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SOME HERBAL MEDICINAL PRODUCTS AS A SOURCE OF PROMISING NATURAL PESTICIDES

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ABSTRACT

Sitophilus granarius L**.** (Coleoptera: Curculionidae), the granary weevil, is a major stored product pest in many countries and specially in Egypt, causing tremendous losses estimated by 10-15%. The present study was aimed to assess the impact of eleven essential oils from : Lavender oil *(Lavandula angustifolia Mill),* Rosemary oil *(Rosmarinus officinalis L.),* Garlic oil *(Allium sativum L.),* Soybean oil *(Glycine max L. Merr),* Sesame oil *(Sesamum indicum L.),* Cardamom oil *(Elettaria cardamomum L. Maton),* Castor oil *(Ricinus communis L.),* Camphor oil *(Cinnamomum camphora L.),* Olive oil *(Olea europaea L.),* Bitter almond oil *(Prunus amygdalus B.),* Coconut oil *(Cocos nucifera L.*) showing its toxicity and insecticidal activity against the adult granary weevil, *Sitophilus granarius* L. Tested plant oils were used with different concentrations and different exposure times (7,10,15 and 30 days). The results showed that the activities of tested oils were better at higher concentrations and higher durations and that was confirmed via the results of LC_{50} values obtained and variations between the different tested oils.

Key words: *Sitophilus granarius* L., plant oils, insecticidal activity, wheat.

INTRODUCTION

Stored-grain insect pests result in economic losses by infesting stored agricultural products. According to an estimate, the overall damage caused by stored-grain insect pests ranged between 10 to 40% of the annual worldwide loss **(Matthews, 1993)**, ranging between 1.25 and 2.5 billion US dollars (**Schöller *et al*., 2006**). *Sitophilus granarius* (L.) (Coleoptera: Curculionidae), the granary weevil, is a major stored-product pest in regions of moderate climate. Furthermore, insect infestations in stored grain led to the production of heat and moisture, thus promoting fungal growth **(Howe, 1951).** The control of stored-product insect populations is primarily depends upon the continued applications of liquid and gaseous insecticides (**White and Leesch, 1995; Ngamo *et al.,* 2007b).** Although, effective, their repeated use for several decades has disrupted the biological control systems by natural enemies and has led to outbreaks of insect pests, the widespread development of resistance, undesirable effects on non-target organisms, and environmental and human health concerns (**Champ and Dyte, 1976**; **White and Leesch, 1995**).

These problems have highlighted the need for the development of new types of selective insect-control alternatives with different modes of action. In this regard, many plant products have been evaluated for their insecticidal properties against different stored-grain pests (**Kim *et al.,* 2003; Cosimi *et al.,* 2009**). A number of plants produce essential oils that have been evaluated for their insecticidal properties against various insect pests (**Shaaya *et al.,* 1991; Kim *et al.,* 2003; Ngamo *et al.,* 2007a; Cosimi *et al.,* 2009).**

Therefore, many efforts have been focused on plant-derived materials for potentially useful products as commercial insect-control agents.

The goal of this study was to assess the effect of applying some essential oils of: Lavender oil (*Lavandula angustifolia* Mill), Rosemary oil (*Rosmarinus officinalis* L.), Garlic oil (*Allium sativum* L.), Soybean oil (*Glycine max* L. Merr), Sesame oil (*Sesamum indicum* L.), Cardamom oil *(Elettaria cardamomum* L. Maton), Castor oil (*Ricinus communis* L.), Camphor oil (*Cinnamomum camphora* L.), Olive oil *(Olea europaea* L.), Bitter almond oil (*Prunus amygdalus* B.), Coconut oil (*Cocos nucifera* L.) as an effective tool in controlling the adult of *Sitophilus granarius* L., i.e: a natural promising protectants.

MATERIALS AND METHODS

Tested plant oils:

Essential oils obtained from local market, (El-Captain® company commercial producers of plant essential oils and aromatic substance) were used in this study as in Table (1).

