



E-ISSN: 2320-7078

P-ISSN: 2349-6800

JEZS 2015; 3 (1): 65-68

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Received: 24-12-2014

Accepted: 04-01-2015

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Repellency evaluation of selected indigenous medicinal plant materials against *Rhyzopertha dominica* (Herbst) (Coleoptera: Tenebrionidae)

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Abstract

Extract of five indigenous plants viz. *Mentha longifolia* (Mint), *Momordica charantia* (Bitter Gourd), *Luffa aegyptiaca* (Sponge Gourd), *Carum copticum* (Ajwain) and *Curcuma longa* (Turmeric) were tested at different concentrations of 25, 50 and 75% to check their repellency effect against *Rhyzopertha dominica* during 10 days of exposure. Complete repellency was exhibited by *Mentha longifolia* followed by *Momordica charantia* (90%), *Luffa aegyptiaca* (80%), *Carum copticum* (76.67%) and *Curcuma longa* (66.67%) at 75% dose rate. Thus, it can be inferred that the natural plant extracts can prove the best alternatives to chemical repellents.

Keywords: Plant extracts, Repellency, *Rhyzopertha dominica*

1. Introduction

Stored product insects cause serious damage to cereals at pre and post harvest levels. The most destructive insects of stored grains are *Rhyzopertha dominica* (Lesser grain borer), *Tribolium castaneum* (Red flour beetle), *Sitophilus zeamais* (Maize weevil) and *Prostephanus truncatus* (Larger grain borer) [1]. *R. dominica* is cosmopolitan in nature and causes significant damage in the warehouses [1]. Currently, synthetic pesticides are used for controlling this pest, but the persistent use of pesticides is causing serious issues like environmental pollution, resistance development, residue accumulation, increasing pest outbreaks, adverse effect on target organisms and health hazards. Due to these issues, there is a dire need to develop and use such products which are economically feasible, socially acceptable and safe for environment and humans [2, 3, 5, 11, 12, 13, 14, 15, 20]. Therefore, this research work was carried out to test the repellent effect of five plant extracts i.e., *Mentha longifolia*, *Momordica charantia*, *Luffa aegyptiaca*, *Carum copticum* and *Curcuma longa* against *R. dominica*.

2. Materials and Methods

The present work was carried out at the Nuclear Institute for Food and Agriculture (NIFA) Peshawar, Khyber Pakhtunkhwa Pakistan, during the year 2013-2014.

2.1 Insect Collection

The test insects were collected from stocked grain of various warehouses in District Nowshera, Mardan and Peshawar regions of Khyber Pakhtunkhwa (KPK) Pakistan.

2.2 Insect Rearing

R. dominica population was reared on the pure wheat flour kept in 300 ml plastic jars. The incubator was used to maintain favorable uniform conditions. Temperature of 27 ± 2 °C and relative humidity of $70 \pm 5\%$ was consistently maintained. Adult beetles were released for egg laying and after 5 days removed from the wheat flour through sieving. The eggs were allowed to hatch and develop under uniform conditions. The homogenous adult population was obtained after 28-35 days [10].

2.3 Plant Material

Plant based natural products i.e., *Mentha longifolia*, *Momordica charantia*, *Luffa aegyptiaca*, *Carum copticum* and *Curcuma longa* were obtained from fresh local market Nowshera KPK, Pakistan.

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2.4 Extract Preparation

The plant materials were brought to the laboratory and shade dried. The dried plant materials were ground using electric blender and sieved through kitchen strainer. Selected plant materials were extracted with distilled water. The residues from the final extracts were dried well for absolute evaporation of the solvent and the residue was collected in brown color vials and preserved at sodium benzoate. The following concentrations, (25%, 50% and 75%) were prepared. The diluted concentrations were used for subsequent experiments. The concentrated stock solution was obtained by subjecting the filtrate to rotary evaporator as devised by Hasan *et al.* [9] and Sagheer *et al.* [16].

