Evaluating the Lethal and Repellent Activities of *Eucalyptus camaldulensis* Essential Oil Against the Adults of *Oryzaephilus surinamensis* on Date Palm Fruits

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Abstract

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Date palm fruits are commonly infested by saw-toothed grain beetle, *Oryzaephilus surinamensis,* which can cause substantial damage. Botanical insecticides are gaining attention as a cost-effective and low-risk alternative to chemical insecticides. In this study, we analyzed the volatile compounds of the essential oils of the leaves and seeds of *Eucalyptus camaldulensis* using gas chromatography mass spectroscopy and evaluated the toxicity of these oils against *O. surinamensis*. Two exposure methods were applied, including contact and fumigation. The GC-MS analysis detected many terpene compounds in both of the leaves and seeds essential oil such as eucalyptol, which acts as a respiratory toxicant against insects. The contact method was more effective in controlling adult insects than the fumigation method. The mortality rate reached 76.50 % when the adults were exposed to 1000 mg/L of the leaves essential oil using the contact method. However, in the fumigation method, the same concentration achieved 61.00 % mortality. The concentration of 1000 mg/L of the seeds essential oil gave 65.00 % mortality by using the contact method and 52.00 % mortality by using the fumigation method. Effective repellent activity of the essential oil was achieved and continued for 24 h, indicating that the essential oil effect is not reversible. Because of their high activity, these essential oils could be used to control insects of stored products, and can be used as a component in integrated pest management programs in combination with microbial insecticides, traps, and beneficial insects.

Keywords: Aromatic plants, date palm, eucalyptol, fumigation, stored products insect, toxicity.

Introduction

Date palms are among the most important fruit trees that are widely cultivated in the tropical and subtropical regions of the world, including the Middle East. Following harvest, dates are attacked by a variety of pests that can negatively impact their nutritional and marketing qualities if left uncontrolled. In order to preserve date fruits from becoming infested by various pests, countries with high production have to spend enormous amounts of money (AbdElgawad *et al.,* 2019). The saw-toothed grain beetle *O. surinamensis* is an insect species known to infest date palm fruits, and can cause significant damage the crop. They are small, dark-brown beetles that have six saw-like teeth on each side of their thorax (Rees, 2007). The larvae and adult insects feed on the fruits, grains, and seeds of various plants, including date palms (Kousar *et al*, 2021). The presence of these beetles in date palm fruits can lead to significant losses in yield and quality. Therefore, it is important to prevent the infestation by this species (Mallah *et al*., 2016), which usually begins in the field until post-harvesting in storages. In order to maintain the quality of dates, several control methods have been applied in the field as well as during storage (Abdelfattah *et al*., 2021).

Many pest control methods are utilized to control storage pests. The most common and effective pest management technique is based on fumigation by chemical pesticides (Donahaye, 2000), which is harmful to the environment and human health (Gariba *et al.,* 2021). However, resistance to fumigants is a crucial issue in controlling stored-product insects worldwide (Price & Mills 1988). There are a few number of fumigants that are used to control stored product pests such as phosphine (Leesch, 1995), after phasing out the use of methyl bromide (UNEP, 1995; Cassanova, 2002). Thus, phosphine has become the most widely used around the world because of its low cost, rapid spread, and the absence of its residues (Chaudhry, 2000; Nayak & Collins 2008). Currently, phosphine is one of the most effective control methods; however, the emergence of resistance to phosphine by the pests means that there is a need to use much higher concentrations of phosphine to control the insect population in the future, and in some cases, it may not be possible to achieve complete control (Lilford *et al*, 2009). Alternative pest management approach can be used to control storage insects, including *O. surinamensis,* which attacks dates. The insecticides made from botanical products have many advantages, including low cost and low health risks, that make them an excellent alternative to chemical insecticides (Ghasemi *et al.,* 2020). In this regard, Al-Qahtani *et al*. (2012) claimed that shammar powder, *Foeniculum vulgare*, ginger powder, *Zingiber afficinale*, and hail powder, *Elettaria cardamomum* have toxic effects on *O. surinamensis*. Such products are typically derived from natural sources, making them safe to use in various environments. Fumigation with plant-based products can control a variety of stored insect pests, including beetles, moths, and weevils. When used correctly, these products can effectively reduce insect populations and protect stored food products from infestation. The insecticidal effect of plant extracts against insects may be attributed to the fact that they contain many active substances such as phenolics,

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oxygenated monoterpenes, and monoterpenes components, which are secondary plant metabolites that affect insects directly or indirectly (Aldosary *et al*, 2018; Gariba *et al*., 2021; Wallis & Galarneau, 2020).