Insect culture and rearing conditions:

The granary weevil, *Sitophilus granarius* L. was used for the present experiments.

A culture of a standard Laboratory strain of *Sitophilus granarius* L. was reared on the grains of wheat kept since 2009 in the laboratory of Environmental protection Department at (28 ± 2 ºC and 70 ± 5% R.H.). Insects were reared in

Table (1): The Scientific name, Family, English name and Arabic name of tested plant oils:

Scientific Name	Family	English Name	Arabic Name
Lavandula angustifolia Mill	Lamiaceae	Lavender	اللافندر
Rosmarinus officinalis L.	Lamiaceae	Rosemary	حصالبان
Allium sativum L.	Amaryllidaceae	Garlic	الثوم
Glycine max L. Merr	Fabaceae	Soybean	فول الصويا
Sesamum indicum L.	Pedaliacae	Sesame	السمسم
Elettaria cardamomum L. Maton	Zingiberaceae	Cardamom	الحبهان
Ricinus communis L.	Acalypheae	Castor	الخروع
Cinnamomum camphora L.	Lauraceae	Camphor	الكافور
Olea europaea L.	Oleaceae	Olive	الزيتون
Prunus amygdalus B.	Rosaceae	Bitter almond	اللوز المر
Cocos nucifera L.	Arecaceae	Coconut	جوز الهند

plastic boxes (15 × 25cm) containing unifested wheat and covered with muslin which fixed tightly by a rubber band. Adults were removed and transferred each day: in this way, the newly emerged insects were homogeneous in the box. These adults were used in bioassays.

Bioassay

- Laboratory studies were conducted to investigate the insecticidal activity of tested plant oils at different concentrations against *Sitophilus granarius* (L.).

The insecticidal activity was determined by the test insect mortality at different exposure periods compared to the untreated control samples.

In these experiments, each of evaluated oils was prepared in a stock concentration of (100µl oil /50 gram grains)(v/w) as follow :a dosage of (100µl) of each tested oil was applied by using micropipette on the sample of 50g sterilized wheat grains in petri dish and mixed well for coating the grains with that dosage of oil.

Also, in each bioassay trial a 100 adult insects of Granary Weevil (*Sitophilus granarius* L.), were collected and used in five replicates, in each one 20 adult insects. A series of concentrations of each tested oil were prepared. The percentage of mortality (%) of adult insects was recorded after 7, 10, 15 and 30 days of exposure to the tested oil. The mortality percentages (%) were recorded to determine the LC_{50} values- Slope and confidence limits for each LDP- line by using the semi-log dosage - probit graphs according to **(Finney, 1971).**

RESULTS

Data of the insecticidal activity of the selected plant oils were presented in Table (2). In general, the mean mortality of the insect was observed at higher concentration and higher duration. The order of the efficacy of the insect mortality was as follows; after 7 days of exposure: Sesame and Camphor > Cardamom oil > Soybean oil > Olive oil> Rosemary oil > Bitter almond oil > Garlic oil > Lavender oil > Castor oil > Coconut oil.

In the case of 10 days after exposure: Sesame oil > Cardamom and Camphor oils > Soybean oil > Olive oil > Bitter almond oil> Rosemary oil > Garlic oil > Lavender oil > Castor oil >Coconut oil . Also, after 15 days of exposure: Cardamom and Camphor > Sesame oil > Soybean oil > Bitter almond and Olive oils > Lavender oil > Rosemary oil > Garlic oil > Castor oil > Coconut oil. And 30 days of exposure: Sesame oil > Bitter almond, Cardamom and Camphor oil > Soybean oil > Olive oil > Rosemary oil > Castor oil > Lavender oil > Garlic oil > Coconut oil.

