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Intitulé

***Toxicity of *Solanum nigrum* and *Atropa belladonna* on the Adults of
Blattella germanica (Blattelidae)***

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♥ *I praise God Almighty a lot, who enabled me to complete this scientific research.*

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♥ *my dearest mother FERAHTIA CHAHRAZAD.*

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♥ *HIBA*

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- ♥ *Finally, my graduation dream has come true.*
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 - ♥ *my mother Feraihayossef*
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INTRODUCTION



Introduction

Cockroaches are an ancient and highly successful form of insect life. They have been in existence since Pennsylvanian (Upper Carboniferous) times. The fossil record indicates that they achieved an optimum body form early in their evolutionary history and have remained a very stable group since that time (Moore & al, 1952)

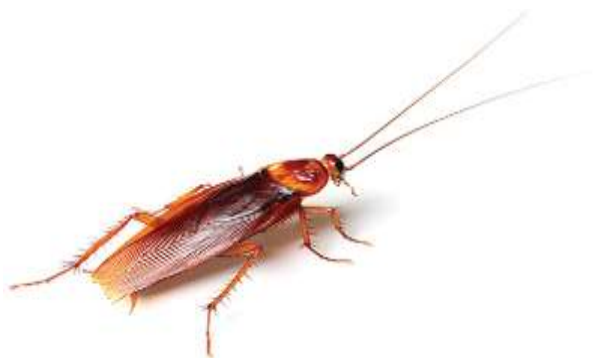
Cockroaches rank among the most important pests in city and town environments (Ebeling, 1975). Most species are of tropical or subtropical origins and thus by being invaded pests in temperate climates would seem to be ideal candidates for classical biological control (Dahlsten & Hall, 1999). Cockroaches are known to contaminate food, leave unpleasant odors in residences and are thought to transmit disease (e.g., hepatitis). Allergic reactions can occur to cockroaches, probably from contact with cockroach body secretions or feces (Ebeling, 1975). Principal species of importance in North America include the German cockroach, *Blattella germanica* (L.), the American cockroach, *Periplaneta Americana* (L.), the brown banded cockroach, *Supella longipalpa*. the Oriental cockroach, *Blatta orientalis* L. and the smoky brown cockroach, *Periplaneta fuliginosa* (bloomquist, 2014).

The German cockroach, *Blattella germanica* (L.), is an indoor sanitary pest worldwide and seriously threatens human health. With the rapid development of insecticide resistance, biological control has gradually become the most promising strategy for cockroach control (Xiao Yuan Pan & al, 2020).

The subject of this review is to focus on fighting the cockroaches, By Taken under the consideration that the german cockroaches is the most common in the area we decided to test the effectiveness of the extract of two different poisonous plant *Solanum nigrum* and *Atropa belladonna* adults of *Blattella germanica* depending on different concentrations and Duration of the exposure to the extract.

Chapter 1:

Bibliographic Synthesis



1. Generality on cockroach

1.1. Origin

Cockroaches are an old group, at least dating back to the carbonate: about 440 million years.... However, these early ancestors have been lacking internal groups for modern cockroaches. Cockroaches are simpering insects without special adaptations such as mouth parts of insects and other insects. Since the nineteenth century, scientists believed that cockroaches were an old group of insects that have Devon origin, according to one of the hypotheses. However, modern genetic evidence strongly indicates that they evolved directly from real cockroaches, and classify many authors now as a platoon of Platudia. (Thomson, 1980).

1.2. Systematic

The cockroach is Pterygotic insects (winged when adult). Regnum Animalia and Domain Eukaryota (Eukaryota are organisms whose cells have a nucleus enclosed within a nuclear envelope). (Sakagouchi & all,2009) belonging to the Order Blattodea (Blattodea is an order of insects that contains cockroaches and termites). (Wattenwyl,1882) and Superorder Polyneoptera (The cohort Polyneoptera is a proposed taxonomic ranking for the Orthoptera). (Martynov,1938) the Classis is Insecta and Subclassis is Pterygota and Infraclassis Neoptera (Neoptera (Ancient Greek néos (“new”) + pterón (“wing”)) is a classification group that includes most orders of the winged insects, specifically those that can flex their wings over their abdomens. (Martynov,1923) It also belongs to the Phylum Arthropoda (phylum Arthropoda). They are distinguished by their jointed limbs and cuticle made of chitin, often mineralised with calcium carbonate) (Von Siebold ,1848). In addition to Subphylum Hexapoda (From Greek for 'six legs') (Lacaille,1825).

1.3 Morphology of Cockroach

1.3.1. General Characteristics of Cockroach

Some of the general characteristics of cockroach are as follows:

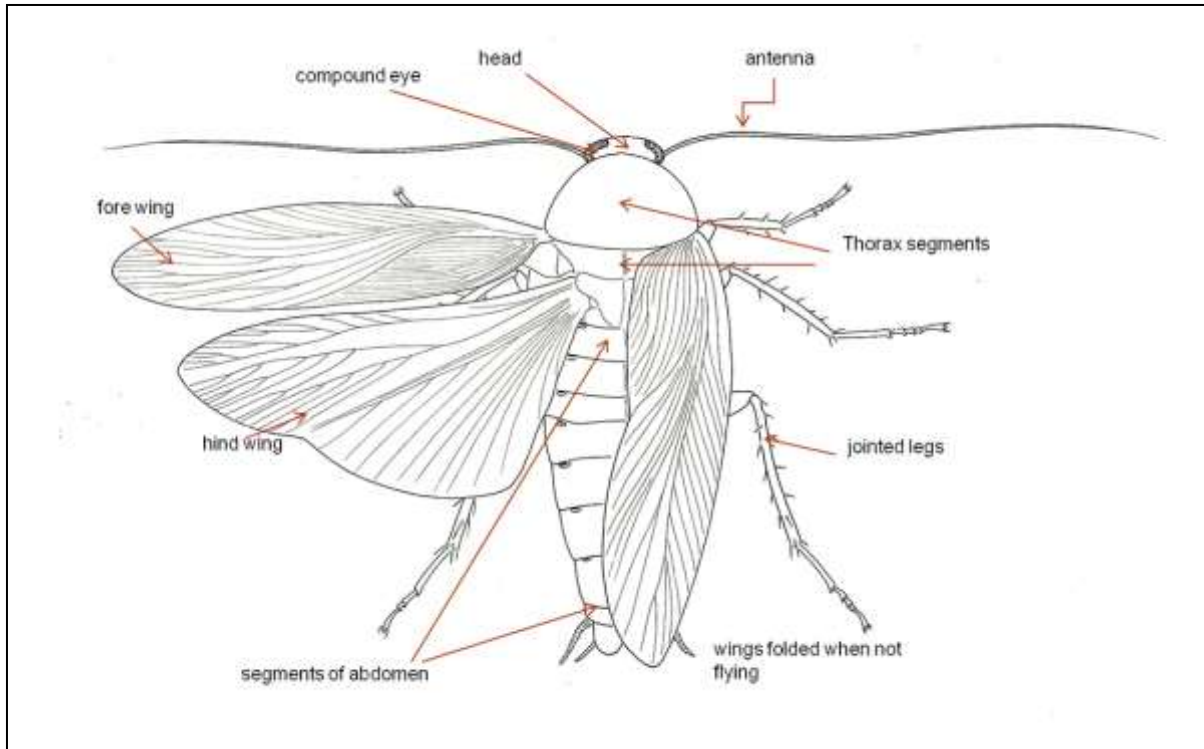


Figure 1. Morphology of Cockroach (Jonathan Ho Kit Lan September, 2020)

They are brown or black-bodied animals that are included in class – Insecta of the phylum Arthropoda.

