

**Efficacy of some plant extracts as botanical acaricide against Date palm dust mite
Oligonychus afrasiaticus (McGregor)**

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Abstract

The purpose of this study was to determine the effectiveness of *Vitex agnus-castus*, *Melilotus officinalis*, and *Cymbopogon citratus* as botanical acaricides against date palm dust mites *Oligonychus afrasiaticus* (McGregor). There are several variables that affect dust mite mortality, including plant species, extraction method, concentration, and time. The findings indicated noteworthy impacts of these variables on the mortality rates of dust mites. The mortality rates of dust mites were significantly affected by the type of plant species ($p < 0.01$). The highest mortality rates were observed with *Cymbopogon citratus*, whereas there was no significant variation between *Vitex agnus-castus* and *Melilotus officinalis*. The extraction method was influential ($p < 0.01$), with ethanol extract performing better than aqueous and hexane extracts in terms of efficacy. Aqueous extraction had a lower efficacy than hexane extraction. The concentration of plant extract considerably affected the mortality rates of dust mites ($p < 0.01$). Increased concentrations led to significantly increased mortality rates, demonstrating a concentration-dependent impact. Dust mite mortality rates were also affected by exposure duration ($p < 0.01$). When the exposure period was increased, the mortality rate increased considerably. Significant differences in mortality rates have been observed for each time period (6, 12, 24, and 48 hours). These findings emphasize the importance of selecting appropriate plant species, utilizing effective extraction methods, optimizing concentration levels, and considering exposure duration for designing efficient dust mite control strategies. *Cymbopogon citratus*, especially when extracted with ethanol and applied at higher concentrations, has the potential to be a natural dust mite control treatment.

Keywords: Acaricide Efficacy; Extract; Mortality rate; Natural alternative; Pest management

Introduction

Phoenix dactylifera L., commonly known as the date palm, is a significant fruit trees in regions with arid and semi-arid climates. It acts as an essential provider of nourishment, revenue, and job opportunities for countless people across the world. (Abdel-Baky et al., 2023; Suhim et al., 2023). The presence of pests and diseases poses a significant challenge to this cultivation, with the dust mite *Oligonychus afrasiaticus* (McGregor) (Acari Tetranychidae) being a major cause for concern (Ali and Fhaid, 2019; El-Shafie, 2022). This mite feeds on the leaves and fruits of the palm tree, resulting in extensive damage to the quality and yield of the fruit (Mohammed et al., 2023). Commonly used techniques for controlling *O. afrasiaticus* involve the use of chemical insecticides, which have the potential to cause harm to the environment, non-target organisms, and human health (Pathak et al., 2022). As a result, there is a growing interest in exploring alternative pest management methods, such as the utilization of natural plant extracts with acaricidal properties (Ngegba et al., 2022).

Earlier investigations have examined the effectiveness of various botanical extracts on different species of mites, laying the groundwork for prospective studies on their potential usefulness in controlling date palm dust mites. According to Lakhdari et al. (2015), a water-based botanical extract sourced from *Zygophyllum album* L demonstrates a mortality rate of 76% against the date palm dust mite. Topuz et al. (2018) investigated the acaricidal efficacy of essential oil for five plant species, including *Vitex agnus-castus*, against *Tetranychus urticae* Koch, and their results were promising. Furthermore, Rincón et al. (2019) evaluated the acaricidal efficacy of *Melilotus officinalis* extracts on *Tetranychus urticae*, emphasising the plant's potential as a natural control agent. Hanifah et al. (2011) investigated the acaricidal properties of essential oils from *Cymbopogon* species against house dust mites, indicating their efficiency in mite management.

Based on previous studies on the effectiveness of some plant extracts in controlling different species of spider mites, the present study aimed to determine the acaricidal activity of *Vitex agnus-castus*, *Melilotus officinalis*, and *Cymbopogon citratus* toward date palm dust mites *Oligonychus afrasiaticus* under laboratory conditions.