E. camaldulensis is one of the medicinal aromatic plants widespread in Iraqi lands and has been used in alternative medicine to treat many diseases (Al-Tameemi *et al.,* 2022). *E. camaldulensis* essential oil also has insecticidal activity against a range of insect pests, including beetles (Mossi *et al*., 2011), and its toxicity is derived from the high content of 1,8-cineole, also known as eucalyptol, which acts as a respiratory toxicant against insects (Aldosary *et al*., 2023; Tine *et al.,* 2023). Therefore, using this plant-based product as a fumigant against stored insects can be an effective and environmentally friendly method of pest control. The objective of this study is to investigate the insecticidal effects of *E. camaldulensis* essential oil through contact and fumigation methods against the saw-toothed grain beetle, *O. surinamensis*, to safeguard date palm fruits from infestation with this insect pest.

Materials and Methods

Extraction of essential oil

Both of the leaves and seeds of *E. camaldulensis* were collected in April 2021, from Abu Ghraib, Baghdad, Iraq. The leaves and seed samples were cleaned and dried in the shade at 25°C for 7-10 days. The dried plants were powdered using an electrical mill and stored in plastic containers. The essential oils from 200 g of plant sample powder were extracted by heating to boiling for 3h using a Clevenger hydrodistillation device in a round glass flask with 1 L of distilled water. 20 mL vials of the essential oil were stored in the refrigerator at 4°C for further use (Aldosary *et al*., 2023).

GC–MS analysis

The GC–MS analysis was conducted in South Oil Company Laboratories, Nihran Omar, Basra, Iraq. An Agilent GC 7890A gas chromatography coupled with an Agilent 5977A mass spectrometer detector (MSD) was used for compound analysis and detection. In the gas chromatographic system, an HP-5MS capillary column (30 m×0.25 mm×0.25 µm) (Agilent Technologies, Santa Clara, CA, USA) was used. The samples were diluted 25 times with hexane (GC grade) and 0.5 µL was injected into the GC–MS using a split mode at a temperature of 250°C. Helium at a constant flow of 1.2 ml/min was used as a carrier gas. The oven temperature started at 60°C for 2 min, and then ramped up at a rate of 5°C/min to reach 280°C, followed by an increased rate of 20°C/min to 320°C, and then held for 2 min with a total run time of 50 min. The MSD temperatures were set at 300°C transfer line, 230°C ion source, and 150°C quad-pole. The scan acquisition mode covered a range of 50 to 600 m/z at a scan speed of 10,000 amu/s, at ionization energy of 70 eV. Mass spectra of the compounds were compared with National Institute of Standards and Technology (NIST) spectra for proper identification (Alnajim *et al.,* 2019).

Insect colony

As part of the mass-rearing process, dates infested with *O. surinamensis* insects were purchased from Basra city local shops. Once the infested dates were in the laboratory, the insects were collected and transferred into polyethene containers (20 cm L x 20 cm W x 20 cm H) that contained pesticide-free dates (cv. Halawi). Each container was wrapped with muslin cloth, secured with a rubber band for ventilation, and kept at 27±5°C and 60±5% RH with 12:12 hours of light/dark in the laboratory until further use (Latifian *et al*., 2020).

Bioassay tests

Five concentrations, 0 (control treatment), 400, 600, 800, and 1000 mg/L of essential oils of the leaves and seeds of *E. camaldulensis* were prepared. Each concentration was diluted in distilled water containing 0.5% of tween 80 as a surfactant to determine their toxicity against saw-toothed grain beetles. The bioassay tests were carried out in the laboratory at 30ºC and 70% RH.