2.5 Determination of percent repellency

The filter paper was cut into two halves and half of the paper was treated with the prepared extracts while the other half was treated with water. The treated paper was allowed to dry for 5-10 minutes and placed on the petridish. Thirty adults (15 days old) were released in the middle of Petridish. The plate was covered to avoid the escape of insects. Small amount of insect diet (wheat flour) was introduced on both sides to reduce the chances of death due to starvation. Percent repellency was calculated by counting the number of beetles in treated and untreated areas consecutively during 10 days of exposure. Each treatment was repeated three times and Completely

Randomized Design was followed. Collected data were statistically analyzed using computer program MSTAT-C.

Table 1: List of indigenous plant extracts used as a repellent against

Plant material	Family	Part used
<i>Mentha longifolia</i>	Lamiaceae	Leaves
<i>Momordica charantia</i>	Cucurbitaceae	Mature fruit
<i>Luffa aegyptiaca</i>	Cucurbitaceae	Mature fruit
<i>Carum copticum</i>	Umbelliferae	Seed
<i>Curcuma longa</i>	Zingiberaceae	Root

3. Results

R. dominica was exposed for ten days to five indigenous plant extracts viz. *Mentha longifolia*, *Momordica charantia*, *Luffa aegyptiaca*, *Carum copticum* and *Curcuma longa*. The concentrations were applied at three different dose ratios i.e., 25%, 50% and 75%. The results depict that dose rate and exposure period had significant effects on the repellency. Repellency increased with increasing dose and exposure period (Table 2). *Mentha longifolia* was found to be the most effective repellent followed by *Momordica charantia*, *Luffa aegyptiaca*, *Carum copticum* and *Curcuma longa* (Fig. 1). Best results were achieved at 75% extract dose followed by 50% and 25%. Complete repellency was achieved with *Mentha longifolia* while the minimum repellency was recorded with *Curcuma longa* at 75% and 25% dose rates respectively.

Table 2: Comparison of the percent repellency of *R. dominica* with interaction of time interval and concentration of plant extracts

Days	Dose Concentration	Extract- wise repellency				
		<i>Mentha longifolia</i>	<i>Momordica charantia</i>	<i>Luffa aegyptiaca</i>	<i>Carum copticum</i>	<i>Curcuma longa</i>
1	25	40.00 def	33.33 fgh	26.67 hi	23.33 ij	16.67 j
1	50	46.67 cd	43.33 cde	40.00 def	36.67 efg	30.00 ghi
1	75	70.00 a	60.00 b	50.00 c	46.67 cd	36.67 efg
2	25	43.33 def	36.67 fgh	30.00 hi	26.67 i	20.00 j
2	50	50.00 cd	46.67 cde	43.33 def	40.00 efg	33.33 ghi
2	75	73.33 a	63.33 b	53.33 c	50.00 cd	40.00 efg
3	25	46.67 def	40.00 fgh	33.33 hi	30.00 ij	23.33 j
3	50	53.33 cd	50.00 cde	46.67 def	43.33 efg	36.67 ghi
3	75	76.67 a	66.67 b	56.67 c	53.33 cd	40.00 fgh
4	25	50.00 cf	43.33 efg	36.67 gh	33.33 hi	26.67 i
4	50	56.67 cd	53.33 cde	50.00 cf	46.67 d-g	40.00 fgh
4	75	80.00 a	70.00 b	60.00 c	56.67 cd	46.67 dg
5	25	53.33 cf	46.67 eh	40.00 ghi	36.67 hi	30.00 i
5	50	60.00 cd	56.67 cde	53.33 cf	50.00 dg	43.33 fgh
5	75	83.33 a	73.33 b	63.33 c	60.00 cd	50.00 dg
6	25	56.67 cf	50.00 eh	43.33 ghi	40.00 hi	33.33 i
6	50	63.33 cd	60.00 cde	56.67 c-f	53.33 d-g	46.67 fgh
6	75	86.67 a	76.67 ab	66.67 bc	63.33 cd	53.33 dg
7	25	60.00 cf	53.33 eh	46.67 ghi	43.33 hi	36.67 i
7	50	66.67 cd	63.33 cde	60.00 cf	56.67 d-g	50.00 fgh
7	75	90.00 a	80.00 ab	70.00 bc	66.67 cd	56.67 dg
8	25	63.33 cf	56.67 e-h	50.00 ghi	46.67 hi	40.00 i
8	50	70.00 cd	66.67 cde	63.33 cf	60.00 d-g	53.33 fgh
8	75	93.33 a	83.33 b	73.33 c	70.00 cd	60.00 dg
9	25	66.67 def	60.00 fgh	53.33 hi	50.00 ij	43.33 j
9	50	73.33 cd	70.00 cde	66.67 def	63.33 efg	56.67 ghi
9	75	96.67 a	86.67 b	76.67 c	73.33 cd	63.33 efg
10	25	70.00 def	63.33 fgh	56.67 hi	53.33 ij	46.67 j
10	50	76.67 cd	73.33 cde	70.00 def	66.67 efg	60.00 ghi
10	75	100 a	90.0 b	80.00 c	76.67 cd	66.67 efg