They have a long antenna, three pairs of legs, two pairs of wings, various mouthparts and various other sensory structures. They are nocturnal omnivorous and scavenger animals, they are active at night (Thomson, 1980).

Their size ranges from : 0.25, inches to 3 Inches and the body is elongated, dorsoventrally flattened and is divided into three segments, head, thorax and abdomen: Head (eyes, Antennae, Mouth),Thorax (is made up of three segments, prothorax, mesothorax and the last one, metathorax.) and Abdomen (Its sclerites are relatively thinner and there are 10 tergites in both males and females) (Thomson, 1980).

Ventrally, the abdomen has only 9 sternites in males and seven in females (In females, the last seventh sternite is larger and boat-shaped. Together with the indistinct 8th and sternites, it forms a chamber-like structure called gynatrium), The posterior part of

gynatrium is called the oothecal chamber because ootheca is formed in it. Behind this chamber, the 7th sternite bifurcates into two prominent oval plates called gynoalvularplates or apical lobes. Abdominal appendages (Thomson, 1980)..

Abdominal segments lack locomotory appendages. At the posterior end, however, there are certain small structures associated with the gonopore. These are different in both sexes. It includes Anal Cerci: These are paired and jointed outgrowths that arise from the 10th tergum. These are sensitive to sound and other vibrations, Anal Styles : These are also paired but thin and small unjointed outgrowths that projects backwardly from the sides of the 9th sternum of male cockroach only. These are also sensitive to touch. And Gonapophyses : In both males and females, the genital aperture is surrounded by some sclerites called gonapophyses. In males, they arise from the 9th segment and form the external genitalia or external genital organs to help the insect in the copulation process. In female cockroaches, gonapophysis belongs to the 8th and 9th abdominal segments to form an ovipositor(Thomson, 1980).

1.4. Development cycle Cockroaches

Are relatively primitive insects with a development cycle reduced to three stages: egg, pupa and adult (Fig.2). The female lays her eggs in groups surrounded by an ootheca that is to say in a sort of leathery case or capsule having the appearance of a pod. Some species such as papin carry the ootheca on the tip of their abdomen for several weeks. Most of the rest will get rid of it after a day or two. Oothecae have a very characteristic shape that often serves as an identification key. Depending on the species, temperature and humidity, hatching takes place after 1 to 3 months. The young, or nymphs, are wingless and generally measure only a few millimetres; white when they hatch, their color darkens within a few hours. The transition to the adult stage occurs through several successive moults over a period of a few months to over a year, depending on the species. The adult is wingless or wings, the latter then comprising an outer pair of coriacate structure covering a pair of folded membranous wings (Courtesy of the natural history museum, London).

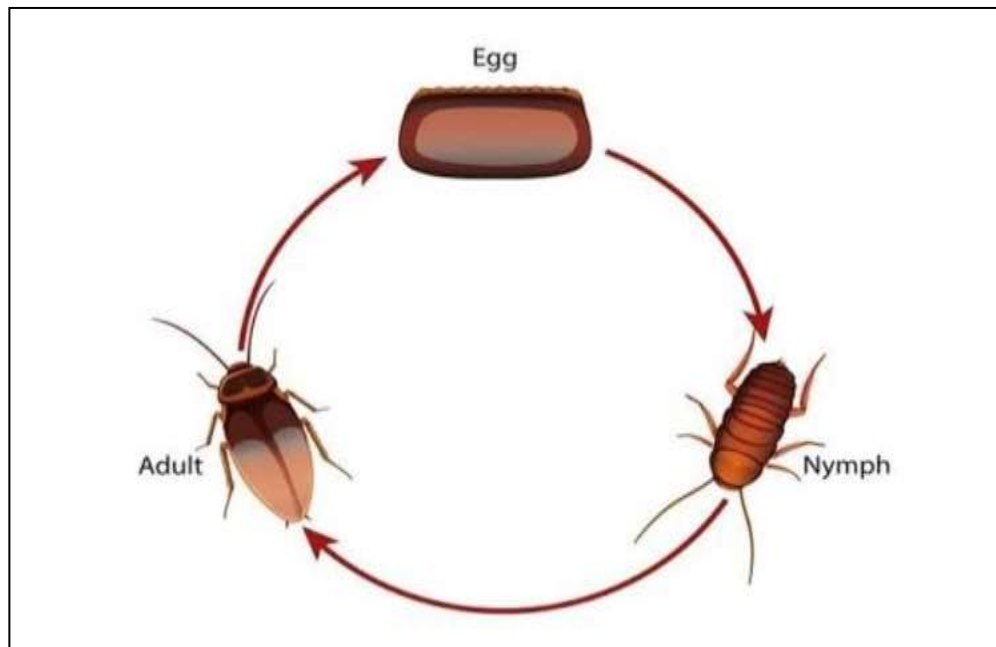


Figure 2. Development cycle of Cockroach. (Courtesy of the natural history museum, London).

1.5. Reproduction

It all starts with pheromones. Male and female cockroaches both produce pheromones, which are used to send sex signals to other roaches in the surrounding area. Once they've attracted a mate, cockroaches then engage in courtship rituals. The females begin the dance by raising their wings to expose the membranes beneath. They also expand their genital chambers while releasing more sex pheromones, signalling to the male that they're ready to mate (Latham, 2020).

Attracted males will approach the female and raise their wings to communicate their interest. They will then back into her, depositing sperm (in the form of a spermatophore) into her genital chamber (Latham, 2020).

Once fertilization has occurred, the female cockroach will lay her eggs in a protective protein casing known as an ootheca. She will then carry the ootheca on her abdomen before finding a safe place to deposit it. The length of time roaches carries their eggs varies from species to species. The American cockroach will carry the ootheca for a few hours or days before depositing it in a protected area, gluing it to the floor with saliva. The German roach, on the other hand, will carry her eggs until a few hours before hatching (Latham, 2020).







Figure 3 : Reproduction type of cockroach (Latham, 2020)

1.6. Presentation of some species of cockroach and their characteristics

The most common urban cockroaches: among the 4000 species of cockroach that exist in the world, four species are the most present. This is: the German Cockroach, the oriental Cockroach, the American cockroach and the cockroach meuble (Thomson, 1980) (table.01).

Table 01: The different criteria of cosmopolitan species of cockroaches

Species	Name	Size	Color
	German Cockroach <i>Blattella germanica</i>	10 to 14 mm	Brownish Yellow
	Oriental cockroach <i>Blatta orientalis</i>	20 to 28 mm	Dark brown
	American cockroach <i>Periplaneta americana</i>	28 to 38 mm	Ferruginous red
	Furniture cockroach <i>Supella longipalpa</i>	10 to 14 mm	Pale brown

1.7. Habitat

The Cockroach has a cosmopolitan distribution, the vast majority of Cockroach species live in nature, under debris, stones, leaves, bark or trunks of trees lying on the ground as well as in cracks in rocks. Domestic species inhabit houses, warehouses, businesses and any other place where they find sufficient humidity and food (cellars, sewers, basements, boiler room). In the tropics, the living environments of Cockroach are much more varied (caves, ant or rodent nests, tree trunk and foliage, etc.) (Grandcolas, 1998).

1.8. Food and ecological role

The Cockroaches are omnivorous insects. They can eat rotting plant matter, paper, and dead animals or table scraps. In general, cockroaches seem to prefer carbohydrates (Hui & *al.*, 2009). They are particularly attracted to meat, dairy products, sweet and starchy foods (starch), but they also eat vegetables, fruits, leather, fabrics, cardboard, plastics, dead or living insects, soil, animal feed, hair, fabrics and paper especially that coated with paste or glue. Cockroaches are particularly abundant and diverse in the tropical and subtropical (Arruda & *al.*, 2001).

In general, they play an important role as decomposers in nature. Indeed, by feeding on plants and dead animals, they thus participate in the rapid recycling of organic matter (Wileyto & Boush, 1984).

