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Repellency Effect of Essential Oils of *Mentha piperita, Rosmarinus officinalis* and *Coriandrum sativum* on *Tribolium confusum* duval (Coleoptera: Tenebrionidae)

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Abstract Confused flour beetle**,** *Tribolium confusum* is a major pest of stored products especially cereal flour depreciating the quantity and quality of the food, economically. The application of repellents could be considered as a new control method in storage products. In this study repellent activity of essential oils of *Mentha piperita, Rosmarinus officinalis* and *Coriandrum sativum* was assayed on *Tribolium confusum* at 27±1 °C, 65±5% R.H under dark condition. The essential oil was obtained from dry seeds of *C. sativum* and aerial parts of *M. piperita* and *R. officinalis* subjected to hydrodistilation using a Clevenger type-apparatus. The results showed that essential oil of *R. officinalis* and *M. piperita* were more repellent than *C. sativum*. The essential oils of *R. officinalis, M. piperita* and *C. Sativum* lead to repellent of 86.22, 82.22 and 67.15 % after 24 h, respectively. Repellency increased with increasing of concentration in all cases. These results demonstrated the efficacy of *M. piperita, R. officinalis* and *C. sativum* oils for applying in organic food protection.

Keywords *Mentha piperita*, *Rosmarinus officinalis*, *Coriandrum sativum*, *Tribolium confusum*, Essential oil, repellency

Introduction

Insects destroy 10 to 40 percent of stored seeds worldwide [1-2]. Procedures are used to control pests, including of physical, chemical and biological methods [3]. Widespread use of synthetic insecticides to protect crops cause adverse effects such as damage to the ozone layer, environmental pollution, toxicity to mammals and non-target organisms, resistance in pests and pesticide residues [4-6]. Therefore in recent years there is tend to use essential oils and their constituents instead of chemical pesticides to protect crops, which this is because essential oils are less toxic to mammals and rapid degradation in the environment than synthetic chemical pesticides [2, 7-8]. Generally been shown that plants containing compounds are extremely powerful, in addition to repellent properties, inhibition of insect feeding and spawning, can be fatal in a short time [1, 9-10]. In Iran, insecticidal properties of essential oils in a large number of plants belonging to different families of plants have been studied [11-17]. In addition to toxicity to insects, plant compounds have repellent properties [18-21]. Shakarami *et al* (2009) [14] Effect of essential oil *Mentha piperita*, *Mentha aquatia*, *Anethum graveolens* on breeding rate a four-point bean beetles have been investigated. In this study, Repellency Effect of Essential oils of *Mentha piperita, Rosmarinus officinalis* and *Coriandrum sativum* on *Tribolium confusum.*
in laboratory conditions was studied.

Materials and Methods

Red flour beetle rearing

Adults of *T. castaneum* on wheat flour (flour and yeast in the ratio of 10 to 1) in one-liter containers at a temperature of 27± 1 ° C and a relative humidity of 65 ± 5% of sawn devices were reared in darkness condition and insects 7 - 1-day-old plants were used to evaluate the repellent effects of essential oils.

Collecting and Drying of Plant Samples

In September 2009, coriander seeds and aerial organ of rosemary plant and in August of the same year, aerial branches *Mentha piperita* in flowering time, from collection of medicinal herbs, University of Zabol (Chahnimeh) were collected and in ventilated and shade was dried.

Coriandrum sativum seeds and aerial organs of *Mentha piperita, Rosmarinus officinalis* after drying in paper bags in a freezer at a temperature of 24 °C until Essential oil extraction were stored.

Essential Oil Extraction

In order to provide essential oils, seeds or plant aerial tissues using electric mill was powdered. In each essential oil extraction, 50 g of powdered seeds or leaves with 500 ml of distilled water using a glass extractor machine (Model Clevenger) at 100 °C for 3 h for seeds (coriander) and 4 hours to aerial organs(Peppermint and Rosemary), were extracted. Essential oils collected from each plant was dehydrated with sodium sulfate and until use in dark glass containers at 4 -°C were maintained. From 50 g dried aerial organ Peppermint, 0/5 ml (1% of returns), and Rosemary 4/0 ml (returns 8/0%) and from 50 g coriander seed powder 2/0 milliliters (returns 4/0%) of essential oil respectively.