Contact toxicity- The filter paper method was used to test for contact toxicity against the adults of saw-toothed grain beetles (Ebadollahi & Setzer, 2020). Petri dishes were filled with filter papers (Whatman No.1), and 200 µL of the extract concentrations were added to each filter paper, and then left to air dry. Fifty adult insects were transferred onto each filter paper using a small soft painting brush, and the petri dishes were covered with parafilm. The experiment was replicated four times for each concentration of the essential oil in the leaves and seeds of *E. camaldulensis*. The mortality rate was recorded after 8, 12, and 24 h. The insects were considered dead if there was no movement in the legs or antenna when touched softly.

Fumigation toxicity- In the study of fumigant toxicity in adults, filter papers (Whatman No.1) were impregnated separately with different concentrations of essential oils with four replicates per concentration as reported by earlier (Ebadollahi & Setzer, 2020). The filter papers were attached to the underside of screw glass jars (250 mL). Fifty adult insects were transferred separately into each jar, and the jars were then tightly covered and incubated at 30ºC and 70% RH. The mortality rate was recorded 12, 18 and 24 h after treatment. The insects were considered dead if there was no movement in the legs or antenna when touched softly.

Repellence activity- To determine the repellence activity of the essential oils against the adult insects, the area preference technique was employed. The Whatman filter paper size 8 cm in a petri dish was divided into two halves; one section was for untreated (0 mg/L) treatment, and the other was treated with 1 mL of 1000 mg/ L of the essential oil. Once the treated filter papers were air-dried at 25°C, they were taped to petri dishes. Ten adults were released in the middle of the petri dish and covered, and insect adults were counted in each part of the petri dishes. Results were recorded 2, 4, 6, 8, 12, 18, and 24 h after treatment. The repellence activity rate of the essential oils was estimated using the following equation (Salem *et al.,* 2018):

$$\text{Repellency (PR\%)} = \frac{\text{number of insects in the untreated part - number of insects in the treated part}}{\text{number of insects in the untreated part + number of insects in the treated part}} \times 100$$

Fruit damage assessment

The date palm fruits cv. Halawi which had not being exposed to any pesticide, were obtained from a local shop. The fruits, weighing 100 g, were sprayed using the optimal concentration of essential oils (1000 mg/L). The control treatment, on the other hand, was only sprayed with water. The fruits were then left to dry for 10 minutes before being transferred to sealed 250 mL glass flasks. After 10 h of starvation, 50 adult insects were released into each flask. The flasks were then placed in an incubator at 27±5°C and 60±5% RH with 12/12 h of light/dark cycle. The number of insects and percentage of accumulative weight loss were counted at 7, 14, 30, 60 and 90 days after treatment. The cumulative weight loss percentage was calculated using the equation:

$$\text{Weight loss (\%)} = \frac{\text{weight of fruits before treatment - weight of fruits after treatment}}{\text{weight of fruits after treatment}} \times 100$$

Data analysis

The data obtained were analyzed using Table of Variance (ANOVA table), the significance of means were compared using Tukey's test at $p \leq 0.05$. Abbott equation (Abbott, 1925) was applied to correct the insects mortality. The statistical and Probit analysis was carried out using Statistical Package for Social Sciences (SPSS software version 23) to determine differences among the means and the lethal concentration (LC_{25} and LC_{50}) values. All experiments were conducted with four replicates for each treatment.

Results and Discussion

Terpenes play an important role in the essential oil toxicity of the plants, as these compounds are volatile. Gas chromatography coupled with mass spectrometry was conducted, and the results revealed number of terpene compounds to be present in the essential oil. Around 14 compounds were identified in the leaves essential oil, whereas only 11 terpene compounds were detected in the seeds oil (Table 1).

