



EVALUATION OF THE INSECTICIDAL ACTIVITY OF *NERIUM* OLEANDER AND *ARTEMISIA CAMPESTRIS* POWDER AND EXTRACT ON WHEAT INSECT PESTS

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ABSTRACT

Objective: The study aimed to evaluate the insecticidal potential of powders and methanolic extracts of two plants of the Lamiaceae and Apocynaceae families spontaneously growing in the region of Tiaret.

Method: Insecticide tests were carried out in the laboratory using the Direct Contact Method.

Results and Discussion: The obtained results showed that *Nerium oleander* and *Artemisia campestris* powders have remarkable insecticidal properties. *N. oleander* powders induced 100% mortality in adults and up to 80% mortality in *Tribolium castaneum* larvae at a dose of 0.5g, after 7 days of exposure. Adults of *Tribolium confusum* showed some resistance to the powders of both plants, with an optimum mortality rate equal to 50% for adults. Larvae of both species were found to be sensitive to *N. oleander* powder with a mortality rate ranging from 80 to 90%. As for the powder of *A. campestris*, adults of *T. castaneum* were more sensitive than those of *T. confusum*, with adults' mortality rate equal to 100%. The methanolic extracts of both plants showed a very remarkable efficacy against the larvae of both species as well as the adults of *T. castaneum* with a mortality rate equal to 100%, after 7 days of treatment at different concentrations.

Research Implications: Algeria has an abundance and diversity of flora that could provide new sources of compounds of plant origin with phytopharmaceutical properties, these results allow us to affirm that powders and methanolic extracts, of the studied plants, can be used for industrial application in the production of bio-insecticides.

Originality/Value: This work could provide alternative or complementary solutions to the use of synthetic organic pesticides to protect stored beans. The development of bio-insecticides derived from plant extracts and the selection of varieties resistant to this pest are part of sustainable agriculture and development.

Keywords: Insecticidal Activity, Methanolic Extract, *Nerium Oleander*, *Artemisia Campestris*, Wheat Pests.

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AVALIAÇÃO DA ATIVIDADE INSETICIDA DO PÓ E EXTRATO DE *NERIUM OLEANDER* E *ARTEMISIA CAMPESTRIS* EM PRAGAS DE INSETOS DO TRIGO

RESUMO

Objetivo: O estudo visou avaliar o potencial inseticida dos pós e extratos metanólicos de duas plantas das famílias Lamiaceae e Apocynaceae, que crescem espontaneamente na região de Tiaret.

Método: Testes de inseticida foram realizados em laboratório utilizando o Método de Contato Direto.

Resultados e Discussão: Os resultados obtidos mostraram que os pós de *Nerium oleander* e *Artemisia campestris* possuem propriedades inseticidas notáveis. Os pós de *N. oleander* induziram 100% de mortalidade em adultos e até 80% de mortalidade em larvas de *Tribolium castaneum* a uma dose de 0,5g, após 7 dias de exposição. Adultos de *Tribolium confusum* mostraram alguma resistência aos pós de ambas as plantas, com uma taxa de mortalidade máxima de 50% para adultos. As larvas de ambas as espécies foram sensíveis ao pó de *N. oleander*, com uma taxa de mortalidade variando de 80% a 90%. Quanto ao pó de *A. campestris*, os adultos de *T. castaneum* foram mais sensíveis do que os de *T. confusum*, com uma taxa de mortalidade de 100% para os adultos. Os extratos metanólicos de ambas as plantas mostraram uma eficácia muito notável contra as larvas de ambas as espécies, bem como contra os adultos de *T. castaneum*, com uma taxa de mortalidade de 100% após 7 dias de tratamento em diferentes concentrações.

Implicações da Pesquisa: A Argélia possui uma abundância e diversidade de flora que podem fornecer novas fontes de compostos de origem vegetal com propriedades fito-farmacêuticas. Esses resultados nos permitem afirmar que os pós e extratos metanólicos das plantas estudadas podem ser utilizados para aplicação industrial na produção de bioinseticidas.

Originalidade/Valor: Este trabalho pode fornecer soluções alternativas ou complementares ao uso de pesticidas orgânicos sintéticos para proteger grãos armazenados. O desenvolvimento de bioinseticidas derivados de extratos de plantas e a seleção de variedades resistentes a esta praga fazem parte da agricultura e desenvolvimento sustentável.

