Evaluation of different concentrations of three alcoholic plant extracts in controlling the static stages of the scale insect *Parlatoria blanchardi* (Targioni-Tozzetti) (Hemiptera: Diaspididae) on date palm cultivar Shweithi *Phoenix dactylifera L.* 1753 in orchards of Al-Muthanna Governorate

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ABSTRACT

An experiment was conducted to evaluate different concentrations of alcoholic plant extracts from the plant parts of *Citrullus colocynthis* seeds, *Conocarpus lancifolius* leaves, and *Conocarpus lancifolius* seeds in controlling the scale insect *Parlatoria blanchardi* (Targ.-Tozz.) on the Shweithi date palm cultivar *Phoenix dactylifera*. The results demonstrated the superiority of *C. lancifolius* leaf extract over the other plant part extracts used in the experiment in eliminating the static stages of the insect, with relative efficiency rates of 31.7% and 51.54% for the egg and adult stages, respectively. The results showed that the optimal concentration yielding the highest mortality rate for the egg stage was 3 ml/L of *C. lancifolius* leaf extract, achieving a relative efficiency rate of 62.2% after 7 days of treatment, with a significant difference compared to all other concentrations and time periods. The highest relative efficiency for the adult stage was also observed with *C. lancifolius* leaf extract at a concentration of 3 ml/L, 7 days after treatment, with a significant difference compared to all other concentrations and time periods, reaching 66.78%.

Keywords: ***Citrullus colocynthis, Conocarpus lancifolius, Parlatoria blanchardi* (Targ.), Phoenix *dactylifera cultivar Shweithi*, plant extracts.**

INTRODUCTION

The date palm, *Phoenix dactylifera* L., is one of the most well-known trees to humankind since ancient times. The date palm is among the most important trees resistant to salinity and drought, and the desert climate does not hinder its productivity. Rather, it is the only significant tree that has adapted well to regions with extreme environmental conditions, as it pollinates, flowers, and its fruits reach maturity under harsh climatic conditions. It is also considered one of the most important trees used as a supportive and suitable ecosystem for other desert crops and trees, providing a favorable environment for the diversity and spread of these coexisting plants.

Date palms face numerous insect pests that affect them, reducing their yield and causing significant economic losses, estimated at more than 34.99% of the total date crop. These pests cause a significant decline in the growth and production stages of the affected palm, sometimes leading to its death. Scale insects belonging to the order Hemiptera infest the fronds, spathes, and fruits, and are considered one of the important pests of date palms, sometimes reaching the roots. Among them, the brown scale insect *Parlatoria blanchardi* (Targi-Tozzi) is of primary importance. It is highly significant on date palms in most of its distribution areas. This insect taxonomically belongs to the armored scale insect family Diaspididae, due to the female's body being covered with a hard wax shield that protects it from unfavorable environmental factors and is often separate from its body. This family causes significant economic damage as it includes many of the most dangerous pests, with approximately 2199 species worldwide belonging to over 399 genera.

Due to the harmful side effects of chemical pesticides on agricultural ecosystems and their direct and indirect harm to public human and animal health, as well as their destruction of many beneficial natural enemies and their success in inducing resistance in target pests and turning secondary pests into primary pests, there has been a need since the early 1970s to find the best alternative methods to limit the spread of these pests.

Among these methods is returning to nature by producing plant-based pesticides, obtained from testing various plant extracts and identifying the effectiveness of different plant parts, which do not differ in their effects from their synthetic chemical counterparts. Their major importance lies in their decomposition into non-toxic substances shortly after use due to environmental factors such as light, heat, and humidity. It is worth noting that plant-based pesticides have been used since ancient times, and many plants have been a source of pesticide production, both in the past and recently. Plant extracts contain many compounds, including organic

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acids, aldehydes, aromatic acids, simple unsaturated lactones, coumarins, quinones, flavonoids, tannins, alkaloids, terpenoids, and steroids, as well as some toxic gases**.**

For the aforementioned reasons, three plants were tested to study the parts of their alcoholic (hexane) extracts and determine their relative efficiency against insects, specifically in controlling the scale insect on the highly susceptible Shweithi date palm cultivar, as some of their extracts have shown effectiveness against certain insect pests that have been studied.

MATERIALS AND METHODS

Insect Identification: Insect specimens were sent for identification to the Research Center and Natural History Museum at the University of Baghdad, under the supervision of Prof. Dr. Razzaq Shaalan Akal.

