

Comparative Study of the Activity Acaricide of Four Essentials Oils on *Varroa destructor* Mite of the Honey Bee *Apis mellifera* in the Center of Algeria

¹S. Koumad and ²M.L. Berkani

¹Agronomical Upper National School, Department of Animal Production,
Hassen Badi, El-Harrach, 16200 Algiers, Algeria

²Agronomical Upper National School, Department of Animal Production,
Beekeeping Laboratory. Hassen Badi, El-Harrach, 16200 Algiers, Algeria

Abstract: This study was performed to determine the activity acaricide of four essentials oils of rosemary (*Rosmarinus officinalis*), laurel (*Laurus nobilis*), Spearmint (*Mentha viridis*) and thyme (*Thymus pallescens*) essentials oils on the control of *Varroa destructor*, the most common parasite of honeybees (*Apis mellifera*). These oils have caused an obvious reduction of the rate of infestation of colonies bees by varroa. Results obtained, show clearly an increased efficiency of the four essentials oils used for varroa control, with the superiority of laurel followed by rosemary spearmint and the thyme as control treatment. However, no abnormal deaths were seen in adult bees during the treatment period. In relation to control of varroa parasite by using four volatile plant oils, data revealed that all tested oils proved efficient in control. The tested treatments can be arranged in descending order according to their efficacy: rosemary, Laurel, spearmint and the thyme.

Key words: Essential Oils • *Apis mellifera* • *Varroa destructor* • Infestation • Efficacy • Mortality

INTRODUCTION

Nowadays, the ectoparasite mite, *Varroa destructor* is considered as one of serious pests of honeybees, it damage to entire colonies by feeding on hemolymph of larvae and pupae [1]. At high levels of *Varroa* infestation, there is a rapid decline in the number of adult bees, severe damage to the brood and death of the colony usually occur [2]. It is the major bottleneck of apiculture development in almost all the world, it impairs the production of honey bee products (honey, wax and other products) and crop production by causing colony collapse [3].

Several synthetic acaricides have been applied in order to fight *Varroa destructor* [4] but, due to the widespread misuse of chemical treatments, several cases of resistance and contamination of hive products have been reported [5, 6].

The orientation towards the natural product such as essential oils of some aromatic plants offers a valid

solution [7]. Several studies have reported the activity acaricide of natural plant extracts against *Varroa destructor*, *Acarapis woodi* [8-12].

These products are generally inexpensive and have fewer health hazards to both man and honeybees [13, 14].

The objective of this study is to highlight the acaricide activity of four essential oils based on herbs: Rosemary (*Rosmarinus officinalis*), the noble Laurel (*Laurus nobilis*), green (*Mentha viridis*) and Thyme (*Thymus pallescens*) on the bee parasite *Varroa destructor* Tellian without major inconvenience to the bee and hive products.

MATERIALS AND METHODS

Essential Oils: The four oils used in this study were purchased in liquid form; they were extracted at the two French laboratories: LARKOPHARMA and LADROME. We evaluated the laboratory dose of 2 ml for the three lots and a dose of 1 ml for the essential oil of thyme applied as

a control treatment. These doses have no negative effect and the bees and the hive products. Each essential oil tested was soaked in a rectangular sponge (1x2cm) in insert shape.

Procedure and Period Treatment: To ensure the absence of change in taste honey with essential oils for the bee colonies tested, it is best to do the treatments after the nectar flow, so little risk of honey flavoring.

Seventeen bee colonies of *Apis mellifera* heavily infested with *Varroa destructor* from the Bouira region in central Algeria, were divided into four lots, each batch of five hives has received two applications of 0.2. µl of essential oils of Rosemary, Laurel and Spearmint and two hives controlled by the essential oil of thyme at 0.1 µl.

The Dead mites and fell on the bottom of the grid floor, covered with an greased diapers were collected and counted twice or three day intervals before and during application of treatments.

Statistical Analysis: Our results on the effect of volatile oils on varroa were analyzed statistically using simple Analysis of variance by software (Stat- box) 6.

RESULTS

Estimated of the Colony Infestation Rate: The initial infestation rate ($D^{\circ} li0$) varroa (in %) recorded in bee colonies tested before the treatments was calculated by the ratio between C: the number of varroa estimated in a colony and P: The number of bees estimated in a colony multiplied by percent: $D^{\circ} li0 = C/P$: and have been illustrated in Fig. 1.