Palavras-chave: Atividade Inseticida, Extrato Metanólico, *Nerium Oleander*, *Artemisia Campestris*, Pragas do Trigo.

EVALUACION DE LA ACTIVIDAD INSECTICIDA DEL POLVO Y EXTRACTO DE *NERIUM OLEANDER* Y *ARTEMISIA CAMPESTRIS* EN PLAGAS DE INSECTOS DEL TRIGO

RESUMEN

Objetivo: El estudio tuvo como objetivo evaluar el potencial insecticida de polvos y extractos metanólicos de dos plantas de las familias Lamiaceae y Apocynaceae que crecen espontáneamente en la región de Tiaret.

Método: Se llevaron a cabo pruebas insecticidas en el laboratorio utilizando el Método de Contacto Directo.

Resultados y Discusión: Los resultados obtenidos mostraron que los polvos de *Nerium oleander* y *Artemisia campestris* tienen propiedades insecticidas notables. Los polvos de *N. oleander* indujeron una mortalidad del 100% en adultos y hasta un 80% en larvas de *Tribolium castaneum* a una dosis de 0.5g, después de 7 días de exposición. Los adultos de *Tribolium confusum* mostraron cierta resistencia a los polvos de ambas plantas, con una tasa de mortalidad óptima del 50% para los adultos. Las larvas de ambas especies fueron sensibles al polvo de *N. oleander* con una tasa de mortalidad que varía del 80% al 90%. En cuanto al polvo de *A. campestris*, los adultos de *T. castaneum* fueron más sensibles que los de *T. confusum*, con una tasa de mortalidad en adultos igual al 100%. Los extractos metanólicos de ambas plantas mostraron una eficacia muy notable contra las larvas de ambas especies, así como contra los adultos de *T. castaneum*, con una tasa de mortalidad del 100% después de 7 días de tratamiento a diferentes concentraciones.

Implicaciones de la Investigación: Argelia tiene una abundancia y diversidad de flora que podría proporcionar nuevas fuentes de compuestos de origen vegetal con propiedades fito-farmacêuticas. Estos resultados nos permiten afirmar que los polvos y extractos metanólicos de las plantas estudiadas pueden ser utilizados para aplicaciones industriales en la producción de bioinsecticidas.



Originalidad/Valor: Este trabajo podría proporcionar soluciones alternativas o complementarias al uso de pesticidas orgánicos sintéticos para proteger los granos almacenados. El desarrollo de bioinsecticidas derivados de extractos vegetales y la selección de variedades resistentes a esta plaga son parte de la agricultura y el desarrollo sostenible.

Palabras clave: Actividad Insecticida, Extracto Metanólico, *Nerium Oleander*, *Artemisia Campestris*, Plagas del Trigo.

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1 INTRODUCTION

Cereals play an important role in the World's agricultural system. They are considered as a main source of human and animal nutrition [1]. Cereals and their by-products are the backbone of the Algerian food system. Indeed, they provide more than 60% of the caloric intake and 75 to 80% of the protein intake of the national food ration [2]. This is why understanding the phenomena which govern their conservation and mastering the techniques of their storage are crucial for the survival of millions of people. On the Algerian eastern high plateaus, the cultivation of durum wheat represents, together with barley and sheep breeding, the main agricultural activity. Durum wheat is consumed by humans most often directly from the production site, whereas the wheat residues are used for animal husbandry [3]. The development of insects and the proliferation of molds on stored wheat has two consequences; alterations in the quality of the grain which affects the nutritional value of the by-products and the production of mycotoxins [4]. Therefore, if no protective measures are taken in the event of this situation, stockpile pests of cereals can wipe out any production effort. In essence, insects cause most of the damage and are represented by primary and secondary pests belonging mainly to the Coleoptera and Lepidoptera families [5]. In fact, insect pests can cause partial and sometimes total losses of stored products by reducing their quality and/or quantity [6]. According to the Food and Agriculture Organization of the United Nations (FAO), losses due to insect pests correspond to 35% of the World's agricultural production [7].

