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INSECTICIDAL EFFECT OF *EUPHORBIA BUPLEUROIDES* LATEX ON *BLATTELLA GERMANICA* (DICTYOPTERA: BLATTELLIDAE)

Imane Azoui[1], Naama Frah[2], Billal Nia[3]*

[1]Department of Natural and Life Sciences, Faculty of Sciences, University of El Hadj Lakhdar, 05000 Batna, Algeria

[2]Institute of Veterinary and Agronomical Sciences, University of El Hadj Lakhdar, 05000 Batna, Algeria

[3]Department of Agronomic Sciences, University of Mohamed Khider, 07000 Biskra, Algeria

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Blattella germanica is commonly found in homes, restaurants, hospitals, other large buildings, and public health implications. It has become resistant to many insecticides. Latex effect of Euphorbia bupleuroides on *B. germanica* mortality was tested in order to obtain a new bioinsecticides. Five concentrations (0%, 25%, 50%, 75% and 100%) were evaluated against males, females and larvae of German cockroach under laboratory conditions. High levels of mortality of *B. germanica* adults and larvae were associated with the increase in the concentration and time of exposure as well.

Keywords: *Blattella germanica*, *Euphorbia bupleuroides*, Insecticidal effect, Latex, Mortality

INTRODUCTION

The German cockroach, *B. germanica* (Linnaeus, 1767), is an important pest of homes, restaurants, and commercial food processing facilities worldwide (Liu et al., 2011). They are considered as important indicators of hygiene because they can cause allergic reactions in sensitive people, and transmit several human pathogens such as viruses, bacteria, protozoa, and helminthes (Yeom et al., 2012). They are always associated with indoor environments such like bathrooms, kitchens, and food storage areas (Nasirian et al., 2011).

Cockroach control was especially dependent on the use of many types of insecticides (Habes et al., 2013), mainly by chlorinated hydrocarbons, organophosphates, compounds based on pyrethroids, and carbamates (Rust et al., 1993). Excessive use of these insecticides has developed resistance (Rust & Reierson, 1991; Zhai & Robinshon, 1992) and also cause harm to humans and the environment (Gagné et al., 1999).

The search for new insecticides and ways to control the German cockroach continue because this insect remains one of the most economically and medically important pests of the urban environment.

Plants secondary metabolites are known to play a crucial role in pests control because some are selective, biodegradable, non toxic products, and have few harmful effects on non target organisms and the environment (Wink, 1993; Isman, 1995). Indeed, about 250,000 plant species in the world have been reported to contain compounds with insecticidal properties (De Silva, 2008).

The Euphorbiaceae family, which is considered one of the largest families of Angiosperms, covers about 7,800 species distributed in approximately 300 genera and 5 subfamilies worldwide. These species grow often in tropical and subtropical environments (Webster, 1994). The chemical constituents of the Euphorbiaceae family plants include triterpenoids and related compounds (sterols, alcohols and hydrocarbons), phenolic compounds (flavonoids, lignans, coumarins, tannins, phenanthrenes, quinones, phenolic acids, etc.), alkaloids, cyanogenic glucosides, and glucosinolates (Abdel-Fattah, 1987).

Euphorbia is the dominant genus which having about 2000 known species from annuals to trees. All these specie contain latex and have unique flower structure (Amir, 2006). Some of the species are used in folk medicines to cure skin diseases, gonorrhea, migraines, intestinal parasites, and warts (Singla & Pathak, 1990). Several studies showed insecticidal and pesticidal effects of Euphorbia genus (Kemassi, 2008; Ayatollahi et al., 2010; Singh, 2012).

Euphorbia bupleuroides is an herbaceous plant with simple leaves growing in mountain rock area (Quezel & Santa, 1963). It is an endemic medicinal plant of Algeria used as an ancient remedy to extirpate thorns and to treat warts. It is well known that the decoction of roots is used in Algeria with anti-inflammatory purposes (Aichour et al., 2014). Its latex is rich in triterpenes (Biesboer & Mahlberg, 1979; Yamamoto et al., 1981).

In this study, we tried to evaluate the insecticidal activity of *Euphorbia bupleuroides* latex against the German cockroach.