Materials and Methods

Collection and Preparation of Plant Materials:

Plant samples were obtained from several areas around the Basrah city -Iraq, including *Vitex agnus-castus*, *Melilotus officinalis*, and *Cymbopogon citratus*. The plant material was properly cleaned to eliminate any dirt or debris and air-dried under shade. Once dried, the plant material

was ground into a fine powder using an electrical commercial mill. Extraction and Concentration of Plant Extracts: 100 grams of the plant material powdered was taken. Three types of solvent were applied (hexane, water, and alcohol (ethanol 70%) in the extraction process. For the water extraction, the plant material was macerated in 400 ml of lukewarm distilled water in an Erlenmeyer flask. The flask was agitated at 100 rpm for 24 hours. After filtering through a Buchner funnel and Whitman No. 1 filter paper, the extract was concentrated under low pressure using a rotary evaporator. For the alcohol extraction, the same procedure was followed, except that 70% ethanol was used instead of water. The crude extracts from both extractions were reconstituted to have a concentration of 20% (w/v) using distilled water. The required concentrations (1, 2, 3, and 4%) were then prepared from the stock solutions by diluting with distilled water. Finally, 1 ml of Tween 80 and one drop of paraffin were added to each solution.

Dust Mite Culture:

To establish a mass culture of date palm dust mites which was used in laboratory experiments. The mites were collected from infested date palm trees in farms located within Basrah city and transferred to a culture setup. The culture setup provided a controlled environment with suitable conditions such as temperature ($25 \pm 2^{\circ}\text{C}$), relative humidity ($70 \pm 5\%$), and photoperiod (16:8 light:dark) for the growth of the mites. Date palm seedlings were provided as a source of nutrition, and the culture was regularly monitored for population growth.

Dust Mite Bioassay:

Individual dust mites (20 individuals per petri dish) were placed in a petri dish with a diameter of 9 cm. Pieces of date palm leaves were added to the petri dish as a food source for the mites. Each dish represented a specific treatment with one concentration of the plant extract. The extract concentrations were sprayed evenly onto the date palm leaves using a fine mist sprayer, ensuring adequate coverage. Petri dishes representing control groups were treated with distilled water or ethanol, depending on the type of extract used. The treated petri dishes were kept under laboratory conditions. The mite mortality was recorded at different time intervals, at 6, 12, 24, and 48 hours after treatment. Dead mites were identified by their lack of movement and responsiveness to touch. The number of dead mites was counted and recorded for each treatment and time after treatment. The mortality was corrected based on the Abbott equation

Data Analysis:

The data was subjected to statistical analysis using analysis of variance (ANOVA), which was followed by a post-hoc analysis using the Least Significant Difference (LSD) test. $P < 0.01$ was used as the significance probability.

Results

In the current study, the effects of four factors—plant species, extraction procedure, concentration, and time were examined in relation to dust mite mortality rates. The data collected for each factor provided crucial information about the efficacy of dust mite control. According to Fig 1, the plant species significantly affected the mortality rates of date palm dust mites. The three plant species” *Cymbopogon citratus*, *Vitex agnus-castus*, and *Melilotus officinalis*” were tested, the average mortality rates were 39.55%, 37.80%, and 37.91%, respectively. Significant variances among the studied plant species were observed by post-hoc analysis (LSD = 1.12, $p < 0.01$). Compared to *Vitex agnus-castus* and *Melilotus officinalis*, *Cymbopogon citratus* showed significantly greater mortality rates ($p < 0.01$). However, there was not a significant difference between *Melilotus officinalis* and *Vitex agnuscastus* in terms of their effected on dust mite mortality rate.