The results obtained (Figure 1) showed that the essential oils of *E. camaldulensis* had a significant effect against the adults of *O. surinamensis*. Generally, the mortality rate values significantly (P=0.05) increased as the essential oil concentration increased. The mortality rate values averaged between 47.50 to 76.50% when the adults were exposed to 1000 mg/L of the leaves essential oil using the contact method (Figure 1), and between 31.50 to 61.00 % when the adults were exposed to the same concentration of the essential oil of the leaves using the fumigation method (Figure 1). Similarly, the seed essential oil produced the highest mortality rate compared to other concentrations, reaching a mortality rate between 37.00 to 65.00 % when using the contact method (Figure 1). Whereas by using the fumigation method, the same concentration also produced the highest mortality rate compared to other concentrations, reaching a mortality rate between 26.00 and 52.50% (Figure 1). On the other hand, the exposure concentration of 400 mg/L had the lowest mortality rate, with a range between 21.00 to 44.50% for leaves and 12.50 to 16.50% for seed essential oil using the contact method. At the same time, the fumigation method produced a mortality rate ranged between 8.00 to 22.50% for the leaves essential oil and between 1.50 to 9.50% for the seeds essential oil.

Table 1. Terpene compounds detected in the essential oils of leaves and seeds of *Eucalyptus camaldulensis* using GC-MS analysis.

Name	Formula	RT*	RI	*m/z*	Leaves	Seeds
Eucalyptol	$C_{10}H_{18}O$	8.43	1022	81.10	+	+
p-Cymene	$C_{10}H_{14}$	8.71	1043	119.09	+	-
p-Mentha-1,5,8-triene	$C_{10}H_{14}$	9.01	1097	91.10	-	+
Linalool	$C_{10}H_{18}O$	9.34	1103	71.09	+	+
1,3,8-Menthatriene	$C_{10}H_{14}$	9.53	1118	93.10	+	-
Fenchol	$C_{10}H_{18}O$	9.83	1120	81.10	+	-
α-Campholenal	$C_{10}H_{16}O$	10.04	1130	93.10	+	-
3-Carene	$C_{10}H_{16}$	10.37	1154	93.10	+	+
Pinocarvone	$C_{10}H_{14}O$	10.63	1164	81.10	+	-
Terpinen-4-ol	$C_{10}H_{18}O$	10.81	1167	71.09	+	-
Trans-Carveol	$C_{10}H_{16}O$	11.33	1202	109.09	+	-
Carvone	$C_{10}H_{14}O$	11.62	1225	82.08	+	-
Thymol	$C_{10}H_{14}O$	12.33	1298	135.09	+	+
Elemene	$C_{15}H_{24}$	12.85	1445	121.10	-	+
Alloaromadendrene	$C_{15}H_{24}$	14.22	1461	161.10	-	+
Y-Muurolene	$C_{15}H_{24}$	14.63	1474	161.00	-	+
Aciphyllene	$C_{15}H_{24}$	14.68	1499	105.10	-	+
Ylangene	$C_{15}H_{24}$	15.34	1523	119.09	+	-
α-Calacorene	$C_{15}H_{20}$	15.59	1546	157.10	-	+
7-epi-a-Eudesmol	$C_{15}H_{26}O$	16.58	1663	91.10	-	+
α-Terpineol	$C_{10}H_{18}O$	17.99	1685	59.09	+	-

*(RT) = retention time; (RI) = retention index; (m/z) = mass to charge ratio; (+) = present; (-) = absent.

The exposure time also affected the mortality rate, as it increased with the increase of exposure time. In the contact method, the mortality values of the essential oil of the leaves and seeds reached their highest values at the exposure time of 24 h compared to the other exposure times. Likewise, in the fumigation method, the 24 h exposure also produced the highest mortality rate compared to other exposure times (Figure 1).

In a comparison between the contact and fumigation methods, it was observed that the toxicity to *O. surinamensis* was higher when the essential oil from both the leaves and seeds of *E. camaldulensis* was applied using the contact method compared to the fumigation method. The LC_{25} and LC_{50} values (Table 2) revealed that the most effective exposure method of the essential oil of *E. camaldulensis* against *O. surinamensis* adults was the contact method. For example, using the contact method, the LC_{25} and LC_{50} values from *E. camaldulensis* leaves after 18 h were 300.11 and 652.75 mg/L air, respectively. Whereas when the fumigation method was used, the LC_{25} and LC_{50} values from *E. camaldulensis* leaves 18 h after exposure were 650.04 and 1125.9 mg/L air, respectively. In addition, using the contact method, the LC_{25} and LC_{50} values of the seeds of *E. camaldulensis* 18 h after exposure were 542.86 and 920.97 mg/L air, respectively. However, when using the fumigation method, the LC_{25} and LC_{50} values of the seeds of *E. camaldulensis* 18 h after exposure were 802.07 and 1144.77 (mg/L air), respectively.

