

Relative efficiency of aqueous extracts of three weed species against red palm weevil larvae

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Abstract

Weeds represent a wide range of plant species that spread worldwide and are important biotic component within many environments. Identification of weeds negative and positive characteristics could lead to a better use of them in many directions such as biocontrol agents. The red palm weevil is considered as one of the insect pests that cause damage on date palms in Saudi Arabia. Some natural products have been tested successfully against different stages of different insect species either under laboratory or field conditions. The aim of this study was to evaluate the effect of aqueous extracts of *Euphorbia peplus*, *Salsola kali* and *Heliotropium longiflorum* leaves and stems on palm weevil larvae. *E. peplus* results showed the LC₅₀ of the leaves- aqueous extract was 6656.32 ± 756.78 mg/L, while the stems- aqueous extracts showed LC₅₀ of 2574.63 ± 602.56 mg/L. *Salsola kali* leaves- aqueous extract on palm weevil larvae showed LC₅₀ of 2088.84 ± 186.21 mg/L, while the stem- aqueous extract resulted in LC₅₀ of 1617.67 ± 57.54 mg/L. The aqueous extracts of *H. longiflorum* leaves on palm weevil larvae reflected LC₅₀ of 3949.04 ± 190.55 mg/L, while the stem- aqueous extract reflected LC₅₀ of 3678.48 ± 398.11 mg/L. According to the obtained LC₅₀'s ± SE, the aqueous extracts of *S. kali* stem and leaves showed relatively higher larvicidal potentiality against palm weevil larvae, followed by *E. peplus* stems, then *H. longiflorum* stems and leaves, and at the last rank and choice, the leaves of *E. peplus* which showed the lowest efficient aqueous extract against palm weevil larvae.

Keywords: euphorbia peplus, salsola spp, heliotropium longiflorum, red palm weevil

1. Introduction

Weed is a word commonly used to refer to harmful plant species, although taxonomists consider weeds as plants that may be undesirable in certain situations and locations, but are of important value in other locations and situations [1]. In fact, weeds represent a wide range of plant species spread worldwide and are important biological component within many agricultural, forest, grassland and aquatic environments [2]. Therefore, weeds should be identified whether they are local or alien, and their negative and positive characteristics should be recorded in order to build a database regarding the weeds inventory which should be of priority to countries. In Saudi Arabia, weeds have been recorded by many researches since the 1970's as documented by Alghamdi, *et al.* [3].

Euphorbia peplus L. is an annual weedy herb of the family Euphorbiaceae that have been used traditionally for many medicinal treatments for the skin and the respiratory system [4]. The stem white, sticky sap contains a variety of chemical compounds such as Ingenol 3-mebutate which is known an anticancer found in the sap. This compound is now marketed as Picato, an approved topical gel for the treatment of actinic keratosis, a form of non-melanoma cancer [4].

Salsola kali is a summer annual weedy species of the family Amaranthaceae that begins life as a typical multiple branched bush, but then it turns into a spherical form. This species is found in abundance in semi-desert regions and salty soils, where rainfall is very low. *S. kali* has the tendency to invade a variety of habitats including; rangeland, semi-arid grasslands as well as agricultural farms, railroad, residential and industrial areas. *S. kali* is called tumble weed as it sometimes tumbles on roads surprising drivers and cause traffic accidents. It is also

reported to be responsible for allergic sensitization in Europe and North America. It should be noted that nitrates and soluble oxalates accumulate in the plants photosynthetic parts at levels poisonous to sheep [5]. Young plants can be served as useful fodder, as long as they are not too high in nitrates or oxalic acids. It is fast germinating and growing species as it requires minimum moisture particularly in disturbed soils [6]. The plant has been traditionally called glasswort and used for long time in making glass due to its high alkali content [7]. The Salsolin phytochemical that can be extracted from *S. kali* has been reported to regulate the blood pressure, as it resembles the papaverine in its effect on the smooth muscles of the uterus [8].

