INSECTICIDAL ACTIVITY OF THREE *SOLANACEAE* PLANTS (*SOLANUM NIGRUM*, *NICOTIANA GLAUCA* AND *ATROPA BELLADONA*) ON GERMAN COCKROACHES (*BLATTELLA GERMANICA*)

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Abstract: *Cockroaches are dictyopteran insects that appeared on earth more than 440 million years ago, with more than 4440 species of cockroaches that are known to date, many of which are considered pests and cause many problems. health issues for humans, such as allergies.*
The fight against cockroaches is one of the current problems that the scientific world is trying to solve, in the face of the chemicals widely used today and which cause the development of resistance in the treated insects in addition to their impact on the environment. In the present study we tested the toxicity of the aqueous extract of three plants of Solanaceae (Solanum nigrum , Nicotiana glauca and Atropa balladona) with regard to the adults of Blattella germanica , where we marked a high mortality rate which can reaching 90% of the population after 30 days of exposure to a dose of 1000 µg / ml of the Solanum nigrum extract , the results give a toxic effect on cockroaches determined at different lethal and sublethal times (TL50% and TL 90 %).

Keywords: *Cockroaches, Blattella germanica , Solanum nigrum , Nicotiana glauca , Atropa balladona , Toxic effect.*

1. Introduction

Cockroaches are insects of tropical origin introduced involuntarily into human habitats, and some of them have become urban animal species. They are installed in all types of housing such as hospitals, restaurants, food shops and private apartments (Nicole *et al.*, 1997).

Domestic cockroach species are known to be harmful insect vectors of pathogens and also contaminate food products with their characteristic odor and their defecations (Grandcolas, 1998).

Cockroaches move freely, they feed on human and animal waste or can come into contact with them during their many movements in sewers, latrines and pipes. Cockroaches from outside will potentially be able to contaminate food with bacteria responsible for food poisoning (Hedjouli, 2022).

The faeces, saliva, bodily secretions, molts and dead bodies of cockroaches are sources of powerful allergens. They will be able to cause skin reactions, topical dermatitis, itching, swelling of the eyelids, rhinitis, but especially asthma. As early as the 1940s, skin rash and asthma phenomena could be attributed to cockroach allergens (Mourier, 2014).

Among the species of cockroaches, *Blattelle germanica* is a dictyopteran insect of the

Blattellidae family (Guillaumin *et al*., 1969) has heterometabolic development, larvae and adults of this species are omnivorous (Pedigo, 1989) constitute an important problem in terms of hygiene and human health (Tine, 2013). They can also vector several human bacterial diseases (Ash and Greenberg 1980). The German cockroach *B. germanica* has a high reproductive potential (Willis *et al.,* 1958) and an ability to build large infectious populations (Nejati *et al.,* 2012).
Conventional chemical insecticides, mainly used for decades, have led not only to environmental pollution, but also to the appearance of insect resistance phenomena. It is imperative to consider the development of more specific insecticides, non-toxic to non-target organisms, biodegradable and less likely to cause resistance in target species (Saxena, 1988). In this axis, we tested the effect of the aqueous extract of three plants grouped in the family of *solanaceae* namely *Solanum nigrum* , *Nicotiana* glauca and *Atropa belladona* on adults of *Blattella germanica.*

2. Materials and methods

2.1. Presentation of the harmful insect

Blattella germanica (*B. germanica*) is a predominant domestic cockroach (Miller and Koehle, 2003), cosmopolitan (Gordon, 1996), oviparous and with heterometabolic development (Guillaumin *et para.* , 1969). It represents a potential vector for diseases such as dysentery, gastroenteritis, typhoid fever and poliomyelitis (Durier and Rivault, 2003).

2.2. Breeding

The cockroaches are placed in plastic boxes with mesh openings on the sides and containing egg cells for shelter. Cockroaches are fed with biscuits and drenched with cotton soaked in water. Rearing is maintained at a temperature of 23 ± 2°C, a relative humidity of (50-55%) and a photoperiod of 12 hours (Appel and Tanley, 2000).

2.3. Presentation of the insecticidal plants studied

Solanum nigrum (*S. nigrum*) is an annual plant, growing as weeds in cultivated fields or under trees, the plant was collected in M'sila (Algeria) in 2017 .

Nicotiana glauca (*N. glauca*) is a perennial plant that grows in semi-arid and humid regions, the plant was harvested in M'sila (Algeria) in 2019.

Atropa belladona (*A. belladona*) is a toxic plant grows in forests, this plant was harvested in Jijel (Algeria) in 2021.

All the plants used in this study were collected and authenticated by the botanist Pr. Rebbas Khellaf from the University of M'sila.

2.4. Preparation of extracts (by decoction)

To prepare the aqueous extracts of the three plants, we weighed the fresh leaves of each one of the latter, namely (*S. nigrum* , *N. glauca* and *A. belladona*), which were soaked in distilled water and allowed to boil over a benzene nozzle at an average temperature. The mixture obtained is filtered using filter paper (Belkhiri, 2022).