The good reduction of the infestation rate was recorded by the treated groups with the essential oils of Rosemary and Laurel and that is to go from 21.34% to 6.68% before after application therefore reduced 14.66% and 23.78% before application to 6.74% after treatment either a reduction of 17.04%, respectively. A minimal reduction of the infestations rates was recorded for the two oils of Thyme (3.61%) and Spearmint oil (2.49%). The average rates of infestation of the varroa calculated after treatments are reduced to (16.66%, 17.06%, 2.49%, 3.61%) in rosemary oil, Laurier, Spearmint and Thyme respectively. concerning the Thyme, our results are not in agreement with those of Eshabah *et al.* [15] which found 45% of reduction in infestations rates when spraying with this essential oil.

The ANOVA revealed that there was no significant difference in reducing the level of *Varroa* infestation between the colonies before and after the application of oils ($p = 0.169$).

Controlling of Varroa in the Colonies Bees: We observe a maximum of individuals varroa during the first application and a gradual reduction dice the second application of treatment which justifies the effect of thyme oil despite its low efficiency of 76.27% in comparison with other essential oils tested.

Our results do not coincide with those of Whittington *et al.* [16] and Dimetry *et al.* [17] which found that thyme oil spray reduced to 79% in varroa bee colonies (Fig. 2).

Essential oils of laurel and rosemary have proven effective against *Varroa destructor*, causing at the first application (58.91%, 41.64%) of mortality, these mortalities have increased slightly in the second application and the application of the control treatment to reach 84.29%, 74.38%, for the Spearmint oil and Thyme, the results are not significant since they do not exceed 20% mortality. The essential oil of thyme has a low insecticide effect on *Varroa destructor* applied to the low dose; she recorded only 12.90% of mortality.

The Effectiveness of Essential Oils: The averages efficacies of four essential oils were at similar levels, but thyme essential oil had a lower efficacy compared to the others (Fig. 3).

Our data revealed that all essential oils were effective against varroa. The essential oils of rosemary and laurel showed good regularity of their effectiveness, greater than 80% for total colonies tested against 80.62% and 76.27% for the essential oil of spearmint and thyme essential oil respectively.

The Rates Mortality of Varroa: At the end of the experiment, after estimating the population of bees and the varroa, initial infestation rates, the mortality varroa rates after application of four essential oils are illustrated in Fig. 4.

The results show that the highest mortality rate of individuals *Varroa destructor* under the effect of essential oils is recorded by Laurier (84.24%) followed by Rosemary (74.23%), the spearmint (19, 22%), the lowest rate was marked by Thyme (5.57%), this fluctuation may be mortality varies depending on the time of application and the active material.