For a long time, the fight against these pests has been based on the use of synthetic insecticides, however such chemicals have often caused many more side effects [8], including their toxicity for vegetation [9] and the various serious disorders they can cause [10]. Nowadays, medicinal plants represent an alternative to these chemical products. Numerous studies have evaluated the insecticidal effect of several aromatic plants. Recent research is directed towards the use of aromatic and medicinal plants in powder form in the protection of stored food, and



shows that powders of the different parts of aromatic plants, like leaves and fruits present an effective insecticidal effect on insect pests of stored seeds. To this end, the aim of this study was to use the powders of two medicinal plants, such as *N. oleander* and *A. campestris*, and their methanolic extracts as bio-insecticides against two very common wheat pests, namely *T. castaneum* and *T.confusum*, found in storage silos.

2 MATERIALS AND METHODS

2.1 BIOLOGICAL MATERIAL

This study was conducted on two *Tribolium* species; *T. castaneum* and *T.confusum*. These two pests were particularly selected because of the severe damage that they cause to stored goods of highly economic importance. In addition, they can easily be grown in the laboratory and therefore a larger sample number could be tested.

Insects' mass rearing was carried out in the laboratory of Plant Biotechnology of the Department of Nature and Life sciences, Ibn Khaldoun University - Tiaret. The insects were placed on durum wheat seeds in glass jars. These jars were then incubated in the dark at a temperature of 30°C and a relative humidity of 70%, thereby providing the optimal conditions for insect development.

For the plant material, we selected two plants commonly used in traditional medicine, known as *N. oleander* L. and *A. campestris* L.

2.2 PREPARATION OF PLANT POWDERS

The leaves of the studied plants were harvested from the region of TIARET (35 ° 22'15 N 1° 19'01E) in early November 2018. The collected leaves were air dried for 15 days in light. They were grounded using an electric grinder, then sieved through a 0.5 mm mesh to obtain a fine powder of homogeneous granularity. The powders were stored in paper bags in the dark for further use.

2.3 PREPARATION OF METHANOLIC EXTRACTS

100 g of powder of each plant was macerated in 700ml of methanol and 100ml of distilled water, and then stirred for 48h at room temperature. The mixture was subsequently



filtered and dried for 7 days at 40°C [11,12]. The crude extracts were then diluted in dimethyl-sulfoxide “DMSO”.

2.4 TOXICITY BIOASSAY BY POWDERS AND EXTRACTS

For the development of the bioassay, the methodology of Dias et al. [13] was used. Damaged wheat seeds were treated with the prepared powders of the two selected plants and their resultant methanolic extracts. Ten samples of the studied insects were individually placed in plastic petri dishes containing 10g of wheat seeds. Doses of 0.1g, 0.3g and 0.5g of each powder (i.e. 1%, 3% and 5% of grains' weight) were added. The same experimental procedure was repeated for the treatment by methanolic extracts with concentrations of 10%, 20% and 30% and a dose of 100µL. All tests were carried out in triplicate.

2.5 STATISTICAL ANALYSIS

The effect of the powders and the methanolic extracts, on the studied insects, was estimated using the analysis of variance of ANOVA with two criteria of classification, including the number of dead insects per concentration and time, using Statistica 6.0 Software.

3 RESULTS AND DISCUSSION

3.1 EFFECT OF NERIUM OLEANDER POWDER ON BOTH INSECTS

The results presented in Figure 1 show that *N. oleander* powder has a very remarkable effect on *T. castaneum* adults for the three used concentrations. The life span of those adults was highly significantly reduced ($P= 0.000264$) when the powder dose increased from 0.1g to 0.5g/10g of seeds. In fact, the mortality rate of adults exceeded 90% after 7 days of treatment with the lowest dose, and reached 100% for the other two doses. However, Larvae of this species was found to be less sensitive to *N. oleander* powders, with a mortality rate ranging from 70.4 to 80.6% for the three concentrations.

On the other hand, the results obtained for adults of *T. confusum*, confirm a certain resistance to *N. oleander* powders. At a dose of 0.5g, the mortality rate reached $50\pm 1.15\%$ and hardly exceeded 20% for the two other doses. In the case of larvae, this rate varied from



50±0.28% to 60±0.288 % for the doses of 0.1g and 0.3g, and reached 90 ±0.57% at the dose of 0.5g, after 7 days of treatment.

