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Department of Agronomic Sciences

DISSERTATION

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Theme

Contribution to the study of the insecticidal potential of some spontaneous plants from the Ghardaia region

Released by:

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Dedication

my lovely father Chouaib who helped me to make this great work, who fight the world for us, for the one and the only, my mother Fatiha who sacrificed for us, gave us the love and patience,

thank you for being my parents. for

my sister Nardjes my only hope,

for my little brother's Lazhar and Mustapha for being both of you with me. my

grandparents zakia and mustapha i love you so much,

also, my grandparents taomii and Fatima,

my best friends Ines, Malak and Sarra.

thank u so much

lovely aunt and her kids

All My uncles

all my friends

I dedicate this work

Leila khouloud

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THANK YOU ALL, AND MAY ALLAH BE WITH YOU

HASSAINE Leila Khouloud

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Liste of Abbreviations

ANIREF : Agence Nationale d'Intermédiation et de Régulation Foncière.

A.N.R.H : Agence Nationale des Ressources Hydrauliques (Direction Générale.

ANOVA : Analysis of variance.

F.A.O : Food and Agriculture Organization.

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Introduction

Introduction

According to the Food and Agriculture Organization of the United Nations (F.A.O), 17% of world food production today is destroyed during storage (10% by insects and 7% by mites, rodents, and diseases). **BOUCHELOS (2018**), Cereals are the most commonly kept commodity and are susceptible to a number of insects and molds that can lower their quality and quantity. Cereals are the subject of much research in the field of stored-product protection **(ABDELGHANI, 2010).** The primary way that insect pests harm things that are stored is by feeding on them directly. Certain species consume the endosperm, which results in weight and quality loss, while other species consume the germ, which causes poor germination and decreased viability of the seed **(MALEK & PARVEEN, 1989; SANTOS et *al.*, 1990).** Thus, due to damage done by insects, grains lose value of marketing, consumption, or planting.

The majority of species are universally palatable and have a brief life cycle of 4-6 weeks. Many storage insects deposit their eggs inside or close to crops. The larvae develop in the product until they reach the pupal stage after hatching. Other insects develop and pupate on top of or between the produce. Adult storage insects can live a long or short life. The first week of maturity is when they lay the majority of their eggs. Some species have a six- to twelve-month life cycle, such as the genus *Sitophilus* and *Tribolium* **(SEMPLE, ET *al.*, 1992)**.

These are some major insect pests of stored food: The rice weevil *(Sitophilus oryzae L.*), the red flour beetle (*Tribolium castaneum Hbst*.), the angoumois grain moth (*Sitotroga cerealella Oliv*.), the almond moth (*Ephestia cautella W*.), the rice moth (*Corcyra cephalonica Staint.*), the cowpea beetle and Southern cowpea beetle (*Callosobruchus chinensis L. & C. maculatus F.*) **(SEMPLE, *et al.*, 1992)**.

Our study is based on the red flour beetle (*Tribolium castaneum Hbst*.), which is considered one of the most harmful insects in wheat. *Tribolium* is a genus of pests that are frequently found in grain and seed storage facilities. According to **TREMATERRA & SCIARRETTA (2004)** and **DAGLISH (2006),** these insects cause significant losses in products such as cereals, beans, animal feed, flours, and others.

Tribolium castaneum damages grain in both quantitative and qualitative ways. Grain weight loss from insect feeding is the cause of quantitative damage **(STEFFAN, 1963; GOLEBIOWSKA, 1969).** Qualitative damage can take several forms, such as the loss of a product's nutritional and aesthetic value, an increase in the percentage of rejects in the grain mass, and the loss of its industrial (baking) qualities.

To treat this damage, farmers go directly to chemical pesticides, but as we know, these products cause so many problems for both humans and the environment. According to **SHARMA (2017),** agrochemicals have been found to pose major risks, and some pesticides may hurt the immunological and endocrine systems of humans as well as accelerate the onset of cancer. As well as environmental problems like soil, every year, a significant amount of chemicals is sprayed on agricultural soils in the form of pesticides and fertilizers. Furthermore, **ATAFAR et *al.* (2010)** stated that there was a chance that these applications would raise the amount of heavy metals in the soil. Use of herbicides, insecticides, and other chemicals is a very easy, fast, and economical technique to eradicate weeds and insect pests in agriculture.

Biological insecticides offer several benefits over chemical insecticides. typically break down more rapidly in the environment, leading to lower residues in soil, water, and food products. Many biological insecticides target specific pests without harming beneficial insects, birds, or mammals **(SHARMA,2017).** These alternatives often work through multiple modes of action; making it difficult for pests to develop resistance, and generally, have low toxicity to humans and animals, reducing health risks associated with exposure. they often have shorter pre- harvest intervals, allowing for quicker turnaround times in agricultural production.

For this reason, scientists focused their attention on biological alternatives, which have received positive results in the agricultural world, such as the invention of pesticides based on spontaneous plants. This led us to study the effect of the spontaneous plant *Citrullus colocynthis* on the *Tribolium* insect.

This document is divided into three chapters. The first chapter introduces the study area, including its geographical location and climate. The second chapter describes the study sites and the methods employed in the field and laboratory. The third chapter elaborates on the main results and discussions. Finally, a conclusion accomplishes the study with prospects.

CHAPTER I

Overview of the Ghardaia Region

Chapter I: Overview of the Ghardaia Region

The presentation of the study region (Ghardaia) is the main topic of this chapter. First, we have given an overview of this region's location; next, we will present the environmental conditions by examining both biotic and abiotic factors.

I.1 Geographical location

Ghardaia is located in the northern part of the Algerian Sahara its Geographic Coordinates is 32° 29′ north, 3° 40′ east, approximately 600 kilometers south of the capital, Algiers, covering an area of 21.352.58 Km² in 572m altitude **(ANIREF, 2021).**

Its position in relation to the surrounding wilayas is as follows:

- ✓ It's approximately located 200 km from Laghouat area in the north
- ✓ 300 km from Djelfa area in the northeast
- ✓ 190 km from Ouargla area in the east
- ✓ 240 km from El Menia area in the south
- ✓ and 350 km from El Bayadh area in the west **(ANIREF, 2021).**

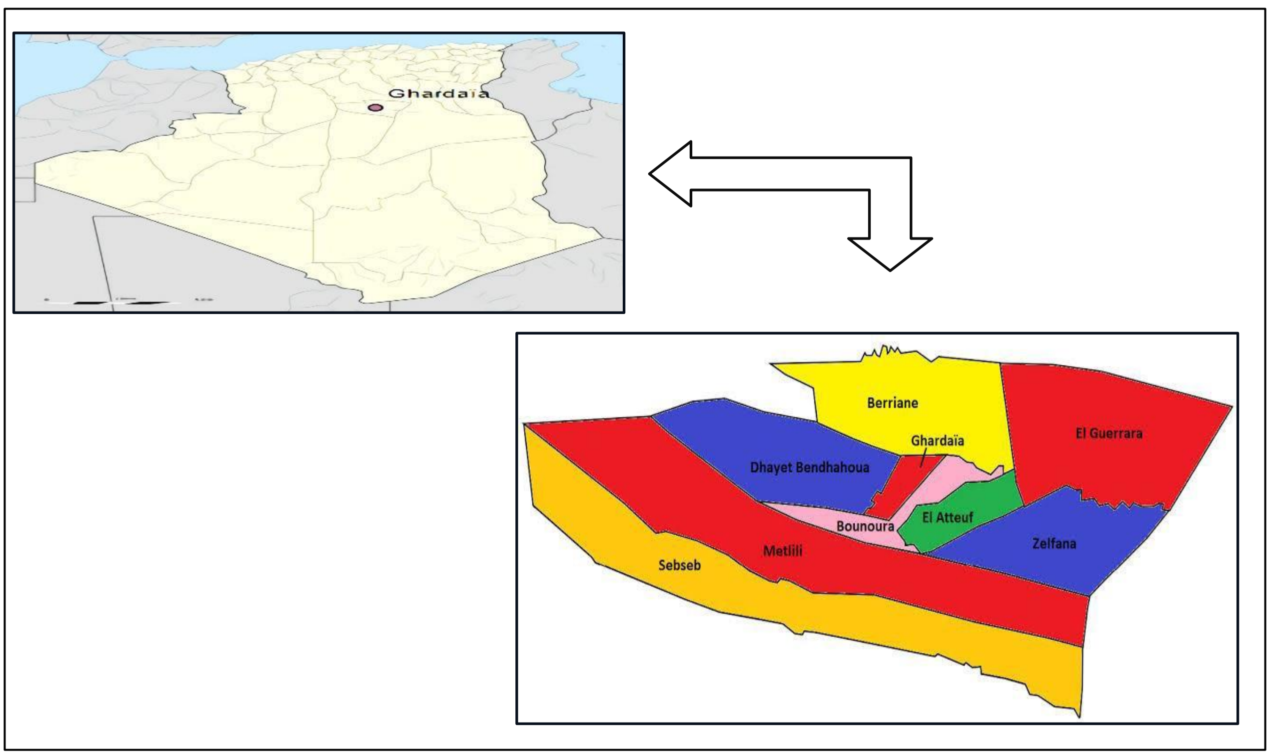

Figure 1: Map showing the location and boundaries of Ghardaia wilaya (google,2023 modified)

I.2 Edaphic factors

According to **DREUX (1980)**, every living organism is influenced by a variety of abiotic factors. These can be edaphic (soil, topography) or climatic (temperature, precipitation...). In this section, we will present the different edaphic parameters.

I.2.1 Geomorphological peculiarities

In the Ghardaia region, we have three Geomorphological peculiarities

- Chabka of M'Zab
- Dhayas Area
- Area of Regs

I.2.1.1 Chabka of M’Zab

The M'zab valley, in the northern Sahara of Algeria, is named "Chebka," which means net, since it is a large rocky plateau that is crossed by complex, deep valleys. The plateau is made up of robust Cretaceous Turonian limestone. Since the beginning of the Quaternary, river erosion has moulded the plateau, creating a complex network of Oueds, four major ones of which sculpt deep valleys. From northwest to southeast, the M'zab oued travels through the area. Because of this complex pattern that resembles a fishnet, the area is known in Arabic as Chebka, which means lace and net **(ANIREF, 2021).** The rocky plateau makes up 21% of the M'Zab region and has an area of about8000 km² **(EL ATLA,2016)**.

I.2.1.2 Dayas Area

This region is situated in the north of Ghardaia and the south of Laghouat, and it stretches south to the Gaâda d'Oum El Hissiâne. These funnel-shaped sinkholes are nestled amid the depressions, the result of floods eroding the sand grains and organic detritus that originally covered the surface. There is a remarkable variety of flowers in these sinkholes. The town of Guerrara is located in a small portion of this area, to the northeast **(ADDOUN, 2020)**.

I.2.1.3 Area of Regs

(ADDOUN, 2020) states that the regs area is located east of the Ghardaia region on top of the Pliocene geological substrate, and is marked by a large number of Regs, which indicate hard, rocky soils. These Regulations are formed in part by deflation processes. The village of Zelfana, which includes El Atteuf and Bounoura, is located in this region.

I.2.2 Geological and pedological particularities

The Sahara region's unique climatic characteristics mean that the traditional definition of "soil" does not apply there. These circumstances prevent normal soil-forming processes from occurring, which would otherwise lead to the formation of distinctive soil horizons with distinctive physical and biological characteristics. Instead, the top layer does not move much and does not have the distinct qualities of conventional soils **(DUBOST, 1991).**

The majority of the soils in the Ghardaia region are skeletal because of wind erosion **(KACI, 2005)** However, as **KACI (2005)** points out, there is frequently a noticeable presence of "Hamada" clay on the surface. On the other hand, the buildup of alluvial deposits in depressions enriches the soil.

I.2.3 Hydrological particularities

The Terminal Complex and the Intercalary Continental ponds provide the majority of the water resources in the southern part of Ghardaia. Drilling is required to reach drinkable water from these bodies of water, which are between 350 and 500 meters below the surface (**ANIREF, 2021).**

I.2.3.1 Oued Zegrir

One of the main rivers that flows through the M'zab region is the Oued Zegrir, which is located in Guerrara. This oued covers an area of 4100 km² and starts at the Oued Ajerma source, which is 860 m above sea level. It is around 270 km long. At an elevation of 300 m, it flows in a southwesterly and southeasterly manner until it reaches the lower region of Bin Falah **(DUBIFE, 1953)**.

I.2.3.2 Oued N'Sa

The Oued Zegrir basin is located south of Zegrir and covers approximately 7800 km². Its source rises to a height of 750 m near Tilghemt, after which it flows northeast of Berriane. It then travels south to meet up with two tributaries that cross the Berriane palm grove: Soudan and Ballouh. It keeps going southeast until it gets to Sabkhet Safioune, which is north of Ouargla **(EL ATLA, 2016)**.

I.2.3.3 Oued M'Zab

The M'Zab basin has a surface area of about 5000 km^2. It stretches 350 km from northwest to southeast through the M'Zab Valley. At Ghardaïa, the river reaches a 500 m elevation. It ends in Sabkhat Safioune, just as the Zegrir does during major floods. The Oueds Labiad and Touzouz are the two principal tributaries upstream of Ghardaïa. Other streams join it downstream, most notably the N'Tissa, which converges with the M'Zab on its right side after crossing the Ben-Isguen palm grove. Furthermore, the Azouil reaches the river on its left side after passing through the Bounoura gardens **(EL ATLA,2016)**.