*Corresponding author e-mail: billal.nia@univ-biskra.dz

MATERIALS AND METHODS

Insect rearing

Colonies of *B. germanica* were maintained under laboratory conditions (25°C, 50 to 70% relative humidity) with a L16:D8 h photoperiod. The cockroaches were reared in plastic containers and provided with unlimited supplies of water and biscuit (food).

Latex dilutions preparation

Euphorbia bupleuroides collected from their natural habitat around Arris, 60 km South East of the city of Batna in the East of Algeria (35°15′27″N, 6°21′3″E). This plant was identified by Dr Oudjhih from the Laboratory of Botanic, Department of Agronomy, Batna, Algeria.

Freshly plant stems were cut and brought to the laboratory in order to extract latex. These stems were let dripping from a cutting into a clean test tube.

5 latex dilutions (0%, 25%, 50%, 75% and 100%) were prepared by adding distilled water according to the protocol of Singh (2012).

0 ml. (Control) no latex was added there is only distilled water.

25 ml latex and 75 ml of distilled water used as 25%;

50 ml latex and 50 ml of distilled water used as a 50%;

75 ml latex and 25 ml of distilled water used as a 75%;

100 ml of latex and 0 ml of distilled water used as 100%.

Toxicity test

Twenty *B. germanica* individuals were placed in plastic boxes to test latex insecticidal effect by ingestion. Indeed, 10 cockroaches were isolated and grouped in boxes (12 × 9 × 4.5) cm containing biscuit (food) and a water tube added with various concentrations of latex (25%, 50%, 75% and 100%) with three replications (Habbachi, 2013). Evaluation time was 28 days for adults and 21 days for larvae. Observation of dead individual numbers was made daily. Erratic movements and disorientated cockroaches were considered as early symptoms of poisoning which were followed by paralysis.

Statistical analysis

Logistic regression analysis was employed to predict the probability that a latex concentration augmentation would increase mortality of cockroaches' individuals in different time intervals. The predictor variables were latex concentrations (25%, 50%, 75% and 100%). The Chi-square value will determine whether there is a difference between the current model and the intercept-only model. Thus, one can conclude that experience is related to programmers' success. We used the statistical program Statistica 8 (StatSoft, Inc., Tulsa, OK) for all analyses.

RESULTS

The Chi-square value for the difference between the current model and the intercept-only model is highly significant (0.000). Thus, one can conclude that mortality is related to latex concentrations. In fact, table 1 shows the logistic regression coefficient, Wald test and odds ratio for each of the predictors. Using a .05 criterion of statistical significance showed that all concentrations for both adults and larvae had significant partial effects (Tables 1 and 2).

Latex effect on adult mortality

The mortality rates of males and females are summarized in Figure 1. In fact, at a concentration of 25% there was no mortality after 7 days. However, after 14, 21 and 28 days, the mortality rate increased from 26% to 100% for males. When concentrations got more, the time required to have high level of toxicity began short. At 50% and 75%, we observed 26% and 56% mortality after 7 days, 46% and 83% after 14 days and 76 to 100% after 28 days. The highest concentration (100%) caused 100% mortality just after 7 days of exposure.

Table 1: Latex toxicity on *B. germanica* adults (LC_{50} and LC_{90}) after 7, 14, 21, and 28 days. M: Male, F: Female

Exposure time (days)	Sex	χ^2	B	χ^2 Wald	*P*	Odds Ratio	LC_{50} (%)	LC_{90} (%)
7	M	379.94	-6.14	117.88	0	1.1	68.27%	92.66%
	F	237.35	-5.01	122.64	0	1.06	79.12%	113.87%
14	M	369.28	-4.12	121.54	0	1.08	52.18%	80.03%
	F	397.14	-5.44	120.84	0	1.09	59.77%	83.94%
21	M	342.43	-2.49	80.75	0	1.09	29%	54.59%
	F	475.11	-5.1	93.05	0	1.13	50.96%	72.96%
28	M	351.71	-2.61	58.65	0	1.13	15.94%	39.23%
	F	471.7	-4.72	94.9	0	1.14	47.22%	69.22%

Table 2: Latex toxicity on *B. germanica* larvae (LC_{50} and LC_{90}) after 7, 14, and 21 days.