Heliotropium longiflorum is an annual or perennial herb or subshrub of the family Boraginaceae, and the name "heliotrope" is derived from the fact that this plant turns its leaves to the sun [9]. Within the family Boraginaceae, *Heliotropium* species exhibit great variation in many features of biological interest including physiognomy, habitat preferences and morphological traits [10].

Heliotropium longiflorum is reported for its traditional medicinal uses for inflammations, gout, rheumatism, skin diseases, menstrual disorder, and poisonous bites. Such medicinal properties have been attributed to the presence of many bioactive components especially pyrrolizidine alkaloids, terpenoids and flavonoids which revealed significant biological activities as antimicrobial, antitumor, antiviral, anti-inflammatory, wound healing, cytotoxicity and phytotoxicity [11].

The palm weevil *Rhynchophorus ferrugineus* (Olivier) (Coleoptera: Curculionidae) is one of two species of snout beetle known as the red palm weevil. Its larvae can excavate holes in the trunk of a palm trees up to a meter long, hence the weevil is considered a major pest that attack 19 palm

species worldwide included coconut palm, date palm and oil palm [12].

It is reported that red palm weevil was recorded for the first time in 1994 in Spain [13] and then in 2006 in France, and in the United States in 2010 [14]. This weevil usually infests young palm trees younger than twenty years, while the adult causes damage through feeding and burrowing into the heart of the palm that lead to its mortality [15]. The weevil is controlled through the application of a systemic insecticide, or drenching the base of palm fronds with the fungus *Metarhizium anisopliae*, or *Beauveria bassiana* [16]. Some other natural products have been tested successfully against different stages of different insect species either under laboratory or field conditions. Therefore, the aim of this study was to evaluate the effect of aqueous extracts of *Euphorbia peplus*, *Salsola kali* and *Heliotropium longiflorum* leaves and stems on palm weevil larvae.

2. Materials and Methods

2.1. Plant materials

Fresh *E. peplus*, *S. kali* and *H. longiflorum* specimens were collected from Al-Baha region in the south-west of Saudi Arabia. Specimens of leaves and stems were chopped and spread on a tarp, and allowed to air dry. Then, the dry coarsely chopped plant material was further ground to pass through a 2.4 mesh screen using a Gehl Mix-All model 55 (Gehl Company, West Bend, WI, USA). After processing, the ground plant material was stored in plastic bags away from direct light at ambient temperature until use.

2.2. Red palm weevil

Red palm weevil larvae (*Rhynchophorus ferrugineus*) were collected from high infested palm tree farms that not received any chemical treatment such as insecticides, and then larvae were kept in a glass jar that contained small pieces of sugar cane.

2.3. Bioassay

Each single test consisted of 20 larvae of *R. ferrugineus* which was taken into 500 ml beaker that have a volume of dechlorinated tap water (PH = 7.4). Plants aqueous extract

(stock) were added at the following concentrations; (1.0, 1.5, 2.0, 2.5, and 3.0 ml), besides the control that was set up using dechlorinated tap water only. Each test was based on three replications. The number of dead larvae was counted after 24 hour of exposure.

2.4. Data analysis

After 24 hours, the dead larvae were counted. The data were plotted in a table organized to show the obtained percentage mortalities corresponding to the concentrations of each aqueous extract used (in ppm). The probit analysis was run to calculate the lethal concentrations (LC₅₀ and LC₉₅) from the obtained regression equation, R-square and the Standard errors.

3. Result and Discussion

The effect of aqueous extracts of *E. peplus* leaves on palm weevil larvae after 24 hours was shown in (Table, 1). The concentrations of 2955, 4432.5, 4432.5, 59107387.5 and 8865 mg/L resulted in percentage mortalities of 15, 30, 40, 75 and 85, respectively. The LC₅₀ was 6656.32 ± 756.78 mg/L, while the LC₉₅ was 13969.88 ± 756.78 mg/L with R² of 0.93. The aqueous extracts of *E. peplus* stem at concentrations of 1550, 2325, 3100, 3875 and 4650 mg/L killed 20, 40, 45, 70 and 90 percent of the tested larvae, respectively. The LC₅₀ was, 2574.63 + 602.56 mg/L, while the LC₉₅ was 7921.54 + 602.56 mg/L and R² of 0.85 (Table, 1). According to the previous results, *E. peplus* stems seemed to be more toxic than leaves.