The exposure time greatly affected the LC_{25} and LC_{50} values, and the 24 h exposure produced the lowest LC_{25} and LC_{50} values. By using the contact exposure method, the LC_{25} reached 206.75 and 461.22 mg/L air for the essential oil extracted from leaves and seeds, respectively, and the LC_{50} reached 444.02 and 763.28 (mg/L air) for oil extract from leaves and seeds, respectively. Furthermore, when using the fumigation exposure method, the LC_{25} for leaves and seeds oil extract were 449.74 and 639.17 mg/L air, whereas, the LC_{50} of leaves and seeds were 849.83 and 1011.30 mg/L air, respectively.

In comparison, the exposure time of 12 h showed the highest LC_{25} value of 519.2 and 752.44 mg/L air for leaves and seeds oil extract when using the contact method, respectively. In addition, when using the fumigation method, the exposure time of 12 h displayed the highest LC_{25} of 923.72 and 1012.26 mg/L air for the leaves and seeds oil extract, respectively. Similarly, when using the contact method, after 12 h exposure, the LC_{50} values of leaves and seeds oil extract were 1155.1 and 1548.84 mg/L air, respectively, whereas after using the fumigation method, the LC_{50} of leaves and seeds oil extract reached 1750.35 and 1503.64 mg/L air, respectively.

The repellence activity of the leaves and seeds essential oils against *O. surinamensis* were effective for a 24 h period. However, the essential oil from the leaves, 12 h after treatment, was more repellent compared to the other treatment periods, and reached 91.25%. Whereas 2 h after treatment, the repellence activity exhibited its lowest value (68.75%). On the other hand, seeds essential oil, 6 h after treatment, had more effect compared to the other treatment periods (67.50%), and it reached its lowest value 24 h after treatment (37.50%). In general, the leaf's essential oils showed significantly more repellent activity than the seed's essential oil (Figure 2).

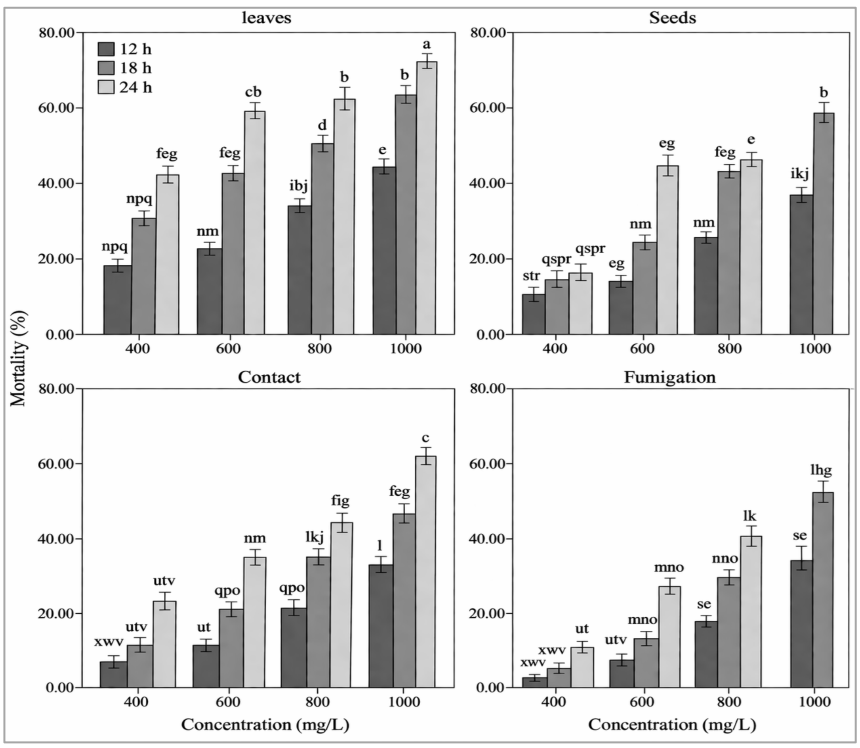

Figure 1. Mortality rate of the adults of *Oryzaephilus surinamensis* after exposure to four different concentrations of the essential oil of the leaves and seeds of *Eucalyptus camaldulensis* using the contact and fumigation methods.
Bars with similar letters in each quadrant are not significantly different by using the Tukey test at P=0.05.