3.2 EFFECT OF ARTEMISIA CAMPESTRIS POWDER ON BOTH INSECTS

As depicted in Figure 2, the adults of *T. castaneum* exhibited a highly significant sensitivity for the three doses of *A. campestris* powders ($P= 0.000740$). The mortality rates of the adults recorded after 7 days of treatment were 97% for the dose of 0.1g, and 100% for the other two doses. The larvae of this species were very sensitive to *A. campestris* powders, with mortality rates exceeding 80% for the three doses.

The adults of *T. confusum* showed a certain resistance to *A. campestris* powders, in which their mortality reached a maximum rate of 70% at a dose of 0.5g and minimum rate of 30±0.28% at a dose of 0.1 g. For the larvae, the dose of 0.5g caused the highest mortality rate (90%±0.33), which was reduced to its minimum value of 50%±0.33 for the doses of 0.1g and 0.3g, at the end of the treatment period.

3.3 EFFECT OF HYDRO-METHANOLIC EXTRACT OF NERIU OLEANDER ON BOTH INSECTS

The treatment of the studied insects using hydro-methanolic extract of *N. oleander* is shown in Figure 3. The mortality rate of *T. confusum* adults was very low at a concentration of 10% of the *N. oleander* extract. This rate slightly increased with higher concentrations but barely reached a rate of 30%. The larvae of this species were more significantly sensitive to methanolic extracts ($P= 0.000264$), as well as recording a 100% mortality rate.

For the three concentrations used, such extracts also highly significantly caused mortality rates close to 100% for the adults and larvae of *T. castaneum*.

3.4 EFFECT OF ARTEMISIA CAMPESTRIS HYDRO-METHANOL EXTRACT ON BOTH INSECTS

The effect of the hydro-methanolic extract of *A. campestris* used as a treatment for the selected insects is demonstrated in Figure 4. There was a small increase in the mortality of adults and larvae of *T. confusum* with increasing concentrations over time ($P = 0.035276$).



The average mortality rate of *Tribolium confusum* adults was 20% for the lowest concentration, and did not exceed 30 ± 0.577350 % at the concentration of 30%. The larvae of this species were more sensitive to methanolic extracts, recording 100% mortality. Similarly, adults and larvae of *T. confusum* were very sensitive to the three concentrations of *A. campestris* hydro-methanolic extracts, with an almost 100% mortality rate.

Fragrant plants belonging to different families, such as Myrtaceae, Poaceae, Umbelliferae, Myristicaceae, have shown an insecticidal activity either by inhibiting adult reproduction or by protecting seeds [14]. According to Regnault-Roger and Hamraoui (1993) [15], the Lamiaceae family is the most effective especially against insects. Indeed, our results showed that powders and methanolic extracts of *N. oleander* and *A. campestris* exerted an insecticidal activity on *T. confusum* and *T. castaneum*, especially on the viability of larvae. In essence, the mortality rate is significantly related to the composition of the leaves, the dose of the treatment and the duration of exposure.

Few studies have tested plant powders on phytophagous insects of stored goods. Bouchikhi (2008) [16] showed that the active substances of the leaves of the white and black varieties of *Phaseolus vulgaris* have a direct impact on the fecundity of *Acanthoscelides obtectus* females. This is because they disrupt the behaviour of the insects during mating and egg-laying. As fertility reduces, the later decreased from 59.39% to 8.05% in the presence of leaves powders of the black variety, which proved to be more effective. According to Bouchikhi (2010) [17], the chemical analysis of the white and black varieties of *Phaseolus vulgaris* revealed very high levels of polyphenols (34.95-38.22mg/g), hydrolyzable tannins (8.07-8.44%), condensed tannins (2.65-3.42%) and flavonoids (15.8-17.6%), with very low yields in essential oils.

The richness in polyphenolic compounds could be the source of the effectiveness of plant powders on insects. According to Regnault-Roger (2002) [18], the chromatographic analysis of the hydrodistilled botanical residues of lamiaceae indicated the presence of numerous phenolic compounds, phenolic acids and flavonoids, which cause the disturbance of insect motility. Moreover, the toxicity of the polyphenols, which are widely found in nature and particularly in plants, is positively correlated with the attractive power of the compound. Flavonoids also have negative effects on insects, significantly reducing oviposition in *Callosobruchus chinensis* and toxicity in adults [19].