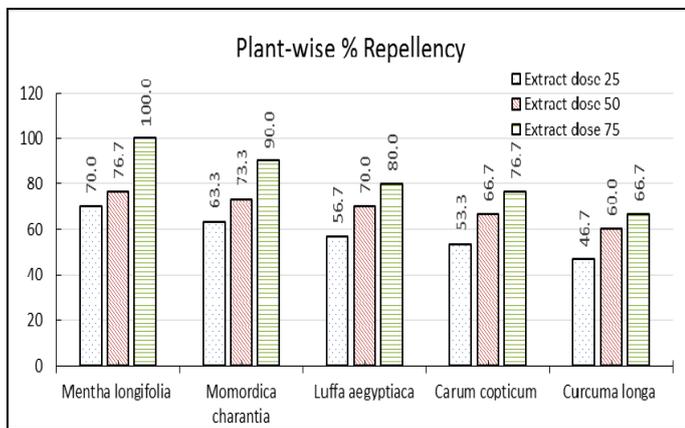


Fig 1: Repellency effect of Plant extracts at three concentrations i.e., 25, 50 and 75% against *R. dominica*

4. Discussion

The repellency effect of all plant extracts was different against *R. dominica*. *Mentha longifolia* was found to be the most effective repellent while *Curcuma longa* was least effective repellent against *R. dominica*. These results are in line with the findings of Akrami, [4] who reported *Mentha longifolia* with 93.3% repellency against stored grain insects. Christos, [7] found *Curcuma longa* as effective, humanly safe and environment friendly extract against *R. dominica* at high dose ratio. Significant difference in repellency was observed with increasing exposure time and dose rate. The repellency action is contributed to the presence of active metabolites in extract. These metabolites are composed of essential oils which are responsible for the repellent action [17]. Gunarathna and Karunaratne, [8], Saljoqi *et al.* [18] and Al-Jabr [6] also reported the same trend. Tripathi *et al.* [19] reported that adults of *R. dominica* were greatly susceptible to contact action of *C. longa* extract.

5. Conclusion and Recommendations

It was concluded that selected plant extracts have high potential to replace the chemical pesticides in protecting stored commodities against *Rhyzopertha dominica*. *Mentha longifolia* found the most effective repellent followed by *Momordica charantia*, *Luffa aegyptiaca*, *Carum copticum* and *Curcuma longa*. Field trials of these extracts are required to check the on-farm repellency effect. Similarly, the application method needs to be properly evaluated.

6. Acknowledgement

The authors express their sincere gratitude to the faculty and staff of the agriculture department, University of Haripur and Nuclear Institute for Food and Agriculture (NIFA), Peshawar for their continuous support to accomplish the above research work.

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