1.9. Impacts on human health

Cockroaches move from one building to another or enter in abundance in dwellings from gutters, sewers and latrines. As they are feeding both waste and human food, they can spread pathogenic germs (Roth & Willis, 1957).

Nuisances: Cockroaches are considered pests because they will be able to invade any place where food is stored that they will contaminate with their faeces and a secretion blackish secretion that they regurgitate when eating. Their salivary and bodily secretions will be the cause of a nauseating and persistent odour. These secretions will be able to alter the taste of food cooked with contaminated utensils. They can also cause damage to fabrics and paper-based products (Mourier, 2014).

Disease transmission: Cockroaches move freely; they feed on human droppings and animals, or can come into contact with them during their numerous movements in sewers, latrines, drains. Cockroaches coming from outside will potentially be able to contaminate food with

bacteria responsible for food poisoning (*Salmonella* spp Which can be found for 35 days in the faeces of cockroaches and *shigella* spp). German Cockroaches have a reputation for transmitting organisms such as *Staphylococci*, *Streptococci*, coliform bacteria, and the polio virus (Erku & *al.*, 2006).

Allergies: The faeces, saliva, bodily fluids, molts and dead bodies of cockroaches, are sources of potent allergens. They will be able to cause skin reactions, atopic 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).

1.10. The struggle

In order to control harmful insects such as cockroaches, man deploys considerable efforts, and seeks new methods of physical, biological or chemical control in order to limit their proliferation (appeal, 1990, Kim & al, 1995; Lyon, 1997). However, the excessive and repeated application of conventional insecticides has appeared in the cockroach. Following the harmful consequences of chemical control of the environment and humans, which result in carcinogenic phenomena and the increase in resistance in cockroaches, we are therefore seeking to use other substances and other control techniques of struggle. At present, the insecticides used are often less toxic and more specific and are based on physiological data of the insect (El Sayed & al, 1997, Ishata & Horowitz, 1998). Natural products are increasingly sought after for an effective fight. The fight against harmful insects, including cockroaches, includes several methods such as those using synthetic analogues of insect hormones (juvenile hormone, ecdysone) which disrupt the hatching of eggs, reproduction and the different behaviours of cockroach, genetic methods and so-called ecological methods, which consist in making the environment unfavourable to the development of the insect (Grandcolas, 1996).

Chapter 2:

Material and methods



2. Material and Methods

2.1. Presentation of the studied area

The Wilaya of M'sila, within its current limits, occupies a privileged position in the central part of northern Algeria as a whole, it is part of the region of the Central Highlands and covers an area of 18,175 km². Its geographical position means that its main vocation remains agro-pastoralism dependent on unfortunately low and irregular rainfall not exceeding 250 mm per year (Figure 4). It is limited: In the North East: the wilayas of Bordj Bou-Arredj and Sétif

- ✓ In the North-West: the wilayas of Médea and Bouira.
- ✓ To the east: the wilaya of Batna
- ✓ To the west: the wilaya of Djelfa
- ✓ In the South East: the wilaya of Biskra (DINET, 2013).

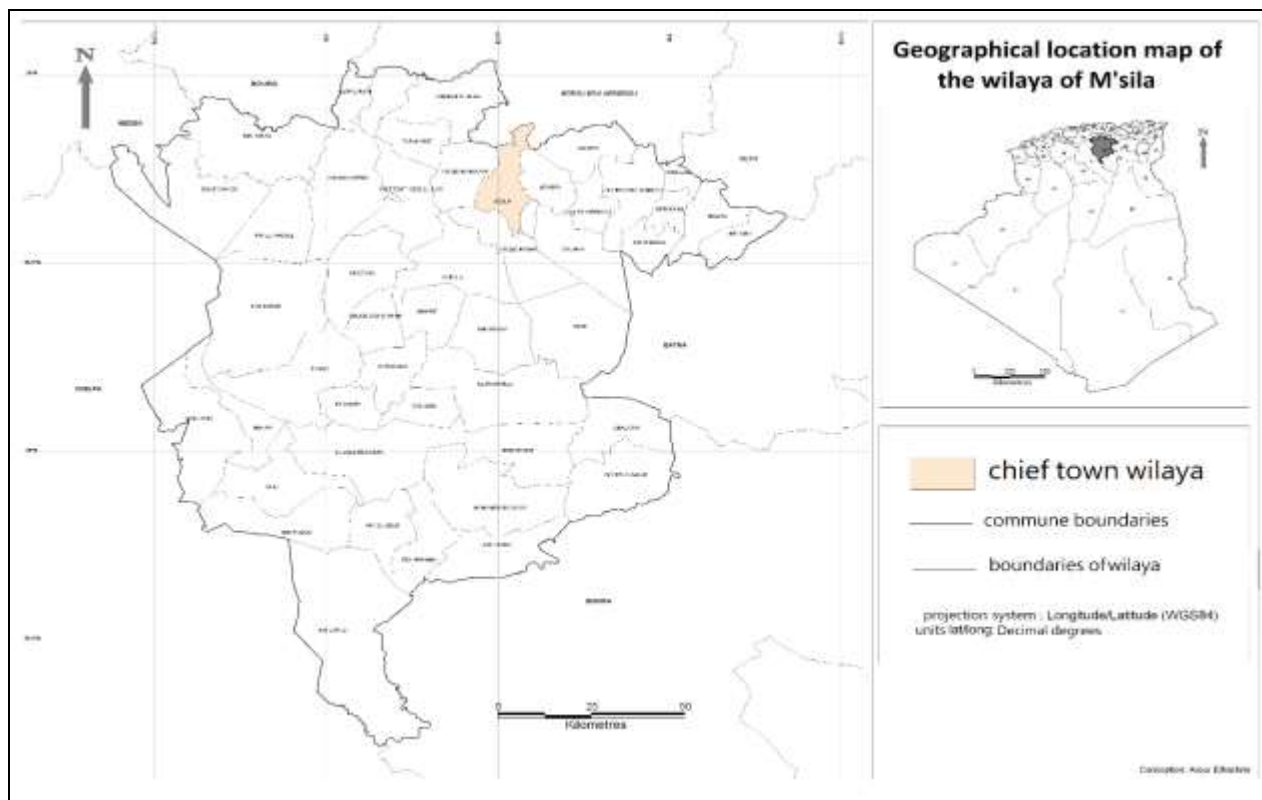


Figure 4. Location of the study area (official sit of the wilaya of M'sila, 2011).

2.1.1. Climate

Data for the M'sila region: Weather: According to ozenda and Lucas (1975), the floor is defined "a set of groupings plants brought together by an ecological affinity in the same range of altitude", the temperature remaining the preponderant climatic factor, where the parameters of the water regime are very important. The climate of M'sila is incessantly allowed to the disturbances which affect the accidental basin of the Mediterranean, as well as to the drying influences of the desert (Lakhdar & Abbas, 2015).

Temperature: Temperature is considered to be a limiting ecological factor in the distribution of plants (Ramade, 1984). According to Hadjadj-Aoul (1995) the cold season is the period during where average temperatures are below 10°C. Then the average temperatures minimum and maximum of our study station for the period (1987-2017) are recorded in (table .1.), for the M'sila station, the mean of the minima of the coldest month "m" observed in December has a value of 4.5°C. Then, the average of the maximums of the month the hottest "M" is recorded in July with 38.8.

Table 2. Monthly average temperatures, maxima and minima of M'sila during the period 1987-2017 (M'sila weather station, 2017).

