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Repellency of three plants extraction against *Oryzaephilus surinamensis* and *Oryzaephilus mercator* (Coleoptera: Silvanidae)

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Abstract
Three plant extraction of Caraway (*Carum carvi*), Ginger (*Zingiber officinale*) and Cardamom (*Elettaria cardamomum*) were studied in the laboratory for repellency effect against Saw-Tooth grain beetle adult and Larvae, *Oryzaephilus surinamensis* and *Oryzaephilus mercator*. Two concentration of every plant extract (5, 10 µl/ml) were examined and ten replications were used for each dose of all the plant extracts and tested in Petri dishes. Results demonstrated that extracts of Caraway and Ginger had higher repellent effect on larvae and adult of *O. surinamensis* and *O. mercator* than that of Cardamom. Pronounced increase of repellency was detected for all plant extracts with increasing time of exposure and concentrations. According to the studies, the plant extracts of Caraway and Ginger can be utilized in protection of *O. surinamensis* and *O. mercator* and suitable replace for artificial pesticides.

Keywords: Saw-tooth grain beetle, caraway, ginger, cardamom, plant extract, repellent

1. Introduction
Oryzaephilus surinamensis L. and *Oryzaephilus mercator* L. are major and destructive insect pest of grains stored in bulk condition. These insect feeds on several products including grain products, fast foods, dried fruits, seeds, nuts, sugar, yeast, tobacco, candy and all products of plant utilized as human food [1]. Pest control in stored product depends mainly on the use of synthetic pyrethroid and organophosphorus pesticides and fumigants, e.g., phosphine and methyl bromide [2]. However, synthetic pesticide can pose serious problems like, hazards in people health, environmental pollution, pest resistance and disrupt of biological control and ecosystem etc. Therefore, to flighting together these problems, there is a necessity for effective and safe insecticides with no toxic influence on non-target organism. Natural products are well accepted to have a range of beneficial biological properties against pests [3, 4]. Many plants extracts can be utilized for stored product pest control as they have a various of properties including repellency to insect pests, pesticidal activity, antifeedant influence and grow regulation of insect [5]. Several researches have screened many plant products for the stored product control and comprehensive review on this title had been undertaken by Lale [6] and Boeke *et al.* [7].
Modarres Najafabadi *et al.* [8] reported the repellent and toxicity of three plant leaves extraction against *O. surinamensis*. Shah *et al.* [9] evaluated the repellent effect of six indigenous plants on *O. surinamensis*. Al-Jaber, [4] also reported toxicity and repellency of seven plant essential oils to *O. surinamensis*. Manzoor *et al.* [5] demonstrated ethanolic plant extracts effect on three storage grain pest including *O. surinamensis*. Adedire *et al.* [10] reported the bioactivity of four plant extracts on Coleopterous pests including *O. mercator*.
In view of the above mentioned, the present study was upon to estimate the possible repellent influence of commonly utilized plant Caraway (*Carum carvi* L.), Ginger (*Zingiber officinale* Roscoe) and Cardamom (*Elettaria cardamomum* (L.)) extracts against adult and larvae of *O. surinamensis* and *O. mercator*.

2. Materials and methods
Experiment conducted in the Entomology Laboratory, Islamic Azad University of Takestan Branch of Iran during April to September 2014.

2.1 Technique of Rearing
Oryzaephilus surinamensis and *O. mercator* was reared in round glass jars (14*10*30 cm) at 25±1 °C and 60±5% RH.

Grains of wheat were sterilized for 30 min at 60 °C and therefore utilized as food for rearing insect pests. Each glass jar was put up with 100 pairs of adult. The opening mouths of the jars were concealed with pieces of cloth fastened with rubber bands to avoid insect escape. These insects were allowed 7 days in the glass jars for oviposition and mating and were deleted from the glass jar. Therefore, the glass jars were put in a growth chamber kept at 27 °C and 60% RH for completing the life span of insects after emergence from the eggs in the food.

2.2 Plant preparation: Fruits of *C. carvi*, *Z. officinale* and *E. cardamomum* were maintained in the shade for air-drying and therefore dried at 60 °C in the oven. Fruit dusts were equipment by utilizing a blender machine. Therefore, the dusts were passed through a 25-mesh diameter hair sieve to get constant and fine dust.

2.3 Extraction preparation: The plant extracts were received according to Chitra *et al*. [11]. 200 g of powder of each dust was mixed with 300 ml of distilled water in a 600 ml beaker separately. Therefore, the mixture was stirred for 60 min by a magnetic stirrer (at 6000 rpm) and maintained for 24 h. The mixture was then filtered through a fine cloth and again through filter paper. The filtered mixtures were gathered in flasks and therefore condensed by evaporation of distilled water in a water bath at 80 °C. Evaporation was done to make the volume of 10 ml and put in a refrigerator.

