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Efficacy of The Essential Oil of *Coriandrum sativum* against *Sitophylus oryzae* (Coleoptera:Curculionidae)

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ABSTRACT

Recently, there has been a great interest in the use of natural products of plant origin due to the side effects of synthetic substances. Since synthetic chemicals used in the agricultural field a great threat to the environment and public health, many studies are carried out on the use of natural products from production to storage. Given the environmental and public health risks associated with synthetic chemicals commonly used in agriculture, extensive research efforts are focused on exploring the utilization of natural products throughout the entire agricultural process, from production to storage. The effiecy of *Coriandrum sativum* L. seed essential oil (Cs-EO) was evaluated in the laboratory condions against the rice weevil-*Sitophylus oryzae* L. adults. The Cs-EO essential oils were applied at four different dose rates (3%, 6%, 9% and 12%) on wheat and fumigant toxicity assay was recorded dead adults after 3, 5, 7, 9 and 11th days. In the 12%, the highest mortality 87.86 % and the lowest mortality at concentration of 3%, 23.28% and of the eleven days. In this study, GC-MS analysis of *C. sativum* was also determined at the same time. Cs essential oil was generated by steam distillation and compounds were identified by GC-MS analysis. GC-MS analysis of EOs from Cs seeds showed it to be reach linalool 79.12%. This study suggest that essential oil of Cs (Cs- EOs) can be used as alternatives to pesticides for management of stored pest control.

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Introduction

Pest and postharvest insect damage and residues cause losses to grain in storage for farmers The huge amount of agricultural production is provided by destroying harmful grasses and insects. Storage pests degrade the quality and quantity of grains such as corn, rice, and wheat, and are a global issue (Jayakumar et al., 2017; Stejskal, et. al. 2010). To keep the grains from being harmed during storage, the right temperatures and preservatives must be utilized. The synthetic chemicals-called pesticides are used for this purpose, but pesticides have harmful effects on the environment and public health as well as increasing crop production (Jayakumar et al., 2017). From this point of view, there is an urgent need for effective, environmentally friendly, biodegradable, non-toxic control tools for storage pest. Many natural pesticides (from plants) are used as an alternative to synthetic pesticides, since they do not cause environmental pollution. Different plant derived compounds including plant extract, and essential oils (EOs) have been suggested for stored-grain pests in recent studies (Nenaah, 2014; Al-Harbi, 2021).

Because of their wide range of bioactivity, contact and fumigant toxicity, repellent, oviposition, and feeding deterrent qualities, plant origin pesticides have been investigated as potential pest management agents. Fumigation is a process, and the most frequent ingredients are methyl bromide and phosphine gas (Nenaah, 2014). Fumigants work by disrupting both the neurological and respiratory systems of insects, causing them to die (de Araújo, 2019). Therefore study into the use of plant-derivedmolecules, has become more important. Hence, investigations into the utilization of plant-derived molecules have assumed heightened significance.

Rice weevil (L.) is one of the most destructive pests of stored grain. *Sitophlus oryzae*, the adults of which are 2mm long and brown/black in color, pierce the stored grain and damage it by feeding from the inside (Koutsaviti; 2018). Several researchers have described in vivo/vitro application of EOs as repellent, ovicidal, incesticidal and fumigant activity in the control of *S. oryzae.* Plant essential oils have been documented to exhibit fumigant and repellent activities against *S. oryzae* (Al-Harbi, 2021; de

Araújo et, al., 2019; Koutsaviti et al., 2018; Sriti Eljazi, 2018). Evaluated repellent activity of essential oil from *Mentha piperita* Linn. leaves (Jesser etal., 2020). Cs-EOs (*C. sativum* esential oil) is a common product used in perfume, cosmetics, and food. It has been reported that coriander EO has antibacterial, antifungal, anti-cancer, antidiabetic, analgesic and antioxidant effects (Rajeshwari et al, 2012; Prachayasittikul et al., 2017; Sriti Eljazi et al., 2018). In this study was evaluated to the efficacy of Cs-EOs against *S.oryzae* in terms of its mortality rate. In this investigation, we evaluated the insecticidal efficacy of coriandrum essential oils (Cs-EOs) against *S. oryzae*, focusing on their impact on mortality rates.