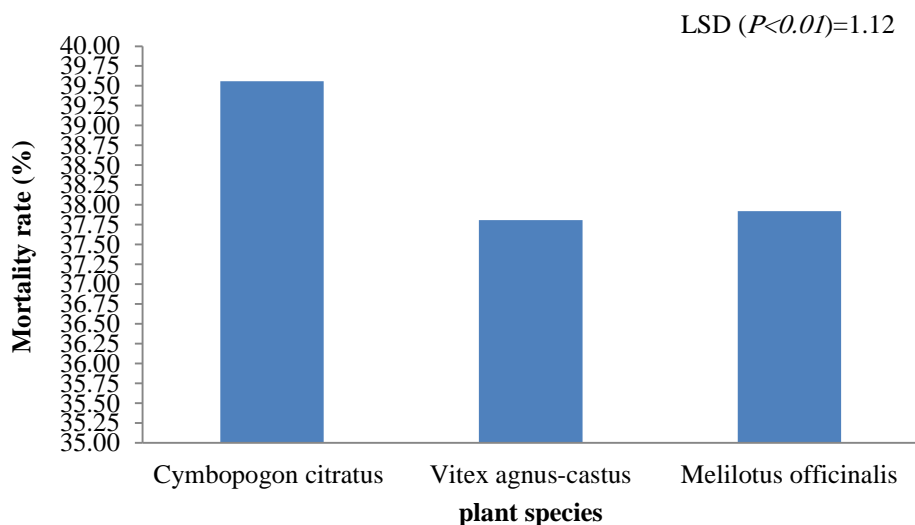


Fig 1. Impact of plant species on mortality rate of date palm dust mite.

Type of solvent used to extract plant samples played a crucial role in managing dust mites (LSD = 1.25, $p < 0.01$). According to Fig 2, the mean mortality percentages for the aqueous, alcohol, and hexane extractions were 3.27%, 46.35%, and 36.65%, respectively. Further analysis revealed that the use of ethanol extraction resulted in significantly greater mortality percentages compared

to both aqueous and hexane extractions ($p < 0.01$). hexane extraction demonstrated moderate efficiency, while aqueous extraction exhibited relatively lower effectiveness.

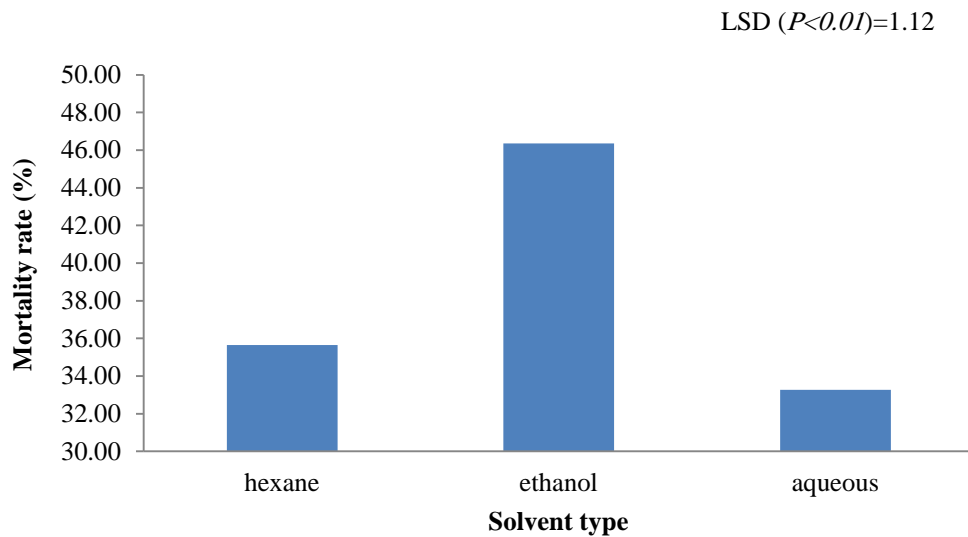


Fig 2. Impact of solvent type on mortality rate of date palm dust mite.

The effectiveness of the plant extracts on the mortality rates of dust mites was significantly influenced by their concentration ($LSD = 1.45, p < 0.01$). The average mortality rates for the various concentrations, including 1%, 2%, 3%, and 4%, were 28.82%, 34.28%, 41.99%, and 48.61%, respectively (Fig 3). Further analysis showed that higher concentrations led to significantly higher mortality rates in comparison to lower concentrations ($p < 0.01$). Specifically, mortality rates significantly rose from 1% to 2%, 2% to 3%, and 3% to 4% concentrations.