Months	J.	F.	M.	A.	M.	J.	J.	O.	S.	O.	N.	D.	Average
T° min	5.3	4.6	7.8	11.0	16.3	21.3	24.8	24.6	19.8	15.0	8.8	4.5	13.65
T° max	14.2	16.1	20.3	23.7	28.5	43.9	38.8	38.2	32.4	26.0	19.1	14.8	25.58
T° avg	9.8	10.4	14.1	17.4	22.4	28.1	31.8	31.4	26.1	20.5	13.9	9.7	19.62

T° min: Monthly average of maximum temperatures in degrees Celsius (°C); T° max: Monthly average of minimum temperatures in (°C); T° avg: Average monthly temperature in (°C)

Precipitation: Rainfall is an ecological factor of fundamental importance for the functioning and distribution of ecosystems (Ramade, 1984). According to Table 2, a annual precipitation of about 200 mm seems to contribute to the determination of the arid character of the region during the period (1987-2017). Appreciable rainfall is observed in the month of October with 24.49 mm. The dry period depends on the minimum rainfall of 6 months on the dry period represents the month of July with 4.3 mm (Table 2).

Table 3. Monthly and annual precipitation of M'sila during the period 1987-2017 (Station M'sila weather forecast, 2017).

Months	J	F	M	A	M	J	J	A	S	O	N	D	Total
P(mm)	17.79	13.45	14.65	20.27	24.12	10.11	3.4	8.54	24.13	24.49	19.9	19.13	200.85

2.2. Presentation of study site

In order to study the types of cockroaches that exists in our wilaya “M'sila”, where we took a period of two months which started at the end of December until the end of February, in this period we chose 6 sites to harvest samples: 4 houses, university residence and a hospital.

Table 4: Main geographic features of selected stations in the region of M'sila

Stations	Latitude	Longitude	Altitude
House N1	35°37'46"N	4°48'53"E	545m
House N2	35°33'30"N	5°14'16"E	574m
House N3	35°18'43"N	4°47'40"E	419m
Hospital	35°42'52"N	4°33'00"E	1.02km
University residence	35°44'24"N	4°32'39"E	568m

2-2-1-Cockroach harvesting site

- **House N1:** This is a place located in “Hamrit” village “Awlad daradj” we found the 5 Cockroach in the warehouse (figure 5) .



Figure 5. House 1 (Personal photo)

- **House N2 :** This is a place located in “ Belaïba ” Magra”, we found 3 Cockroaches in kitchen (figure 6).



Figure 6. House 2 (Personal photo)

- **House N3:** This is a place located in “Meif” kobana”, we found 2 Cockroaches in kitchen. (figure 7)



Figure 7. House 3 (Personal photo)

- **University residence :** This place located pole university of M’sila we found 3 cockroaches in room (figure 8).



Figure 8. University residence (S4) (Personal photo)

- **Hospital:** It is hospital Zahrawi wish located in city center we found about 330 cockroaches in kitchen and patient rooms (figure 9).



Figure 9. Zahraoui hospital (Personal photo)

2.3. Sampling method

To know and list the different species of cockroach that colonize the environment, we harvesting them by using a plastic tube in dark, warm and humid places (under sinks and bathtubs, behind large household appliances that give off heat (stove, refrigerator motor, microwave, etc.), various dots (garbage vacuum columns, air vent, heating, electric wand, etc.), in nooks and behind cupboards, behind tapestries.



Figure 10. Cockroach sampling method (Personal photo)

2-4. The identification of harvested species

The identification of the cropped species: for the identification of the cropped species, a binocular magnifier it is used by the determination that is made to the naked eye thanks to the shape of the wings, colors and abdominal ends of our cockroach and thanks to (Chopard, 1951)

2.5. Biological material

2.5.1. Presentation of the *Blattella germanica*

The German cockroach is the most widespread and common cockroach in urban areas, however how this invasive species has spread globally is poorly understood. We reviewed the published and grey literatures, and museum data, to document the spread of the German cockroach, and how it may have interacted with other urban cockroach species. We found that the German cockroach likely originated from South Asia, was introduced into Europe no later than the 18th century, from where it invaded worldwide. The spread of the German cockroach was facilitated by the improvement of transportation technologies, especially from colonial trading, and indoor heating in cooler climates. Studies of population genetics have found that once introduced into a new location, the German cockroach spread rapidly through local expansion, and this could be within single (large, multiple-story) buildings. This

local expansion resulted in displacement of other urban cockroach species, likely due to their small size requiring fewer resources, shorter generation times and so faster evolution, especially for pesticide resistance. These findings may help to identify new pest management methods. Future research could use genetic tools at larger scales to map distribution routes across the globe and interaction with pesticides and the evolution of resistance. (Bourguignon, 2018).

➤ **Scientific classification**

Kingdom: Animalia

Phylum: Arthropoda

Class: Insecta

Superorder: Dictyoptera

Order: Blattodea

Family: *Ectobiidae*

Genus: *Blattella*

Species: *Blattella germanica* (Linnaeus, 1767)



➤ Cycle of life

Behavior and life cycle the German cockroach is omnivorous, eating a wide range of human foods, pet food, fruit, leather, and even book bindings. They also feed on the dead bodies and excrement of other cockroaches. They prefer to live in cracks, crevices, and voids away from light (Figure 11). Cockroaches come out looking for food during the dark hours. Within a home, they are mostly found in the kitchen and bathroom, where food and water are available. Areas around the stove and refrigerator in a kitchen usually have the largest number of cockroaches. Females live 140–280 days, whereas males live 90–140 days. A female produces 5–8 ootheca with a total of 200–250 eggs. The entire life cycle is completed in about 100 days. Active growing field populations are comprised of 80 percent nymphs and 20 percent adults. The major factor limiting German cockroach survival is cold temperatures. At temperatures below 59°F (15°C), cockroaches can survive but will not continue to develop from nymphs to adults (Wang, 2021).

Egg: eggs are carried in an egg case (ootheca), by the female until just before they hatch. The egg case can be seen from the posterior end of the female. a typical egg case contains about 40 eggs. It is about 5/16 inch long, 1/8 inch high, and 5/64 inch wide (8 mm by 3 mm by 2 mm). If the egg case is detached from the female, either manually or after exposure to insecticides, the egg case will typically not hatch unless it is within one to two days from hatching (Wang, 2021).

Nymph: the nymphal stage begins with egg hatch and ends with the emergence of the adult. Nymphs do not have wings. Their sizes range from 1/8 to 9/16 inch (3 to 14 mm). Nymphs molt 5–6 times before becoming adults. The stage between molts is called an instar (Wang, 2021).

Adult: the adult is 1/2 to 5/8 inch (13 to 16 mm) long, brown to dark brown in color. They are commonly identified by the two dark parallel stripes on their thorax. Males are slender and thinner with the posterior end tapered, females are wider and thicker with the posterior end rounded. (Wang, 2021).

