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Repellent Activity Of Essential Oils From Artemisia Herba Alba Asso. And Teucrium Polium L. Against Tow Stored Product Insects

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Abstract

Essential oils extracted from the aerial parts of Artemisia herba alba Asso. and Teucrium polium L. was tested under laboratory conditions for repellent activity against two stored product insects, the Confused Flour Beetle, Tribolium confusum Jacquelin du Val (Coleoptera: Tenebrionidae) and Lesser Grain-borer ; Rhyzopertha dominica F. (Coleoptera : Bostrichidae). The essential oils of each plant were obtained by hydrodistillation method. Repellency activity studied at 0,031; 0,062; 0.094 and 0,125 µl/cm² doses. The essential oil of A. herba alba exhibited significantly stronger repellency effects; as at 0,125 µl/cm² oil dose caused 90 and 76.68 % repellency of T. confusum and R. dominica, respectively. At the highest dosage 0,125 µl/cm² repellency effects of T. polium oil against T. confusum and R. dominica were 76.68 and 50.02 %, respectively. According to the results obtained, it can be concluded that T. polium oil (Repulsion Mean 76.68%) recorded a very significant repellent effect against Tribolium confusum adults exceeds that of A. herba alba, and A. herba alba oil (Repulsion Mean 58.35%) recorded a very significant repellent effect against R. dominica adults exceeds that of T. polium.

Keywords: Artemisia herba alba Asso. , Teucrium polium L., Tribolium confusum, Rhyzopertha dominica F., essential oils, Repellency.

INTRODUCTION

The genus Teucrium which belongs to the family Lamiaceae, includes 300 species widespread all around the world (Awadh et al., 2008). Golden germander (Teucrium polium L.) is a Mediterranean shrub (Pacifico et al., 2012) a wild-growing flowering plant, found abundantly in South-West of Asia, Europe and North is Africa (Baradaran et al., 2013**;** Skoutie et al., 2012) aerial parts of Teucrium polium L. are used widely in the daily diet and for medicinal purposes (Sharififar et al., 2009). Used for its diuretic, antipyretic, diaphoretic, antispasmodic, tonic, anti-inflammatory, antihypertensive, anorexic, analgesic, antibacterial and antidiabetic effects (Pacifico et al., 2012), antilipeidemic herbal medicament (Shahraki et al., 2007), anti-nociceptive hypo lipidemic and hypoglycemic effects (Kalantari et al., 2014). This plant is used also as a spice and refreshing beverage (Sharififar et al., 2009).

Artemisia, one of the larger genera in the family Asteraceae and the largest genus in the tribe Anthemideae, comprises from 200 to more than 500 taxa at the specific or the subspecific level (Mohamed et al., 2010). The Algerian flora comprises 12 species of Artemisia (Quezel & Santa, 1963). Many Artemisia species have a high economic value in several fields, as food plants and as antihelminthic and antimalaria in medicine (Mohamed et al., 2010). Wormwood Artemisia herba-alba, called Shih is a wild aromatic medicinal shrub

(Sharaf et al., 2011 ; Shibli et al., 2018) which grows in the arid areas of North Africa and the Middle East (Shibli et al., 2018), was known for its therapeutic and medicinal properties (Mohamed et al., 2010 ; Benmenine et al., 2018), it was used in both traditional and modern medicine (Mohamed et al., 2010).

The lesser grain borer Rhyzopertha dominica (F.) is one of the most destructive insect pests of stored grain (Mau et al., 2012). Worldwide; both adults and larvae are voracious feeders. Lesser grain borers infest all types of cereal grains, but prefer wheat, corn, or rough and brown rice. Tropical in origin, possibly from the Indian subcontinent, they also feed on peanuts, nuts, birdseed, cocoa beans, and beans as well as processed products such as macaroni, tobacco, and dried spices (Hagstrum et al., 2012). This pest has been controlled successfully by fumigation with phosphine for the last several decades, though strong resistance to (Mau et al., 2012).

The confused flour beetle, Tribolium confusum Jacquelin du Val, is one of the serious insect pests infesting grain and other stored food products, from flour and cereals to spices (Boussaada et al., 2008 ; Nowaczyk et al., 2009). The insect Tribolium confusum due to the significant reductions either in quantity or quality of cereal grains (Russo et al., 2015) and is responsible for large economic losses every year (Nowaczyk et al., 2009).

The use of synthetic insecticides against stored product insect pests has posed serious problems to man and the environment. Thus, there is an urgent need to develop safer alternatives that have the potential to replace toxic chemicals. This research aims at evaluating the effectiveness of tow insecticide oils (Artemisia herba-alba, Teucrium polium) on the two céréals insect pest in order to develop alternatives to toxic chemical use.

MATERIALS AND METHODS

Plant materiel

The aerial parts of Artemisia herba alba Asso. and Teucrium polium L. were collected from M'Sila region (Algéria) in 2019. The fresh aerial parts are dried in the room temperature and obscurity for used in the extraction of essential oil.