I.2.3.4 Oued Metlili

Less than 400 km^2 make up the Metlili basin, which is mostly contained inside the Metlili Oasis. Its eastern boundary, which is completely south of the M'Zab valley, is not well defined. The basin is 214 km long overall. Its riverbed is broken up downstream by dayas, the most notable of which is the Guemta daya, which absorb some of the runoff waters. The Erg Ghanem dune barrier blocks the Oued Metlili upstream, some 134 km from its source **(EL ATLA, 2016).**

I.3 Climatic characteristics

Temperature and precipitation are the two climatic variables that best describe the area that is being studied. These variables are presented in the following.

I.3.1 Temperatures

Temperature is a limiting factor of the utmost significance since it regulates all metabolic conditions and processes as well as the distribution of all living species and communities in the biosphere (**RAMADE, 1984).**

Table 1 compiles the monthly temperature readings from the Ghardaïa weather station for the years 2023 and the past ten years.

Table 1: Ghardaia region's average monthly temperatures, maxima, and minima for the years 2023 and the previous ten years (2014–2023)

	T (°C)	Ghardaïa											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2014-2023	M	17.08	19.02	22.66	28.01	32.77	38.25	41.57	40.22	36.08	29.11	22.36	17.92
	m	6.02	7.97	10.98	15.2	20.91	25.01	28.56	27.71	23.97	17.48	11.41	7.18
	(M+m)/2	11.55	13.50	16.82	21.61	26.84	31.63	35.07	33.97	30.03	23.30	16.89	12.55
2023	M	16.3	16.8	25.4	28.8	30.9	37.2	43.8	39.6	36.4	30.5	25.3	19.3
	m	5.2	6.9	12.7	15.5	18.8	24.7	29.8	27.2	23.9	18.5	13.2	8.7
	(M+m)/2	10.75	11.85	19.05	22.15	24.85	30.95	36.80	33.40	30.15	24.50	19.25	14.00

(Tutiempo, 2024)

M: Average monthly maximum temperatures in °C;

m: Average monthly minimum temperatures in °C;

(M+m) / 2: Amounted monthly temperatures in °C.

In the period from 2014 to 2023, January has the lowest average temperature (11.6°C, Tab. 1), while July has the highest average temperature (35.1°C). As well as in 2023, July turns out to be the warmest month with an average temperature of 36.8°C, while January is the coldest month with an average temperature of 10.8°C.

I.3.2 Precipitation

Precipitation is a very important ecological component because of its direct effects on biodiversity and its biological units (**MUTIN, 1977**).According to **QUEZEL (1978)**, the average annual precipitation is a significant factor to take into account because, in arid regions, the amount of water received annually is still essential for plant growth, for soils to be strengthened and to facilitate the migration of the most soluble elements and water erosion processes (salts, gypsum, and limestone). The maximum quantity of rainfall is necessary. Table 2 lists the quantity of rainfall that was recorded in the Ghardaïa region in 2023 and the past ten years.

Table 2: Monthly precipitation (mm) for the Ghardaia region recorded for the years 2023 and the previous ten years (2014–2023)

	Ghardaïa												Cumul
P (mm)	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2014-2023	1.60	3.84	3.53	3.66	3.99	0.71	0.20	4.09	4.70	3.27	3.35	1.27	34.20
2023	4.31	3.05	0.00	0.00	1.52	0.00	0.00	5.08	0.00	0.00	0.00	4.07	18.03

(Tutiempo, 2024)

P: Monthly precipitation in millimeters.

The total precipitation from 2014 to 2023 was 34.21 mm. However, the total precipitation recorded for 2023 was 18.03 mm (Table 2). January had the most precipitation (4.31 mm).

I.4 Climate synthesis

A number of climate indices, including the EMBERGER climate diagram, the BAGNOULE and GAUSSEN shadow thermal diagram, the Martonne drought index, and the Thornwaite rainfall index, are used to synthesize climate data (**DAJOZ, 1971**). In our study, we utilized EMBERGER climate diagram and BAGNOULE and GAUSSEN shadow thermal diagram.

I.4.1 GAUSSEN Ombrothermal Diagram

It is feasible to identify periods of drought using the BAGNOULE and GAUSSEN ombrothermic diagrams. GAUSSEN defines a drought as when the average monthly temperature in degrees Celsius is less than double the amount of precipitation in millimeters ($P \leq 2T$).

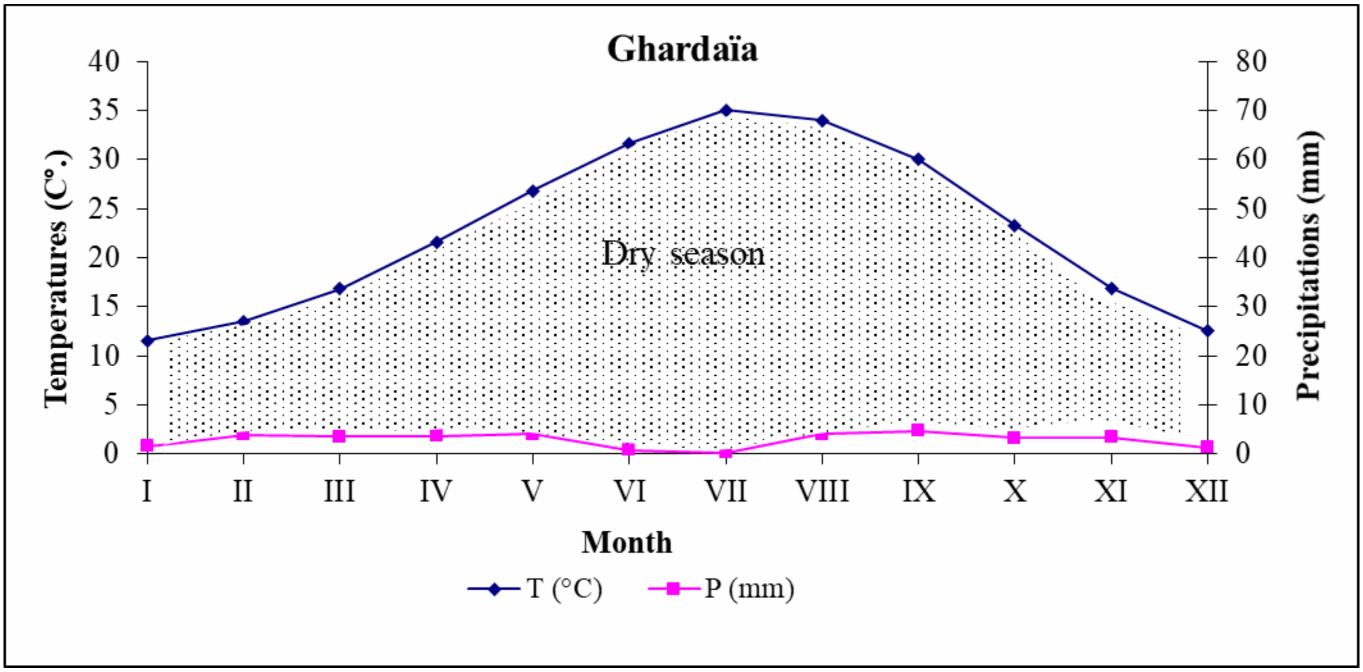

Figure 2: GAUSSEN Ombrothermal Diagram, 1953 for a 10-year period (2014-2023) of the Ghardaia region

In the Ghardaia region, based on BAGNOULE and GAUSSEN ombrothermic diagram, we have observed a drought and a lack of rainfall over the past 10 years (Fig. 2).

I.4.2 EMBERGER climatogram

The EMBERGER index (1932) defines the degree of humidity in the climate. It considers the average of the coldest month's minimum temperatures (m), the hottest month's maximum temperatures (M), and the annual precipitation. It, like the Gaussen xerothermal index, is well suited to Mediterranean regions, allowing for the delineation of multiple climatic stages. This is accomplished by calculating a quotient, Q2, with the following formula:

$$Q2 = \frac{1000\,P}{(\frac{M+m}{2})(M-m)}$$

P: Annual precipitation in mm;

$(\frac{M+m}{2})$: Average annual temperatures;

(M- m): Extreme thermal amplitude in °K;

M: Average of the maxima of the hottest month in °K;

m: Average of the minimums of the coldest month in °K;

°K: degree kelvin.

The previous formula was simplified by (**STEWART, 1969**) using the following quotient:

$$Q3 = 3.43 \times \frac{p}{M - m}$$

Q3: EMBERGER rainfall quotient;

P: Annual precipitation in mm;

M: Average of the maximums of the hottest month (°C);

m: Average of the maximums of the coldest month (°C).

The value of the quotient Q3 for the study region, calculated from climatic data obtained over a period of 10 years (2014-2023), is equal to 3.30. The average maximum temperatures of the hottest months are M=41.57°C. The average minimum temperatures of the coldest months, calculated for the same period, is m=6.02°C. By plotting these values on the EMBERGER Climatic Diagram.

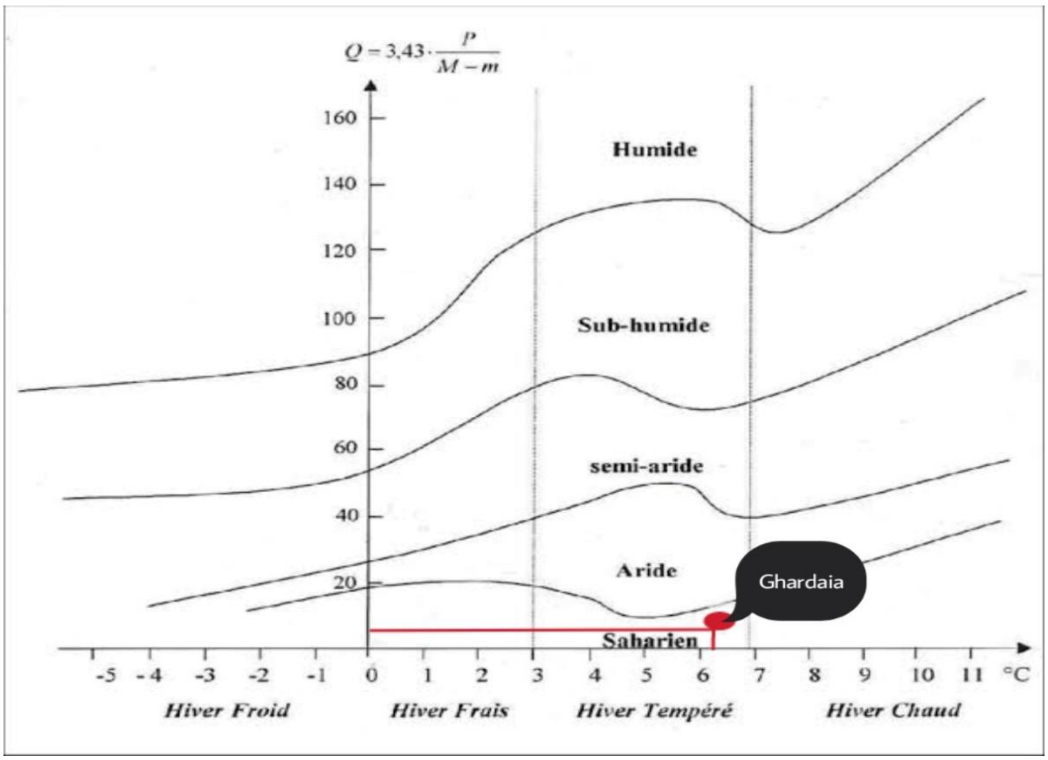

Figure 3: Place of the Ghardaia region in the Emberger Climagram (2014-2023)

I.5 Bibliographic data on the vegetation of the Ghardaia region

The phenomena of oasis are one of the most distinctive characteristics of the Maghreb region. **PERENNES (1993)** attributes the heritage of oasis gardening to a number of variables, including the size of the Saharan desert, the abundance of water at different depths, the long-standing inhabitants, and the considerable trade between Black Africa and the Mediterranean.

According to **KHENE (2007)**, a very productive date palm crop forms the upper tier of an irrigated agricultural area. Life in this heavily populated area is centered around water resources. Herbaceous crops are grown on the lower tier, while fruit trees like orange, lemon, fig, apricot, pomegranate, olive, peach, almond, and apple trees can be found on the upper tier.

The Ghardaïa region's plant cover is made up of a range of tree, shrub, and herbaceous species, depending on the altitude. Here, Phoenix dactylifera is the predominant species. Fruit, market gardening, and condiment crops are grown either beneath these trees or close by (**QUEZEL and SANTA, 1926; OZENDA, 1983; ZERGOUN, 1994**). In addition to palm grove plantations, this sub-Saharan region boasts diverse floristic compositions, making it unique. Examples of these compositions include *Aristida pungens*, *Retama raetam*, *Calligonum comosum*, *Ephedra alata*, *Drimia noctiflora*, *Erodium glaucophyllum*, *Halodium scoparium*, *Capparis spinosa*, *Zilla macroptera*, *Pistacia atlantica*, *Ziziphus lotus*, *Tamarix articulata*, and *Populus euphratica* (**OZENDA, 1983**).

According to **DJILALI (2009)**, the flora of Ghardaïa comprises a variety of species, including 25 families and 73 species. The Asteraceae family is the richest in terms of species, with *Anvillea radiata*, *Artemisia campestris*, and *Artemisia herba-alba* being its most prominent representatives.

