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EFFICIENCY OF SOME BOTANICAL MATERIALS AS CONTROL AGENTS AGAINST *Varroa destructor* MITE (ANDERSON AND TRUMAN) INFESTING HONEYBEE COLONIES

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ABSTRACT: The present investigation was carried out during autumn season of 2017 to evaluate the efficiency of some botanical materials in controlling *Varroa* mite infestation in Carniolan and Italian honeybee colonies, in the Research Apiary of Faculty of Agriculture, Zagazig University, Zagazig, Egypt. Results cleared that treating Carniolan and Italian honeybee hybrid colonies with garlic extract, garlic oil, garlic paste, cinnamon extract, *Eucalyptus* crystals and cinnnamen powder + powdered sugar (1:1) increased significantly numbers of fallen mites, that ranged 175-263 mites/ Carniolan hybrid colony and 128-206 mites/ Italian hybrid colony compared to 27 and 22 fallen mites/ control colony of the two hybrids, respectively. As a results post-treatment percentage of infestalion ranged 5-12% in treated Carniolan colonies, 4-10% in treated Italian ones, regardless of the test agent. Meanwhile, untreated control colonies manifested 27 and 26% infestation for the two respective hybrids. Therefore, the percentage of efficiency of the test botanicals garlic extract, garlic oil, garlic paste, cinnamon extract, *Eucalyptus* crystals and cinnamon powder + powdered sugar (1:1). In Carniolan hybrid colonies recorded 76.54, 73.17, 66.88, 74.86, 64.81 and 57.77% against *Varroa* mite infestation, respectively**.** The respective percentages in Italian hybrid colonies were 78.69, 75.76, 70.32, 73.07, 70.85 and 63.56%.

Key words: *Varroa destructor*, *Apis mellifera*, botanicals, carniolan hybrid, Italian bees, fallen mites.

INTRODUCTION

Honeybees are considered the most economic insect due to their important role in pollination of field and horticultural crops, increasing the crops productivity as well as honeybee products that possess nutritional and medicinal importance. However, honeybees are relable to be infested with many pest, causing servere losses. The mite *Varroa destructor* has become the most important pest of *Apis mellifera* colonies. Different methods have been applied to manage this mite in modern hives, including mechanical, chemical and natural procedures. Although chemical methods reduced the mite infestation and succeeded to a great extent, yet resistance of mite to most acaricides used for control formed a significant problem. Also, chemical abuse leads to improper residues in hive products *e.g.*, honey and beeswax **(Wallner, 1999)**. Depending on alternative techniques in controlling *Varroa* mite, natural materials *e.g.*, essential oils and botanical extracts were utilized and variable efficiencies were achieved **(Yousif-Khalil and Khattaby, 1993; Sammataro *et al*., 1998; Omar *et al*., 2001)**. However, honeybees have naturally evolved some special features (hygienic and grooming behavior) to defend themselves against these dreaded ectoparasitic mites. Some worker bees in the colony detect the diseased or infested pupae, uncap the cells and remove the effected brood from the hive (**Peng *et al*., 1987; Boecking and Spivak, 1999**). Due to which the numbers of fertile and immature mites are

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reducing in honey bee colony. This is called hygienic behaviour. Another defensive mechanism is grooming behavior; in which the adult bees remove feral mites stuck on their bodies (auto-grooming) or attract other workers by doing special movements to remove them (allgrooming). During this action, mites are injured from legs (amputation) or idiosoma due to bites of worker bees (**Vaziritabar *et al*., 2016**) and fall down on bottom board. This behviour can also be considered as possible limiting factor to mite population. The present study was planned with the hypothesis that hygienic and grooming behaviors of *Apis mellifera* colonies against *Varroa destructor* could be enhanced *via* some practical proceses applying the most modern apicullural techniques and making use of some botanicals and natural materials.

MATERIALS AND METHODS

This experiment was performed in the Research Apiary of Faculty of Agriculture, Zagazig University Egypt during autumn season of 2017.