Powders extracted from plants of *Artemisia herba-alba* (Asteraceae), *Rosmarinus officinalis* and *Origanum glandulosum* (Lamiaceae) significantly decreased the longevity of *Acanthoscelides obtectus* adults [20]. According to El Akhalet *al.* (2015) [21], the larvicidal



activity of *Nerium oleander* extract against *Culex pipiens* larvae can be explained by its richness in flavonoids, sterols, terpenes, triterpenes, and coumarins

4 CONCLUSIONS

This work focused on the influence of two methods that we recommend to control populations of *T. confusum* and *T. castaneum*, using powders and methanolic extracts of two plants, *N. oleander* and *A. campestris*, commonly used in traditional medicine. We have shed light on certain practices that are deeply rooted in the habits of protecting stored food. As for the use of powders; the maximum mortality obtained was 100% for the doses of all the plants used, while recording a very important mortality of the larvae of both insects for the plants studied. *T. castaneum* adults proved to be more sensitive to plant powders than *T. confusum* adults. Methanolic extracts of *N. oleander* and *A. campestris* showed the effectiveness of this treatment against adults of *T. castaneum* as well as the larvae of both insects. *T. confusum* adults have some resistance to methanolic extracts of plants. These natural insecticides also preserve the grains and their germination capacity. Therefore, the powders and extracts of the studied plants are environmentally-friendly alternative insecticides.

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ATTACHMENTS

Figure 1

Effect of N. oleander powder on larvae and adults T. castaneum and T. confusum as functions of time and dose

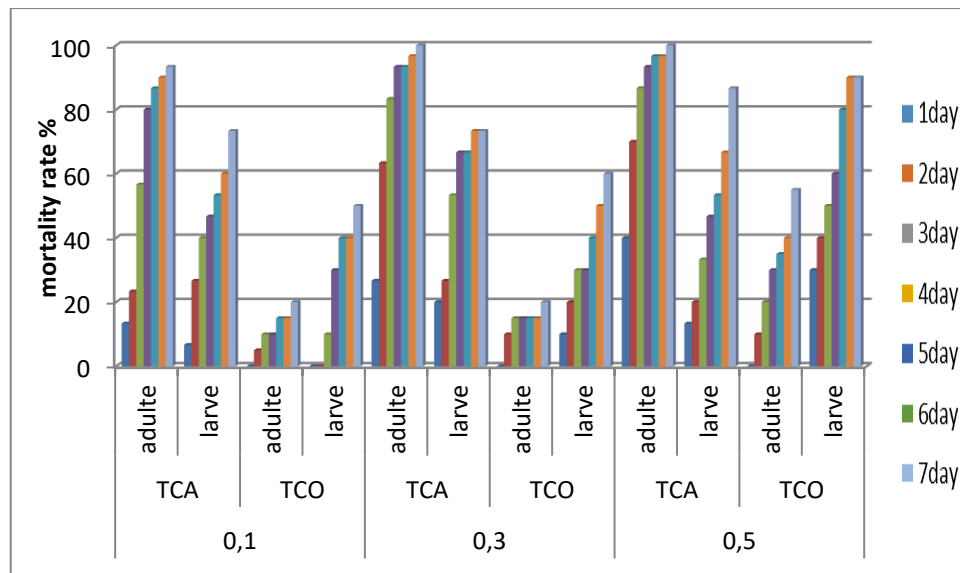


Figure 2

Effect of A. campestris powder on larvae and adults of T. castaneum and T. confusum as functions of time and dose