Cornulaca monacantha, *Tetraena alba*, and *Ephedra alata* are the three main species found in the regs. Downstream of Oued M'Zab, it is possible to find halophilic floristic populations, including *Atriplex halimus*, *Salsola vermiculata*, and *Anabasis articulata*, which represent significant cases (**ABONNEAU, 1983**).

I.6 Bibliographic data on the fauna of Ghardaia region

The wildlife of the Sahara developed special defense mechanisms against dehydration and extreme cold in response to the region's arid climate (**VIAL and VIAL, 1974**). Ghardaïa's fauna comprises both vertebrates and invertebrates (**KADI and KORICHI, 1993**).

The entomofauna of the Ghardaïa region is classified into several orders, including Orthoptera, Dermoptera, Homoptera, Coleoptera, and Lepidoptera (**ZERGOUN, 1994**). Species such as *Leptonychus sabulicola*, *Erodius singularis*, and *Zophosis mozabita* are among the most representative of this fauna.

In terms of reptiles, the research area hosts two orders, four families, and five species, as well as two families and two species of amphibians (**HOFER, 1988**).

The avifauna of the study region, which includes species such as the House Swallow, White-headed Wheatear, Striated Bunting, House Sparrow, White Sparrow, Ringed Dove, Rock Pigeon, Common Raven, Ascalaph owl, Short-eared owl, among others, holds significant importance (**DJILALI, 2009**).

Thirteen mammal species, distributed across four orders and eleven families, have been identified in the region (**KADI AND KORICHI, 1993**). Among them, the order Rodentia is particularly notable for its diversity, with species such as *Jaculus jaculus*, *Mus musculus*, *Gerbillus gerbillus*, and *Massoutiera mzabi* being the most representative.

CHAPTER II

MATERIALS AND METHODS

Chapter II: Material and Methods

This chapter will discuss the selection and description of study stations. Following that, we will discuss each of the sampling methods we have chosen. Finally, we'll look into the different approaches to using the findings.

II.1 Description and choice of study station

Daia Ben Dhahoua is a commune in the wilaya of Ghardaïa (Algeria), located 10 km northwest of Ghardaïa. Its area is 2.175 km^2 (**BENYOUCEF, 2018**). Its geographic Coordinates are 32° 32′ 13″ north, 3° 36′ 20″ east and it is limited:

To the North by the commune of Hassi Rmel.

To the East by the commune of Berriane.

To the West by the commune of Metlili.

To the South by the commune of Bounourra.

Our experiments were conducted on spontaneous plants in the Daia Ben Dhahoua area (oued labiod). This location was chosen for the study because it is unaffected by human activity, which will increase the variety and accessibility of naturally occurring plants.

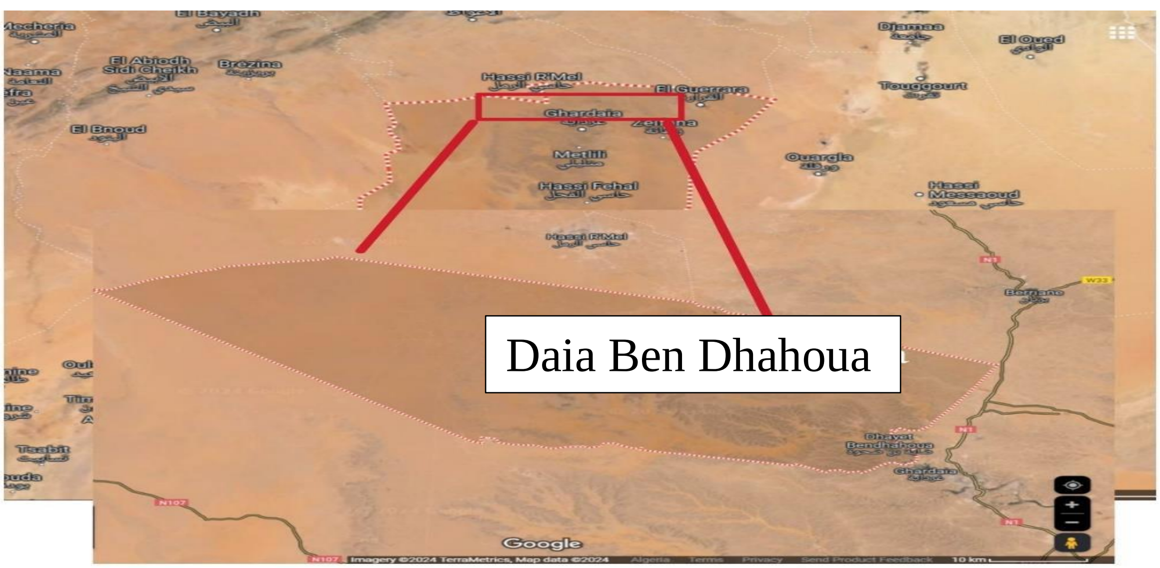

Figure 4: Location of the Daia Ben Dhahoua region (wilaya of Ghardaïa) (Google earth, 2024)

II.2 Used material and products

Specific material was employed for the field gathering of plants that were to be taken to the lab for extraction. Also included are the materials and products utilized in the extraction procedure. All of this equipment is listed as follows:

- Glass bottles to preserve the grounded plant material. - Spatula and precision balance for weighing. - Filter paper for the filtration of extracts. - Beaker for the recovery of filtrates. - Vacuum filtration ramp - Orbital Shaker - Rota vapor for solvent evaporation - Dark-colored glass bottles for storing extracts. - Gloves and mask (protection during extraction).	- Distilled water and solvents (ethanol, methanol, ethyl acetate, and dichloromethane). - Separatory funnel - Laboratory drying oven - A tape measure for measurements. - Secateurs for cutting hard parts. - Paper bags for conservation and transport to the drying location. - GPS (geographic positioning system).

II.3 Plant material and sampling

For plant material sampling and treating, we measured 100 meters by 50 meters in the field and then weighed all of the plants around it. We repeat this operation three times at random. Then we took all of the different spontaneous plants found in the field (Figure 5,6).

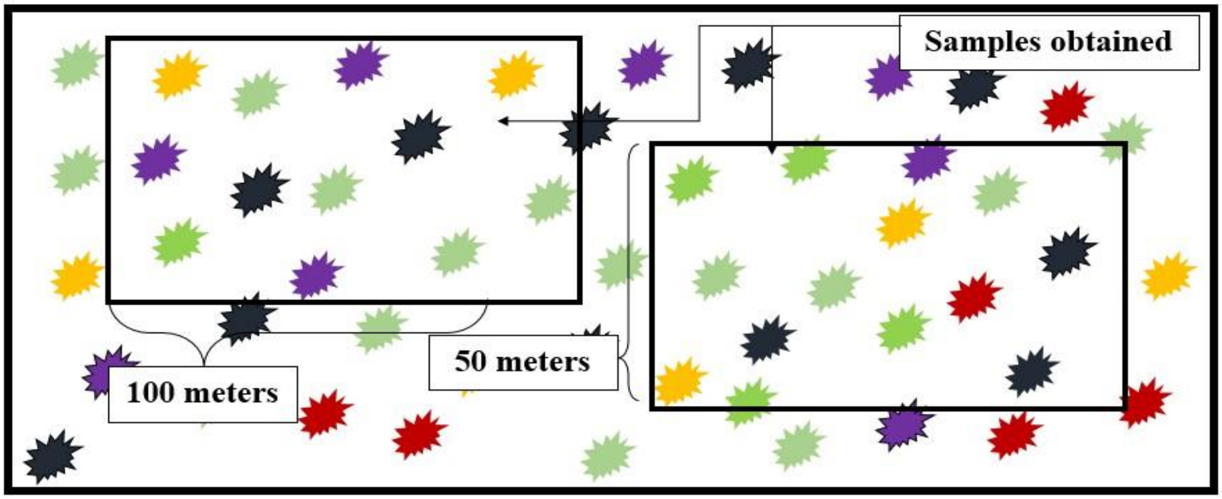

Figure 5: Parcel diagram of the oued labiod Station (Daia ben dhahoua) (original)

Figure 6: oued labiod station (Daia ben dhahoua)

- ✓ **Vegetation station**

A variety of spontaneous plants can be found in Oued El Abyad Station, including *Zilla spinosa*, *Peganum harmala*, *Xnathium spinosum*, *Citrullus colocynthis (L.)*, *Rhanterium adpressom*, *Pergularia tomentosa*, *Asphodelus tenuifolius*, and *Euphorbia guyoniana*.

Citrullus colocynthis (L.) **(Schrad).** is the chosen plant to be studied in the current experiment. It is a perennial creeping herbaceous plant commonly found in sandy desert areas. It is a member of the family Cucurbitaceae and native to the Mediterranean basin, West Asia, and the coast of North Africa. Its common names include colocynth, bitter apple, bitter cucumber, desert gourd, and vine of Sodom, among others **(MARIOD AND JARRET, 2022)**. This plant offers different pharmacologic properties in traditional medicine such as antidiabetic, anti-inflammatory, abortifacient, analgesic, and antiepileptic **(RAHIMI et *al*., 2012).** As well as, it seeds oil has antibacterial, antioxidant, anticancer, insecticidal, and other useful and important properties.

Figure 7: *Citrullus colocynthis* plant (Quinta do ouriques, 2022)

The plant material collection was in March 2024 in the region of Daia ben dhahoua in oued labiod (wilaya of Ghardaïa).

Following the gathering, every part of the plant (root, flower, leaves, fruit, and seed) was cleaned and kept at room temperature in a dark chamber (out of the sun) for at least 15 days. It was ground and kept in paper bags until needed after it had dried.

II.4 Extract preparation

Solid-liquid extraction is the technique of removing active ingredients from plant matter. This technique, according to **VELICKOVIC ET *AL*. (2006),** is a basic operation that aims to dissolve solid components in a liquid to extract or separate them.

In the current experiment, the compounds were separated according to their solvent solubility using solid-liquid extraction by maceration using a variety of organic solvents with different polarities, such as acetone, ethanol, methanol, and ethyl acetate. Maceration is a simple procedure that consists of letting the plant material in a solvent for a predefined period to extract the active ingredients **(HAMIA ET *AL*., 2014).**

- ✓ **Methanolic extraction**

This operation consists of macerating a quantity of 20 g of the vegetable powder in an orbital Shaker, with 80 ml of methanol and 20 ml of distilled water for 24 hours in the dark and at room temperature. The extracts obtained were filtered on filter paper. After filtration, it was evaporated using a rotary evaporator (Heidolph), and then we put the extract in a laboratory drying oven at 45 °C for 45 minutes to 1 hour for the elimination of solvents. The residues obtained are stored in the refrigerator at 4°C until further use (**CHOUIKH et *al*., 2015**).

- ✓ **Ethanol extraction**

This preparation was made by maceration of 20 g of vegetable powder in an orbital Shaker, with 70 ml of ethanol and 30 ml of distilled water for 24 hours in the dark and at room temperature. The extracts obtained were filtered using filter paper and then evaporated using a rotary evaporator (Heidolph). After evaporation, we put the extract in a laboratory drying oven at 45 °C for 45 minutes to 1 hour for the elimination of solvents. The residues obtained are stored in the refrigerator at 4°C until further use **(CHOUIKH et *al*., 2015)**.

- ✓ **Extraction of flavonoids**

A quantity of 20g of dry matter was macerated with 100 ml of methanol at room temperature in the dark for 24 hours. After filtration, the solvent was evaporated under reduced pressure in a rotary evaporator at 50°C. Then, we added 100 ml of warm distilled water and 100 ml of Ethyl acetate and we put the new mixture in a separator funnel (figure 9). After the separation, we got the Ethyl acetate phase for evaporation in a rotary evaporator at 50°C to get the flavonoids extract (phase Ethyl acetate) **(BEKKARA et *al*., 1998).**

- ✓ **Extraction of tannins**

A quantity of 20g of dry matter was macerated with 30 ml of distilled water and 70 ml of acetone at room temperature in the dark for 72 hours. The extracts obtained were filtered on filter paper. After filtration, the solvent was evaporated in a rotary evaporator at 50°C to remove acetone. Then, we added 70 ml of Dichloromethane for separation of the organic and aqueous phases by separator funnel (figure 9); the organic phases were further extracted with Ethyl acetate (70 ml) and evaporated at 50°C **(ZHANG et *al*., 2008)**.

