (71.48)	84.12	4540.32	1.87 (3.00)	26.38 (19.74)
Mustard oil	1	41.81 (44.44)	62.45	2615.76	3.23 (9.93)	38.88 (39.40)
Coconut oil	1	36.99 (36.20)	58.73	2091.83	3.59 (12.39)	42.93 (46.39)
Sesame oil	1	39.85 (41.06)	58.22	2392.05	3.37 (10.86)	42.59 (45.80)
Groundnut oil	1	34.99 (32.88)	53.36	1854.95	3.80 (13.94)	47.41 (54.20)
Palm oil	1	43.95 (48.17)	65.00	2893.64	3.00 (8.50)	34.50 (32.08)
Control	-	-	-	-	4.32 (18.16)	51.34 (60.98)
S. Em. ± Treatment (T)	-	0.82	2.42	58.61	0.10	1.59
Period (P)	-	0.83	-	-	0.04	-
T×P	-	2.49	-	-	0.12	-
C.D. at 5% T	-	2.28	7.19	174.13	0.28	4.70
P	-	2.29	-	-	0.11	-
T×P	-	NS	-	-	NS	-
C.V. %	-	9.60	6.22	3.34	7.01	7.45

Figures in parentheses are retransformed values, those outside are $\sqrt{x+0.5}$ * and arc sin** transformed values.

Table 2: Effect of non-edible oils on organoleptic qualities (taste and smell) of maize grains after 6 months of storage

Treatments	Dose (%)	Rank (Out of 10)
Neem oil	1	2.47 (5.60)
Pongam oil	1	2.02 (3.58)
Mahua oil	1	1.97 (3.38)
Castor oil	1	2.55 (6.00)
Control	-	2.85 (7.62)
S. Em. ±	-	0.06
C. D. at 5%	-	0.18
C. V. %	-	5.90

Figures in parentheses are retransformed values, those outside are $\sqrt{x+0.5}$ transformed values

Conclusion

Castor, neem and pongam oils were found highly effective against *R. dominica* in stored maize. Groundnut and coconut oils were less effective with higher adult emergence and lower adult mortality. Among the nonedible oils, castorand neem oils were organoleptically more acceptable.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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