A total 21 honeybee colonies from each of Italian and Carniolan hybrids were considered. Such colonies were equalized in strength as usual, being suffering from nearly the same rate of mite infestation. The colonies were hived in Langstroth wooden hives with screened thin sticky board to be placed on bottom board to catch the fallen mites. The sticky board was weekly replaced by new ones (to count the fallen mites on the older one. The total number of fallen mites allover the experimental period was summed and recorded.

The rate of *Varroa* mite infestation was assessed twice, *i.e*. at the onset and at the end of the experiment to calculate the percentage of efficiency of the test materials

The Test Botanical Materials

Plant extracts

Boiling water extracts of garlic and cinnamon cortex were made by boiling 30 g of macerated garlic cloves or cinnamon phylum in 100 ml water for 10 minutes in tightly covered glass gar. After cooling a filteration process was made to separate the supernatant which kept in dark bottles until needed for application.

On experimentation, absorbent suitable cotton swaps were used to absorb a quantity of 30 ml of the supernatant then placed on the top par of boord combs for seven days. The older swaps were then replaced with another treated fresh cotton swaps. The process was repeated 4 times to complete the course of treatment. Thereafter, the rate of mite infestation was evaluated to calculate the percentage efficiency of the test botanical materials.

Garlic oil

Garlic oil was obtained from SiGMA Company for Pharmaceuticals (1965 SG/12) (9165 SG/91). Absorbent thick carton sheets (3x 10 cm) were used to absorb 2 ml oil / sheet that placed on the top bar of brood combs of the test colonies.

Cinnamon powder

Powdered cinnamon cortex was mixed with powdered sugar at the rate of (1:1) then dusted on the bees covering the combs at the rate of 2 g per comb once weekly for 4 times. Fallen mites were captured on sticky boards placed on the bottom board of the test hives.

Garlic paste

A paste of macerated garlic cloves was used at the rate of 30 g/ colony / fortenight. The paste was offered to the test colonies in perforated plastic bags to be hung between brood combs.

Eucalyptus crystals

Eucalyptus crystals were purchased from El-Gomhoria company for pharmceuticals and medical equipments.

Control colonies

Control colonies of both hybrids were fed sucrose syrup without any addition.

In all cases, screened thin sticky board was placed on the bottom board in the test hives to catch the fallen mites and to prevent the alive fallen mites from re- attached to bee workers. The sticky board was replaced with new clean one at the end of each interval (treatment), meanwhile the fallen mites on the older board were counted then the board was then cleaned and prepared for the next use.

The efficiency of the test materials as control agents against *Varroa* mite was calculated basing upon the rate of *Varroa* infestation pre- and post- treatment according to **Hinderson and Tilton Equation (1955)**.

Reduction of infestation (%) = 100 x (1 – {Ta x Cb} / {Tb x Ca})

Where:

T = (%) infestation of treated colonies and C = (%) infestation of untreated colonies (a = after; b = before treatment).

Data obtained were statistically analysed according to **Snedecor and Cochran (1967)** methods that calculated according to COSTAT computer program **(Anonymous, 2005)**

RESULTS AND DISCUSSION

The efficiency of garlic extract, garlic oil and garlic paste, cinnamon extract, powder and *Eucalyptus* crystals as control agent against the mite *Varroa destructor* was investigated in Carniolan and Italian hybrid honeybee colonies during autumn season of 2017. Judgement of the efficiency was calculated basing upon the pre- and post-treatment rate of infestation. Data obtained, in detail are as follow:

Pretreatment Percentage of Infestation

Results presented in Table 1 clear that pretreatment rate of *Varroa* infestation recorded between 13-21% in the test colonies, in general, without any significant difference between the test colonies in this parameter.