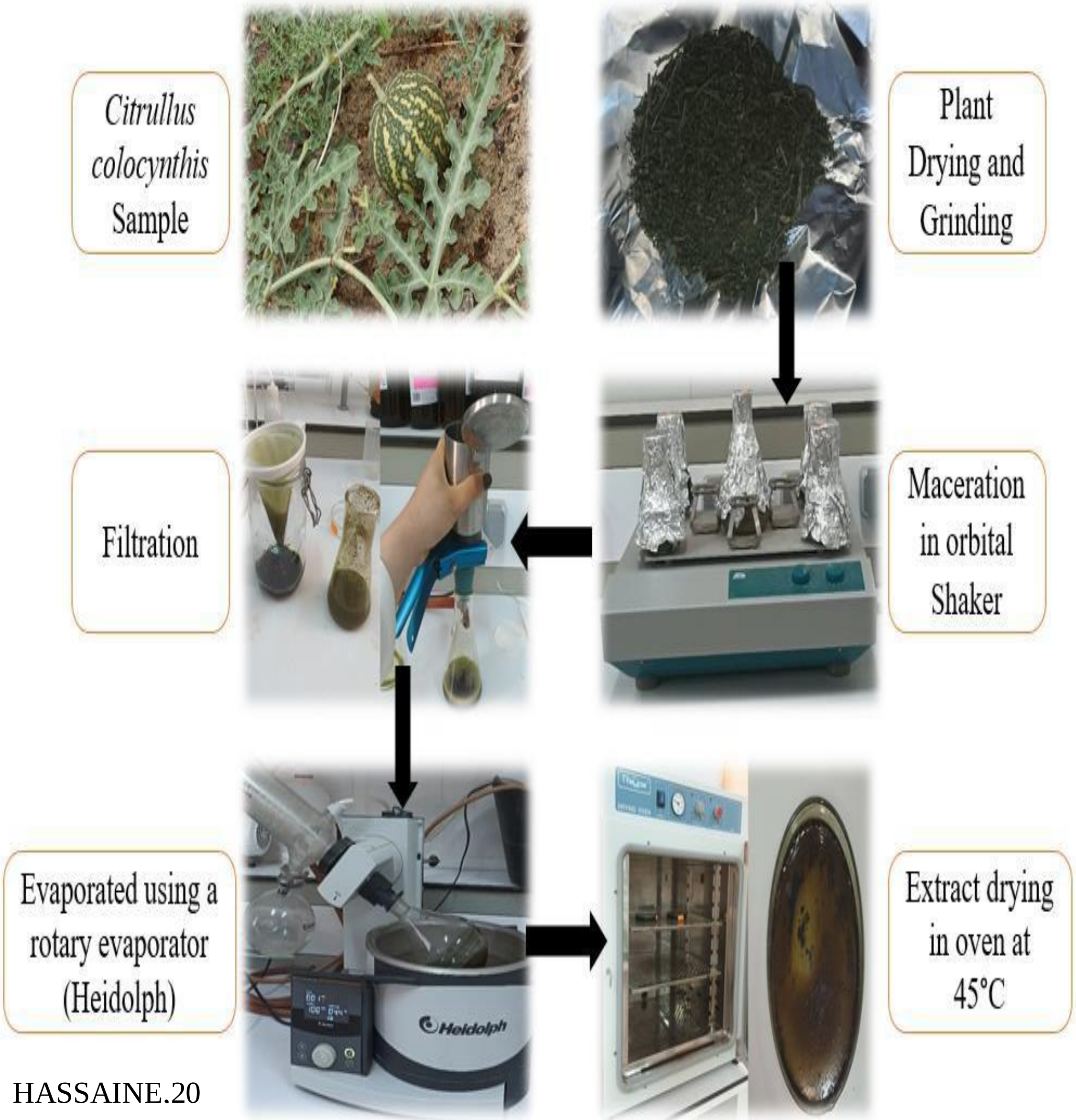

Figure 8: Extraction protocol (original)

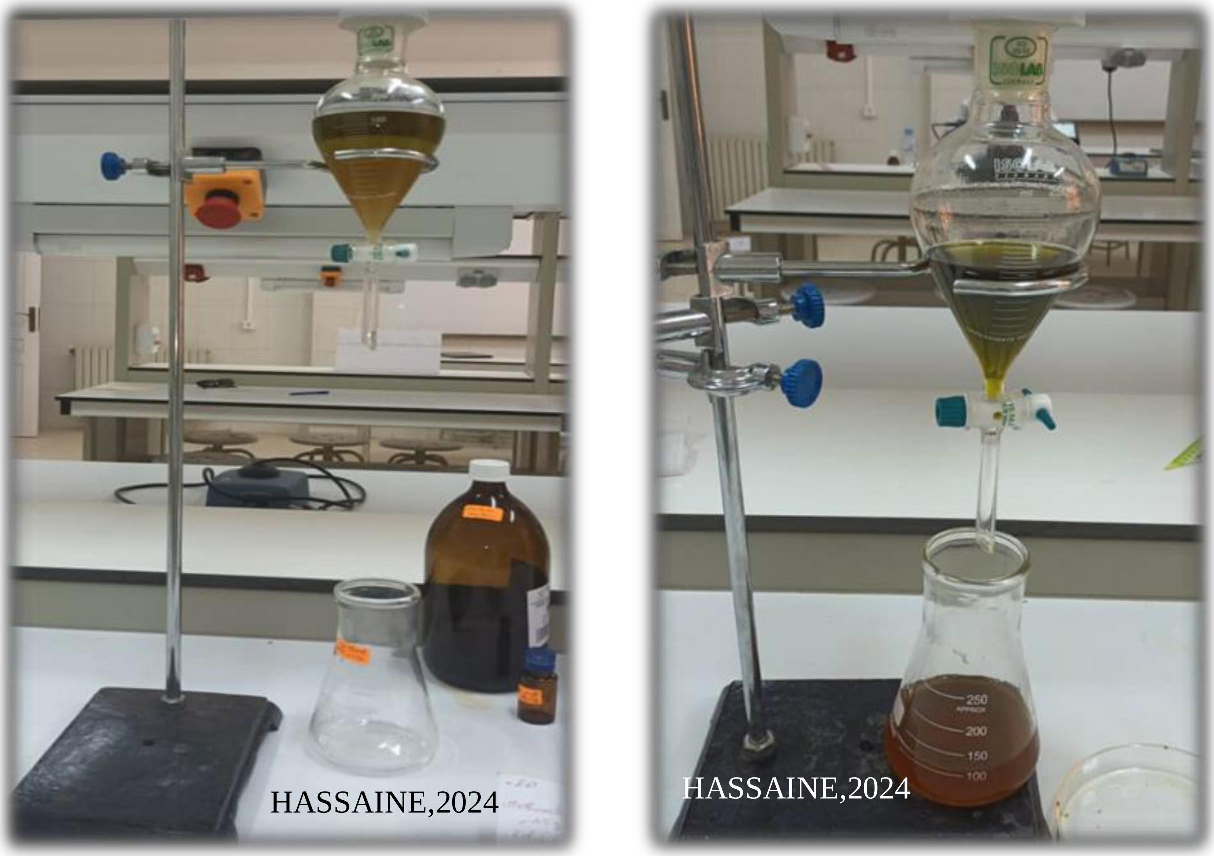

Figure 9: Tannins, flavonoid extraction by separator funnel

II.5 Calculation of extract yield

The percentage of yield extracts was calculated by the following formula:

$$R(\%) = \frac{M}{M0} \times 100$$

R (%): Yield expressed in%.

M: Mass in grams of raw dry extract.

M0: Mass in grams of plant material to be treated.

II.6 Insect breeding

II.6.1 Choice of insect and description

Tribolium castaneum, a member of the insect class of the Coleoptera order, was the animal species selected to assess the insecticidal potential of *Citrullus colocynthis,* extracts. This bug is frequently seen in food storage buildings. As a result, we selected this pest for our research due to its significance in causing harm to stored food as well as its ease of handling and reproduction in the laboratory.

Tribolium castaneum (Herbst.) (Figure 10) is an animal species belonging to the Coleoptera order (Coleoptera-Tenebrionidae). T. castaneum, can be classified as follows:

- ❖ Kingdom: Animalia
- ❖ Division: Arthropoda
- ❖ Sub branch: Antennata
- ❖ Class: Insecta
- ❖ Subclass: Pterygota
- ❖ Order: Coleoptera
- ❖ Under order: Polyphaga
- ❖ Family: Tenebrionidae
- ❖ Genus: *Tribolium*
- ❖ Species : *Tribolium castaneum* (Herbst)

Figure 10: *Tribolium castaneum* insect under binocular magnifier (original)

II.6.2 Breeding of *Tribolium castaneum*

T. castaneum was raised on semolina and flour in a plastic box at room temperature. (Figure 11)

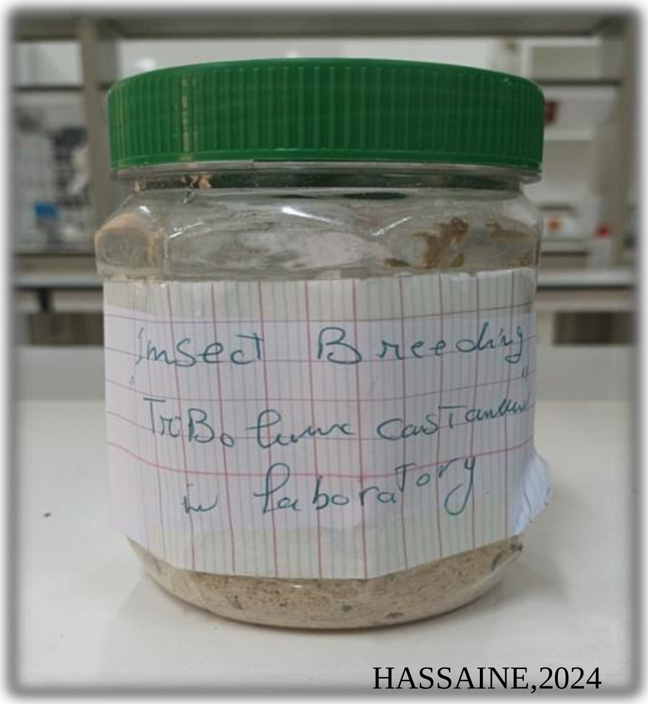

Figure 11: Breeding of *Tribolium castaneum* in the laboratory (Original)

II.7 Biological tests

Toxicity tests were carried out to evaluate the effectiveness of spontaneous plant extracts on *Tribolium castaneum*, with two methods of treatment being carried out: contact and ingestion, In different concentrations (250, 500, and 750 ml).

II.7.1 By contact

The plant extracts at different concentrations are sprayed directly into a Petri dish lined with filter paper. While the negative control batch is made up of insects treated with distilled water. Each Petri dish receives 1 ml of product tested at different doses or controls. Each batch made up brings together 45 individuals, distributed equally over three Petri dishes (repetition), or 15 individuals per dish. Insect mortality was recorded at a time interval of 72 hours.

II.7.2 By Ingestion

Feeding the insects semolina treated with spontaneous plant extracts (flavonoids, tannins, methanolic, and ethanolic extracts) in varying amounts is the treatment's method. The concentrations were made by combining 10 ml of acetone and 10 mg of *Colocynthis vulgaris* extract. One milliliter of our extract was added to a petri dish containing one gram of semolina, and everything was thoroughly mixed. It is then allowed to dry for 20 to 30 minutes. Next, 15 mature *T. castaneum* individuals were added to every Petri dish that held the treated semolina. Every extract was subjected to three repetitions for every treatment. Over three days, the dead insects were counted.

Figure 12: Contact and ingestion treatments by *Citrullus colocynthis* extracts (Original)

II.8 Mortality rate

The first factor used to determine if a chemical or biological treatment is effective is mortality. The following formula was used to assess the proportion of deaths counted in the control and treated groups after using the plant extract **(HEROUINI, 2021).**

$$\text{Observed mortality} = \frac{\text{Number of deaths}}{\text{Total number of individuals}} \times 100$$

Mortality rate was obtained by using this formula **(ABBOTT 1925)**:

$$\text{Corrected mortality (\%)} = \frac{\text{Mortality in treated individuals} - \text{mortality in the control}}{100 - \text{mortality in the control}} X\ 100$$

The DL_{50} was calculated by transforming used doses into decimal logarithms as well as values of percentages of corrected mortality to probits using the table of **CAVELIER (1976)**. The DL_{50} is given starting from the straight regression lines.

Probits = f (log doses)

II.9 Statistical analysis

II.9.1 Analysis of variance (ANOVA)

The most effective parametric technique for analyzing experiment data is analysis of variance (ANOVA). Originally, it was designed to evaluate the differences between numerous treatment groups, avoiding the challenge of utilizing t-tests to make multiple comparisons between group averages **(SNEDECOR AND COCHRAN, 1980)**. ANOVA is a very sophisticated and nuanced method with numerous versions, each of which is appropriate for a certain experimental setting. Therefore, it is feasible to use the incorrect kind of ANOVA in a given experimental setting and, as a result, get incorrect conclusions from the data.

CHAPTER III

RESULTS AND DISCUSSION

Chapter III: Results and Discussion

Our study is a component of a larger body of work on sustainable farming practices, efficient conservation, and storage, as well as alternate pest management strategies for commodities that are preserved. The primary objective is to find a natural insecticide that will minimize the disadvantages and adverse effects of using chemical pesticides.

III.1 Yield of extracts

Depending on the solvent used during the extraction process, the *Citrullus colocynthis* extracts produced varying yield rates along with varying degrees of color and smell. A percentage is given for the yield, which was calculated using 20 grams of dry and crushed plant material. A summary of each extract's characteristics is given in Table 03, and a histogram of the extraction yields is shown in Figure 13.

We point out that the maximum extraction yield (25.85%) was found in the hydro-methanolic extract obtained during maceration, which was followed by the hydro-ethanolic extract (23.8%), the flavonoids extract (2.75%), and the tannins extract (0.5%). Regarding these extracts' color and smell, the majority of them had a dark green color and a strong smell. Moreover, the ethanolic and hydro-methanolic extracts had a pasty aspect, in contrast to the extracts of tannins and flavonoids, which displayed a powdered quality (table 03).