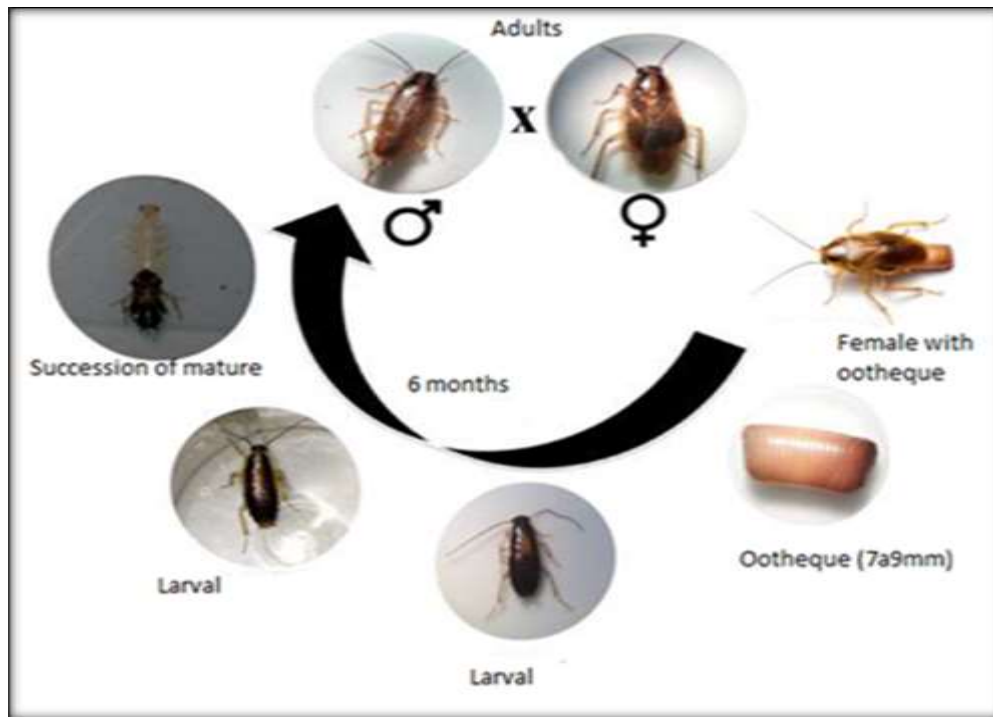


Figure11. *B. germanica* life cycle (Bounadji & Magri, 2020).

2.5.2. Mass breeding

We raised German cockroaches collectively in transparent plastic boxes. We provided them with the food” dog food “and water in cotton placed in a plastic cover and we also put egg cartons because it allows them to live, reproduce and lay eggs.



Figure 12. *Blattella germanica* breeding technique (Personal photo)

2.5.3. Presentation of the plant species used

➤ *Atropa Belladonna*

Atropa Belladonna is a poisonous plant also called deadly nightshade. Its roots leaves and fruits contain alkaloids: atropine, hyocyamine and scopolamine. The risk of poisoning in children is important because of possible confusion with other berries. *Atropa Belladonna* acute intoxication is a severe condition, it's should be considered in the presence of anti-cholinergic toxidrome, the differential diagnosis include other plants or psychoactive drugs containing atropine. The treatment is mainly symptomatic including gastrointestinal decontamination with activated charcoal. In severe cases, physostigmine can be used as an antidote (Adnane & al, 2012).

Scientific classification

Kingdom: Plantae

Clade: Tracheophytes

Clade: Angiosperms

Clade: Eudicots

Clade: Asterids

Order: Solanales

Family: *Solanaceae*

Genus: *Atropa*

Species: *Atropa belladonna*

Binomial name: *Atropa belladonna*

(Köhler's Medicinal Plants 1887)



Figure 13. Illustration of *Atropa belladonna* (1. Port, 2. Flower, 3. Fruit), Jijel,

Photos K. Rebbas, 01.09.2021

➤ *Solanum nigrum*

The plant *Solanum nigrum* linn (*Solanaceae*). Commonly called as black night shade in English, Makoi in Hindi, Kachchipandu in Telugu, Munatakali in Tamil, Piludi in Gujarati & Kamuni in Marathi. It is an erect, divaricately branched, unarmed, suffrutescent annual herb. Leaves ovate or oblong, sinuate-toothed or lobed, glabrous; flowers 3-8 in extra-axillary drooping srebumbellate cymes; fruits purplish black or reddish berries; seeds many, discoid, yellow, minutely (Saleem & al , 2010).

- **Taxonomical classification**

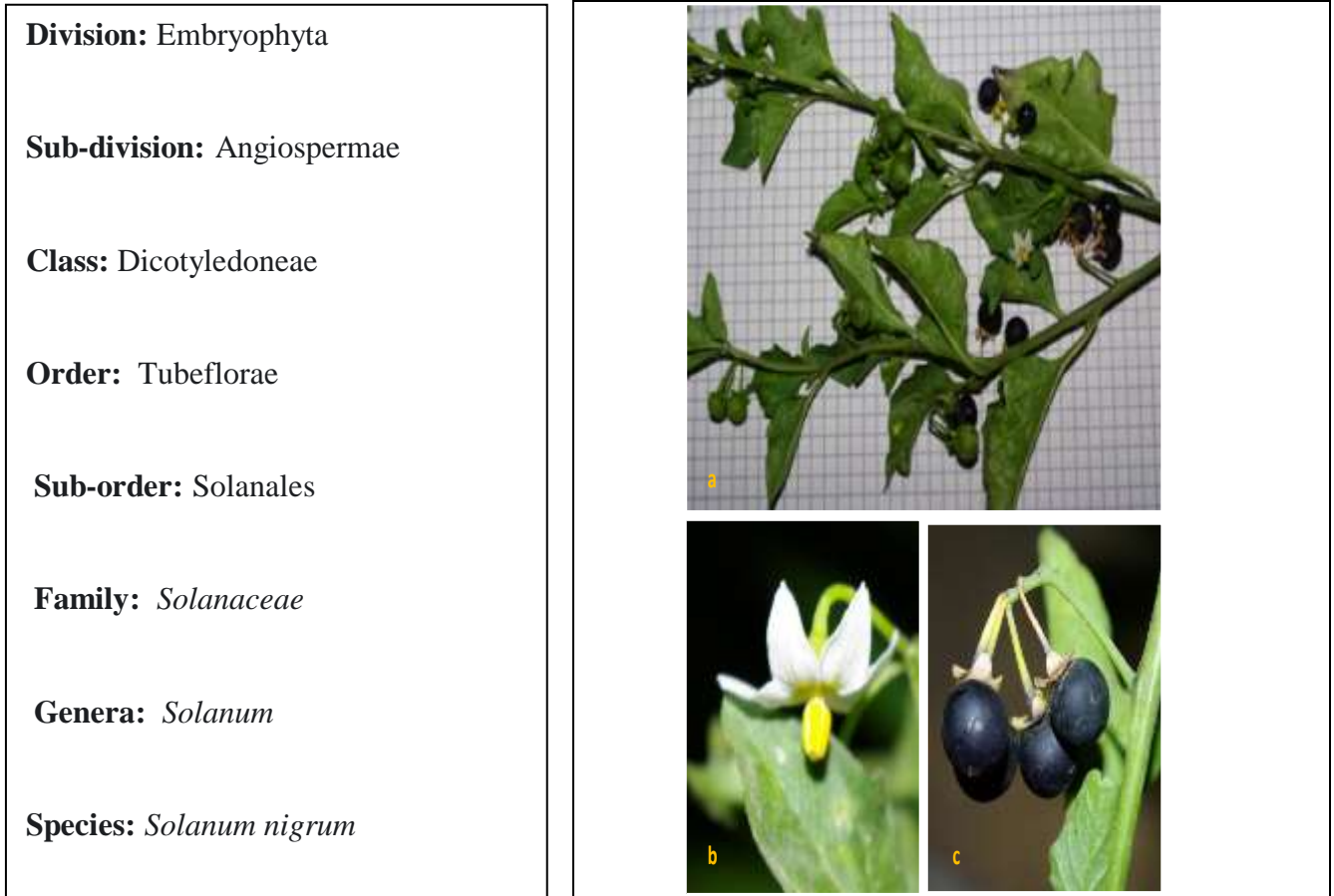


Figure 14. *Solanum nigrum* (a: plant, b: flower, c: berries, photos: K. Rebbas,2017).

- **Habitat and distribution**

These species are only semi cultivated in a few countries in Africa and Indonesia, and are largely utilized as a vegetable and fruit source through harvesting from plants growing spontaneously as weeds in cultivated fields, or in weedy plant communities, under trees, along fences and roads, in shaded areas, near buildings and on waste land. They therefore constitute a volunteer crop. Some communities semi cultivate the vegetable in home gardens or on fertile land portions near homesteads. There are a few reports of the cultivation of the garden huckleberry for its fruits in North America.T.S. (Saleem & al , 2010).