Essential oil distillation

Essential oil was extracted from the aerial parts (100 g of dry matter) of each plant subjected to hydrodistillation during approximately for 3 hours using a Clevenger-type apparatus. The organic material along with water is placed in the round bottom flask at the base for boiling. The steam produced rises and is collected into a small burette. Finally, water and oil are separated by the difference in density. The essential oils were collected stored in sterile tubes at 4°C.

Animal material

The mass breeding of Tribolium confusum is carried out in a plastic jar contains 1000g of durum wheat semolina, and mass breeding of Rhyzopertha dominica is carried out in a plastic jar contains 300g of durum wheat grains. This is done under laboratory conditions at a temperature of 20-25°C and at a relative humidity between 65 and 70%.

Repellency test

The repellent effect of the essential oils of each plant on the adults of the two insects was evaluated using the preferential zone method on filter paper described by Mc Donald et al., (1970).

Repellency assay was carried out in glass petri dishes diameter 09 cm (63,62 cm^2). Test solutions of serial dilution, 2, 4, 6 and 8 µl of essential oils were prepared in 1ml acetone, corresponding respectively to the

dose : 0,031; 0,062; 0.094 and 0,125 µl/cm². The Whatman filter paper 09 cm (63,62 cm²) was cut into two equal halves and each test solution was applied to filter paper half as uniform. The other half of filter paper was treated with acetone only. The volatile solution treated and acetone treated halves were dried to evaporate completely. Both treated and untreated halves were then attached with cellophane tape and placed at the bottom in each petri dish. Twenty insects were released at the centre of filter paper disc and then petri dishes were covered. Three replicates were set for each concentration of essential oils solution. Number of insects on both treated and untreated halves were recorded after 2 h of the start of the experiment.

The percentage of repulsion (PR) was calculated using the following formula:
percentage of repulsion **(PR) % = [(NC-NT)/NC+NT)] ×100**

Where:
NC – number of insects in the controlled zone
NT – number of insects in the treated zone
PR – percent repellency.
The PR was ranked in six different classes as described by McDonald et al. (1970) as shown below:

Table 1: Percent Repellency (PR) classes ranked by Mc Donald et al., (1970)

Class	PR proportion (%)	Description
O	PR < 0.01	Not repellant
I	0.1 < PR ≤ 20.0	Fair repellant
II	20.1 ≤ PR ≤ 40	Moderate repellant
III	40.1 ≤ PR ≤ 60	Good repellant
IV	60.1 ≤ PR ≤ 80	Very repellant
V	80.1≤ PR ≤ 100	Perfect repellant

Statistical Analysis

The median repellent dose (RD50) (dose that repelled 50% of the exposed insects) at 2 h of exposure , was calculated using Finney (1971) method.

RESULTS AND DISCUSSION

The results of the evaluation of the repulsive effects of the essential oils from Teucrium polium and Artemisia herba alba on adults of Tribolium confusum and adults of Rhyzopertha dominica are shown in Tables 2, 3 and Figures 1, 2. The repulsion percentage of the two oils used increases according to the dose. The result reveals that the highest dose of T. polium and A. herba alba had a strong repellent effect of 96.69% , 90% respectively on adults of T. confusum and 76.68, 76.68% respectively on adults of R. dominica. At the lowest dose (0,031 µl/cm^2) repellency effect of essential oils extracted from T. polium and A. herba alba were recorded to be 46.67 and 46.67% against T. confusum and 26.66 and 40% against R. dominica, respectively. From these results it was concluded that higher concentration of essential oils resulted in maximum repellency of the pest as compared to lower concentrations. Moreover, the results of the median repellent dose value (RD50) of essential oils of Teucrium polium and Artemisia herba alba are shown in table 4.

Table 2. Repulsion percentage of essential oils from Teucrium polium and Artemisia herba alba against Tribolium confusum adults

Doses µl/cm2 essential oils	0,031	0,062	0.094	0,125	**Repulsion Mean %**	**Class**
Teucrium polium	46.67	76.68	86.69	96.69	76.68	IV Very repellant
Artemisia herba alba	46.67	66.68	70	90	68.33	IV Very repellant

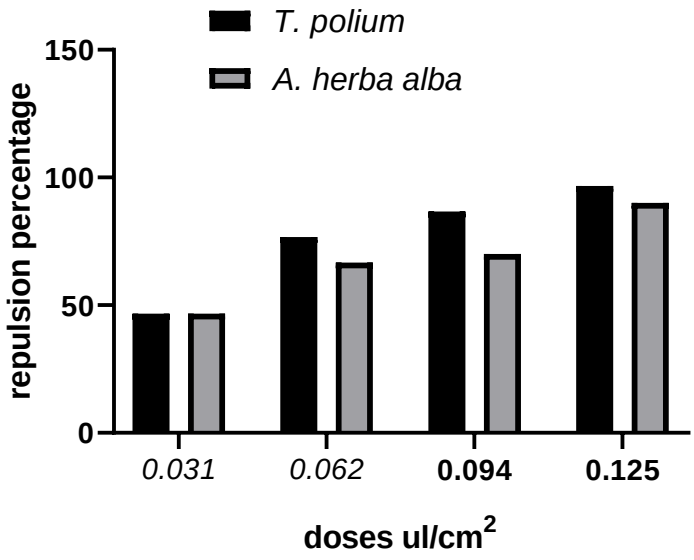

Figure 1. Repulsion percentage of essential oils of Teucrium polium and Artemisia herba alba on adults of Tribolium confusum