E. peplus was noticed to be rarely attacked by insects in the field, which can be attributed to the fact that this plant contains insecticidal constituents.

Acetone extract of the plant proved to be toxic to mosquito larvae. Crude alkaloids present at a concentration of about 0.04 % on the dry weight basis, were isolated and screened for their toxicity and proved to be more toxic than the acetone extract [17]. The terpenoids in the latex of *E. peplus* are rich and highly diversified, and might function as constitutive defense metabolites against insect herbivores and pathogens [18]. Generally, *E. peplus* leaves was more lethal against mosquito larvae as noticed by Ghramh *et al* [19].

Table 1: Effect of aqueous extracts of *E. peplus* leaves and stems on palm weevil larvae after 24 hours

Leaves		Stems	
Concentration (mg/L)	Tested Mortality (%)	Concentration (mg/L)	Tested Mortality (%)
2955	15	1550	20
4432.5	30	2325	40
5910	40	3100	45
7387.5	75	3875	70
8865	85	4650	90
Control mortality	0		0
Polar substances	59.1%		31%
Probit analysis			
Regression Equation	Y = -11.41 + 4.38X	Y = -6.46 + 3.36X	
SE-X	0.69	0.81	
SE-Y	2.57	2.78	
R ²	0.93	0.85	
LC ₅₀ (mg/L)	6656.32 ± 756.78	2574.63 ± 602.56	
LC ₉₅ (mg/L)	13969.88 ± 756.78	7921.54 ± 602.56	

The percentage mortalities of the aqueous extracts of *Salsola kali* leaves on palm weevil larvae after 24 hours at the concentrations of 1490, 2235, 2980, 3725 and 4470

mg/L were 25, 60, 70, 80 and 90, respectively. The LC₅₀ was, 2088.84 ± 186.21 mg/L, while the LC₉₅ was 5111.29 ± 186.21 mg/L and R² was 0.93 (Table, 2). The percentage

mortalities of aqueous extracts of *Salsola* stem at concentrations of 1000, 1500, 2000, 2500 and 3000 mg/L were 20, 45, 55, 85 and 90, respectively. The LC_{50} was, 1617.67 ± 57.54 mg/L, the LC_{95} was 3743.98 ± 57.54 mg/L and R^2 was 0.96 (Table, 2). According to the previous results, *S. kali* stems seemed to be more toxic than leaves.

Extracts of some *Suaeda* species have been reported previously for its larvicidal activity. For example, the effect of acetone extracts of four indigenous medicinal plants against *Tribolium castaneum* showed significant insecticidal activity by *Nicotiana tabacum* extract followed by *Salsola baryosma*, *Pegnum hermala* and *Saussurea costus* extracts

[20]. Also, five triterpene glycosides, among which two compounds, never reported before, have been isolated from the roots of *Salsola imbricata*, a shrub widely growing in Egypt [21]. In addition, *Salsola foetida*, *Suaeda fruticosa*, *Haloxylon salicornicum*, and *H. recurvum* from Cholistan, Pakistan, were investigated against adult worms of *Haemonchus contortus*, *Trichuris ovis*, and *Paramphistomum cervi*. The LC_{50} 's indicated that the methanol and aqueous-methanol extracts of *C. decidua*, *H. recurvum*, and *H. salicornicum* as well as the methanol extract of *S. fruticosa* have the potential to be developed into plant-based remedies against the studied helminthes [22].