Table 3: Characteristics of *Citrullus colocynthis* extracts

Extracts	Yield%	Color	Smell	Aspect
Hydro-methanolic	25.85	caramel	very strong	pasty
Hydro-ethanolic	23.8	dark green	very Strong	pasty
Tannins	0.5	dark green	less	powdery
Flavonoids	2.75	green	very strong	powdery

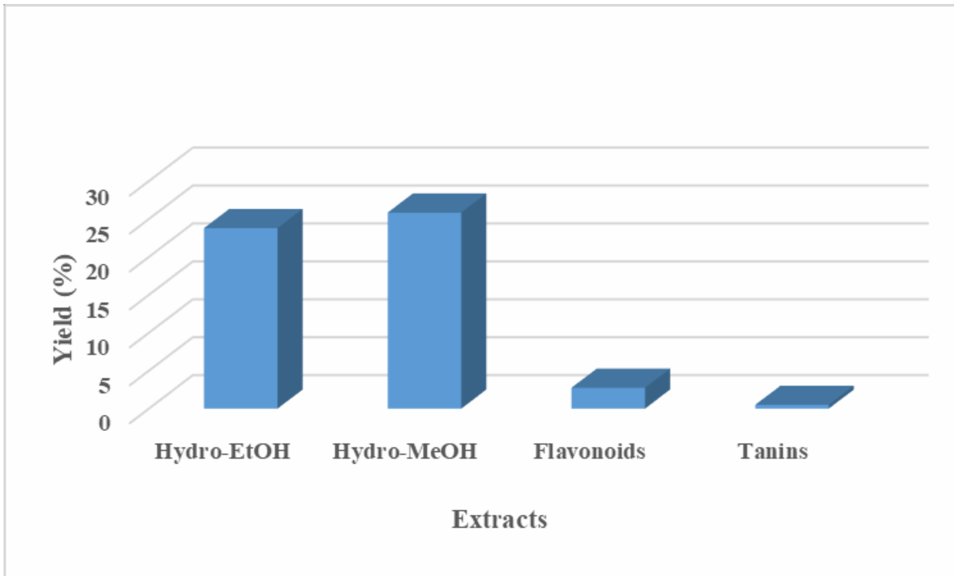

Figure 13: Yields in (%) of *Citrullus colocynthis* extracts

The use of solvents with varying polarity allowed us to distinguish between the extracts. It should be noted that the choice of these solvents was based on the findings of several previous studies, which demonstrated that using aqueous ethanol or aqueous methanol increases extraction yield significantly when compared to extractions with pure organic solvents **(VAZQUEZ ET AL., 2008; MUSSATTO ET *AL*., 2011; KHERRAF, 2018). CHAOUCHE (2014) also** explained this phenomenon by stating that the presence of water destabilizes the cell walls, allowing for deep penetration into the cellular matrix, and, as a result, the solvent will come into touch with a bigger quantity of solute, promoting a high extraction yield. Again, the polarity and type of the solvents utilized determine the extraction yield **(FRANCO ET AL., 2008).**

Many factors influence extraction yield, the most important of which are: the species' harvest origin, the harvest season, the part of the plant used, the extraction method, the duration, temperature, and location of drying **(HMIRI ET AL., 2011; MOGHADDAM AND MEHDIZADEH, 2017).** Our findings on the yield of ethanolic extract exceed those of **AHMED ET AL. (2020),** who worked on the same plant *Citrullus colocynthis (L.)* with an ethanolic solvent that ranges at 12.45%.

III.2 Insecticidal activity of *C. colocynthis* against *T. castaneum*

In this section, we are going to assess the insecticidal potential of our plant against *T. castaneum.* It will be evaluated depending on the type, mode, doses, and time used in the current experiment.

III.2.1 Depending on the type of extracts

Figure 14 displays the results of the toxicity of *C. colocynthis* extracts (tannins, flavonoids, hydro-ethanolic, and hydro-methanolic) against *T. castaneum* along with the mortality rates.

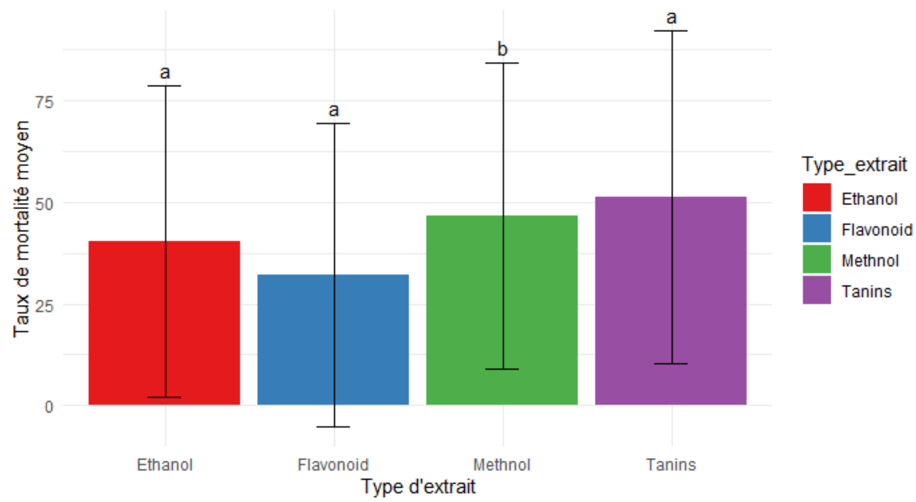

Figure 14: Toxicity of *C. colocynthis* against *T. castaneum* depending on the type of extracts

The results demonstrated that the extract of tannins had the greatest recorded death rate, more than 50%, and was followed by the extracts of flavonoids, hydro-methanolic, and hydro-ethanolic (figure 14).

III.2.2 Depending on the utilization

The findings of the toxicity of *C. colocynthis* extracts against *T. castaneum* are shown in Figure 15, together with the corresponding mortality rates based on the utilization types.

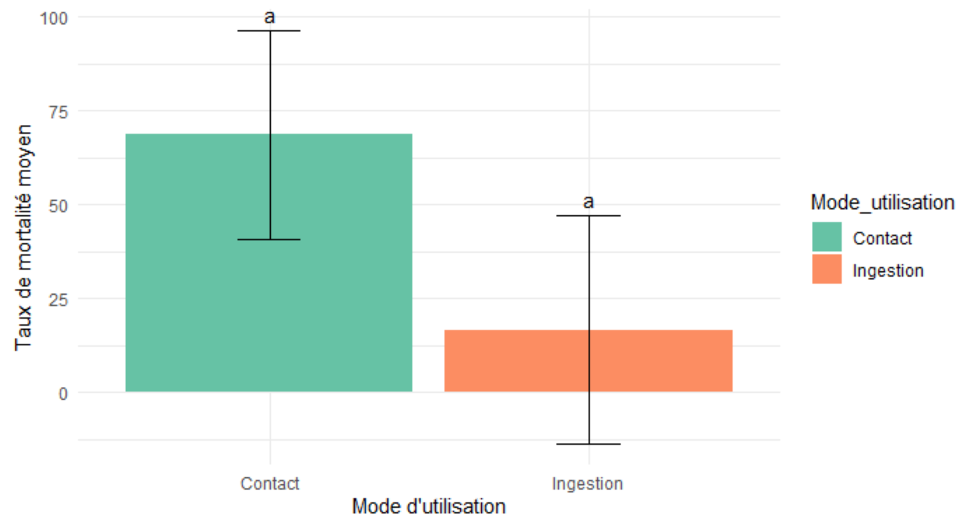

Figure 15: Toxicity of *C. colocynthis* against *T. castaneum* depending on the mode of extraction

The findings shown in Figure 15 explain why the ingestion type had a low death rate while the contact type had the highest recorded mortality rate when employing these extracts. As a result, our treatment's outcomes verified that applying these extracts in contact with *Tribolium castaneum* would result in interesting toxicity beyond digestion. It should be noted that this pest is highly harmful when in contact with it.

III.2.3 Depending on doses

Figure 16 displays the findings of the toxicity, based on dosages, of *C. colocynthis* extracts against *T. castaneum.*

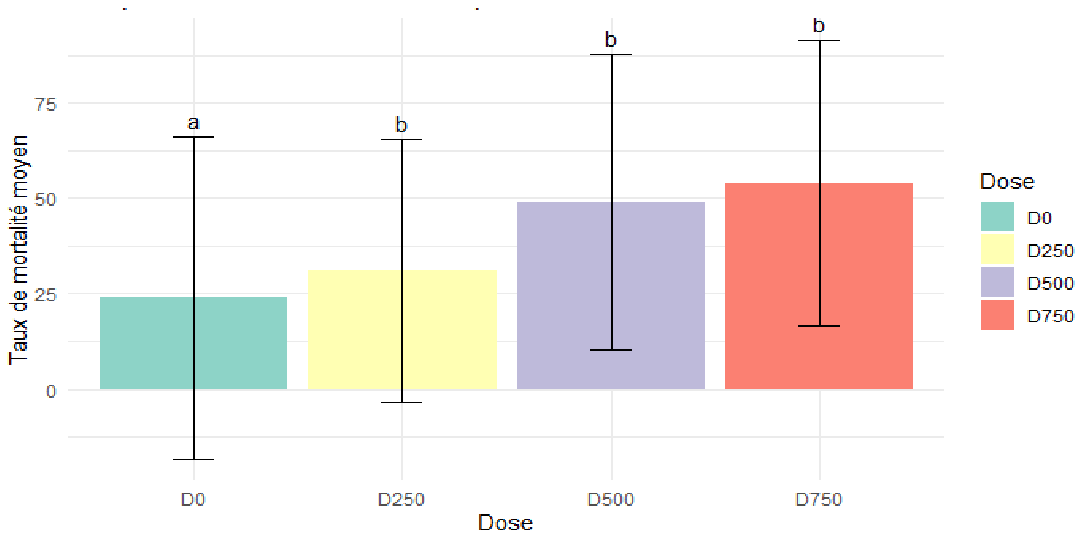

Figure 16: Toxicity of *C. colocynthis* against *T. castaneum* depending on doses

The dose of 750 in all extracts recorded more than 50% in comparison to the control, meaning that it had the maximum insecticidal impact. D500 recorded less than 50%, and at least 250 had the lowest insecticidal effect.

III.2.4 Depending on the time

Figure 15 represents the results of the toxicity, depending on the time, of *C. colocynthis* extracts against *T. castaneum*.

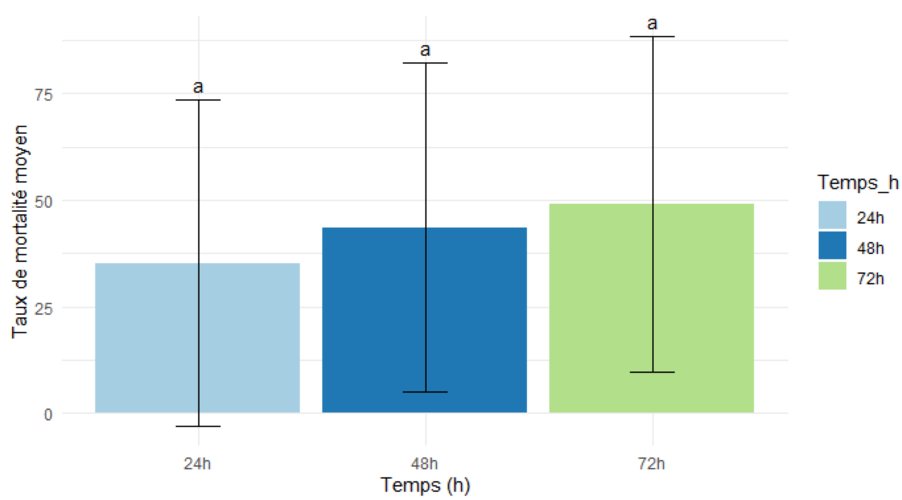

Figure 17: Toxicity of *C. colocynthis* against *T. castaneum* depending on the time of exposure

The results depicted in the above figure suggest that the mortality rate peaked after 72 hours of exposure, or well over 50% of individuals. The 48 hours period also seems to have some efficacy, although not nearly as much as 50%.

III.3 Calculation of the lethal dose (LD_{50}/LD_{90}) of the extracts

Table 4 lists the lethal concentrations (LD/LC) for each extract when ingested or contacted with it.

Table 4: Lethal dose (LD_{50}/LD_{90}), in mg, of the extracts of *C. colocynthis*

	Contact		Ingestion	
Extracts	**LD50**	**LD95**	**LD50**	**LD95**
Flavonoids	0.123	0.986	17.306	555.113
MeOH	0.123	0.986	0.975	5.769
Tannins	0.035	1.445	0.451	0.805
EtOH	0.016	108.28	0.665	0.841

The lethal dose/concentration for *C. colocynthis* extracts based on the mode of treatment (ingestion or contact) is shown in the above table. The LD_{50} and LD_{95} values for contact use, respectively, range from 0.016 mg to 0.123 mg and 0.986 mg to 108.28 mg (table 2). The LD_{50} and LD_{95} values, in contrast to the ingestion use, range from 0.451 mg to 17.306 mg and 0.805 mg to 555.113 mg, respectively. These findings so support earlier research on toxicity, which found that contact mode was more effective than intake.

The figures below show the Probit analysis of lethal doses (LD_{50}/LD_{90}) in *C. colocynthis* by contact and ingestion.