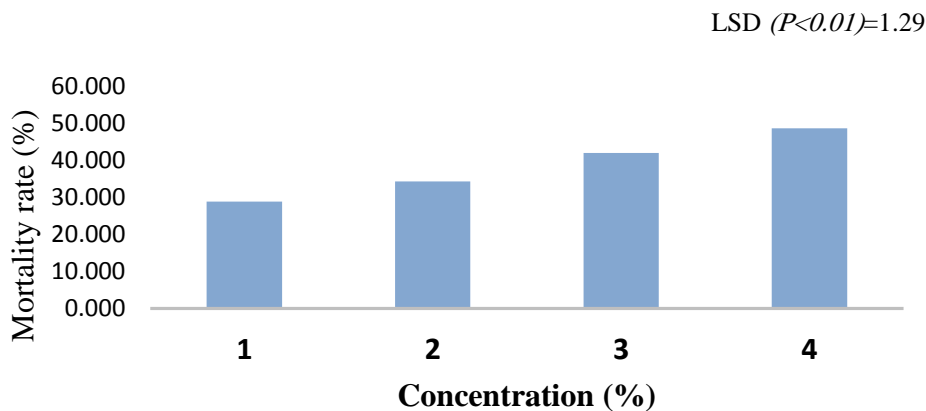


Fig 3. Impact of extract concentration on mortality rate of date palm dust mite.

The duration of exposure of the plant extracts, indicated by time intervals of 6, 12, 24, and 48 hours, impacted dust mite mortality rates (LSD = 1.45, p 0.05). As shown in Fig 4, during different periods, the grand mean mortality rate was 16.47%, 33.76%, 45.76%, and 57.62%. As exposure duration increased, dust mite mortality rates increased significantly (p 0.05). There were substantial changes in mortality rates among time intervals, indicating a time-dependent impact.

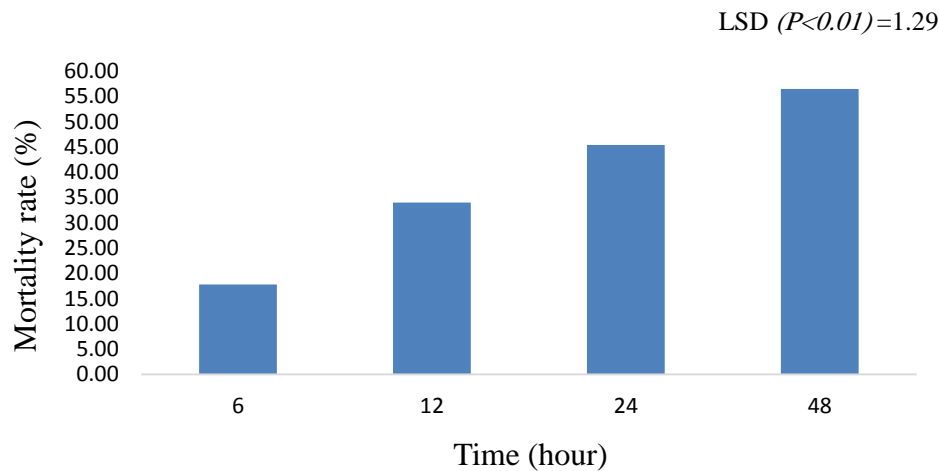


Fig 4. Impact of time of exposure on mortality rate (%) of date palm dust mite.

Table 1. displays revealed that the highest mortality rate was observed for *Cymbopogon citratus* (95.61%), recorded in the ethanol extract at a concentration of 4% after 48 hours. In contrast, the lowest mortality rate for *Cymbopogon citratus* was 11.31%, observed in the aqueous extract at a concentration of 1% after 6 hours. *Vitex agnus-castus* showed a maximum mortality rate of 73.27% in the ethanol extract at a concentration of 4% after 48 hours, while the lowest rate of 9.13% was observed in the aqueous extract at a concentration of 1% after 6 hours. Regarding *Melilotus officinalis*, the greatest mortality rate (67.65%) was noted in the water-based solution with a 4% concentration after 48 hours, whereas the least rate (9.21%) was observed in the water-based solution with a 1% concentration after 6 hours. These results imply that distinct botanical varieties have varying efficacy levels in causing the demise of dust mites.

Table 1. effect of plant species, extract, concentration and time on the mortality of date palm dust mite.