2.5. Toxicity test

Young adults (male and female) of cockroaches (*B. germanica*) are isolated and grouped by 10 individuals in three repetitions in boxes (13 x 11 x 5 cm) containing dog food (food) and a tube of water with added a concentration of the aqueous extract and the control batches are watered with pure water. The same test applied for the three plants tested.

The experiment is monitored for a month, where the number of dead individuals is observed daily in order to determine concentrations and lethal times (Habbachi, 2013).

The concentrations of the extracts tested and the exposure times of the cockroaches are illustrated in Table 1, we chose two concentrations for each plant (500 and 1000 µg/ml for *S. nigrum* , 1000 and 1500 µg/ml for *N. glauca* while 35 and 70 µg/ml are the doses tested for *A. belladona*), and monitoring is done for 2.15 and 30 days for *S. nigrum* and *N. glauca* and for 5, 15 and 30 days for *A. belladona* .

Table 1. *Concentrations C (µg/ml) of aqueous extracts tested and exposure times T (days) of cockroaches in the present study*

Plant species	Concentration Applied (µg/ml)		Exposure time (days)		
	C1	C2	T1	T2	T3
S. nigrum	500	1000	2	15	30
N.glauca	1000	1500	2	15	30
A. belladona	35	70	5	15	30

2.6. Statistical analysis of data

With regard to the results obtained for the toxicological study, we calculated according to the mathematical procedures of Finney (1971), the lethal times (TL50% and TL90%) for each of the bio-insecticides used.

3. Results

3.1. Effect of *S. Nigrum* on *B. Germanica mortality*

Figure 1 summarizes the different mortality rates of *B. germanica* recorded after 2, 15 and 30th days of exposure to two concentrations (500 µg/ml and 1000 µg/ml) of *S. nigrum* . After the first 15 days of exposure we observed a low mortality which can reach 33.33% for the low concentration and 56.66% for the high dose. After 30 days of treatment, the mortality rates increase for the two concentrations and reach the values of 66.66% and 90% respectively.

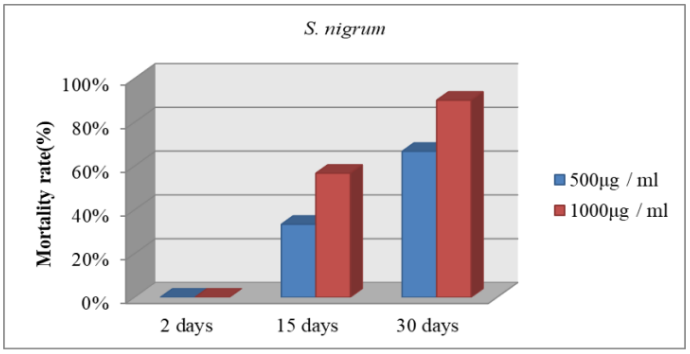

Fig. 1. *Corrected mortality rate of B. Germanica treated with S. Nigrum*

3.2. Effect of N. Glauca on B. Germanica mortality

The results illustrated in Figure 2 show that adults of *B. germanica* are sensitive to the extract of *N. glauca* , this sensitivity is reflected in high mortality rates recorded after 30 days of monitoring, of which we marked 70 % mortality when using a dose of 1000 µg/ml of the extract and 86.87% for 1500 µg/ml of the latter.

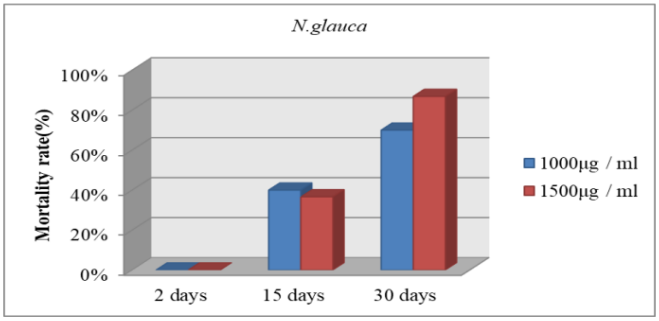

Fig. 2. *Corrected mortality rate of B. germanica treated with N. glauca*

3.3. Effect of *A. Belladona* on *B. Germanica mortality*

The use of the aqueous extract of *A. belladona* against the adults of *B. germanica* causes a mortality rate which varies between 3.35% and 26.7% depending on the concentrations and the exposure times. The application of the low concentration (35 µg/ml) induces a mortality rate of 3.35% after 5 days of exposure while the high concentration (70 µg/ml) shows a mortality rate of 5% after 5 days and 23.35% at 30 days (Fig.3).