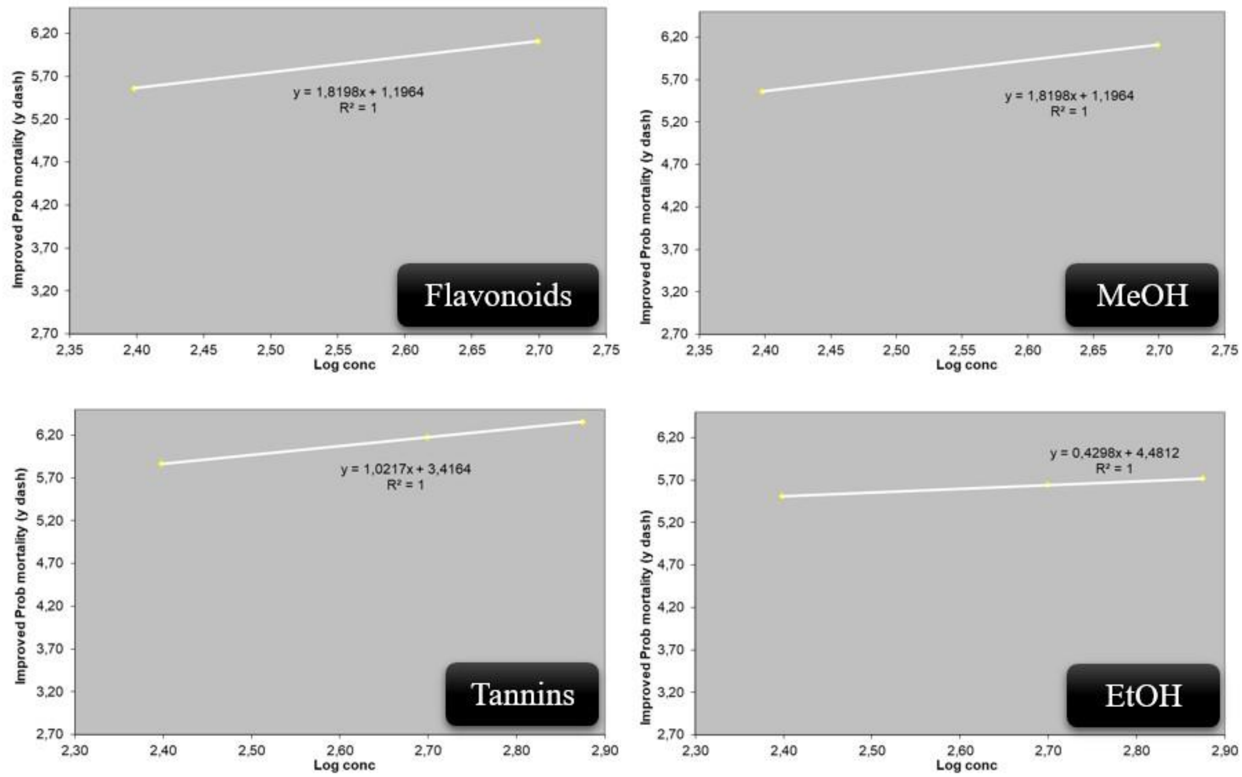

Figure 18: Probit analysis Graph showing lethal doses in *C. colocynthis* by contact

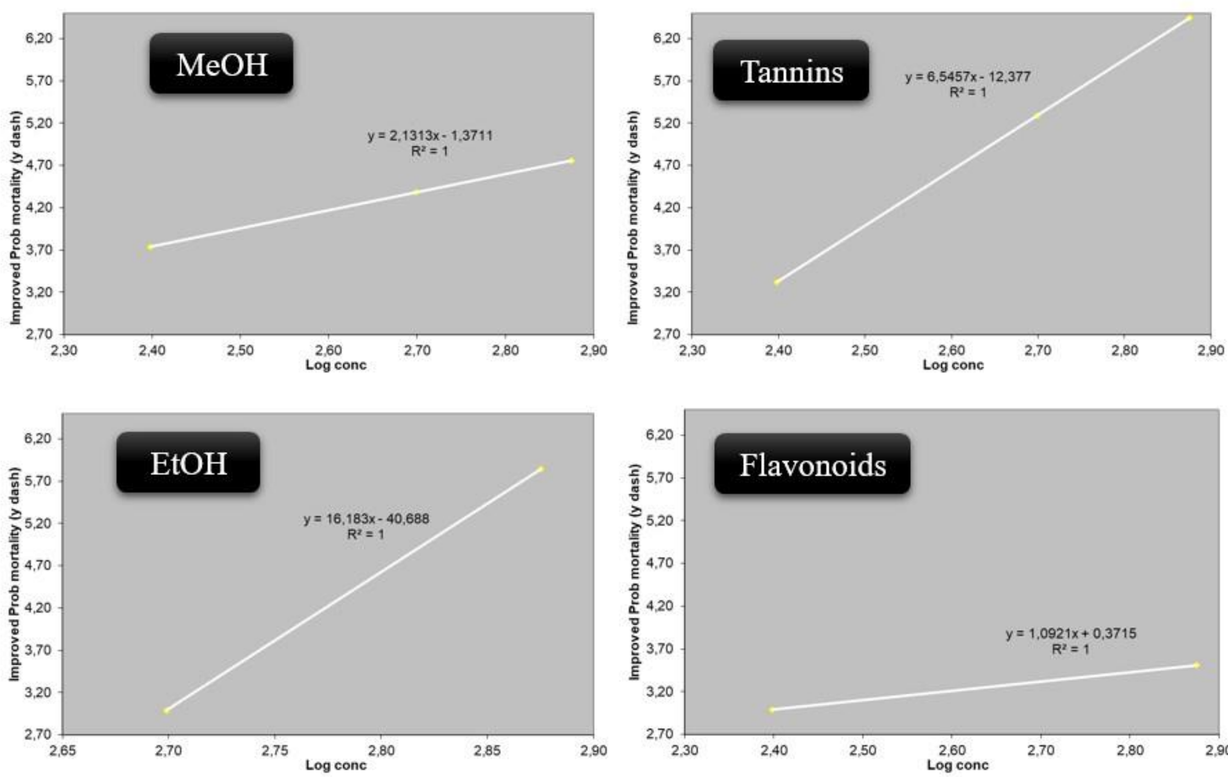

Figure 19: Probit analysis Graph showing lethal doses in *C. colocynthis* by ingestion

III.4 Calculation of the lethal time (LT_{50}/LT_{90}) of the extracts

Table 5 lists the lethal times (LT_{50}/LT_{90}) for each extract when ingested or connected with it.

Table 5: Lethal times (LT_{50}/LT_{90}), in hours, of the extracts of *C. colocynthis*

	Contact		Ingestion	
Extracts	**LT_{50}**	**LT_{95}**	**LT_{50}**	**LT_{95}**
Flavonoids	22h	1162h	/	/
MeOH	22h	1162h	115h	463h
Tannins	0.03h (1.8 min)	99h	44h	85h
EtOH	1h	9450h	44h	95h

Our findings enabled us to record lethal time (LT_{50}) values by contact, ranging from 0.03h (1.8 min) to 22h. Furthermore, the range of LT_{95} values is 99h to 9450h. Moreover, the ingestion utilization mode revealed that the LT_{50} and LT_{95} values varied from 44 to 115 and 85 to 95 hours, respectively. Tannins had the best timing, with 0.03 hours (1.8 minutes) recorded.

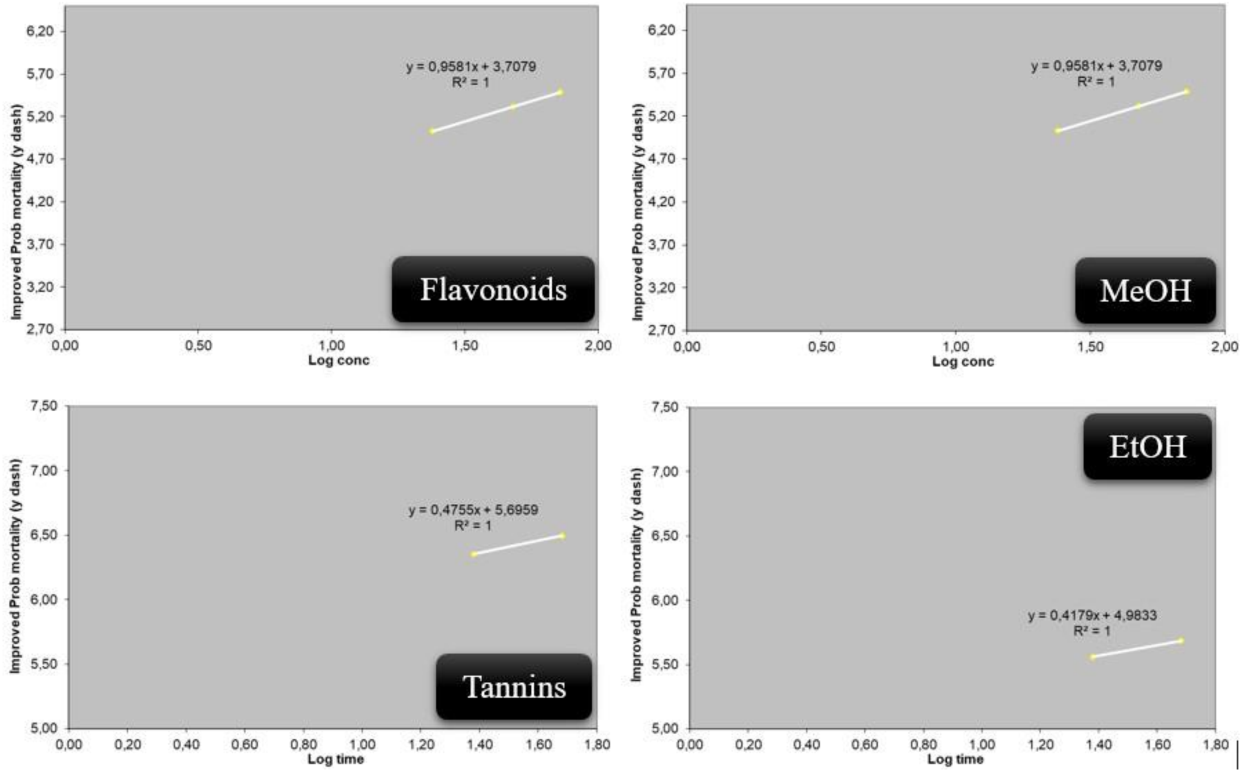

Figure 20: Probit analysis Graph showing lethal times in *C. colocynthis* by contact

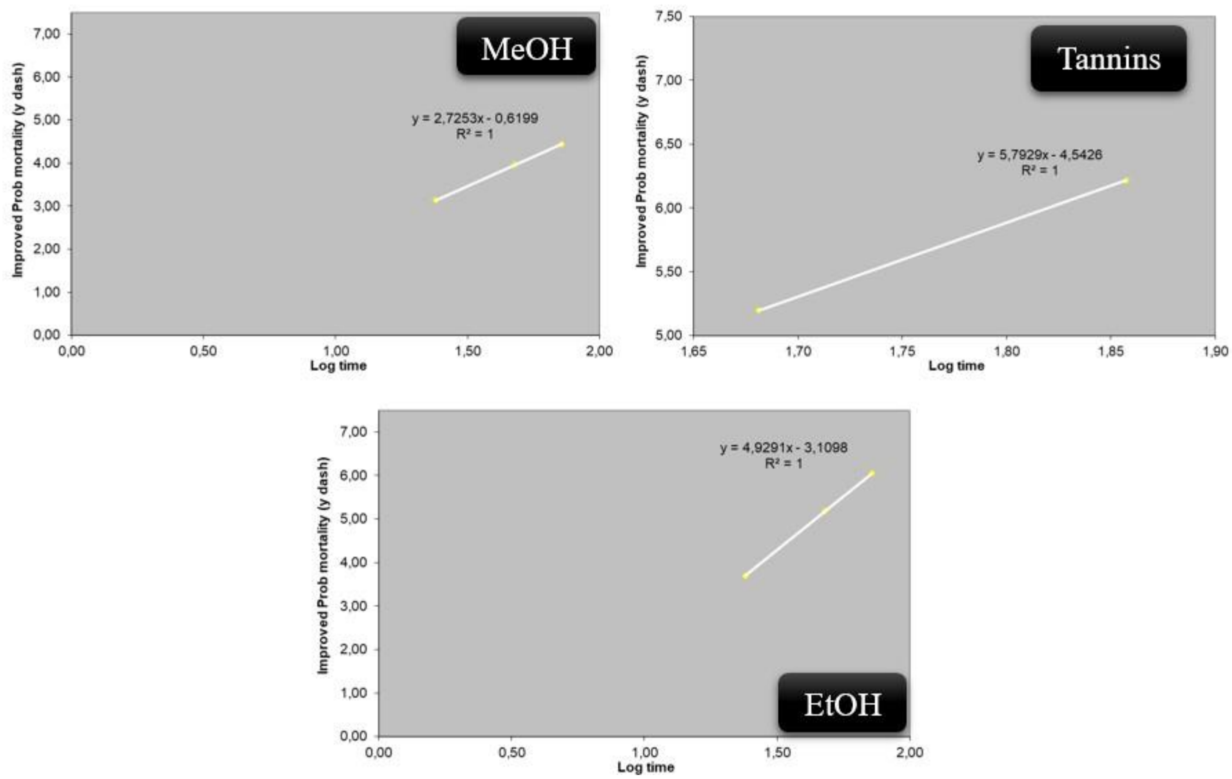

Figure 21: Probit analysis Graph showing lethal times in *C. colocynthis* by ingestion

III.5 Comparative study using ANOVA statistical test

ANOVA (Analysis of Variance), a statistical method, is used to compare the means of several groups and ascertain whether there are any noteworthy differences between them.