Table 2. LC_{25} and LC_{50} (mg/L) values of essential oils from different parts of *Eucalyptus camaldulensis* against the adults of *Oryzaephilus surinamensis* obtained from contact and fumigation toxicity.

Plant part	Time (hours)	LC_{25} mg/L	95% confidence limit lower	95% confidence limit upper	LC_{50} mg/L	95% confidence limit lower	95% confidence limit upper	Slope±S.E.
Contact toxicity								
Leaves	12	519.20	431.13	495.52	1155.10	984.21	1533.90	1.94±0.32
	18	300.11	209.22	367.97	652.75	585.78	725.13	2.00±0.31
	24	206.75	159.17	272.93	444.02	363.27	504.01	2.03±0.31
Seeds	12	752.44	676.47	849.57	1548.84	1251.40	2303.86	2.15±0.36
	18	542.86	487.75	588.84	920.97	846.29	1031.96	2.93±0.33
	24	461.22	406.19	505.66	763.28	712.91	825.45	3.08±0.33
Fumigation toxicity								
Leaves	12	923.72	828.20	1087.70	1750.35	1390.67	2685.70	2.43±0.39
	18	650.04	544.50	702.94	1125.90	1003.56	1338.83	2.83±0.35
	24	449.74	378.14	504.13	849.83	775.69	960.50	2.44±0.32
Seeds	12	1012.26	930.52	1145.60	1503.64	1291.94	1756.96	3.93±0.56
	18	802.07	757.16	852.450	1144.77	1054.13	1300.05	4.31±0.46
	24	639.17	591.21	613.79	1011.30	928.89	1136.29	3.39±0.36

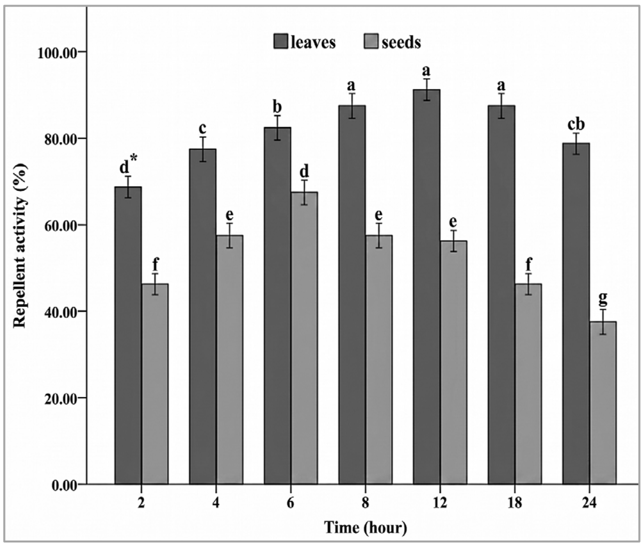

Figure 2. Repellence activity of the essential oil extracted from leaves and seeds of *Eucalyptus camaldulensis* after different treatment periods using a concentration of 1000 mg/L.

Bars with similar letters are not significantly different at P=0.05 based on Tukey test.

* = similar letters in each column are not significant differences at *P<0.05*.

Following the application of 1000 mg/L concentration, both essential oils from the leaves and seeds showed a significant effect in reducing the number of the insects over various treatment periods. The essential oil of the leaves demonstrated a greater impact compared to the seeds oil, whereas both oils showed more effectiveness compared to the control treatment (Figure 3-A). 60 and 90 days after exposure to leaves essential oil, and 90 days of exposure to seeds essential oil, both oils showed significant reduction in the insect density, complete mortality compared to the control treatment which had 71.25 insects. This reduction in number of insects when using the essential oils had a positive effect on the fruits yield of date palm. The control treatment had an accumulated yield loss of 66.00%, 90 days after releasing the adult insects, compared to 10.75 and 12.75% yield loss for the leaves and seeds essential oil treatment, after the same period, respectively (Figure 3-B).