Insect Colony Preparation: Experimental samples of the insect's mobile stages (crawlers) and static stages were collected from date palms infested with the insect. The infestation process was carried out on small, one-year-old, uninfected date palm offshoots, which were brought from orchards in the northern district of Al-Rumaitha and placed in pots with a diameter of 40 cm. When planting the offshoots in the pots, they were prepared to be larger than the offshoot size. The soil was mixed in a 1:1 ratio of peat moss and alluvial soil ("river sand"). The mixture was added to the pots to a suitable depth of about 50 cm, and then the offshoots were gradually planted and buried with pressure. The soil was compacted and then irrigated well with a specialized irrigation system (drip irrigation). The offshoots were transferred to a wooden shade to provide suitable conditions for the growth of the different insect stages.

Alcoholic Extraction of Plant Extracts:

1- Preparation of *Citrullus colocynthis* alcoholic extract.:

C. colocynthis seeds and thyme leaves were purchased from the local market (herbalists), washed, and cleaned with distilled water three times to remove dust and impurities. They were then dried under laboratory air and conditions, with continuous stirring to prevent spoilage. They were ground thoroughly into powder using an electric grinder. The resulting powders were placed in labeled paper bags until use.

The secondary organic compounds were extracted from the powdered plant parts using 50 grams of each plant part powder separately in paper extraction thimbles within a Sohxlet continuous extraction apparatus with 1 liter of 70% hexane as an organic solvent. A magnetic stirrer was used to enhance the oil yield from the plant part. The ratio of plant part powder weight (g) to organic solvent volume (L) was 1:20. The extraction was carried out at temperatures ranging from 40-60°C for 72 hours (3-9 cycles). The extracts were then dried using a Rotary evaporator at 50°C with a rotation speed of 240 rpm [11, 13, 14]. All experimental samples were stored in tightly sealed dark bottles, away from direct light, and frozen at -20°C until the experiment. The extraction was performed in the graduate studies laboratories at Al-Muthanna University.

2- **Preparation of the alcoholic extract of *Conocarpus lancifolius* leaves:**

C. lancifolius leaves were collected from city streets and cleaned with distilled water to remove dust, as mentioned previously in paragraph (1). The same extraction method was used.

3- **Preparation of the alcoholic extract of *Conocarpus lancifolius* seeds*:***

C. lancifolius seeds were collected from city streets and cleaned with distilled water to remove dust, as mentioned previously in paragraph (1). The same extraction method was used.

Evaluation of the Efficacy of Different Concentrations of Pre-Prepared Plant Extracts

A stock solution was prepared for all used extracts by dissolving 1 gram of their dry residues in 5 milliliters of the solvent (hexane) and completing the volume to 10 milliliters with sterile distilled water to obtain a 10% stock solution. Concentrations of 1%, 2%, and 3% were prepared by diluting the stock solution. One milliliter of an adhesive (liquid paraffin) was added to each concentration, as well as two drops of a surfactant (Tween 80) per 100 milliliters of the concentration. The control treatment used only sterile distilled water [15, 16].

The field experiment was conducted in a date palm orchard infested with scale insects in Al-Rumaitha district, specifically in the Al-Sayed Hassoun orchards north of the district in Al-Muthanna Governorate. For this experiment, 57 date palm trees of the most susceptible cultivar (Shweithi) were selected, with a height ranging from 2 to 4 meters (offshoots or young palms). The date palm trees were divided into three groups, each containing three trees, where each group represented one treatment. There were seven treatments in total, one of which was the control. The palm trees were sprayed with the plant extracts at the concentrations mentioned above. Three fronds of the Shweithi cultivar, the most susceptible to insect infestation, were taken, and the number of dead individuals was counted in the field, with nine fronds for all treatments, before and 7 days after treatment. The efficacy of the extract in killing scale insect eggs was

calculated using Abbot's formula (1925) as cited in [17, 18].

Percentage of extract efficacy =

$$\frac{\text{Percentage of unhatched eggs in the control} - \text{Percentage of unhatched eggs in the treatment}}{\text{Percentage of unhatched eggs in the control}} \times 100$$

Table 1. Plants used in the study with a simplified scientific classification

#	Arabic Name	English Name	Scientific Name	Family
1	بذور الحنظل	Bitter melon	*Citrullus colocynthis (*)*	Cucurbitaceae
2	اوراق الكونوكاربس	Conocarpus Leaf	*Conocarpus lancifolius*	Combretaceae
3	بذور الكونوكاربس	Garlic	*Allium sativum*	Alliaceae

Statistical Analysis: The results of the experiment were analyzed according to the Complete Randomization Design (C.R.D.) at a probability level of 0.05. The significance of differences between means was tested using the Least Significant Difference (L.S.D.) test at the aforementioned probability level [19].