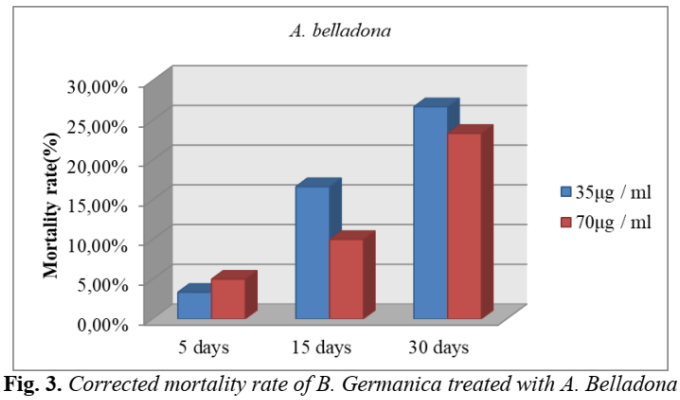

Fig. 3. *Corrected mortality rate of B. Germanica treated with A. Belladona*

4. Toxicological parameters

The results of Table 2 show that the use of a concentration of 500 µg / ml of the extract of *S. nigrum* causes the mortality of 50% of the cockroach populations after 20.89 days of treatment and 90% after 69.18 days of exposure. While the high dose (1000 µg / ml) causes mortalities of 50% after 12.02 days of follow-up and 90% after 31.62 days.

Concerning the extract of *N. glauca* we noticed that the low concentration (1000 µg/ml) can kill 50% of *B. germanica adults* after 18.62 days of treatment, the same percentage can die after 16.21 days if a high dose (1500 µg/ml) is used. On the other hand, to eliminate 90% of the adults of the same species with the use of the two concentrations (1000 µg/ml and 1500 µg/ml) we need 83.17 and 38.90 days respectively (Tab.2).

The results also show that the use of 35 µg / ml of the aqueous extract of *A. belladona* generates after 0.14 days the mortality of 50% of the adults of *B. germanica* , and 70 µg / ml of the same product can eradicate 90 % of the cockroach population after 14 days of exposure (Tab.2).

Table 2. *The toxicological parameters of the insecticidal plants used*

Plants tested	Concentrations (µg/ml)	Regressions	TL50% (Days)	TL90% (Days)
S. nigrum	500	Y=1,72+2,47x (R^2=0,48)	20.89	69.18
	1000	Y=1,66+3,07x (R^2=0,98)	12.02	31.62
N.glauca	1000	Y=2,52+1,95x (R^2=0,90)	18.62	83.17
	1500	Y=0,84+3,41x (R^2=0,88)	16.21	38.90
A. belladona	35	Y=-3,79+4,60x (R^2=0,62)	0.14	0.11
	70	Y=2,54+0,93x (R^2=0,97)	14	55

5. Discussions

The excessive and repeated application of conventional chemical insecticides has caused a phenomenon of resistance to appear in cockroaches and particularly in *B. germanica (Valles et al. al.,* 2000).

The use of plant extracts as an insecticide has been known for a long time, in fact pyrethrum, nicotine and rotenone are already identified as insect control agents, in more recent works the insecticidal properties of certain plants have been tested. on insect larvae (Crosby, 1996).

According to (Fournier, 2003) the aqueous extracts, powders and essential oils of plants contain molecules with insecticidal properties.

The Solanaceae family is one of the largest plant families, with nearly a hundred genera comprising over 2,500 species. Members of the family are scattered across all continents, in both tropical and temperate climates. It is a cosmopolitan family, composed of grasses, bushes and shrubs and which includes medicinal and/or toxic plants, many food and ornamental species. The diversity of the family from a chemical point of view is significant and

formidable poisons are produced (Hammiche *et al.,* 2013).

In this study, we tested the effect of aqueous extract of *S. nigrum, N. glauca* and *A. belladona on* adult mortality of *B. germanica* , the results show that there is a positive correlation between the rates of mortality, the concentration used and the exposure time.

Solanum is a rich source for several classes of compounds such as alkaloids (Emmanuel *and al* ., 2006), steroids (Ferro *and al* ., 2005) and phenolic compounds which enters the pharmaco-chemical industry (El-Sayed and Hassan, 2006).

Nicotine is also the most effective insecticide against aphids, whose mortality in its presence sorrels between 98 and 100%. It also acts on young scale insects and many sucking insects such as psyllids and leafhoppers (Zahaf, 2016).

For its part, belladonna is a deadly poison for humans as for animals, its toxicity has been confirmed on mice, rabbits and hares (Michel, 2001).

Conclusions

In this work, we demonstrated the efficacy of aqueous extract of *S. nigrum* , *N. glauca* and *A. belladona* as bio-insecticides on adult mortality of *B. germanica* . Mortality rates are positively correlated with the concentrations used and the duration of treatment. Our hope is that in the near future, we will be able to reduce chemical treatments against domestic cockroaches which may have developed resistance to the latter, for which the valorization of extracts from other plants in integrated pest management is then hoped.

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