2.4 Different concentration Preparation: Two different concentrations viz., 5 and 10µl/ml of each of fruit extracts were equipment by dissolving the stock solution in the distilled water.

2.5 Test of repellency: Test of repellency was organized according to the method of Talukder and Howse [12]. Petri dishes were divided into two parts, treated and distilled water (untreated). With the help of a pipette, 1 ml solution of each fruit extract was utilized to one half of the petri dishes. This treated half was then air-dried. Ten *O. surinamensis* and *O. mercator* adults and larvae were extricated at the center of each Petri dish and covered. For each dose and fruit extract, ten replications were utilized. Therefore, the numbers of larvae and adult beetle present on each side of the Petri dishes were counted at 12, 24, 48 and 72 h. The data were expressed by the below formula [13]: $RI\ (\%) = (C\text{-}T)/(C+T)*100$. Where, *RI*= Repellency Index, *T*= Larvae or adult insect present in the control half and *C*=Larvae or adult insect present in the treated half. Data (*RI*) were analyzed utilizing analysis of variance (ANOVA) and percentages were apart by the Tukey's test (P=0.05) [14].

3. Results

The percent repellency of *O. surinamensis* larvae against 5 and 10 µl/ml concentrations of different plant extracts at different hours after treatment are presented in Table 1. The repellency rate of caraway and ginger extract demonstrated significant with cardamom at different hours after treatment at 5µl/ml concentration. The maximum percent of repellent alive *O. surinamensis* larvae were recorded in caraway extract. The percent repellency of *O. mercator* larvae against 5 and 10 µl/ml concentrations of different plant extracts at different hours after treatment are presented in Table 2. The repellency rate of caraway and ginger extract demonstrated significant with cardamom at different hours after treatment at 5 and 10µl/ml concentrations.

Extracts of three plants on the rate of repellency against *O. surinamensis* adult at different hours after treatment at 5 and 10µl/ml concentrations are presented in Table 3. The maximum percent of repellent *O. surinamensis* adult were recorded in caraway extract. *O. surinamensis* adult was significantly repellent at 12 and 24 h after treatment of 10 µl/ml concentration.

The percent repellency of *O. mercator* adult against three plant extracts at 5 and 10 µl/ml concentrations is shown in Table 4. It was obvious from the two tables that the extracts plant tested showed significant repellency at 12 h after treatment of two concentrations. Hence, after 72 h of treatment, the maximum number of repellent alive insects was recorded in caraway at 72 h after treatment of two concentrations.

Table 1: Effect of three different plant extracts on repellency (%) (Mean±SE) of *Oryzaephilus surinamensis* larvae at 5 and 10 µl/ml concentration

Concentrations	Hours after treatment	Cardamom	Ginger	Caraway
5	12	17.5±5.90b	40±8.16ab	52±8a
	24	28±6.80b	84±6.53a	86±6.70a
	48	52±9.05b	94±3.06a	98±2a
	72	58±11.33b	92±4.42a	98±2a
10	12	31.11±7.53b	46±10.34b	78±6.97a
	24	38±8.13b	70±10.43a	78±6.97a
	48	88±5.33a	92±4.42a	98±2a
	72	96±2.67a	98±2a	100±0a

* Means in rows followed by the same letters are not significantly different at (p<0.05, Tukeys-test)

Table 2: Effect of three different plant extracts on repellency (%) (Mean±SE) of *Oryzaephilus mercator* larvae at 5 and 10 µl/ml concentration

Concentrations	Hours after treatment	Cardamom	Ginger	Caraway
5	12	17.78±5.21b	35.56±7.29ab	52±9.05a
	24	40±7.30b	52±10.83b	88±6.11a
	48	54±9.91b	90±5.38a	96±2.67a
	72	70±12.01b	96±2.67a	98±2a
10	12	33.33±7.46b	48±9.98b	80±7.30a
	24	30±8.02b	88±4.42a	88±5.33a
	48	86±6a	94±3.06a	98±2a
	72	96±2.67a	96±2.67a	98±2a

* Means in rows followed by the same letters are not significantly different at (p<0.05, Tukeys-test)

Table 3: Effect of three different plant extracts on repellency (%) (Mean±SE) of *Oryzaephilus mercator* adult at 5 and 10 µl/ml concentration