Material and Methods

Chemicals and Reagents

All the chemicals and standarts were of analytical grade. Milli-Q water was used for preparing all solutions and cleaning.

Test Insects

Adult rice weevils were obtained from a colony mainted by the department of Plant Protection of Agricultural Faculty of Tokat Gaziosmanpaşa University. *S.* oryzae was reared on sterilized whole wheat. We sourced adult rice weevils from a colony maintained by the Department of Plant Protection at the Faculty of Agriculture, Tokat Gaziosmanpaşa University. *S. oryzae* was reared on sterilized whole wheat. All test procedures were carry out at 23±2°C, 65% RH and L/D regime of 12:8 hours. Test insect used in fumigant toxicity studies were two week post emergence.

Plant materials, Essential Oil and GC-MS analysis

Coriander seeds were supplied from cultivar plant areas in Tokat Gaziosmanpasa University, Faculty of Agriculture. The seeds were dried at shade and stored in a room temperature. Coriander seeds were grinded, washed with distilled water. They were subjected to hydro distillation (4 h) in a Clevenger's apparatus and obtained essential oil.

The chemical profile of Cs-EOs was analyzed by Gas chromatography coupled with mass spectrometry (GC-MS). GC-MS analysis carried out using a Trace 1310 gas chromatograph equipped with an ISQ single quadrupole mass spectrometer (Thermo Fischer Scientific, Austin, TX). The GC oven temperature was adjusted an initial temperature 70°C for six minutes then heated up to 235°C at 3°C/min and finally 10 min 235°C. The ion source and detector temperature were set at 250°C. A thermos TG-WAXMS GC column (60m×0.25mm×0.25µm) was used for identification.

The carrier gas was helium with a flow rate 1.2mL/min. the chemical contents of the obtained oil were determined according to their retention times in mass spectroscopy and corrected by comparison of the known compounds using mass spectral library search against the National Institute of Standards and Technology (NIST).

Fumigant Assay

In order to fumigant toxicity test Cs-EOs was tested against adults of *S. oryzae*. Ten adults with of mixed male/female were placed with two gram of wheat grains in a polystyrene vial (10 cm height and 3 cm diameter). A filter paper strip (2 cm diameter) treated with essential oil solution prepared in acetone (8%, 14%, 20%, 26%, and 32%) was fastly put to the vial. All the vials were closed and stored in dark. Each set of concentration was six replicates. A positive control without essential oil was kept for comparison. After 3,5,7,9 and 11th day of fumigation, mortality of adults was recorded.

Statistical Analysis

All statistical analyzes were carried out with the help of MINITAB (Release 14) package program. Dose-death trial results were analyzed with the help of Polo-PC probit package program.

Results AND Discussion

Chemical contents of Cs-EOs were analyzed by GC-MS. The identification of the chemical contents was based on retention time and percentage comparison with authentic standards. Major compound was linalool (79.12%) which is in consent with previous reports (Eikani et al., 2006; İzgi & Telci, 2017), (Table 1) (Figure 1).

Table 1. Chemical composition of Cs-Eos

Rt	Compound name	%
7.79	α-Pinene	2.67
9.20	Camphene	0.49
10.89	2- α-Pinen	0.25
11.56	Sabinene	0.15
14.07	α-Myrcene	0.43
16.50	l-Limonene	1.28
20.66	çTerpinene	2.82
23.25	Benzene, methyl(1-methylethyl)	1.12
24.46	α-Terpinolene	0.30
58.95	Camphor	6.16
66.41	L-Linalool	79.12
69.71	3-Cyclohexen-1-ol,4-methyl-1-(1methylethyl)	0.33
77.42	(+)-α-Terpineol	0.88
81.71	Geranyl acetate	2.10
87.34	Geraniol	1.88