RESULTS AND DISCUSSION

Effect of Varying Concentrations of Plant Extracts on the Mortality Rate of Egg Stage of Scale Insect P. blanchardi on Al-Shuwaithi Date Palm Variety.

The results showed the effect of plant extracts at all varying concentrations on the eggs of the scale insect over 7 days. Upon conducting the statistical analysis as shown in Table (2), significant differences were observed between these extracts. The varying concentrations (1, 2, and 3 ml/liter) yielded the following results: The lowest hatching rate in the scale insect eggs was recorded when using Conocarpus tree seed extract, reaching 4.32% after 7 days from the start of treatment at the first concentration (1 ml/liter). Conversely, the highest egg mortality rate was recorded at the 3 ml/liter concentration of Conocarpus tree leaf extract, reaching 62.2% within the same study period. The lowest egg mortality rate was observed when using all extracts at a concentration of 1 ml/liter, with an average mortality rate of 12.72% for all extracts. Meanwhile, the highest mortality rate was recorded when using all extracts at a concentration of 3 ml/liter, with an average of 31.39%. Additionally, the lowest egg mortality rate for all concentrations was recorded for Conocarpus seed extract, reaching 7.47%. In contrast, the highest egg mortality rate for all concentrations was recorded for Conocarpus leaf and *Citrullus colocynthis* seed extracts, reaching 42.3% and 39.74%, respectively. These percentages showed significant differences compared to the control treatment, which had a mortality rate of 0.00%.

Table 2. Effect of Varying Concentrations of Plant Extracts on the Mortality Rate of *P. blanchardi* Scale Insect Eggs on Date Palm

Extract Type / Concentrations	Percentage of Unhatched Eggs After 7 Days of Treatment			Average
	1	2	3	
Comparison	0	0	0	0
1ml* L-1	22.44	24.5	4.32	17.1
2 ml* L-1	40.23	40.1	8.21	29.5
3 ml* L-1	56.	62.2	9.87	42.9
Concentrations Average	29.8	31.7	5.6	
L. S. D $_{0.05}$	Extract Type 22-1	Concentration 5.31	Interaction 6.21	

The numbers (1,2 and3) indicate the sequence of plant extracts used in the experiment

Table 3. Number of Live Unhatched Eggs of P. blanchardi Scale Insect on Al-Shuwaithi Date Palm Fronds

Extract Type Concentrations	Number of Live Hatched Eggs After 7 Days (%) of Extract Treatment			Average
	1	2	3	
Comparison	69	54	93	72
1 ml* L^{-1}	53.5	52.1	66:02	57:21
2 ml* L^{-1}	32.3	32.3	49-57	38.06
3 ml* L^{-1}	40.4	35.2	83.82	53.14
Concentrations Average	48.8	43.4	1025	
L. S. D $_{0.05}$	Extract Type 1.22	Concentration 5.31	Interaction 6.21	

These results are consistent with the studies of both Al-Saadi [20] and Al-Sudani [21] during their research on certain plant extracts. They found that the presence of active chemical compounds in eucalyptus leaf extract, such as simple phenols, tannins, flavonoids, saponins, terpenes, glycosides, resins, and coumarins, played a role in reducing the studied insects (cowpea weevil *Callosobruchus maculatus* and barnacle *Balanus amphitrite*). The results showed that the lowest relative efficacy was 0% for tea and eucalyptus extracts after 3 days of treatment, at concentrations of 2 g/L for tea and 2 ml/L for eucalyptus, and also for eucalyptus extract after 1 day of treatment at a concentration of 1 ml/L. Conversely, the highest concentration that yielded the highest relative efficacy was for aloe vera extract, followed by eucalyptus, at a concentration of 3 ml/L, with a non-significant difference, being 63.2% and 60.2%, respectively. These results align with the findings of Akbar et al. [22], who, in their study of certain plant extracts, including eucalyptus, found that eucalyptus gave a moderate mortality rate of 65.5%.

Effect of Varying Concentrations of Plant Extracts on the Mortality Rate of Adult *P. blanchardi* Scale Insects on Al-Shuwaithi Date Palm Variety

The results in Table (4) showed variations in the effectiveness of plant extracts in controlling the mortality rates of adult *P. blanchardi* over different time periods under controlled laboratory conditions. Insect mortality rates began to appear within 24 hours of treatment initiation and increased with higher concentrations. Additionally, cumulative daily mortality rates increased with longer post-treatment durations. The results indicated a significant superiority of the average type of plant extract used in reducing insect populations. The highest mortality rates were recorded for Conocarpus leaf and *C. colocynthis* seed extracts, reaching (51.54 and 45.05)%, respectively, compared to Conocarpus seed extract, which showed a lower effectiveness of 10.97%.