2.6. Toxicological treatment

2.6.1. Plant extract preparation

➤ Ethanoic extract

The maceration method: firstly, we should prepare 70% ethanol by adding 70% of absolute ethanol solution to 30% distilled water. Secondly, we prepare the plant by drying it then crushing it into a fine powder, more than the possibility of extraction of plant product all this work is always done avoiding the extract light

• Method

Put the ethanol inside the magnetic mixer, block it from light and let it stir for 3 days or without stirring for 7 days. Filtration of the given extract drying of the extract by the rapid vapo rata is the first step. Second step drying in the oven for 24 hours at a temperature of 40C° to prepare the solution, we follow the following steps: He puts the extract in the oven for 5 to 7 days at 40C°. A dry solution is obtained which is crushed. NB: the dry extract in the form of powder avoid light because the molecules of plants without sensitive to light and heat can be transformed. The powder can be stored in a cold, dry place for 6 months.



Figure 15. Preparation of extracts *Atropa Belladonna* (Personal photo)

➤ **Aqueous extract**

We prepare the aqueous extract of the plant by weighing the fresh leaves of the plant used *Atropa Belladonna* which is placed in distilled water and boiled on a spoon of benzene at medium temperature. Finally, the mixture obtained is filtered. using filter paper.



Figure 16: preparation of extracts *Solanum nigrum* (Bakhti & Aouina, 2021)

➤ **Breeding**

Breeding a group of individuals is used in different (toxic) treatments, while it has been done these individuals in at the Al-Zahraoui 'M'sila' hospital.

2.6.2. Toxicity test

Adults of *Blattella germanica* females and males are treated by isolating and aggregating 10 individuals from the same sex in each box including 6 boxes of the same concentration (3 pink boxes for females and 3 blue boxes for males) and we use 3 concentrations. These plastic containers contain dog food and a plastic cover with cotton moistened with aqueous extract of different concentrations of *Atropa Belladonna* or *Solanum nigrum*.



Figure 17. Treatment and separation boxes. (Personal photo)

Table 5 : *Atropa belladonna* (Aqueous).

Toxic molecule	<i>Atropa Belladonna</i>		
Concentration(g/l)	15	35	70

Table 6: *Solanum nigrum* (Ethanoic).

Toxic molecule	<i>Solanum nigrum</i>		
Concentration(g/l)	0.2	0.3	0.4

2.7. 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 (LC50% and LC90%) for each of the bio insecticides used. During the 30 days of exposure to bio insecticides, the variable measured is the number of dead individuals daily. The observed mortality rate is corrected by Abbott's formula which makes it possible to know the real toxicity due to the bio insecticides. The various rates undergo an angular transformation according to the Bliss tables. The data are thus normalized and are the subject of an analysis of variance on XL Stat 2009. The data obtained are then transformed into probity, which makes it possible to establish a regression line according to the decimal logarithms of the concentrations used or the exposure times. So for the study of sexual behavior were analyzed by descriptive metric methods giving, the average, the standard deviation, the minimum and the maximum. The results are presented in Box-plots and were the subject of an analysis of variances (ANOVA) on XLSTAT 2014 software (Addinsoft, New York, NY).

Chapter3: Results



3. Results

3.1. Toxicological study

3.1.1. Effect of *Solanum nigrum* plant on the mortality rate of *B. germanica*

We tested the poisonous effect of the *Solanum nigrum* plant on multiple cockroach individual in several different concentrations (0,2g/l, 0,3g/l and 0,4g/l), this plant causes deaths of cockroach and varies according to several factors (including sex, concentrations and duration).

➤ Male

We see in the table below the different mortality rate of male *B. germanica* after days from the exposure of *Solanum nigrum* plant in different concentrations, we observes the changes on the rate between the concentrations and we can see that it was low mortality rate in the first 5 days it can reach to 3.3%, after 15 days it increase on 0.2 g/l tell 10% , but gets settle in 0.3g/l and 0.4 g/l at 6.7% . Then up to the maximum after 30 days in the concentrations 0,2g/l until 13,3% and remain a consistent in the remaining concentrations.

Then the results come out to be significant in the first check out 5 days with (F=8.5; P: 0.01*) and also in the second 15 days with (F=8.50; P: 0.01*) ; and in the last check out the result was not significant with (F=3.68 ; P: 0.09) (table 07) .

Table7: Mortality rate caused by the different concentrations of *Solanum nigrum* on male *B. germanica*

Concentration	5 days	15 days	30 days
0,2 g/l	3.3%	10%	13.3%
0,3 g/l	6.7%	6.7%	6.7%
0,4 g/l	0%	6.7%	6.7%
F	8.50	8.50	3.68
P	0.01*	0.01*	0.09

➤ Female

We see in the table below the different mortality rate of female *B. germanica* after days from the exposure of *Solanum nigrum* plant in different concentrations (0,2g/l, 0,3g/l and 0,4 g/l) , we observes in the first concentrate 0.2g/l the rate is fixed for 15 days 13.33% and in 30 day it

is up to 20%. we can see in the second concentrate 0,3g/l the rate is varied ; it is start in the 5 days with value 13.3% , and in 15 days it is up to 16.7% , and in 30 days it is returned to preliminary value 13.33% .we can see also in the last concentrate the various in the mortality rate in the first 5 days it is 16.7% , in 15 days 0.4g/l it is up to value 20% , and in 30 days it is continued to rise until arrive to 33.3% (table 08).

Then the results it was not significant in 5 days with (F=0.46; P: 0.64) , in the 15 days with (F=0.22; P: 0.80) and in the last the result (F=0.33; P: 0.72) (table08).

Table 8: Mortality rate caused by the different concentrations of *Solanum nigrum* on female *B. germanica*

Concentration	5 days	15 days	30 days
0,2 g/l	13.3%	13.3%	20 %
0,3 g/l	13.3%	16.7 %	16.7%
0,4 g/l	16.7 %	20 %	33.3%
F	0.46	0.22	0.33
P	0.64	0.80	0.72

➤ **Toxicological parameters of *Solanum nigrum* aqueous extracts on *B. germanica***

In regard of the deadly times our results reveal that we need 2 or 3 times concentrated values of *Solanum nigrum* plant to get 50% and 90% mortality rate, the result in the males was weak (0.82g/l & 0.72g/l) and in the females the concentration was strong (5.72g/l & 87.18g/l) in the first 5 days. After 15 days the concentration of murder get down to(0.07g/l & 0.01g/l) in the males and in the females are not compatible(1.77g/l & 7.47g/l). then on the concentration changes that we need 0.20g/l to get 50% mortality rate and takes 0.07g/l for 90% mortality rate in the males and the female on the other hand the concentration was (1.06g/l) for 50% mortality rate and (2.94g/l) for 90% mortality rate .The results show that there is a positive correlation between the registered mortality rates and the concentration of the extract used against adults of *B. germanica* (Table09).

Table9: Lethal concentration of *Solanum nigrum* water extracts

Exposure time	Males			Females		
	Regression	LC50% (g/l)	LC90 % (g/l)	Regression	LC50%(g/l)	LC90%(g/l)
5 days	Y=3.06-9.90X R=0.7	0.82	0.72	Y=4.18+0.47 X R=0.82	5.72	87.18
15 days	Y=3.18-0.72X R=0.90	0.07	0.01	Y=4.49+0.89 X R=1.00	1.77	7.47
30 days	Y=2.92-1.31X R=0.90	0.20	0.07	Y=4.92+1.26 X R=0.68	1.06	2.94

3.1.2. Effect of plant *Atropa belladonna* on the mortality rate of *B. germanica*

We tested the poisonous effect of the *Solanum nigrum* plant on multiple cockroach individual in several different concentrations (15 -35 - 70 g/l), this plant causes deaths of cockroach and varies according to several factors(including sex, concentrations and duration).