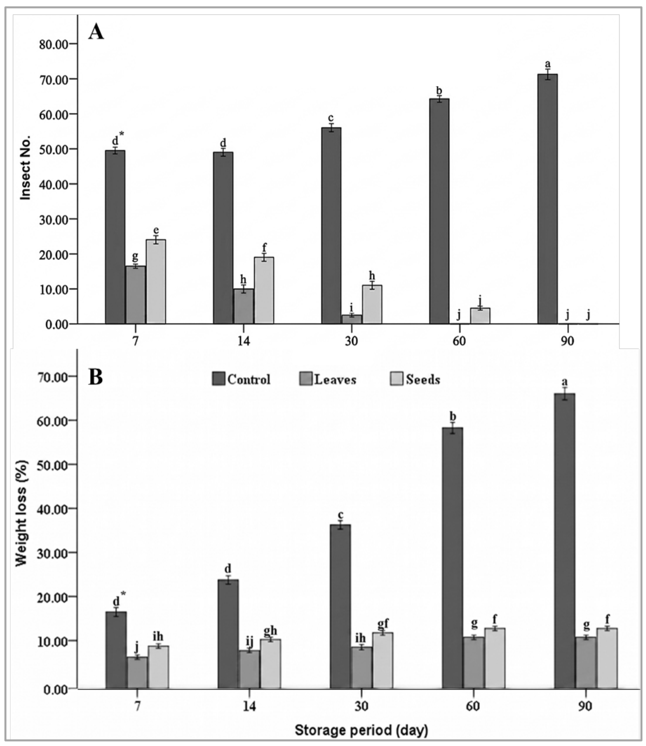

Figure 3. Effect of the essential oil of leaves and seeds of *Eucalyptus camaldulensis* on the insect number (A) and date palm fruit weight (B) after various treatment periods using a concentration of 1000 mg/L.

Bars with similar letters are not significantly different at P=0.05 based on Tukey test.

The findings of the current study confirmed the effectiveness of essential oils extracted from the leaves and seeds of *E. camaldulensis* for the control of saw-toothed fruit beetle infesting date palm fruits under laboratory conditions. These results are in agreement with previous studies which indicated the effectiveness of the essential oils of *Eucalyptus* spp. in fighting against several insect species, especially storage insects (Adak *et al.,* 2020; Aldosary *et al.,* 2023; Emeka *et al.,* 2020), due to the presence of active substances that cause mortality such as eucalyptol. The slight difference in the type of these compounds in the current study compared to previous studies may be attributed to the location of sample collection and the environmental conditions, which affect the content and type of active substances in the oil (Barbosa *et al.,* 2016; Čmiková *et al*., 2023).

In our study, we found that *E. camaldulensis* seed essential oil had good insecticidal activity against adult insects, suggesting that it would be useful as a stored insect pest control agent. The LC_{25} and LC_{50} values of these essential oils decreased over time. Mahmoudvand *et al.* (2011) stated that the essential oil of *E. cardamomum* had fumigant toxicity on *S. granarious*. It was observed that the toxicity of both of the leaf and seed extracts was high when the essential oil was applied using the contact method compared to the fumigation method. This might be due to the fact that in the contact method, the active ingredients reach their target better than when using the fumigation method. However, the toxicity of the essential oil in both exposure methods was relatively low. This might be because the beetles of stored products are known for their resistance to the plant pesticides compared to other insect species. Huang *et al*. (2000) showed that cardamom is more effective as a contact and fumigant pesticide against the adults of *S. zeamais* than those of *T. castaneum*.

The results obtained in this study showed good repellent activity of the essential oil, which continued for 24 h, which is an important factor when choosing the plant product as an insecticide (Nerio *et al*., 2010). For example, because the colonies of *A guerreronis* are located under the perianth of the fruit, plant-acaricidal repellency can be effective against the adults. It makes them leave the protection of the perianth for dispersion (Monteiro *et al*., 2012).