Exposure time (days)	χ^2	B	Wald χ^2	P	Odds Ratio	LC_{50} (%)	LC_{90} (%)
7	69.1	- 6.14	63.24	0.000	1.05	122.8%	142.8%
14	189.68	- 3.9	126.62	0.000	1.05	78%	97%
21	251.62	- 2.31	97.96	0.000	1.05	46.2%	65.2%

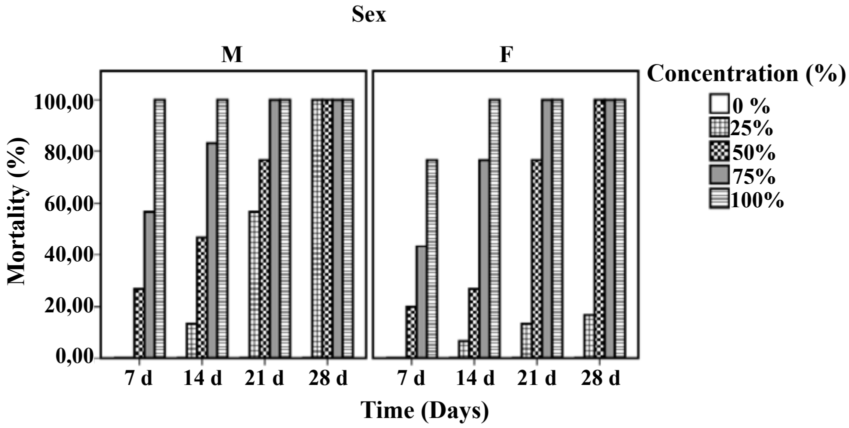

Figure 1: Mortality rates in males (M) and females (F) of *B. germanica* treated with different concentrations of latex.

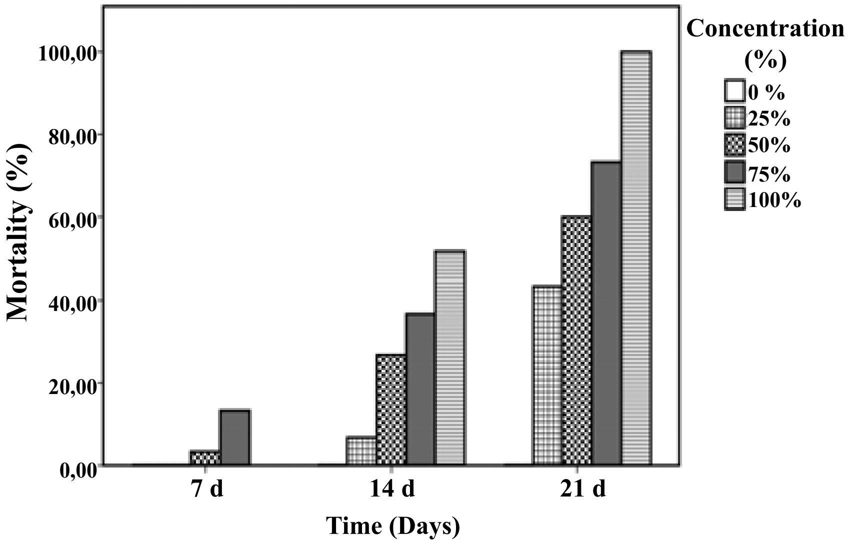

Figure 2: Mortality rates in *B. germanica* larvae treated with different concentrations of latex.

In females, only 16% of mortality was recorded after 28 days using a concentration of 25%. The highest concentration (100%) caused 76% of mortality after 7 days and 100% mortality after 28 days of exposure (Figure 1).

Latex lethal concentrations were calculated after 7, 14, 21 and 28 days of exposure. Results showed that males are generally more sensitive to latex effect than females (Table 1). Indeed, after 28 days, the LC_{50} recorded was 15.94% for males and 47.22% for females whereas the LC_{90} was 39.23% for males and 69.22% when females were exposed to the latex.