DISCUSSION

The essential oils and their constituents have been shown to be a potent source of botanical pesticides **(Huang *et al.*, 2000).** Also **(Kostyukovsky *et al.*, 2002)** reported that a number of essential oils extracted from various spices and medicinal plants were found to be active against *S. oryzae*, *R. dominica*, *O. surinamensis* and *T. castaneum.*

And by throwing more light on that concept, where a number of these essential oils were extracted from spices, herbal and medicinal plants and applied against several stored product insects less detrimental to non-target organisms & are readily biodegradable **(Laznik *et al.*, 2012**).

(EL-Nahal *et al.,* 1989) noticed that the period of exposure appeared to be the most important factor affecting the efficiency of these vapours rather than the dosage**. (Laznik *et al.,* 2012)** proved that the activities of essential oils were better at higher concentrations than at lower ones.

Table (2): Effect of different plant oils after different times of exposure against the adult stage of granary weevil, *Sitophilus granarius* L.

	LC$_{50}$ (%) for Tested Oils										
Bioassay periods (Days)	**Lavender oil**	**Rosemary oil**	**Garlic oil**	**Soy bean oil**	**Sesame oil**	**Cardamom oil**	**Castor oil**	**Camphor oil**	**Olive oil**	**Bitter almond oil**	**Coconut oil**
7	0.202	0.121	0.175	0.040	0.022	0.026	0.537	0.022	0.064	0.128	1.678
10	0.207	0.114	0.145	0.030	0.005	0.016	0.420	0.016	0.034	0.036	1.594
15	0.072	0.101	0.137	0.015	0.008	0.007	0.270	0.007	0.028	0.028	1.556
30	0.042	0.018	0.091	0.004	0.001	0.002	0.031	0.002	0.005	0.002	0.561

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Commonly, we have to postulate in more and deep details and throwing more light on the main reasons responsible for different responses and attitudes of the tested botanical oils possessing a vast spectrum of properties, chiefly the insecticidal activity, Antimicrobials and …. etc.

Accordingly and besides all what mentioned before, it was noticed that there is a positive correlation between the toxicity of the oils and their taxonomic plant families reflecting different chemical constituents of these plant oils, which probably and ultimately responsible for all these different responses represented in different toxicity responses and levels . That attitude has a high degree of agreement with a lot of references **(Calgar *et al.,* 2007, Tripathi *et al.,* 2009, Zapata and Smagghe 2010 and recently by Chaubey 2011 & very recently Liu *et al.,* 2013 and Chu *et al.,* 2013).**

And by going after more specifications, it was reported that these essential oils when tested against that pest and other related ones were affecting via inhalation, ingestion and absorption via its cuticle. That concept could be expected in that study and showing an accordance with the results recorded by **(Anwar *et al.,* 2005, Tripathi *et al.,* 2009 and recently by Zapata and Smagghe 2010).** So in other words we can say that it was the possible and expected mode of entry of these oils and explaining why these insects showed to be very sensitive for topical or contact application by these essential oils. These results in that study were in an agreement with that obtained by **(Tapondjou *et al.,* 2005, Iloba and Ekrakene 2006, Odeyem *et al.,* 2008, Conti *et al.,* 2010, Zapata and Smagghe 2010 and very recently by Chu *et al.,* 2011).**

Again by going after, the published and reported chemical structures of these oils in different references showing a high number of hydrocarbon's and other related compounds which mainly in the formal aliphatic or aromatic of terpenes, terpenoids **(Tripathi *et al.,* 2009)**.

Also phenols, alkaloids - sesquiterpenes and oxygenated monoterpenes were familiar and present in essential oils **(Conti *et al.,* 2010).** So it is obviously and exactly that all these different structures of mainly and secondary compounds play a very clear and effective role in showing different biochemical responses and activities of these oils postulating the importance of these different phytochemicals and so reflecting a various & diverse responses, **(Conti *et al.,* 2010).**

So we can say that these previous observations in references were in an agreement with the different recorded results and achieving that concept of correlation between different oils - their chemical structures and different biochemical and toxicological activities.