Table 2: Effect of aqueous extracts of *Salsola kali* leaves and stems on palm weevil larvae after 24 hours

Leaves		Stems	
Concentration (mg/L)	Tested Mortality (%)	Concentration (mg/L)	Tested Mortality (%)
1490	25	1000	20
2235	60	1500	45
2980	70	2000	55
3725	80	2500	85
4470	90	3000	90
Control mortality	0	0	
Polar substances	29.8%	20%	
Probit analysis			
Regression Equation	$Y = -9.01 + 4.22X$	$Y = -9.44 + 4.50X$	
SE-X	0.66	0.54	
SE-Y	2.27	1.76	
R^2	0.93	0.96	
LC_{50} (mg/L)	2088.84 ± 186.21	1617.67 ± 57.54	
LC_{95} (mg/L)	5111.29 ± 186.21	3743.98 ± 57.54	

As shown table (3), the percentage mortality of aqueous extracts of *H. longiflorum* leaves on palm weevil larvae after 24 hours, at concentrations of 2550, 3825, 5100, 6375 and 7650 mg/L were 20, 45, 60, 85 and 95, respectively. The LC_{50} was 3949.04 ± 190.55 mg/L, the LC_{95} was 8244.78 ± 190.55 mg/L and the R^2 was 0.96. The percentage mortalities of aqueous extracts of *H. longiflorum* stem at concentrations of 2250, 3375, 4500, 5625 and 6750 mg/L were 25, 40, 50, 80 and 90, respectively. The LC_{50} was 3678.48 ± 398.11 mg/L, the LC_{95} was 9340.51 ± 398.11 mg/L, and the R^2 was 0.91 (Table, 3). *H. europaeum* a relative species of *H. longiflorum*, has been reported to contain three major alkaloids: heliotrine N-oxide 0.08%, lasiocarpine 0.09% and lasiocarpine N-oxide 0.05%; and four minor alkaloids: heliotrine 0.02%, europine 0.02%, acetylasiocarpine 0.03% and a novel alkaloid acetylasiocarpine N-oxide 0.05% [23]. Yusufoglu *et al.*, [24]

reported that, toxic symptoms and mortalities were reported when mice were given the extracts at doses up to 4000 mg/kg. Accordingly, it suggested that oral LD_{50} of both extracts was higher than 4000 mg/kg. However, isolated from the resinous exudates of *H. megalanthum* and was evaluated for several plant-defensive properties (insecticidal, antifungal, and phytotoxic) [25]. The most common toxic pyrrolizidine alkaloids found in *Heliotropium* were mono- or diesters of C1-C2 unsaturated necine bases [1, 2-dehydro PAs] of the supinidine-type, heliotridine-type, and retronecine-type [26, 27].

Potential toxic effects of water extract of *H. bacciferum* on the reproductive system were investigated in rats. It revealed no changes in the tissues of the testes, although, some changes were detected in the cauda epididymis, the most important of which was the development of small lesions of spermatic granuloma [28].

Table 3: Effect of aqueous extracts of *H. longiflorum* leaves and stems on palm weevil larvae after 24 hours

Leaves		Stems	
Concentration (mg/L)	Tested Mortality (%)	Concentration (mg/L)	Tested Mortality (%)
2550	20	2250	25
3825	45	3375	40
5100	60	4500	50
6375	85	5625	80
7650	95	6750	90
Control mortality	0	0	
Polar substances	51%	45%	
Probit analysis			
Regression Equation	$Y = -13.45 + 5.13X$	$Y = -9.44 + 4.05X$	
SE-X	0.62	0.72	
SE-Y	2.28	2.60	

R ²	0.96	0.91
LC ₅₀ (mg/L)	3949.04 ± 190.55	3678.48 ± 398.11
LC ₉₅ (mg/L)	8244.78 ± 190.55	9340.51 ± 398.11

The relative efficiency of aqueous extracts used in this study, according to the obtained LC₅₀ values, cleared that, *Salsola kali* stems showed relatively higher larvicidal potentiality (1617.67 mg/L) against palm weevil larvae followed by *S.*

Kali leaves (2088.84 mg/L), *E. peplus* stems (2574.63 mg/L).