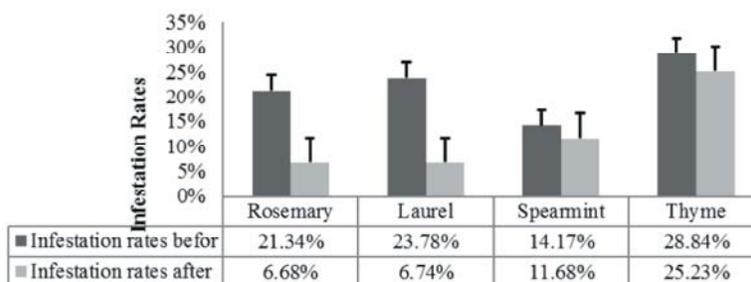


Fig. 1: The Infestation Rate of essential oils tested

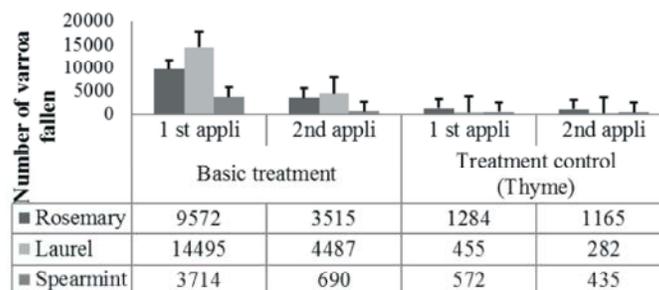


Fig. 2: Varroa fallen when applying essential oils

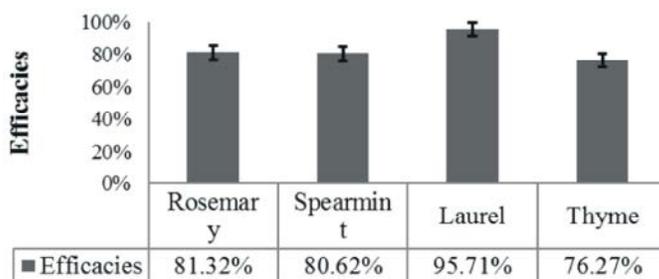


Fig. 3: Efficiency rate of four essential oils tested

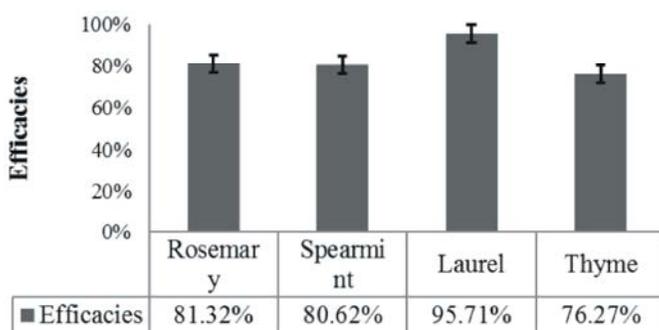


Fig. 4: The Varroa mortality rates

DISCUSSION

The essential oils from four plants tested, have shown an acaricidal activity against varroosis and also against other organisms such as insects, mites, bacteria, fungi and nematodes [10, 18, 19].

According to the results, we can estimate that the essential oils of the plants tested are effective against varroa in particular essential oil laurel and rosemary, spearmint oil has reduced to the average infestation rate of varroa in colonies of bees tested at a low rate followed by Thyme oil used as control treatment.

The greatest number of dead mites was recorded after the first application of treatments and gradually decreases after the second application and the introduction of control treatment in particular for spearmint oil. Whereas, for the groups treated with Thyme oil the number of varroa mites fallen has significantly increased.

Laurel oil recorded the largest number of varroa mites fallen followed by oil Rosemary, represented by 3794.4, 2617.4 varroa, respectively. Our results are not in agreement with those of Kutukoğlu *et al.* [20] which recorded a lower efficacy of laurel (76.7%), compared to other oils used. For the spearmint oil our results are in agreement with those of Rezk and Gadelhak [21] who reported that the total numbers of mite fallen after a month of treatment with essential oil of *Mentha sp* were 15.67 and 16.33 for the two apiaries treated, respectively.

Berkani [22] Recorded a very good efficiency of 97.34% and 73.02% for essential oils of laurel and rosemary respectively. It is apparent clearly that that these two oils can be considered effective against varroa, our results are similar to those of Fathy and Fouly [23] which recorded of 97% mortality rate with rosemary oil and with those of Eguaras *et al.* [24] and Allam *et al.* [25] especially for the oil of rosemary and thyme oil that eliminate 91.7% of varroa. The thyme, meanwhile, recorded a lower efficacy compared with other essential oils (76.27%) which oppose the results of Abd El-Wahab *et al.* [26] and Ariana *et al.* [27] this could be due to different species. Colin *et al.* [28] Have obtained superior efficacy in 90% of the essential oil of *Thymus vulgaris* against varroa.

In general, the averages of varroa mortality are 95.75%, 83.32%, 80.62%, 76.27% observed in colonies treated with essential oils to laurel, rosemary, spearmint and thyme respectively. ANOVA shows that there are significant differences between treatments with essential oils and application of control treatment based on thyme essential oil.

In revenge, our results are not in concordance with the results of Da Costa Vieira *et al.* [29] who found a rate of varroa mortality of 52.50% after applying the essential oil of rosemary. At contrast of essential oil of spearmint, which is often characterized by a more variable effectiveness, sometimes unsatisfactory and sometimes close to 100%, according to Amrine *et al.* [30] which concluded that the essential oil of spearmint is effective and has eliminated 50% of the mites. In 2002 [27] found that the essential oil of spearmint, eliminated 97 percent of

mites, but was ineffective at low doses. Furthermore, Hamaad *et al.* [31] who found that the spray of thyme oil causes 65.9% of varroa mortality and has great potential for the control of this mite in Egyptian conditions.

CONCLUSION

In summary, the percentage of efficiency and control of varroa mite presented in this work seems to be satisfactory for oils laurel and rosemary and average for both of oils thyme and spearmint compared to those obtained from synthetic acaricides commonly used to control varroa, but if they are used in high doses they may caused high mortalities of adult bees.

Therefore, the results presented in this study suggest that the essential oils of laurel and rosemary could play an important role, the use of these plants and their derivatives may reduce mite populations in the colonies *A. mellifera*, other studies are needed to identify other factors that may be involved in a successful control of varroas.

Moreover, although the development of acaricide made from natural substances do not pretend to avoid the use of conventional products to control the mite, but at least to reduce the use of chemicals and could provide a useful tool in an IPM program for the control of varroa in bee colonies if the mode, dosage and duration of application are well respected. However, they can be used as a supplementary treatment with other organic compounds because these materials proved to be harmless to the bee and quite safe to the environment when they are used properly.

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