Additionally it is well known that these oils mainly depends upon major volatile components they posses **(Maciel *et al.,* 2010).**

Also these oils are lipophilic in its nature and permitting to show a degree of toxicity. Rather than these oils were anticipating different effects on metabolic processes-biochemical - physiological and behavioral changes towards the tested insects **(Chaubey 2011).**

That explanation could be expected in the recorded results, but it needs more studies to be sure of these facts.

So to fulfill the picture, it was reported 1-stly about the mode of action of these oils is still not confirmed yet. But most appear to cause death of insects could be by suffocation **(Khalezzaman and Chowdhury 2003)**. And by more specification **(Tripathi *et al.,* 2009)** proved that route of action of oils was longely in the vapour phase via respiration causing an impairment for respiration.

That point of view also reported by **(Zapata and Smagghe 2010).** Recently **(Singh 2012)** showed that oil can be used preventively as well as curatively. Also the oil coating prevents gaseous exchanges. And more than the protective effect of oil may last for up to 3 months. That response was in an agreement with the recorded data in that study.

Rather than very recently **(Grdiša, M. And Gršić 2013)** proved that the major constituents of these botanical oils act as nerve toxins and contact poisons. Certainly, we have to pay attention to the need for more specific studies to can predict its mode of action and main targets affected. Again by throwing more light, since biological functions, normally are very selective processes, i.e: a group of chemical having certain and similar biological activities must show and reflect a feature of selectivity in its response **(Horborne 1988)**.

That concept proved through that study offering a kind of physiological selectivity, so expecting and reflecting different modes of action of these plant oils, that criteria was confirmed very recently by **(El-Araby 2014).**

CONCLUSION

Plant oils can play an important role in stored-grain protection and reduce the need for, and risks associated with, the use of insecticides.

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الملخص العربي

بعض المنتجات العشبية الطبية كمصدر واعد للمبيدات الطبيعية

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تعتبر حشرة سوسة القمح من اهم الحشرات التي تصيب الحبوب المخزونة وتسبب خسائر كبيرة تقدر بـ ١٠-١٥ % . شملت الدراسة الحالية تقييم كفاءة ١١ زيت نباتي وهم (اللافندر- حصالبان- الحبهان - الثوم- السمسم- الخروع- الزيتون- فول الصويا- جوز الهند- اللوز المر - الكافور) وسميتها ضد الطور البالغ لحشرة سوسه القمح وذلك تحت ظروف المختبر. استخدمت الزيوت النباتية فى هذة الدراسة بتركيزات مختلفة واوقات تعرض (٧، ١٠، ١٥ ،٣٠يوم) حيث أظهرت النتائج أن نشاط الزيوت كان افضل عند التركيزات الاعلى وفترات التعرض الاطول وهذا ما أكدته النتائج المتحصل عليها من تأثير طول فترة التعرض وكذلك اختلاف التأثير من زيت لاخر .

وقد بينت النتائج المتحصل عليها أن زيوت السمسم والكافور كانوا الاكثر سمية ضد الحشرة المختبرة بقيمة LC_{50} تساوى لكل منهما ٠،٠٠٢٢% وذلك بعد ٧ أيام من التعرض، أما بعد ١٠ أيام من التعرض حقق زيت السمسم أعلى سمية بقيمة LC_{50} تساوى ٠،٠٠٠٥%. أما بعد ١٥ يوم من التعرض كان كلا من زيت الحبهان وزيت الكافور الاعلى سمية من بين الزيوت المحتبرة بقيمة LC_{50} تساوى ٠،٠٠٠٧% . خلال التجربة وبعد ٣٠ يوم من التعرض حقق زيت السمسم أعلى سمية بقيمة LC_{50} تساوى ٠،٠٠٠١%.

الكلمات الاسترشادية: سوسة القمح، المبيدات الطبيعية، الزيوت الطبيعية، العشبيات الطبية.

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