Table *6*: ANOVA statistical test investigate the correlation between different variables

Source	Df	Sum Sq	Mean Sq	F value	Pr(>F)	signification
Type_extract	3	12508	4169	18,992	1,96E-10	***
Mode_utilisation	1	161890	161890	737,414	2E-16	***
Dose	3	30319	10106	46,034	2E-16	***
Time_h	2	7775	3887	17,707	1,33E-07	***
Type_extract:Mode_utilisation	3	2602	867	3,951	0,009613	**
Type_extract:Dose	9	57153	6350	28,926	2E-16	***
Mode_utilisation:Dose	3	20182	6727	30,643	2,21E-15	***
Type_extract:Time_h	6	2073	346	1,574	0,158866	.
Mode_utilisation:Time_h	2	3216	1608	7,324	0,000935	***
Dose:Time_h	6	4422	737	3,357	0,003983	**
Type_extract:Mode_utilisation:Dose	9	15126	1681	7,656	3,84E-09	***
Type_extract:Mode_utilisation:Time_h	6	3704	617	2,812	0,012851	*
Type_extract:Dose:Time_h	18	3844	214	0,973	0,494153	.
Mode_utilisation:Dose:Time_h	6	3610	602	2,74	0,014968	*
Type_extract:Mode_utilisation:Dose:Time_h	18	3376	188	0,854	0,633896	.
Residuals	144	31613	220			

The results of the ANOVA analysis showed that the insect mortality rate is significantly influenced by the factors Type_extract, Mode_use, Dose, and Time_h. Moreover, there were significant interactions between several combinations of factors, including Type_extract: Usage_mode (p = 0.009613), Extract_type:Dose (p = 2E-16), Usage_mode:Dose (p = 2.21E-15), and others.

These findings suggest that to optimize the effectiveness of biopesticides, it is crucial to take into account both the individual impacts of variables and their interactions.

To compare different types of extracts, another analysis using Tukey testing was conducted.

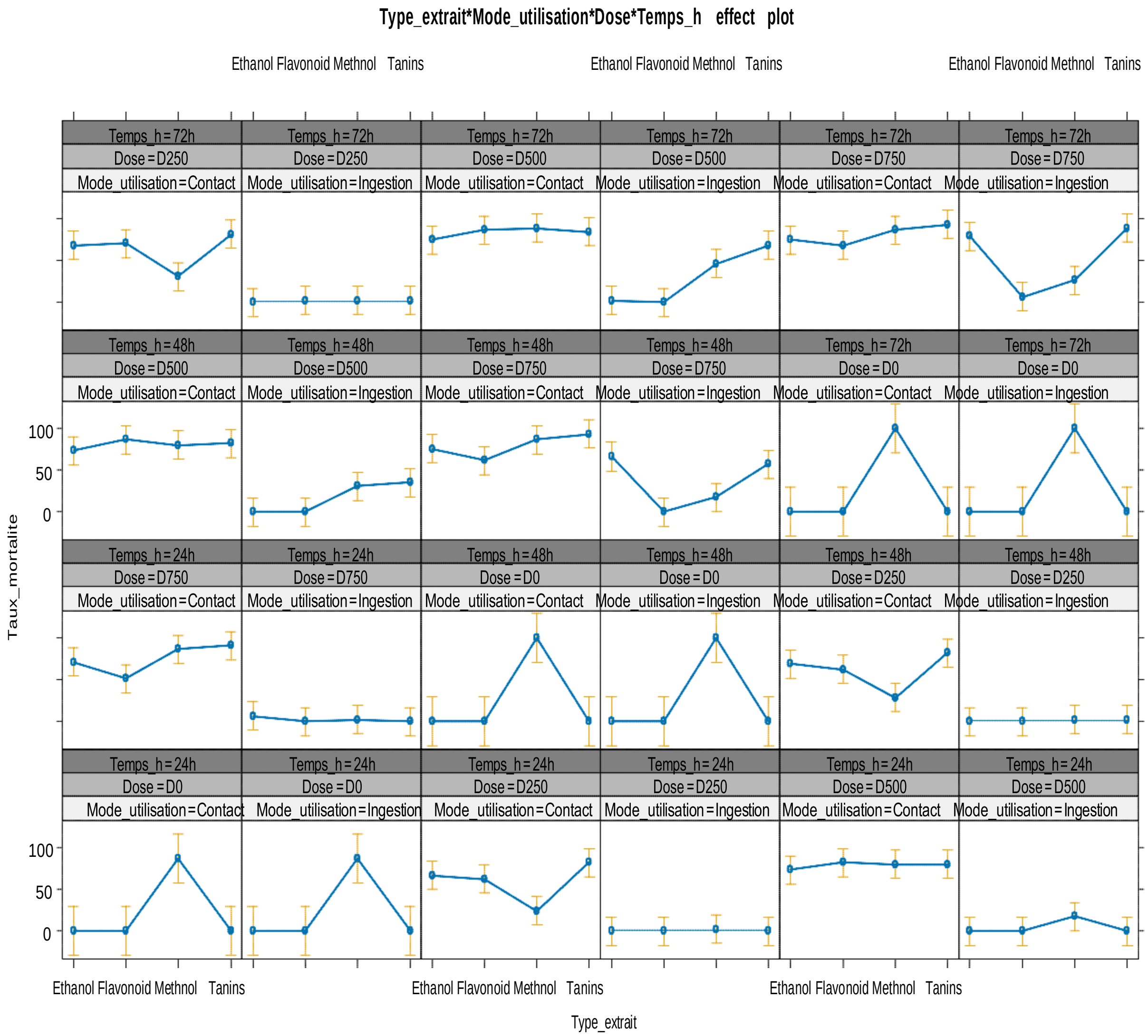

Figure 22: Comparative study linking different types of extracts

According to these findings, the hydro-methanolic extract greatly raises the death rate compared to the other extracts. There is no visible difference between ingestion and contact in terms of method of usage. The doses of D250, D500, and D750 are all considerable, but they do not differ that much from one another.

The findings imply that methanol is the most efficient at raising the death rate, regardless of the manner of usage or duration of application (D250, D500, or D750).

Extracts are combinations of substances with various functional groups, polarity, and chemical properties. The chemical complexity of the extracts may result in inconsistent results depending on the test utilized. **NADEEM ET AL. (2012)** conducted experiments on the same plant, using the same insect and an ethanolic solvent. Their findings revealed that the 72-hour exposure time of *C. colocynthis* had a good effect on the mortality of the test insects, which was comparable to ours depending on the time. Furthermore, the lethal concentration (50%) was estimated at 10%; however, our results showed that the lethal dose at 95% was 10.8%.

In addition, another comparison study with **SARWAR ET AL. (2019),** who worked on the same plant with different solvents (acetone), discovered that *Citrullus colocynthis* has the highest repellency (89.11%) after 72 hours and at a 10% concentration.

On the other hand, our results, depending on time and concentration, were higher than those obtained by **SAGHEER ET AL. (2016)** using acetone solvent. The maximum recorded mortality of *T. castaneum* was 35.40% at 30% *C. colocynthus* concentrations.

The traits applied by contact contain more hazardous chemicals than the traits applied for consumption. This is consistent with the findings of **MOULAY (2022),** who investigated the same insect using different plants.

Conclusion

Conclusion

The excessive use of chemical pesticides has prompted us to help with our modest study, which aims to limit the use of chemical insecticides while also reducing food poverty by aiding in finding control alternatives against stored cereal insect pests.

We evaluated the insecticidal activity of extracts from *Citrullus colocynthis (L.)* gathered in the Ghardaïa region, namely the Dhaya Ben Dhahoua zone, against *Tribolium Castaneum*. Our findings revealed that:

- The solvents with the highest polarity produced the largest yields, while the lowest polarity gave the lowest yield.
- Extracts with high-polarity solvents (ethanol and methanol) have more interesting insecticidal activity than those with low polarity.
- Contact therapy leads to higher mortality rates than ingestion.
- Differentiation in doses resulted in varying mortality rates.
- As time passes, the mortality rate increases.

Perspective

In perspective, various works can be viewed in the continuum of work that began:

- Investigate the impact of *Citrullus colocynthis* extracts on different biological parameters, such as the life cycle (larva and adult).
- Assess the effectiveness of *Citrullus colocynthis* against other stored cereal pests.
- Evaluate the effectiveness of *Citrullus colocynthis* (seeds, fruits, leaves, and roots) against stored pests.

Bibliographic Reference

Bibliographic Reference

ABDELGHANY, A. Y., AWADALLA, S. S., ABDEL-BAKY, N. F., EL-SYRAFI, H. A., & FIELDS, P. G. (2010). Stored-product insects in botanical warehouses. Journal of Stored Products Research, 46(2), 93-97.

ABBOTT WA (1925) Method of computing the effectiveness of an insecticide. J Econ Entomol 18(2):265–267.

ABOUNNEAU J. (1983) Préhistoire du M'Zab (Algérie-Wilaya de Laghouat). Thèse Doctorat de 3ème cycle en Art et Archéologie, Univ. Paris I, 268 p.

ADDOUN T, (2020) – Dynamiques spatiales des agglomérations du Sahara nordcentral algérien (wilaya de Ghardaïa). Doctoral deplome. Univ d'Oran 2, 351p.

AHMED, M., PEIWEN, Q., GU, Z., LIU, Y., SIKANDAR, A., HUSSAIN, D., ... & JI, M. (2020). Insecticidal activity and biochemical composition of Citrullus colocynthis, Cannabis indica and Artemisia argyi extracts against cabbage aphid (Brevicoryne brassicae L.). Scientific reports, 10(1), 522.

AL-GHAMDI, A. A. M. (2015). Ecological studies on the colocynth, Citrullus colocynthis (L.)(Curcurbitaceae) from Shada, Saudi Arabia and its insect repellent properties. Life Science Journal, 12(1), 125-133.

ANIREF, (2021) de ghardaia Monographie de la wilaya de Ghardaïa.

A.N.R.H., de Ghardaïa (2006) – Note relative aux resources en eau souterraines de la wilaya de Ghardaïa. Ed. Agen. Nati. Alg.Ress. Hydr. (A.N.R.H.), 26 p.

ARMSTRONG, R. A., EPERJESI, F., & GILMARTIN, B. (2002). The application of analysis of variance (ANOVA) to different experimental designs in optometry. Ophthalmic and Physiological Optics, 22(3), 248-256.

ATAFAR, Z., MESDAGHINIA, A., NOURI, J., HOMAEE, M., YUNESIAN, M., AHMADIMOGHADDAM, M., & MAHVI, A. H. (2010). Effect of fertilizer application on soil heavy metal concentration. Environmental monitoring and assessment, 160, 83-89.

BEKKARA F, JAY M, VIRICEL MR, ROME S., (1998). Distribution of phenolic compounds within seed and seedlings of tow Vicia faba vs differing in their seed tannin content, and study of their seed and root phenolic exudation. Plant and Soil, 203:27-36.

BOUCHELOS, K. T. (2018). Insects of warehouses and food.

BIAD R., (2022) Ecologie du peuplement avien dans la Vallée du Mzab (Ghardaïa, Sahara algérien). Doctoral diplome . Eco – Env, Univ, 8 Mai 1945, Guelma.97p.

BRAHIM BENYOUCEF, 2018. Le M'Zab : regarde d'urbanisme et de sociologie. Ed Librinova, p325

CAVELIER A.,1976.- Cours phytopharmacie. Ed. Institut National Agronomique d'ELHarrach.T.1, 514p.

CHAOUCHE T., (2014). Contribution à l'étude des activités anti oxydantes et antimicrobiennes des extraits de quelques plantes médicinales. Thèse de doctorat. Université Abou-Bakr-Belkaid,Tlemecen, Algérie.

CHOUIKH A., MEKKI M., ADJAL E.H., (2015). Effects of extraction methods on antibacterial activity of different extracts of Calligonum comosum L'Hér. growing in Sahara Algerian. International Journal of Recent Scientific Research, 6;4: 3534-6.

DAJOZ J., (1971) Précis d'écologie. Ed. Dunod, Paris, 434 p.

DAGLISH, G. J. (2006). Survival and reproduction of Tribolium castaneum (Herbst), Rhyzopertha dominica (F.) and Sitophilus oryzae (L.) following periods of starvation. *Journal of Stored Products Research*, *42*(3), 328-338.

DJILALI K., (2009) Etude du régime alimentaire de deux rapaces nocturnes dans la région de Ghardaïa. Cas du Hibou ascalaphe Bubo ascalaphus (Savigny, 1809) et du Hibou des marais Asio flammeus (Pontoppidan, 1763). Mem master. Agro, univ, kasdi merbah. Ourgla, 144p

DUBIEF J. (1963). Le climat du Sahara. Mém. hors-série. Tome I. Institut de recherche Saharienne, Algérie, 312 p.

DUBOST D., (1991) - Ecologie, aménagement et développement des oasis algériennes. Thése d'état de l'université de Tours, France, 550 p.

EL ATLA F, (2016) Etude de la faune entomologique de la région de Ghardaïa cas Metlili et Sebseb. Mem master. Agro., Univ de ghardaia. 91p.

EL-HALIM, A., HEND, T., AYAD, E. L., & EL-DEEB, S. E. (2023). Efficiency of Utilizing Citrullus colocynthis (L) Essential Oil Alone and When it Mixed with Diatomaceous Earth Against some Stored Products Insect Pests. Journal of Plant Protection and Pathology, 14(12), 405-413.

FRANCO D., SINEIRO J., RUBILAR M., SÁNCHEZ M., JEREZ M., PINELO M., COSTOYA N., NÚÑEZ M.J., (2008). Polyphenols from plant materials: Extraction and antioxidant power. Electron J.Environ. Agric. Food Chem. 7, 3210–3216.