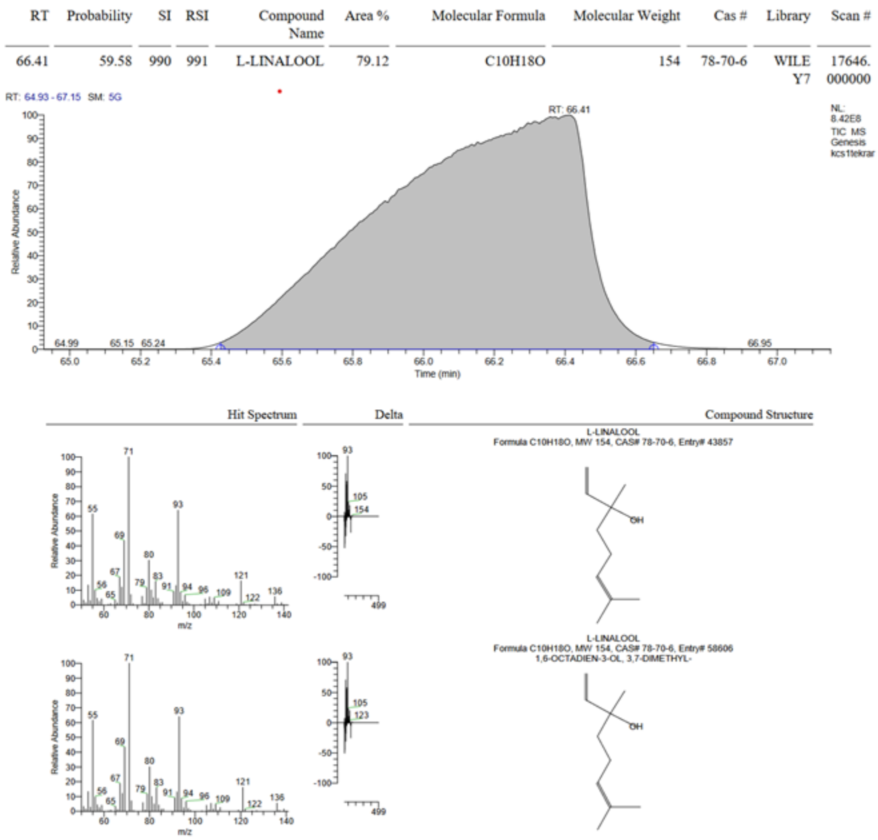

Figure 1. GC-MS spectra of essential oil

Table 2. The main compounds of coriander essential oil from diferent countries

Samples	Essential oil	References
Iran	Linalool (73.05%), a-Pinene (9.18%), Gama-Terpinene (7.65%), hydro-distillation with a clevenger apparatus	[Zamindar et al., 2016]
Tunisia	Linalool (26.12–66.08%), extracted with OMEGA 20 extruder a-Pinene (11.65–43.80%), p-Cymene (3.34–5.20%),	[Hossein et al., 2014]
Canada	Linalool (78.96%), Cymene (6.38%), Ocimene (4.46%), Camphor (3.62%), hydro-distillation with a clevenger apparatus	[Galata et al., 2014]
Iran	Linalool (66.29–63.27%), hydro-distillation with a clevenger apparatus	[Hossein et al., 2014]
Türkiye	Linalool (78.96%), hydro-distillation with a clevenger apparatus	[Zhang et al., 2015]
Tunisia	Linalool (79.22%), hydro-distillation with a clevenger apparatus	[Siriti et al., 2018]
Serbia	Linalool (64.04%), Isolated EOs in n-hexane	[D. Micić et al., 2019]
Türkiye	Linalool (79.12%), hydro-distillation with a clevenger apparatus Camphor (6.16%),α-Pinene (2.67%)	Present Study

The contents in the essential oil of the plant may differ depending on the geographical location, climate and seasonal conditions. As can be seen in Table 2 the coriander seeds contain more than 60% linalool, oxygenated monoterpen as major components.

Smilar to our study, it was observed that more than 70% of the content of coriander seeds collected from different places such as Maraghe, Khoramabad, Estahbanat, Tabriz, Hamedan, Bajestan, Amol, and Yazd was linalool in 2010 (Ebrahimi, et al., 2010). Existing literatures has established that ecological variations exert a substantial impact on seed yields, oil content, and compositional traits across various Coriandrum varieties were reported. Previous research has demonstrated that the essential oil content and composition of *C. sativum* can be influenced by cultivation practices, ontogenetic factors, and genetic influences (Telci et al., 2006; Msaada et al., 2007).