The effectiveness of eucalyptus essential oil is due to its content of many active substances, such as terpene compounds (monoterpenes and monoterpenoids compounds), which are toxic and lethal to many insect species (Batish *et al*., 2008; Dhakad *et al*., 2018). Hence, leaf oil was more effective than seed oil due to its higher terpene content. The terpene compounds are the most common insecticidal constituents of plant extracts and essential oils against stored product insects (Ahn *et al*. 1998). Phytochemically, terpene substances are volatile and lipophilic, allowing them to penetrate the insect cuticle and interfere with its physiological functions (Aldosary *et al*., 2018; Chaudhari *et al*., 2021). Various arthropod pests have been proven to be killed by terpene substances which have ovicidal, repellent, antifeeding, or biocidal properties (Maggi & Benelli, 2018; Mwamburi, 2022). As a result of their high activity, these essential oils could be used in various ways to control stored product insects to replace the current chemical fumigant. In addition, they can be used as a component of integrated pest management in combination with microbial insecticides, traps, and beneficial insects. In light of this, further investigation into the potential use of these natural fumigants in controlling insects of stored products might be worthwhile.

The safety issues of *E. camaldulensis* seeds and leaves essential oils need to be researched further before this material can be used as a novel fumigant. The mechanism of action of this essential oil and the development of formulations for improving potency and stability, as well as reducing cost, are areas that require further attention.

It can be concluded from this study that the contact method has more toxicity against adult insects than the fumigation method. However, both exposure methods had a good effect on the adults of *O. surinamensis. More research* on these essential oils is needed to investigate their potential to apply as fumigants against stored grain insect pests.

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الملخص

النجم، إيهاب، محمد الدرويش، ناصر الدوسري، حازم علي وغزوان فيصل السعدي. 2026. تقييم النشاط القاتل والطارد للزيت العطري لنبات *Eucalyptus camaldulensis* ضدّ بالغات حشرة *Oryzaephilus surinamensis* على ثمار نخيل التمر. مجلة وقاية النبات العربية، 44(2):244-252. https://doi.org/10.22268/AJPP-001391

تُصاب ثمار نخيل التمر بخنفساء الثمار ذات الصدر المنشارية (*Oryzaephilus surinamensis*)، والتي يمكن أن تسبب أضراراً كبيرة اذا تركت بدون مكافحة. وقد اكتسبت المبيدات الحشرية النباتية اهتماماً كبديل فعال من حيث انخفاض تكاليفها وأضرارها على البيئة مقارنة بالمبيدات الحشرية الكيميائية التقليدية. لذلك هدفت هذه الدراسة إلى تحليل المركبات المتطايرة للزيت العطري لأوراق وبذور نبات *Eucalyptus camaldulensis* باستخدام مطياف الكتلة الغازي GC-MS وتقييم سمية هذه الزيوت ضدّ بالغات هذه الآفة، واختبرت طريقتان للتعرّض (التلامس والتبخير). بينت نتائج تحليل GC-MS عن وجود العديد من مركبات التربين في كلّ من الزيت العطري للأوراق والبذور مثل اليوكالبتول الذي يعمل كمادة سامة للجهاز التنفسي ضدّ الحشرات. كانت طريقة التلامس أكثر فعالية في السيطرة على الحشرات البالغة من طريقة التبخير. بلغت نسبة الموت 76.50% عندما تعرضت الحشرات البالغة لـ 1000 مغ/ليتر من الزيت العطري للأوراق باستخدام طريقة التلامس، بينما عند

استخدام طريقة التبخير، أعطى التركيز نفسه معدل موت 61.00%. سجل التركيز 1000 مغ/ليتر من الزيت العطري للبذور معدل موت 65.00% عند استخدام طريقة التلامس و 52.00% لطريقة التبخير. تمّ تحقيق نشاط طارد فعال للزيت العطري واستمر حتى 24 ساعة؛ مما يثبت أن الزيت العطري ذو تأثير مديد لفترة طويلة. أكدت النتائج أنه يمكن استخدام هذه الزيوت العطرية بالتضافر مع المبيدات الحشرية الميكروبية والمصائد والحشرات المفيدة في المكافحة المتكاملة لحشرات المواد المخزونة.

كلمات مفتاحية: نباتات عطرية، نخيل التمر، يوكاليبتول، تدخين، حشرات المواد المخزونة، سمية.

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