The analysis of the average concentration factor of the extracts revealed a statistically significant effect. The 3 ml/L concentration of *C. colocynthis* seed and Conocarpus leaf extracts yielded the highest mortality rates, reaching (59.64 and 66.78)%, respectively, with a significant difference from other concentrations. In contrast, the 1 ml/L concentration of Conocarpus seed extract showed the lowest effect on adult scale insect mortality, with an effectiveness rate of 8.17%. The statistical analysis results indicated significant differences between the concentrations of the plant extracts.

The results of the treatment time factor analysis showed that the 7-day post-treatment period significantly outperformed the other time periods in reducing insect populations. This difference was statistically significant compared to the other periods. The highest average time-related efficacy rate for mortality across all extracts was 52.25%, indicating that mortality efficacy increased with longer post-treatment durations. Conversely, the lowest time-related mortality efficacy across all extracts was observed on the first day of treatment, at 12.77%. Furthermore, there was an interaction effect between the concentration and treatment time factors on adult mortality. The highest effect was observed at the 3 ml/L concentration after 7 days for Conocarpus leaf and *C.colocynthis* seed extracts, reaching (87.78% and 89.88%), respectively. These results were significantly different from other time periods within the study. In contrast, the lowest mortality rate was recorded at the 1 ml/L concentration on the first day for Conocarpus seed extract, at 2.23%, which was significantly different from other interactions. All these results showed significant differences compared to the control treatment.

It is evident from the aforementioned results that as the concentration of the extract increases, the insect density decreases, and the effectiveness of the plant extract increases.

Table 4. Effect of Varying Concentrations of Three Plant Extracts on the Mortality Rate of Adult P. blanchardi Scale Insects on Al-Shuwaithi Variety

Type of Plant Extract Used	Plant Extract Concentration	% Percentage of Adult Mortality/Day				Average Concentration Factor	Average Plant Extract Type
		1 day	3 days	5 days	7 days		
Control	0	0	0	0	0	0	0
Citrullus colocynthis	1ml* L^{-1}	12.31	20.54	33.45	51.45	29.44	45.05
	2 ml* L^{-1}	23.45	40.12	52.36	68.41	46.09	
	3 ml* L-1	32.42	50.56	67.78	87.78	59.64	
Conocarpus leaves	1ml* L^{-1}	18.21	30.44	39.87	65.17	38.42	51.54
	2 ml* L^{-1}	29.73	40.23	51.23	76.54	49.43	
	3 ml* L^{-1}	38.43	60.24	78.55	89.88	66.78	
Conocarpus seeds	1ml* L^{-1}	2.23	5.12	9.98	15.34	8.168	10.97
	2 ml* L^{-1}	3.88	8.21	10.92	21.33	11.09	
	3 ml* L^{-1}	5.42	9.87	13.44	25.87	13.65	
Average Treatment Time Factor		12.77	21.71	35.13	52.25		
L.S.D(0.05)	Extract Type		Interaction	Time Period		Concentration	
	4.75		1.05	5.13		8.26	

The variation in the effectiveness of the plant extracts used in this study to reduce the population density of adult scale insect *P. blanchardi* may be attributed to the fact that adult scale insects possess a thick body wall with a waxy layer. This contributes to reducing infestation and providing partial protection against the plant extracts. The insects form surface waxy barriers that contribute to resistance and slow down the penetration rate of these plant-derived extracts into their bodies, resulting from the increased thickness of their body walls or changes in their structural composition [23].

CONCLUSION

This study demonstrated that plant extracts can be used as an easier, simpler, and better alternative to other physical and chemical techniques against the white scale insect *P. blanchardi* on date palms. They are a fast, clean, and environmentally friendly method that does not require expensive equipment for their production. Plant extracts showed significant relative effectiveness against the scale insect. The highest results were obtained, particularly at a concentration of 3 ml/L, with a mortality rate of up to 89.88% on the seventh day of treatment with Conocarpus leaves, while the lowest was observed with Conocarpus seeds at 1 ml/L, with a mortality rate of 2.23% on the first day. The results also indicate that *C. colocynthis* seed and Conocarpus leaf extracts were the most effective in killing and reducing egg hatching of the scale insect. Their use may be considered more environmentally safe for controlling *P. blanchardi* in date palm orchards. However, further scientific research in orchards is necessary to investigate and track their environmental impacts on human and animal health.

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