Latex effect on the larvae mortality

The results of Figure 2 showed that the mortality rate varied with concentrations and time. In fact, after 21 days, mortality recorded was 43%, 60%, and 75% using 25%; 50%, and 75% concentrations respectively. With the highest concentration, we obtained 100% of mortality for the same time interval (Figure 2).

From the logit analyses, lethal concentrations were calculated after 7, 14, and 21 days of exposure. After 7 days, the LC_{50} was 122.8% whereas LC_{90} was 142.8%. In the 21st day, LC_{50} and LC_{90} recorded were 46.2% and 65.2% respectively (Table 2).

DISCUSSION

The *E. bupleuroides* latex was tested against common species and most widespread pest houses, restaurants, and places of food stokcage. These pests such *B. germanica* are considered to be more resistant to synthetic insecticides (Saito & Hama, 2000). In the literature, the Euphorbiaceae family is known for potent latex available in the most of its species leaves and barks. Vimal & Das (2014) reported that *Euphorbia antiquorum* (L.) latex extract showed high toxicity against *Aedes aegypti* (L.) larvae where LC_{50} value was 10.70 ml/dl after 48 hours of exposure. After 24 hours, the LD_{50} values for different latex fractions of 24 h were in a range of 5.0-17.613 µg/mg while combined mixtures of *Calotropis procera* (Aiton) showed synergistic activity against termites and caused comparably high mortality with LD_{50} was 1.987-6.016 µg/mg (Upadhyay, 2013). Larvicidal properties of *Euphorbia* latex against larvae of Anopheles mosquitoes were evaluated by Mwine *et al*. (2010). Results indicated that the latex made total mortality at the highest dilution used of 1:250 in 5 days. Lee *et al*. (2010) examined the insecticidal effects of *Sebastiania corniculata* against *Laodelphax striatellus*, *Nilaparvata lugens*, and *Sogatella furcifera*. The chloroform fraction of *S. corniculata* showed the most potential activity against *L. striatellus* (DL_{50}=1.09 µg/female), *N. lugens* (DL_{50}=4.46 µg/female), and *S. furcifera* (DL_{50}=2.32 µg/female).

Euphorbia sp. latex is particularly rich in diterpens and triterpen esters (Khan *et al*., 1989; Rasool *et al*., 1989). They are the most relevant compounds to the toxicity and considerable biological activities which are known such insecticidal and pesticidal **(**Singh, 2012; Sandhyarani & Kumar, 2014; Vimal & Das, 2014**)**. Many studies showed the amoebic effect (Tona *et al*., 2000), nematicide activity (Liu *et al*., 2014), molluscicidal activity (Bakry & Hamdi, 2009), and antitermite activity (Upadhyay, 2013).

Brunner and Isman (2001) tested the synergistic effect of 4 terpens on acute toxicity in connection with *Spodoptera litura* larvae. These compounds reduced growth by 20% on average 3 days after administration. Also, Roman Pavela (2010) recorded acute toxicity and mutual synergistic effect of six monoterpenoids on *Spodoptera littoralis* larvae with LD_{90} values <100 µg/larva (weight 25-30 mg). Terpens contained in an essential oils extracted from aromatic plants, were reported effective as repellent, larvicidal, pupicidal or adulticidal against different species of cockroaches (Liu *et al*., 2011; Sittichok *et al*., 2013). These compounds mode action is mainly reported to be the nervous system. Octopamine receptor and acetyl cholinesterase enzyme are two of its target sites (Kostyukovsky *et al*., 2002). Phorbol esters are the diterpenoids which occur naturally in many plants of the Euphorbiacaeae and Thymelaeaceae family (Goel *et al*., 2007). Their application at different concentrations caused significant high mortality rate on the nymph and, adult cockroaches and termites (Beninger *et al*., 1993; Lateef *et al*., 2014).

CONCLUSION

The findings of the present study suggest that *Euphorbia bupleuroides* latex extract may be explored as potential natural insecticidal agent against *Blattella germanica*. It was especially efficient against males and larvae. The latex is known to contain terpens, which are recognized by their toxicity.

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