H. longiflorum stems (3678.48 mg/L) and leaves (3949.04 mg/L) and at last rank, *E. peplus* leaves (6656.32 mg/L) that showed lowest efficient extract (Figure, 1).

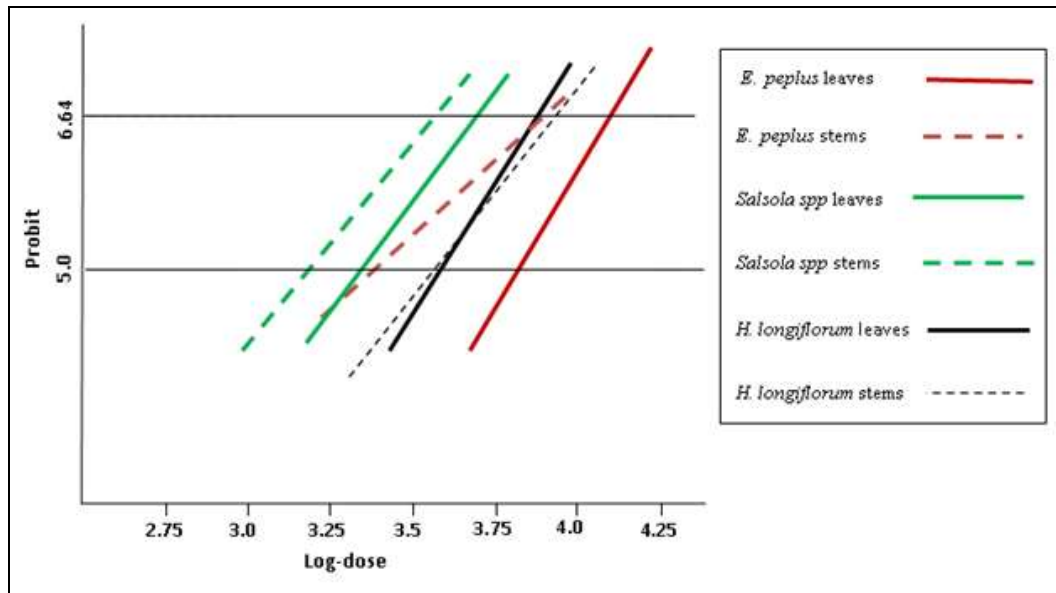


Fig 1: Log dose-probit lines for the selected plant parts against red palm weevil larvae

The intensive use of insecticides against the invasive populations of red palm weevil imparts detrimental effects on non-target animals, environmental pollution, and insecticide residues in the food [29]. Natural insecticide Abamectin (ABM) has been evaluated against developmental stages of red palm weevil under laboratory conditions.

Bioassay test showed that ABM at 600 ppm (µg/ml) caused 60% mortality against females and males after 24 hours, and after the increase of the concentration to 1000 ppm, the adults' mortality reached 100%.

Neonate larvae exhibited more sensitivity toward ABM, where 200 and 500 ppm caused 80 and 100% mortality at 24 hours after treatment with LC₅₀ 98.7 ppm and LC₉₅ 352 ppm. In the meantime, the toxicity effect of the treatment with ABM up to 500 ppm checked at the 24-hour period was 0% mortality against 25-day old larvae, and then it reached 60% by the same concentration at 7 days after treatment [30].

4. Conclusions

The aqueous extracts used in this study, showed promising potentiality to control red palm weevil larvae. *S. kali* stems-aqueous extract showed relatively higher larvicidal potentiality against palm weevil larvae followed by *S. kali* leaves, *E. peplus* stems, *H. longiflorum* stems and leaves and at last rank, *E. peplus* leaves. In almost all cases, the stems part showed more potentiality than leaves. The current study recommends for further investigation of the active compounds of the three weed species which might be a better approach in pest management with less harm to both environment and human health.

5. References

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