Number of Fallen *Varroa* Mites

As shown in Table 1, the mean total number of fallen mites recorded 201, 194, 178, 175, 240, 263 and 27 mites per Carniolan hybrid colony treated with garlic extract, garlic oil, garlic paste, cinnamon extract, *Eucalyptus* crystals, cinnamon powder + powdered sugar (1:1), as well as control colonies, respectively. The corresponding figures for Italian hybrid colonies were 173, 191, 206, 177, 196, 128 and 22 mites /colony. Analysis of variance cleared that all the test materials increased significantly the number of fallen mites in treated colonies as compared to the control ones received no control agents for both hybrids. However, the numbers of fallen mites were relatively higher in Carniolan colonies when compared with that counted in Italian ones.

The number of fallen *Varroa* mites in the treated test colonies was significantly higher as compared to that of control colonies. In addition, the highest fallen numbers were in garlic extract - treated colonies, cinnamon powder + powdered sugar and *Eucalyptus* crystals-treated Carniolan colonies and in garlic paste – treated Italian hybrid colonies. In this respect, **Yousif- Khalil and Khattaby (1993)** working on *Eucalyptus* and worm wood smoke and **Abd El-Halim *et al*. (2006)** working on oils of thyme, *Eucalyptus* and garlic reported that the counts of fallen *Varroa* mites in treated honeybee colonies were significantly higher as compared to the fallen mite numbers in control colonies. Moreover, the numbers of fallen mites did not correlate with neither the efficiency of the test agents nor the infestation levels. This statement is partially supported by that of **Nganso *et al*. (2017).**

Post-treatment Rate of *Varroa* Infestation

Obtained results indicated that the mean post treatment rate of *Varroa* infestation attained (6, 8, 8, 5, 8, 12, 27) in Carniolan hybrid colonies treated with garlic extract, garlic oil, garlic paste, cinnamon extrac, *Eucalyptus* crystals, cinnamon powder + powdered sugar and untreated colonies (control), respectively (Table 1). The corresponding figures for Italian hybrid colonies were 4, 7, 9, 7, 8, 10 and 26%. Statistical analysis detected significant differences between all the test materials and the control in this parameters. However, cinnamon and garlic extract were more potent in Carniolan colonies and Italian hybrid colonies, meanwhile the mixture cinnamon powder + powdered sugar (1:1) was the least potent agent among the test botanic materials examined.

Percentage of Reduction in the Rate of Infestation (% Efficiency)

Results presented in Table 1 clear that the mean calculated percentage of efficiency of the test botanic materials attained 76.54 , 73.19, 66.88, 74.86, 64.81 and 57.77 % in Carniolan hybrid colonies treated with garlic extract, garlic oil, garlic paste, cinnamon extract, *Eucalyptus*

Table 1. Efficiency of some botanicals in controlling *Varroa* mite infesting Carniolan and Italian hybrid honeybee colonies during autumn season of 2017

Honeybee hybrid	Carniolan hybrid					Italian hybrid				
Control agent	Pre-treat. infestation (%)	Fallen *Varroa* mites		Post-treat. infestation (%)	Reduction = efficiency (%)	Pre-treat. infestation (%)	Fallen *Varroa* mites		Post-treat. infestation (%)	Reduction (efficiency) (%)
		No.	No folds				No.	No folds		
Garlic extract	18	201	7.44	6	76.54	13	173	7.86	4	78.69
Garlic oil	21	194	7.18	8	73.19	20	191	8.68	7	75.76
Garlic paste	17	178	6.59	8	66.88	21	206	9.36	9	70.32
Cinnamon extract	14	175	6.48	5	74.86	18	177	8.04	7	73.07
Eucalyptus crystals	16	240	8.88	8	64.81	19	196	8.90	8	70.85
Cinnamon powder + sugar powder (1:1)	20	263	9.74	12	57.77	19	128	5.81	10	63.56.
Control	19	27		27	———	18	22		26	-
LSD 0.05	NS	89		7.4		NS	82	9.2		

crystals and cinnamon powder + powdered sugar (1:1), respectively. The corresponding figures for Italian hybrid colonies reached 78.69, 75.76, 70.32, 73.07, 70.85 and 63.56%. In conclusion, garlic (extract , oil and paste) and cinnamon extract manifested higher efficiency in controlling *Varroa* mite, while cinnamon powder + powdered sugar manifested the least efficiency in both hybrid colonies. In addition, Italian hybrid colonies showed relatively higher response to the test botanicals.