Repellent Effects of the Essential Oils

According to the method of Smith *et al* (1999) [22] with slight variations, on both sides of a plastic container with a volume of 65 ml cubic shaped cap, a hole was built. And every hole with a plastic tube with a diameter 1 and length 4 cm to other plastic container with the same dimensions was connected. In two container which on sides of the middle container was placed, a container as a control and the other as a treatment container were considered. Middle container as a base for the release of 50 insects within 7-1 days, which had been kept hungry for 24 hours, were considered. Within the control container, 40 grains of wheat (with 1ml acetone) was poured. On grains, various concentrations of 3/0, 7/0, 2/1 and 2/2 micro liters essential in 1 ml acetone poured and 10 minutes to evaporate acetone waited. The lid during the test was Opened and covered with lace. After 24 hours, the number of insects in each dish was counted. Percent of essential oil repellency according to formula percentage repulsion (%R)= 2(X-50)Was calculated, Where X represents the insect percentage Within control container [23]. The test in temperature 1 ± 27 ° C and relative humidity was 5 ± 65% and in the dark condition was performed.

Statistical Analysis

The experiment was a factorial design with three replications performed. Before statistical analysis to normalize the percentage repellency data, conversion Arcsin $\sqrt{X/100}$ were used. If there is a significant difference between treatment, means using Duncan's test at 5% level were statistically compared. All statistical calculations using Spss16.0 software and drawing diagrams by Excel 2003 was performed.

Results and Discussion

Results of Analysis of variance of repellency the aerial parts of rosemary essential oil, Peppermint of coriander seed on red flour beetle showed that the there is significant difference between the repellency percentage of essential oil of plants in 1 % level (Table 1). Rosemary essential oil with an average of 22/86 percent on the pest repellency is the most effective. It was found that the essential oil of rosemary with an average of 22/86 percent and Peppermint

essential oil with an average of 22/82 percent of repellency, there is no significant difference. But Coriander essential oil, but with two other studied showed no significant difference at 5% level (Table 2).

Table 1: Analysis of variance of repellency percent of essential oils Peppermint, rosemary and coriander on red flour beetle *T. confusum* adults after 24

Sources changes	Mean-square	Computing F	Degrees of freedom
Plant	0.108	37.088**	2
Concentration	0.211	33.79**	3
Plant×Concentration	0.004	0.65 ^{ns}	6
Error	0.006		24

^{ns}Non significant

Significant difference at the one percent level

Table 2: Mean percentage repellency of essential oils of Peppermint, rosemary and coriander on adults of *T. castaneum*

Essential Oil	Mean Percentage Repellency
Mentha piperita	82.22a
Rosmarinus officinalis	86.22a
Coriandrum sativum	67.15b

Similar letters in columns of mean percentage repellency in Duncan test no Significant difference in the level of 5% percent.

Table 3: Percentage repellency (mean ± SE) essential oils of Peppermint, rosemary and Coriander seeds the red flour beetle *T. confusum* at different concentrations

Concentration	*Mentha piperita*	*Rosmarinus officinalis*	*Coriandrum sativum*
0.3	68.70±3.8^{b}	72.68±0.71^{b}	45.61±2.21^{c}
0.7	81.73±4.4^{a}	87.42±3.2^{a}	66.88±3.5^{b}
1.2	88.59±1.6^{a}	89.85±1.6^{a}	78.25±1.81^{a}
2.2	89.85±1.62 ^{a}	95.03±2.8^{a}	78.27±2.01^{a}

Similar letters in each column indicate no Significant difference according to Duncan's test at the level of five percent.