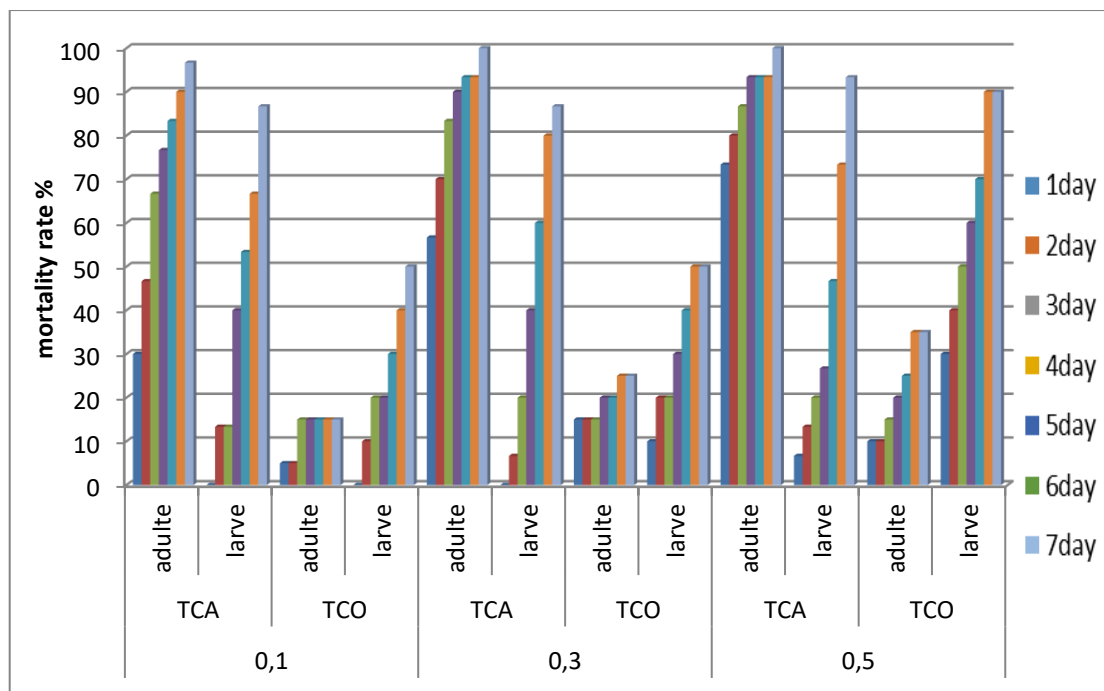




Figure 3

Effect of methanolic extracts of *N. oleander* larvae and adults of *T. castaneum* and *T.confusum* as functions of time and dose

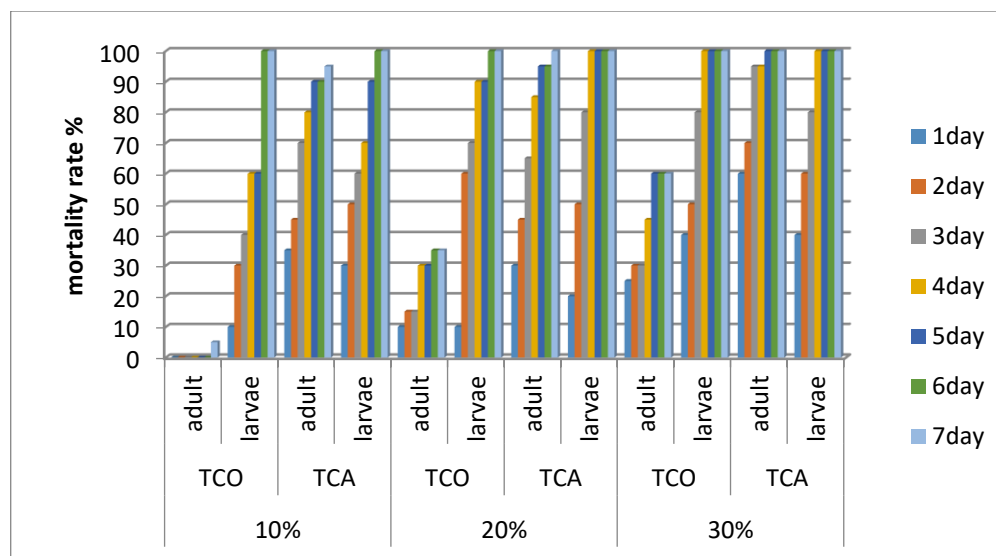


Figure 4

Effect of methanolic extracts of *A. campestris* on larvae and adults of *T. castaneum* and *T. confusum* as a function of time and dose