Generally, all the test botanicals were effective in controlling mites especially garlic and cinnamon extracts which showed higher potency. On the other hand, cinnamon powder + powdered sugar showed the least efficiency. However, the test botanical materials can not be depend upon solely in controlling the target pest, but in IPM programs. Moreover, it seems that the test botanicals play dual role, the first by it direct effect on the target mite meanwhile the second role seemed to be the inducement (enhancing) of the defensive behaviour of bee workers against the pest (grooming behaviour). The same conclusion was also reported by **Howis *et al*. (2012)**, indicating that Apivarol As and organic acid enhance grooming behaviour of bee workers. In this respect, **Haggag and El-Badawy (1999)** reported between 89.6 – 94.1% reduction in *Varroa* infested brood after the 3rd treatment with thymol, camphor, garlic and thymol + garlic. Also, **Refaei (2011)** found that camphor oil efficiency attained 71%. In addition, **Ab El-Wahab *et al*. (2012) and Zheng *and* Zhong (2012)** found that the efficiency of cinnamon oil in controlling *Varroa* mite recorded 40 and 12%, respectively. Also, **Ghasemi *et al*. (2011), Gregorc and Planine (2012) and Ahmad *et al*. (2013)** reported thyme oil as potanical control agent against *Varroa* mite. Moreover, **Goswami and Khan (2013), Qayoum *et al*. (2013) and Goswami *et al*. (2014)** reported that garlic efficiency against *Varroa* mites reached 75, 77% mortality. They attributed the protective effect of garlic to tomalin and other sulphatic compounds.

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تقييم فعالية بعض المواد النباتية في مكافحة حُلم الفاروا الذي يهاجم طوائف نحل العسل

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تم إجراء هذه الدراسة في المنحل البحثي التابع لكلية الزراعة، جامعة الزقازيق، مصر، في موسم الخريف للعام 2017 وذلك لتقييم فاعلية بعض المواد النباتية في مكافحة طفيل الفاروا الذي يهاجم طوائف نحل العسل، هذا وقد اظهرت النتائج أن معاملة طوائف هجين النحل الإيطالي والكرينولي بمستخلص الثوم وزيت الثوم وعجينة الثوم ومستخلص القرفة وبللورات الكافور ومخلوط دقيق لحاء القرفة مع السكر البودرة 1:1 قد أحدث زيادة معنوية في أعداد الفاروا المتساقطة والتي تراوحت بين 175–263 حُلم لكل طائفة هجين كرنيولي ومن 128– 206 حُلم لكل طائفة هجين إيطالي مقارنة بـ 27 و 22 فاروا متساقطة لكل طائفة مقارنة من الهجينين على الترتيب، وكنتيجة لذلك إنخفضت نسبة الإصابة في الطوائف بعد معالجتها حتى تراوحت بين 5–12% للطوائف الهجين الكرينيولي و4–10% في الطوائف الهجين الإيطالي، في حين بلغت نسبة الإصابة 27 و26% في طوائف الهجينين قيد الدراسة على الترتيب، لهذا بلغت نسبة الخفض في الإصابة 76.54، 73.17، 66.88، 74.86، 64.81 و57.77% في طوائف الهجين الكرينيولي و78.69، 75.76، 70.32، 73.07، 70.85 و 63.56% في طوائف الهجين الإيطالي عقب المعالجة بمستخلص الثوم، زيت الثوم، عجينة الثوم، مستخلص لحاء القرفة، بللورات الكافور وبودرة القرفة والسكر، على الترتيب.

المحكمـــون:

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