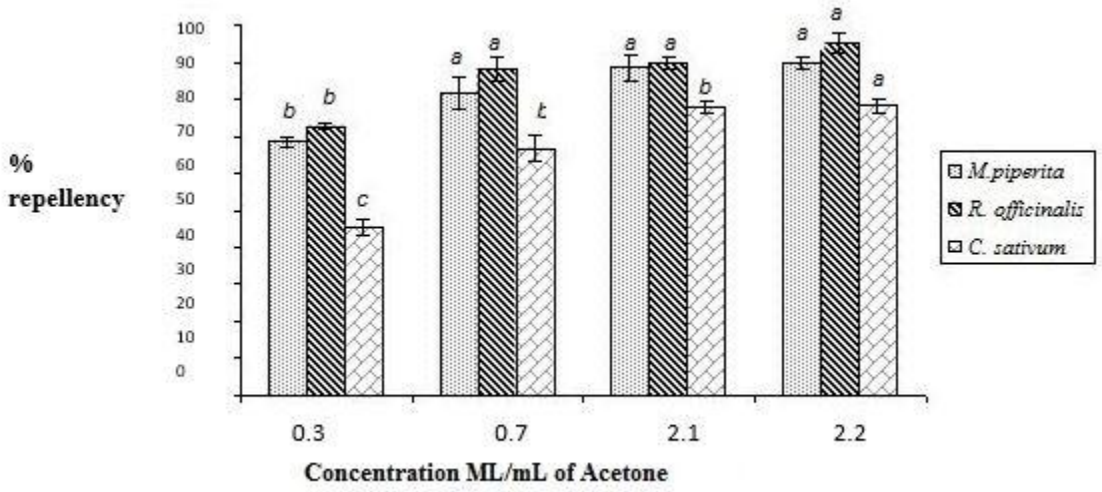

Figure 1: Percentage repellency (mean ± SE) of the studied essential oils on red flour beetle T. confusum adults after 24 hours

Analysis of variance showed that the percentage of essential oil repellency at different concentrations, there are significant differences in the level 1 % (Table 1). The results show that increasing the concentration, repellency percent is gradually increased. And most repellency percent at concentrations 2/2 ml micro liters of acetone were

observed (Table 3). It is also mentioned in the report other investigators [17-18]. Generally experiments showed that the essential oil of rosemary most repellent and coriander have minimal repellency effects. So that the essential oil of rosemary in lowest concentration(3/0 microliter ml acetone) have repellency effect with a 72.68 percent and the essential oil of coriander with same concentration, have 45/61% repellency percent on the red flour beetle (Table 1). Also, at the highest concentration (2/2 ml micro liters of acetone) the most effective repellency is equivalent to 03/95% was observed in *Rosmarinus officinalis* and the lowest repellency effect equal the 78.27 percent was observed in the seed essential oil of coriander. The results show that the repellency effect of Peppermint essential oil in lowest concentration, 68.70 % and the repellency in highest concentration was 85/89 percent.

In the study by Islam *et al* (2009) [18] on coriander oil on *T. castaneum* was performed, Essential oil at the lowest concentration (2 µg/ml) caused a 74% repellency and at the highest concentration (12 µg/ml) was caused entirely repellency. While the study, the lowest concentration of essential oil of coriander seed (3.0Micro liters per mL of acetone) 45% repellency and the highest concentration (2/2 micro liters in ml acetone) have 78.25 percent of repellency on *T. confusum* (Table 3).

Peppermint and Rosemary essential oils at concentrations of 2Ml per 56 ml and 100 percent, respectively repellent effects on pest *Plodia interpunctella* have created. The results, in terms of essential oil repellency power both plant on red flour beetle, similar results have been achieved on Hindi moth larvae.In this experiment, the interaction of plant essential oils with concentrations showed no significant difference, indicating that all three plant essential oil concentration increases, the repellency percentage has risen (Table 1).

Monoterpenoids as dominant constituents of essential oils that have proven their insecticidal properties. The materials having high vapor pressure and respiratory toxicity can be effective in the control of storage pests. 1, 8 cineol is one of the monoterpene. This is the most important compounds identified in the essential oil of rosemary [24]. Also, L-menthol, the most important matter identified in the essential oils of Peppermint linalool in coriander [18, 25].

Various studies represent toxicity and repellency effects of these three compounds. For example, researchers reported that 1,8-cineol have respiratory toxicity on *Sitophylus oryzae*. It also showed that menthol and linalool have repellency effect and respiratory toxicity on *Tribolium castaneum*, *T. Confusum* and *Sitophylus oryzae* [26-27]. According to study we can conclude that the repellent effects of three essential oils on the red flour beetle could be related to these compounds.

In general, studies have shown that plant essential oil have ultra-high repellency effects on storage pests, particularly red flour beetle adults. Repellency properties of essential oils of *Artemisia princeps*; *Cinnamomum camphora* Pamp; *Artemisia annua* L. is considered [28-29]. So considering repellent effects of essential oils on red flour beetle and low-risk of this compound to humans and other mammals, essential oil can be a good alternative to chemical pesticides for controlling of stored pests and in integrated pest management to reduce pesticide used.

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