Table 3. Repulsion percentages of essential oils from Teucrium polium and Artemisia herba alba essential oils against Rhyzopertha dominica adults

Doses µl/cm2 essential oils	0,031	0,062	0.094	0,125	**Repulsion Mean %**	**Class**
Teucrium polium	26.66	43.37	53.37	76.68	50.02	III Good repellant
Artemisia herba alba	40	53.37	63.38	76.68	58.35	III Good repellant

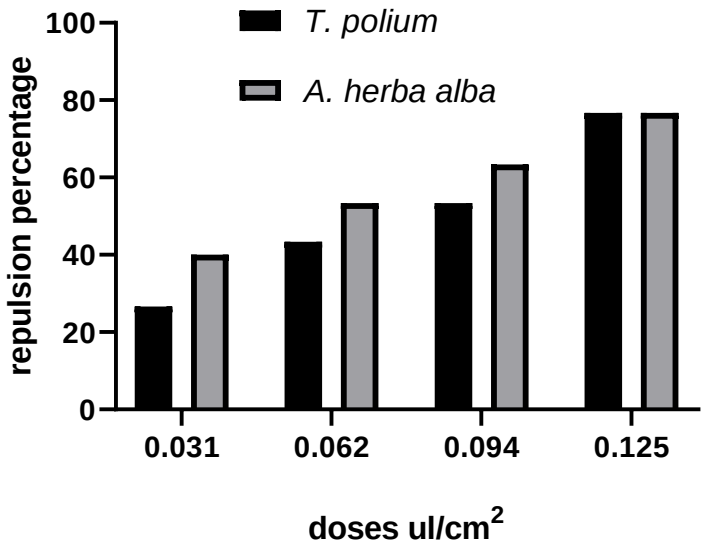

Figure 2. Repulsion percentage of essential oils of Teucrium polium and Artemisia herba alba on adults of Tribolium confusum

Table 4. RD50 of tow plants Teucrium polium and Artemisia herba alba

	Teucrium polium	**Artemisia herba alba**
Tribolium confusum	0.057 µl/cm^2	0.064 µl/cm^2
Rhyzopertha dominica	0.078 µl/cm^2	0.072 µl/cm^2

According to the classification established by Mc. Donald et al., (1970) it can be concluded that T. polium oil recorded a very significant repellent effect against Tribolium confusum adults exceeds that of A. herba alba, and the essential oil of A. herba alba exhibited an important repulsive activity, which exceed the essential oil of T. polium against R. dominica. This difference appears to be related to the chemical composition of essential oils from both species, and sensibility of T. confusum and R. dominica.

Many researchers pointed that some of plant essential oils show strong repellency effects against storage pests (Mishra et al., 2012; Salem et al., 2017 ; Martínez et al., 2018 ; Moutassem et al., 2021) .

Results of our study compare favorably with other investigations in which A. herba alba and T. polium essentials oils produced significant activity against pest insects. In this context, Bouchikhi-Tani et al., (2018) were tested essential oil of A. herba alba with various amounts on the larvae of Tineola bisselliella. Delimi et al., (2013) demonstrated the Toxicity of the oil of A. herba alba against Ephestia kuehniella and Zaim et al., (2012) showed a toxic effect of A. herba alba on the survival of the adult of Euchorthippus albolineatus. Additionally, the Fumigant and repellent properties of sesquiterpene-rich essential oil from Teucrium polium subsp. capitatum (L.) is testing against T. casteneum and C. maculatus adults by Khani & Heydarian (2014),

and Bekircan et al., (2014) tested antifeedant activity of essential oil obtained from Teucrium polium L., against larvae of Agelastica alni L., Coleoptera: Chrysomelidae.
Among the aromatic plants Anethum graveolens, Apium graveolens, Eucalyptus glauca, Malva parviflora, Mentha longifolia, Zingiber officinale, Juniperus polycarpus L., Juniperus sabina L., Melia azedarach, Mentha arvensis, Olea europaeal, Punica granatum , Lavandula stoechas, Lavandula pedunculata, Thymus daenensis, Achillea wilhelmisii, Artemisa haussknechtii have been reported to be repellent and toxic to Tribolium (Ali1 & Mohammed , 2013 ; Mohammed, 2013 ; Mahmoodavand & Shakarami, 2014 ; Khani et al., 2017 ; Bachiri et al., 2018).

CONCLUSION

The results of these studies suggest that all the test plants have potential for repellent action, according to the classification established by Mc. Donald (1970) is Teucrium polium oil (76.68%) compared to Artemisia herba alba oil (68.33%) on adults of Tribolium confusum. For adults of Rhyzopertha dominica the oil of Artemisia herba alba (58.35%) is more repellent compared to the oil of Teucrium polium (50.02%). Both essential oils have repellent effects. We deduce that this essence can be used as an active raw material in the formulation of pesticides for the protection of stored against pests.

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