The fumigant toxicity of Cs-EOs samples of *S. oryzae* adults is shown in Table 3. The fumigant toxicity tests indicated that Cs-EOs had a significant fumigant activity on *S. oryzae* as compared to control sets. Mortality of insect was paralleled with increase dose and exposure time of essential oil. While there are many studies on the toxic effects of essential oils on storage pests, there are few data on their mechanism of action.

High level of fumigant activity against *S. oryzae* especially on the 9th and 11th days and killed more than 50% (Table 3). Increasing mortality was showed for the rice weevil when the concentrations and exposure times increased. The highest concentration 12% that caused 87.86% mortality for test insects after trial. It was determined that the all concentration was effective according to the control at all doses and statistically significant as well. The LC_{50} values of the essential oils tested are summarized in Table 4.

Table 3. Fumigant toxcity of coriander seeds essential oils against *Sitophilus oryzae*

Concentration %	3 d	5d	7 d	9 d	11 d
3	0.00±0.48 CC	11.10±0.99 AA	20.89±0.24B B	21.25±0.47 BB	23.78±0.51 DD
6	1.27±0.51 BC	14.41±0.33 AA	26.18±0.06 BB	28.71±1.01 BB	58.23±0.34 CC
9	4.05±0.68 AB	18.91±0.99 AA	31.73±0.37 BB	45.53±0.12 AA	73.24±0.10 BB
12	9.81±0.42 AA	19.26±0.45 AA	39.02±0.08 AA	51.25±0.12 AA	87.86±0.19 AA
Control	0.00±0.00 CC	0.00±0.00 BB	0.00±0.00 CC	0.00±0.00 CC	3.69±0.56 EE

Table 4. LC_{50} values of coriender seeds EOs against the adults of *Sitophilus oryzae*

Essential oil	LC_{50}(95%CI)	Slope±SE	χ2	Heterogeneity
5 day	125.72 (37.342-0.19)	0.74±0.26	15.43	0.73
7 day	24.89 (14.78-145.28)	0.94±0.23	36.81	1.23
9 day	11.32 (9.34-15.47)	1.39±0.23	17.68	0.58
11 day	5.16 (4.69-5.11)	3.040 ±0.25	19.88	0.66

LC50 values of coriander against *S. oryzae* were 125.72, 24.89, 11.32 and 5.16 respectively. In 11. day Cs-EOs vapour caused high mortality and toxical effect compared to other days. The mortality in *S. oryzae* was increased with increasing exposure time and concentration (Table 4). Toxic effect of using treatment methods showed that increasing mortality with increasing concentration (Kraikrathok et al., 2013; Karan et al., 2018). The different results of the insect species to the EOs has previously been reported for stored product insects (Negahban et al., 2007).

In conculusion, chemical composition analysis of Cs-EOs was performed by library searching and retention time with GC-MS method. This study revealed the fumigant activity of coriander essential oil rich in linalool. The use of Cs-EOs especially linalool can be considered as an excellent alternative to synthetic insecticides for control *S. oryzae* without negative health effects (Ismann &Grienesen, 2014). De Clerck et al., 2020 pointed out that biological activities of plant terpenoids include repellency and insecticidal effect, growth inhibition through altered protein availability, and direct toxicity. Plant-derived essential oils (EOs) represent promising alternatives for pest management due to their diverse biological activities, biodegradability, and minimal impact on non-target organisms and the environment (Boyer et al., 2012; Peschiutta et al., 2019; Patiño-Bayona et al., 2021).

Essential oils are volatile, which could be of great interest for the reduction of the residues, as well as agricultural applications (Zanellato et al., 2009). Particular emphasis has been placed on the relative efficacy against pathogens and insects, multifaceted mechanisms of action, and the comparatively low toxicity to mammals and humans associated with essential oils. Overall our works and results showed that essential oils from coriander seeds present important perspectives for useful application in Rice weevil. Also this study adds knowledge to the development of newer and safer bio insecticides based on essential oils for *S. oryzae* control in rice. The results indicated that Cs EOs have potential to be candidate as natural insecticides for the control of stored grain.

Declarations

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Author's Contribution

Kadriye Ozlem Saygı: Conceptualization, Methodology, Formal analysis and investigation, Writing - original draft preparation, Writing - review and editing Ayşe Yeşilayer: Conceptualization, Methodology, Formal analysis and investigation, Writing - review and editing

Conflict Interest

Authors declare that they no conflict interest.

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