Concentrations	Hours after treatment	Cardamom	Ginger	Caraway
5	12	15±14.14c	36±7.19b	66±9.46a
	24	40±5.97b	80±8.43a	98±2a
	48	83.78±5.83a	92±4.42a	98±2a
	72	86±5.20a	95.78±2.82a	100±0a
10	12	24±4.99a	52±9.52b	88±4.42c
	24	71±9.24b	92±4.42a	98±2a
	48	96±2.67a	96±2.67a	100±0a
	72	96±2.67a	100±0a	100±0a

* Means in rows followed by the same letters are not significantly different at (p<0.05, Tukeys-test)

Table 4. Effect of three different plant extracts on repellency (%) (Mean±SE) of *Oryzaephilus mercator* adult at 5 and 10 µl/ml concentration

Concentrations	Hours after treatment	Cardamom	Ginger	Caraway
5	12	12.5±3.66c	35.56±6.37b	68±6.80a
	24	32±6.80c	58±7.58b	88.4.42a
	48	64±8.32b	84±6.53a	98±2a
	72	92±4.42a	94±4.27a	100±0a
10	12	26±6c	50±9.07b	86±4.27a
	24	67±8.70b	90±4.48a	96±2.67a
	48	83.78±5.83a	97.78±2.22a	100±0a
	72	94±3.06a	98±2a	100±0a

* Means in rows followed by the same letters are not significantly different at (p<0.05, Tukeys-test)

4. Discussion

Studies in world different parts have been utilizing plants extract for pests control including stored grain insects. Previous researches showed that different plant extracts were utilized in pest control and they established eco-friendly and effective. Many studied demonstrated the plants compounds that have a various of substances including repellence to pests, pesticidal activity, effects of antifeedant, toxicity to mites, nematodes, and other pests, regulation of insect growth, also antiviral, antifungal and antibacterial substances against plant pathogens.

Manzoor *et al.* [5] reported the extract of five plant leaves, Bakain (*Melia azedarach*), Datura (*Datura stramonium*), Lemongrass (*Cymbopogon citratus*), Mint (*Mentha longifolia*) and Habulas (*Myrtus communis*) were repellent to *O. surinamensis*. They demonstrated that the maximum number of repellent alive insects were showed in Lemon grass after 48 h. Modarres Najafabadi *et al.* [8] evaluated the repellency and toxicity of three plants leaves extract, Mint (*Mentha longifolia*), Neem (*Azadirachta indica*) and Datura (*Datura stramonium*) against *O. surinamensis*. They reported that high repellency was achieved from Datura extract. Al-Jaber [4] reported the seven plant extract *viz*., Mint, *Mentha viridis*; Citronella, *Cymbopogon winterianus*; Camphor, *Cinnamomum camphora*; Almond, *Prunus amygdalus*, Hasa Luban, *Rosmarinus officinalis*, Babonj, *Matricaria chamomilla* and Jojoba, *Simmondsia chinensis* at 0.125, 0.25, 0.75 and 1.00 concentrations were repellent to *O. surinamensis*. He demonstrated that Babonj had strong repellent action (81.94%) and Mint had less repellent action (32.96%). Adedire *et al.* [10] demonstrated the extract of four plant, Baker (*Dennettia tripetala*), Baillon (*Eugenia aromatic*), Thonn et shum (*Piper guineense*) and Beauv (*Anchomanes difformis*) were lethal influences against four Coleopterous pests including *O. mercator*. They showed that the ethanol extracts of Baillon had the most potent toxic to *O. mercator* adult and had the least LD_{50}.

The results of this study denoted that the highest repellency against *O. surinamensis* was observed in *Carum carvi* and lowest effective repellency was found in *Elettaria cardamomum* against two species.

The results of present research are somewhat in coincidence with those demonstrated by the Moravej *et al*. [15] that the terpenoid extracts effect of Caraway (*Carum carvi*) and Cardamom (*Elettaria cardamomum*) extract had repellent and lethal influences against rust-red flour beetle, *Tribolium castaneum* (Herbst). The difference in this research with the present study maybe due to difference in dose of the treatment, pest species, research methodology, laboratory conditions. The plants utilized in this research established repellent effects for the *O. surinamensis* and *O. mercator*. These plant extracts have a range of chemicals which can be insulated and utilized for insect pest control. From the present research, it is concluded that the terpenoid extracts of plant materials i.e Caraway (*Carum carvi*), Ginger (*Zingiber officinale*) and Cardamom (*Elettaria cardamomum*) consist toxic principles with significant repellency influences and could be a potential grain protecting against *O. surinamensis* and *O. mercator*. Stored grains to mix with extract of plants appear to have change in color. This fault could decrease the market value of the stored grain or consumer admittance. The elimination of these plant extract stains reminder on the grain they keep might be a proper area for future examinations.

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