Plant species	Solvent type	Concentration %	Time (hour)			
			6	12	24	48
Cymbopogon citratus	hexane	1	13.48	17.66	32.66	37.94
		2	16.87	23.67	29.28	51.22
		3	21.97	27.07	45.27	60.40
		4	27.07	33.87	50.54	62.95
	ethanol	1	14.98	33.78	41.38	53.55
		2	17.13	38.97	61.08	71.12
		3	18.57	49.18	71.29	85.40
		4	25.37	57.68	73.84	95.61
	Aqueous	1	11.31	16.33	31.16	38.95
		2	11.77	27.07	32.68	41.53
		3	18.57	38.98	42.21	50.20
		4	21.97	49.18	49.69	60.06
Vitex agnus-castus	hexane	1	14.14	17.51	29.50	37.61
		2	14.67	23.17	29.97	50.38
		3	19.77	28.27	43.58	58.88
		4	23.17	33.37	48.68	60.58
	ethanol	1	12.46	37.63	46.21	51.04
		2	14.67	36.77	58.88	67.46
		3	18.07	48.68	62.79	69.63
		4	26.57	55.48	70.49	73.27
	Aqueous	1	9.13	17.51	29.50	37.61
		2	12.97	26.57	31.67	40.18
		3	16.37	36.77	40.18	48.68
		4	18.07	50.38	54.80	61.09
Melilotus officinalis	hexane	1	12.88	28.02	39.93	47.75
		2	13.91	34.14	42.78	53.61
		3	14.59	34.37	50.13	63.57
		4	20.54	36.86	58.12	75.04
	ethanol	1	22.11	25.64	37.93	46.24
		2	23.26	31.76	39.07	59.31
		3	27.68	37.20	52.68	67.31
		4	31.93	42.48	57.44	67.65

		1	9.21	16.92	29.06	37.18
	Aqueous	2	13.40	26.15	31.42	40.27
		3	16.80	36.69	39.42	44.93
		4	18.84	49.62	48.43	65.87

Discussion

concentrations, and exposure times on dust mite mortality. The study results show that there are significant differences in the efficiency of different plant species in reducing dust mites. Among the investigated plant species, *Cymbopogon citratus* had significantly higher death rates than *Vitex agnus-castus* and *Melilotus officinalis* ($p < 0.01$). The findings show that the ethanol extract of *C. citratus* leaf was toxic to dust mites. Several previous investigations found that *C. citratus* has insecticidal and acaricidal activity against mites and other pests (Hanifah et al., 2011; Moustafa et al., 2021). A diverse range of bioactive compounds present in *C. citratus*, such as alcohols, ketones, esters, aldehydes, saponins, terpenoids, terpenes, neryl, nerol, myrcene, geraniol, citral, gernyl acetate, and numerous flavonoids (Shah et al., 2011; Hussain et al., 2023). Terpenoids have particular interest since they have been shown to possess acaricidal properties (Zieliska et al., 2018). The results of this study are consistent with the results of many studies that indicated the effectiveness of lemongrass leaf extract had the best acaricidal effect against species of mites such as house dust mites (Hanifah et al., 2011) and *Panonychus citri* (McGregor) (Zhu et al., 2023), the African red mite (*Eutetranychus africanus*) (DOUNGNAPE et al., 2021), and the scabies mite. Based on the solvent type factor, the ethanol extract caused more dust mite deaths than the aqueous and hexane extracts. Ethanol has been shown to extract a wide range of bioactive substances from plant material, including phenolic compounds, alkaloids, and terpenoids (Stéphane et al., 2022). Acaricide activities have been observed for these bioactive substances (Tomczyk & Suszko, 2011). The acaricide potential of plant extracts obtained by ethanol from diverse plants has been demonstrated in several previous studies (Deka et al., 2022). These acaricidal compounds, including terpenoids, may explain the higher mortality rates observed in ethanol extracts. It has been found that extract concentration is positively correlated with dust mite mortality rate. Higher concentrations (3% and 4%) resulted in more fatalities when compared to lower values (1% and 2%). This finding is similar to a previous study that revealed concentration-dependent insecticidal activity in plant extracts (Lakhdari et al., 2015; Moustafa et al., 2021; Deka et al., 2022). Higher concentrations may result in higher quantities of bioactive

chemicals in extracts, which may lead to enhanced toxicity against dust mites (Ngegba et al., 2022). In terms of the time factor, longer exposure times resulted in greater dust mite mortality rates. As the duration of exposure escalated from 6 to 48 hours, there was an increase in the death rate of dust mites. This finding suggests that plant extracts' bioactive compounds necessitate time to manifest their acaricidal actions on dust mites (Fu et al., 2021). Likewise, studies examining the acaricidal efficacy of plant extracts against other pests have yielded comparable results (Hanifah et al., 2011; Zhu et al., 2023). Prolonged exposure enables the bioactive substances to penetrate and interact more extensively with the physiological processes of the dust mites, leading to increased mortality rates (Jian et al., 2022).