➤ Males

We see in the table below the different mortality rate of Male *B. germanica* after days from the exposure of *Atropa belladonna* plant in different concentrations (15.35.70g/L), we observe in the first concentrate (C1=15g/l) the rate is various like follow in first (5 days) it was weak (3.3%) and in (15 days) the mortality rate it is rise to (13.3%) and in (30 days) it is still up to (23.3%). we can see in the second concentrate (C2=0.3g/l) the rate is varied also ; it is start in the(5 days) with value (6.7%), and in (15 days) it is up to (33.3%), and in (30 days) it is rise slightly(36.7%). In the last concentrate(C3=70) the various in the mortality rate is also varied in this latter like follow : in the first (5 days) it is (6.7%), in (15 days) it is up to value (10%), and in (30 days) it is get rise to (26.7%).

The results of significant in the first check out (5 days) with (F=0.76 - P=0.50) and in the second (15 days) with(F=0.39 - P=0.68) ; and in the last check out with(F=1.42 -P=0.31) it was all of them no significant. (Table10).

Table10: Mortality rate caused by the different concentrations of *Atropa belladonna* on male *B. germanica*

Concentration	5days	15 days	30 days
15 g/l	3.3 %	13.3%	23.3%
35 g/l	6.7 1%	33.3%	36.7 %
70 g/l	6.7 %	10.0%	26.7%
F	0.76	0.39	1.42
P	0.50	0.68	0.31

➤ Females

We see in the table below the different mortality rate of female *B. germanica* after days from the exposure of *Atropa belladonna* plant in different concentrations (15.35.70g/l), we observe in the first concentrate (C1=15g/l) the rate it is weak (6.7%) in first (5days) and it rise in (15 days) with (10%) and in 30 days it still up to (16.7%).we see in the second concentrate (C2=35g/l) the mortality rate is no in the two time periods (0%) (5days and 15 days) and in the last period we see little up (3.3%).we can see also in the last concentrate (C=70g/l) the diversity in the mortality rate like follow: in the first (5 days) it is no (0%), it is up to value (10%), and in 30 days it is continued to rise until arrive to (26.7%).

The results are divided as follows: it is significant just in the first check out (5 days) with (F=16 - P=0.004) but in the second (15 days) with (F=4.24 - P=0.07) ; and in the last check out with (F=1.65- P=0.26) both of them it is no significant.(table 11) .

Table11: Mortality rate caused by the different concentrations of *Atropa belladonna* on female *B. germanica*

Concentration	5 days	15 days	30 days
15 g/l	6.7 %	10.0 %	16.7 %
35 g/l	0.0 %	0.0%	3.3 %
70 g/l	0.0 %	10.0%	26.7 %
F	16.0	4.24	1.65%
P	0.004	0.07	0.26

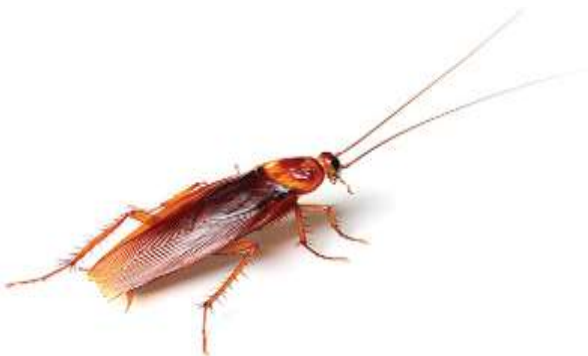
➤ **Toxicological parameters of *Atropa belladonna* aqueous extracts on *B. germanica***

In the table below the results show us there are a positive relationship between mortality rate and concentrations. In 3 times concentrated values of *Atropa belladonna* plant to get 50% and 90% mortality rate: First, for Males the first 5 days we need (148.4g/l) to kill 50% and (533.7g/l) to kill 90% and this concentrates was strong, we observe in 15 days the concentrate weak according first 5 days ($1 \cdot 10^{-2}$ g/l); ($9 \cdot 10^{-6}$ g/l) to kill 50%;90% . In the 30 days the concentration it also strong (112.4g/l) for 50% and (2.47g/l)for 90%.Second,according to females the concentrate is weak (2.23g/l) for 50% and (1.76g/l) to kill 90% in the first 5 days, in the 15 days the concentrate is down to kill 50% we used ($5 \cdot 10^{-3}$ g/l) and for 90% is ($2 \cdot 10^{-4}$ g/l), and the last period 30 days the concentrates was also strong (91.17g/l) for 50% and (2428.1g/l) for 90%.(table12)

Table12: Lethal concentration of *Atropa belladonna* water extracts

Exposure time	Males			Females		
	Regression	LC50%(g/l)	LC90%(g/l)	Regression	LC50%(g/l)	LC90%(g/l)
5 days	Y=0+1X R=1.00	148.4	533.7	Y=9.33-5.38X R=0.89	2.23	1.76
15 days	Y=4.31-0.17X R=0.13	$1 \cdot 10^{-2}$	$9 \cdot 10^{-6}$	Y=3.05-0.38X R=0.06	$5 \cdot 10^{-3}$	$2 \cdot 10^{-4}$
30 days	Y=4.15+0.18X R=0.30	112.4	2.47	Y=3.24+0.39X R=0.21	91.17	2428.1

Chapter4: Discussion



4. Discussion

The world has been blessed with high and different numbers of insect some of those are harmful and some aren't such as cockroach which has been exist at least dating back to the carbonate: about 320 million years, cockroach is simple insect with strong ability improvement of transportation technologies, especially from colonial trading, and indoor heating in cooler climates. Studies of population genetics have found that once introduced into a new location, the German cockroach spread rapidly through local expansion, and this could be within single (large, multiple-story) buildings. This local expansion resulted in displacement of other urban cockroach species, likely due to their small size requiring fewer resources, shorter generation times and so faster evolution, especially for pesticide resistance (Qian tang & al, 2019). These findings may help to identify new pest management methods. Future research could use genetic tools at larger scales to map distribution routes across the globe and interaction with pesticides and the evolution of resistance, because of having this ability which make hard to eliminate it, as well as the researchers try different biological & chemical experiments.(Qian tang & al, 2019).

we basically use chemical control in our daily life such as pesticides but it's turns out be toxic to the health of living beings and for the environment (seck, 1994) the overuse and repeated application of insecticides conventional chemicals has caused in cockroaches and particularly in *B.germanica* a phenomenon of resistance (Valles & al, 2000; Fulton & Key, 2001; Yuet & al, 2003; Kristensen & al, 2005). It is very effective because they produce interesting results (seck, 1994) .This resistance results in physiological, biochemical modifications and behavioral (Cochran, 1990, 1991; Sharf et al., 1997; Saito & Hama, 2000).

so we have resorted biological control to became very promising strategy through use ethanolic extract of *Solanum nigrum* & aqueous extract of *Atropa belladonna* on *Blattella germanica*, wish was cockroach collected from M'sila (Zahrawi) hospital. with different concentration and the reason we used it has lethal characteristics represented in toxic effect.

Solanum nigrum, centering around the species commonly known as the black, garden or common nightshade, *Solanum nigrum* L., is one of the largest and most variable species groups of. The genus. It is more usually referred to as the section Morella (Maurella (Dun.) Dumort. Morella (Dun.) Bitt.), but since the generic type is *S. Nigrum*, the correct name for this section is

Solanum (Seith,1962). Species belonging to this section are distributed from temperate to tropical regions, and from sea level to altitudes over 3500 meters. Though this species group is often referred to as the *Solanum nigrum* complex, the section is composed of a large number of morphogenetic distinct taxa, which show their greatest diversity and concentration in the New World tropics, particularly in South America. *Solanum nigrum* itself is a predominantly Eurasian species, which does not occur naturally in South America (Edmonds, 1979). In most parts of the world, particularly in Europe and North America, these species are considered to be troublesome weeds of agriculture, but in many developing countries they constitute a minor food crop, with the shoots and berries not only being used as vegetables and fruits, but also for various medicinal and local uses.(Edmonds, James & al, 1997).