HEROUINI, A., KEMASSI, A., TAIBAOUI, Z., AITOUDIA, A., CHERIF, R., & EL HADJ, M. D. O. (2020). STUDY OF SOME PHYSICO-CHEMICAL PROPERTIES AND INSECTICIDAL ACTIVITY OF SEED OIL OF Citrullus colocynthis Schrad.(Cucurbitaceae) ON Tribolium castaneum Herbst (Coleoptera: Tenebrionidae).

HMIRI S., RAHOUTI M., HABIB Z., SATRANI B., GHANEMI M., EL AJJOURI M., (2011). Évaluation du potentiel antifongique de l'huile essentielle de Mentha peliguim et d'Eucalyptus dans la lutte biologique contre les champignons responsables de la détérioration des pommes en conservation. Bulletin de la Société Royale des Sciences de Liège, Vol. 80, 2011, p.824 –836.

GOLEBIOWSKA, Z., 1969. The feeding and fecundity of Sitophilus granarius L., Sitophilus oryzae L. and Rhyzopertha dominica F. in wheat grain. Journal of Stored Products Research 5, 143–155.

KACI S. (2005) – Contribution à l'étude des potentialités de milieu oasien : cas de la wilaya de Ghardaïa Mém. Ing. Agr. Saha., Univ. Ouargla, 89 p.

KADI A. ET KOURICHI B., (1983) – Contribution à l'étude faunistique des palmeraies des trois régions du M'Zab (Ghardaïa, Metlili, Guerara). Mém. Ing. Agr. Saha., Univ. Ouargla, 68p.

KHERRAF A., (2018). Caractérisation physicochimique et évaluation du potentiel antioxydant, antimicrobien et antiinflammatoire de la microalgue Nannochloropsis gaditana. These de doctorat. Université Djillali Liabes faculté des sciences de la nature et de la vie Sidi bel Abbes,p74.

KHENE B., (2007) Caractérisation d'un agro système Oasien – Vallée du M'Zab et Guerrara wilaya de Ghardaïa. Thèse Magister. Inst. Natio. Agro. El Harrach. Alger.173 p

MALEK, M. AND PARVEEN, B. (1989). Effect of insects' infestation on the weight loss and viability of stored BE paddy. Bangladesh Journal of Zoology. 17: 1, 83-85.

MARIOD A.A., JARRET R.L., (2022). Antioxidant, antimicrobial, and antidiabetic activities of Citrullus colocynthis seed oil.

MUSSATTO S.I., BALLESTEROS L.F., MARTINS S., TEIXEIRA J.A., (2011). Extraction of antioxidant phenolic compounds from spent coffee grounds. Separation and Purification Technology, 83(15):173-179.

MUTIN G., (1977) La Mitidja - Décolonisation et espace géographique. Ed. Office publ. Univ., Alger, 607 p.

MOGHADDAM M., MEHDIZADEH L., (2017). Chemistry of Essential Oils and Factors Influencing Their Constituents. Soft Chemistry and Food Fermentation. Book chapter.

NADEEM, M., IQBAL, J., KHATTAK, M. K., & SHAHZAD, M. A. (2012). Management of Tribolium castaneum (Hbst.)(Coleoptera: Tenebrionidae) using neem (Azadirachta indica A. Juss) and tumha (Citrullus colocynthis (L.)). Pakistan Journal of Zoology, 44(5).

OZENDA P., 1991- Flore de Sahara. 3ème Ed. (C.N.R.S.), Paris, 662 p.

PERENNES J., (1993) Des jardins andalous aux spéculateurs d'Agadir : Diversité et dynamisme des irrigants au Maghreb. Edition KHARTALA. Paris.

QUEZEL P. SANTA S., (1962) – Nouvelle flore de l'Algérie et des régions désertiques méridionales. Ed. Centre nati. rech. sci. (C. N. R. S.), Paris, T. I, 565.

QUEZEL ET SANTA, (1963) Nouvelle flore de l'Algérie et des régions désertiques méridionales. Ed. Centre nati. rech. sci. (C. N. R. S.), Paris, T. II, pp. 571 – 1170.

RAMADE F., (1984) - Eléments d’écologie - Ecologie fondamentale. Ed. Mc Graw-Hill, Paris, 379 p.

ROUARI, L., GOUZI, H., GHERMAOUI, M., BENACEUR, F., KEMASSI, A., MERABTI, B., ... & CHAIBI, R. (2022). First study of larvicidal activity of Algerian Oudneya africana extracts against Culex pipiens larvae. Ukrainian Journal of Ecology, 12(1), 65-70.

SAGHEER, M. U. H. A. M. M. A. D., AMAN, Y. A. S. I. R., AHMED, F., RANJHA, M. H., ALI, Q., & ALI, K. (2016). Fumigant bioactivity of extracts of Citrulus colocynthes, Moringa oleifera and Azadirachta indica against Tribolium castaneum and Alphitobius diaperinus under laboratory conditions. In 10th International Conference on Controlled Atmosphere and Fumigation in Stored Products, Winnipeg, Canada (pp. 459-464).

SEMPLE, R. L., FRIO, A. S., HICKS, P. A., & LOZARE, J. V. (EDS.). (1992). Mycotoxin prevention and control in foodgrains.

SANTOS, J.P., MAIA, J.D.G AND CRUZ, I. (1990). Damage to germination of seed corn caused by maize weevil (Sitophilus zeamais) and Angoumois grain moth (Sitotroga cerealella). Pesquisa Agropecuaria Brasileira. 25 : 12, 1687-1692.

SHABBIR, A. A., ASIM, M. A., KHALIQ, M. H., & ALI, T. (2019). Effects of Medicinal Plants Moringa olifera, Calotropis porcera, Citrullus colocynthis as Toxicants against Tribolium Castaneum.

SHARMA, N., & SINGHVI, R. (2017). Effects of chemical fertilizers and pesticides on human health and environment: a review. International journal of agriculture, environment and biotechnology, 10(6), 675-680.

SOUILEM. I, MOULAY L.C, (2022) Étude de l'activité insecticide des extraits des feuilles de l'olivier de la région de Ghardaïa**.** Mem master, bio, Univ ghardaia.53p

STEFFAN, J.R., 1963. Tribu des calandrini. Les calandres des grains (Sitophilus). In: Balachowsky, A.S (Ed.), Entomoloquie Applique`e a l’ Agriculture. Tome I, Vol. 2. Masson et Cie Paris, pp. 1070–1099.

TREMATERRA, P., & SCIARRETTA, A. (2004). Spatial distribution of some beetles infesting a feed mill with spatio-temporal dynamics of Oryzaephilus surinamensis, Tribolium castaneum and Tribolium confusum. *Journal of Stored Products Research*, *40*(4), 363-377.

TUTIEMPO, 2024 https://en.tutiempo.net/

VAZQUEZ, G. FONTENLA, E. SANTOS, J. FREIRE, MS. GONZALEZ-ALVAREZ, J. ANTORRENA, G., (2008).Antioxidant activity and phenolic content of chestnut (Castanea sativa) shell and eucalyptus (Eucalyptus globulus) bark extracts. Industrial crops and products, 28(3): 279-285.

VIAL Y ET VIAL M., (1974) - Sahara milieu vivant. Ed Hatier, Paris, 223 p.

ZERGOUN Y., (1994) Peuplement orthoptérologiques à Ghardaïa. Thèse Magister, Inst. nati. Agro., El Harrach, 192 p.

ZHANG S.Y., ZHENG C.G., YAN X.Y., TIAN W.X., (2008). Low concentration of condensed tannins from catechu significantly inhibits fatty acid synthase and growth of MCF-7 cells. Biochemical and Biophysical Research Communications. 371; 4:654-8.

Abstract

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The application of these fractions on the flour beetle insect was performed with two methods, contact and ingestion, using three doses/method/extract. The results showed that all the extracts have a toxic potential against this pest noting that the highest mortality rates were recorded by tannin extract (>50%), while the flavonoid extract showed the lowest mortality rate (<25%).

Depending on the method of application, the contact mode showed greater effectiveness (>50%) than the ingestion mode (<25%). Furthermore, depending on time, the period of three days was more effective than the other times (mortality > 50%). In contrast, for doses, the biggest dose (750 mg/mL) was the most effective among the doses given. The use of this biopesticide can promise to protect stored grains from beetle infestation and reduce the risk of secondary human exposure.

Keywords: *Citrullus colocynthis*, extracts, biopesticide, *Tribolium castaneum, cereals, fractions*

Résumé

La présente étude vise à évaluer l'efficacité de quatre extraits de *Citrullus colocynthis* (L), une plante récoltée dans la région de Dhaya Ben Dhahoua (Ghardaia) contre l'insecte Tribolium rouge de la farine, *Tribolium castaneum*, dans le cadre de la recherche des méthodes alternatives de lutte contre les insectes ravageurs des denrées stockées. Différentes fractions ont été extraites de *C. colocynthis* par macération en utilisant différents solvants de polarités diverses. Ces extraits nous ont permis d'obtenir que les extraits bruts (MeOH/H2O et EtOH/H2O) obtiennent les rendements les plus élevés (respectivement 25,85% et 23,8%) par rapport aux fractions. L'application de ces fractions sur l'insecte coléoptère de la farine a été réalisée selon deux méthodes, contact et ingestion, en utilisant trois doses/méthode/extrait.

Les résultats ont montré que tous les extraits ont un potentiel toxique contre ce ravageur, notant que les taux de mortalité les plus élevés ont été enregistrés pour l'extrait de tanin (>50%), tandis que l'extrait de flavonoïdes a montré le taux de mortalité le plus faible (<25%).

Selon la méthode d'application, le mode contact a montré une plus grande efficacité (>50%) que le mode ingestion (<25%). De plus, selon le temps, la période de trois jours était plus efficace que les autres temps (mortalité > 50 %). En revanche, pour les doses, la concentration la plus élevée (750 mg/mL) était la plus efficace parmi les doses administrées. L'utilisation de ce biopesticide peut promettre de protéger les grains stockés contre l'infestation des insectes et de réduire le risque d'exposition humaine secondaire.

Mots-clés : *Citrullus colocynthis*, extraits, biopesticide, *Tribolium castaneum*, céréales, fractions

ملخص

تهدف الدراسة الحالية إلى تقييم فعالية أربع مستخلصات من نبات *Citrullus colocynthis (L)* وهو نبات تم جمعه بمنطقة ضاية بن ضحوة (غرداية) ضد حشرة خنفساء الدقيق الأحمر *Tribolium castaneum*، وذلك في إطار البحث عن طرق بديلة لمكافحة الحشرة. مكافحة الآفات الحشرية للمواد الغذائية المخزنة. تم استخلاص أجزاء مختلفة من نبات الحنظل عن طريق النقع باستخدام مذيبات مختلفة ذات أقطاب مختلفة. أتاحت لنا هذه المستخلصات الحصول على أن المستخلصات الخام (MeOH/H2O وEtOH/H2O) حصلت على أعلى إنتاجية (25.85% و23.8% على التوالي) مقارنة بالاجزاء.

تم تطبيق هذه الأجزاء على حشرة خنفساء الدقيق بطريقتين، التلامس والابتلاع، باستخدام ثلاث جرعات/طريقة/مستخلص.

أظهرت النتائج أن جميع المستخلصات لها قدرة سامة ضد هذه الآفة، مع ملاحظة أن أعلى معدلات الوفيات سجلت لمستخلص التانين (<50%)، بينما أظهر مستخلص الفلافونويد أقل معدل وفيات (<25%).

اعتمادًا على طريقة التطبيق، أظهر وضع الاتصال فعالية أكبر (< 50%) من وضع الابتلاع (<25%). بالإضافة إلى ذلك، اعتمادًا على الوقت، كانت فترة الثلاثة أيام أكثر فعالية من الأوقات الأخرى (نسبة الوفيات> 50%). من ناحية أخرى، بالنسبة للجرعات، كان التركيز الأعلى (750 ملغم/مل) هو الأكثر فعالية بين الجرعات المعطاة. قد يعد استخدام هذا المبيد الحيوي بحماية الحبوب المخزنة من الإصابة بالحشرات وتقليل خطر التعرض البشري الثانوي.

الكلمات المفتاحية: نبات الحنظل، مستخلصات، مبيد حيوي، تريبوليوم كاستانيوم، الحبوب،الاجزاء

Contribution to the study of the insecticidal potential of some spontaneous plants from the Ghardaia region

Abstract

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Contribution à l'étude du potentiel insecticide de quelques plantes spontanées de la région de Ghardaïa

Résumé

La présente étude vise à évaluer l'efficacité de quatre extraits de *Citrullus colocynthis (L)*, une plante récoltée dans la région de Daia Ben Dhahoua (Ghardaia) contre l'insecte *Tribolium rouge* de la farine, *Tribolium castaneum*, dans le cadre de la recherche des méthodes alternatives de lutte contre les insectes ravageurs des denrées stockées. Différentes fractions ont été extraites de *C. colocynthis* par macération en utilisant différents solvants de polarités diverses. Ces extraits nous ont permis d'obtenir que les extraits bruts (MeOH/H2O et EtOH/H2O) obtiennent les rendements les plus élevés (respectivement 25,85% et 23,8%) par rapport aux fractions.

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المساهمة في دراسة القدرة المبيداتية لبعض النباتات العفوية بمنطقة غرداية

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Contribution à l'étude du potentiel insecticides de quelques plantes spontanées de la région de Ghardaïa.

Après les corrections apportées au mémoire, L'étudiant :

1- HASSAINE Leila Khouloud

Est autorisé à déposer le manuscrit au niveau du département.