Conclusion

The present study offers an understanding of the factors that impact on the mortality rates of dust mites. The effectiveness of controlling dust mites was assessed based on the species of plants used, the solvent type, the concentration, and the duration of exposure. , *Cymbopogon citratus* plant exhibited the highest mortality rate compared with other plants. Ethanol extraction proved to be more effective than aqueous and hexane methods. Increased concentrations of the plant extracts resulted in higher mortality rates, while longer exposure periods had a significant impact on dust mite mortality as well. These findings highlight the need to consider these parameters when developing efficient strategies for controlling dust mites. The development of long-lasting and efficient techniques for controlling dust mite infestations may be achieved through additional research and development in this field.

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فعالية بعض المستخلصات النباتية في مكافحة حلم غبار النخيل (*Oligonychus afrasiaticus* (McGregor)**(Acari Tetranychidae)**¹ حازم محسن علي ¹ خالد عبد الرزاق فهيد ² خير الله موسى عواد¹ مركز ابحاث النخيل - جامعة البصرة - العراق² قسم وقاية النبات - كلية الزراعة - جامعة البصرة - العراق**الخلاصة**

اجريت هذه الدراسة بهدف تحديد المتغيرات التي تؤثر على معدل وفيات حلم الغبار *Oligonychus afrasiaticus* واستكشاف خيارات مكافحة المحتملة لهذه الافة. وكانت متغيرات الدراسة، بعض الانواع النباتية وهي عشبة الليمون *Cymbopogon citratus* و كف مريم *Vitex agnus-castus* والحنديق *Melilotus officinalis* وطريقة الاستخلاص (كحولي هكشاني ومائي) وتركيز المستخلص ومدة تعرض الافة للمستخلص. أشارت النتائج إلى التأثيرات الجديرة بالملاحظة لهذه المتغيرات على معدلات وفيات عث الغبار، تأثرت معدلات وفيات عث الغبار بشكل كبير بنوع الأنواع النباتية ($P < 0.01$). وقد لوحظت أعلى معدلات الوفيات مع نبات عشبة الليمون، في حين لم يكن هناك اختلاف كبير بين نباتي كف مريم الحندقوق. وكانت طريقة الاستخلاص مؤثرة معنويًا، حيث كانت فعالية المستخلص الإيثانولي أفضل من المستخلصات المائية والهكسان، و كان الاستخلاص المائي اقل فعالية من استخراج الهكسان. أثر تركيز المستخلصات النباتية بشكل كبير على معدلات وفيات حلم الغبار إذ أدت زيادة التركيز إلى زيادة معنوية في معدلات الوفيات، مما يدل على تأثير يعتمد على التركيز. كما تأثرت معدلات وفيات حلم الغبار بمدة التعرض إذ زاد معدل الوفيات بزيادة فترة التعرض. ولوحظت اختلافات معنوية في معدلات الوفيات لكل فترة زمنية (6 و 12 و 24 و 48 ساعة). تؤكد هذه النتائج على أهمية اختيار الأنواع النباتية المناسبة، واستخدام طرق الاستخلاص الفعالة، وتحسين مستويات التركيز، والنظر في مدة التعرض لتصميم استراتيجيات فعالة لمكافحة حلم الغبار. نبات عشبة الليمون، خاصة عند استخراجه بالإيثانول وتطبيقه بتركيزات أعلى، لديه القدرة على أن يكون معالجا طبيعيا للتحكم في حلم الغبار.

الكلمات المفتاحية: مبيدات حلم، استخلاص، معدل الوفيات، البديل الطبيعي، ادارة الآفات.