Through our study, we shall see the deadly effect of the plants *Solanum nigrum* on adults *Blattella germanica* according to concentrations (0.2g/l,0.3g/l and 0.4g/l), the deadly concentrations (LC 50; LC90) drop down during the treatment, the mortality rates was diversified in order to eliminate 50% we utilized 5.72g/l and for 90% we used 87.18 g/l in the female but the male was extremely dissimilar that we need 0.82 g/l to terminate 50 % & 0.72 g/l for 90%. Through this we draw conclusion that males has stronger resistance than the female.

solanum nigrum is a deadly plant according to many researchers such as Girre 2001 , Jennifer M .Edmonds and James A.Chweya in their book Black nightshades : *Solanum nigrum* L. and related species1997.

We proceed with *Attropa belladonna* with several concentrations (15 g/l & 35 g/l & 70 g/l.) the deadly concentrations (LC 50; LC90) drop down and increase during the treatment, the mortality rate changes in order to eliminate 50% we use 148.4g/l and for 90% we use 533.7g/l that for males, but the concentration in the females was totally different we utilized 2.23 g/l for 50% and for 90% 1.76g/l on first 5 days , then 1×10^{-2} g /l on 15 days to terminate 50%. On the 90% we used 9×10^{-6} g/l that for males. , but the concentration in the females was we used 5×10^{-3} on 50% and for 90% was 2×10^{-4} .on the other period 30 days the males 112.4 g/l and 2.47 g/l for 50% & 90% and females 91.17g/l & 2428.1g/l for 50% & 90%. we conclude from the previous results of the experiments that female have more resistance ability than males .

Atropa is a poisonous plant according to many researchers who study different types of the plant like: *Atropa pallidiflora* Schönb.-Tem , *atropa komarovii* Blin. & Shalyt and *Atropa acuminata* Royle , John forbes. (Maqbool & al, 2014)

There are many other plants that been experiments on *Blattella germanica* with similar result like Masna (2016) which showed that *Peganum harmala* causes mortality *Blattella germanica* adults and also Bounadji and Magri(2020) with *Ruta chalepensis L* in the researches of alternative methods to chemical insecticides, by taken under the considering its serious impact to the human health.

During these experiments, we noticed that the cockroach smells the extract and won't approach, and this applies to strong concentrations of plant extracts and in weak concentration it drinks the extract from the cotton there for we registered higher mortality rate then the stronger concentration, the males were highly active then the females and we noticed that there where side effect aqueous extract like lack of activity & opening one of the wings shortly before death. Some of the cockroach we experiment on found to have high resistance level to the poisonous effects of extracts (*Atropa belladonna* & *Solanum nigrum*) which gain them the ability to survive and adapt.

Conclusion



Conclusion

Cockroach, even mention the name could be frightening for some people and allergen for others, it can find a suitable environment to grow and spread because of its mild and subtropical climate, they are harmful to humans animals and plants in many ways.

The presence of cockroaches in our urban environments has led to a study toxicology. In this part of work, we highlighted the direct impact of two extract plants: *Solanum nigrum* and *Atropa belladonna* on adults of *B. germanica*, in vitro under controlled conditions.

we were able to determine that *Solanum nigrum* it has good insecticidal activity against female adults of *B. germanica* unlike the male; in order to eliminate 50% (LC50) we need stronger concentration than what we need to eliminate 90% (LC90).

Observed mortality is positively correlated with concentrations used and duration of exposure adults for this molecule. In parallel, the aqueous extracts of *Atropa belladonna* to eliminate 50% (LC50) from adult female *B. germanica* we need 91.17g/l and 2428.1 g/l for 90% (LC90), on the other hand we need 148.4g/l to eliminate 50%(LC50) and 533.7g/l for 90% (LC90). So calculations of lethal concentrations and the fatal times indicate the differences. In the end we realized that *Atropa belladonna* is more toxic compared to *Solanum nigrum*.

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Abstract:

Cockroach dictyoptera insects. Appeared on earth more than 400 million years ago and there is more than 4000 species only 50 are urban most of them considered harmful.

They have been a big problem that the scientist in all over the world trying to solve and because of the wide use of chemical insecticides we need to find an alternative solution so we use biological insecticides which's basically made of plants aqueous extract.

During this work we focused on testing two different toxic plants *Atropa belladonna* and *Solanum nigrum* on adult *Blattella germanica* by using different concentration of these molecules for studied the effect of these products on mortality. when we checked the results in 30 days period it shows us the effectiveness and ability of those aqueous extract to eliminate cockroaches, Although some have gained great resistance, but the result showed the positivity and the promising future of biological control.

Keywords: Cockroach, *Blattella germanica*, *Atropa belladonna*, *Solanum nigrum*, toxicity.

Résumé:

Les blattes dictyoptères insectes. Apparu sur terre il y a plus de 400 millions d'années et il en existe plus de 4000 espèces dont seulement 50 sont urbaines pour la plupart considérées comme nuisibles. Ils ont été un gros problème que les scientifiques du monde entier tentent de résoudre et en raison de la large utilisation d'insecticides chimiques, nous devons trouver une solution alternative, nous utilisons donc des insecticides biologiques qui sont essentiellement constitués d'extraits aqueux de plantes. Au cours de ce travail nous nous sommes attachés à tester deux plantes toxiques différentes *Atropa belladonna* et *Solanum nigrum* sur des *Blattella germanica* adultes en utilisant différentes concentrations de ces molécules pour étudier l'effet de ces produits sur la mortalité. lorsque nous avons vérifié les résultats sur une période de 30 jours, cela nous montre l'efficacité et la capacité de ces extraits aqueux à éliminer les cafards, bien que certains aient acquis une grande résistance, mais le résultat a montré la positivité et l'avenir prometteur de la lutte biologique.

Mots-clés : Blatte, *Blattella germanica*, *Atropa belladonna*, *Solanum nigrum*, toxicité.

ملخص:

الصراصير هو حشرات من نوع dictyoptera . ظهرت على الأرض منذ أكثر من 400 مليون سنة ويوجد أكثر من 4000 نوع فقط 50 منها حضرية معظمها تعتبر ضارة.

لقد كانت مشكلة كبيرة يحاول العلماء في جميع أنحاء العالم حلها و بسبب الاستخدام الواسع للمبيدات الحشرية الكيميائية، احتجنا إلى إيجاد حل بديلة و لذلك فكرنا باستخدام المبيدات الحشرية البيولوجية و التي تتكون أساساً من مستخلصات مائية نباتية.

ركزنا خلال هذا العمل على اختبار نبتتين سامتين مختلفتين هما *Atropa belladonna* و *Solanum nigrum* على البالغين من *Blattella germanica* باستخدام تركيزات مختلفة من هذه المواد لدراسة تأثيرها على معدل الوفيات. عندما قمنا بفحص النتائج يوميا خلال فترة 30 يوماً، تبين لنا فعالية و قدرة هذه المستخلصات المائية في القضاء على الصراصير، على الرغم من أن البعض منها قد اكتسب مقاومة كبيرة إلا أن النتائج أظهرت إيجابية المكافحة البيولوجية و مستقبلها الواعد.

الكلمات الرئيسية : صرصور، *Blattella germanica* ، *Atropa belladonna* ، *Solanum nigrum* ،سمية.