

Use of Essential Oils in Bees

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Abstract

Over time, studies have shown that the natural methods used in the control and spread of bee diseases are effective, which develops a continuous interest in discovering new alternatives in this regard. Essential oils have been tested in bee colonies for the purpose of preventing or combating pathogens. The inhibitory effect of the essential oils is given by the content in citral and geraniol, as well as the benzene content in the composition of the essential oil of cinnamon. Recent findings show that the use of essential oils can improve the health of bee families. Essential oils include a series of antimicrobial, antibacterial, antifungal, antiparasitic compounds from plants that play a role in reducing bacterial resistance. Natural antibiotics based on essential oils can be alternatives to chemically synthesized antibiotics, as they do not contaminate the bee products.

Keywords: bees, essential oils, supplementary feeding.

1. Introduction

Studies conducted in recent years have shown that the introduction of essential oils in the supplementary feeding of bees has proved to be an effective alternative method because it had as effect in spring the stimulation of the queen egg laying and the nectar harvest, and in the fall the maintenance in proper conditions of the bee families [1]. According to the research conducted by [2], by administering essential oils, in the supplementary feeding with sugar syrup of the bee families, changes in the size of the bee population take place, the queen becomes more prolific, and this is demonstrated by significant increases in the amount of brood, compared to the control groups. These natural products used to protect bee families from pathogens have been studied by [3], which used several essential oils in different concentrations. The research results were favourable for the doses used. According to the studies undertaken by [4], in beekeeping, essential oils from plants can be an alternative method of

controlling bee diseases. With the use of these natural products, the risk of drug residues in bee products is thus reduced.

2. Effects of using essential oils on bees

Oregano essential oil contains carvacrol between 14.5% and 90.3% [9]. This has been shown to have an influence on reducing the number of the *Nosema* spores, but also on the pathogenic bacteria and fungi [15-17]. [18], consider that treating bee families in the spring with oregano oil solutions in 33% doses causes a mortality of 91% of the *Varroa destructor* mites, while a concentration of 20% leads to a 82% mortality. Studies by [19] have shown that the toxicity of essential oils including oregano oil is significant on the *Varroa destructor* mite. Experiments have shown that oregano oil in combination with clove, menthol and thymol oil in doses of 0.75 mg causes *Varroa destructor* mite mortality in percentages of 87, 96, even 100%. In the experiments carried out by [20], after applying several treatments having as a basic component the

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essential oregano oil with addition of clove essential oil in buffers containing about 1g mixture, the results showed a reduction by 57,8% of the *Varroa destructor* mite. Following the treatment

Table 1. Properties of essential oils (processing after various authors)

Essential oil name	Properties	Authors
Basil	Antimicrobial, antibacterial, antiviral, antifungal	[5]
Lavender	Therapeutic, sedative, anxiolytic, analgesic, mood stabilizers, anticonvulsant, curative, neuroprotective	[6]
Rosemary	Carminative, aromatic, antidepressant, stimulant, antispasmodic, astringent, antimicrobial	[7]
Cloves	Antioxidants, antimicrobials, anti-inflammatory, antifungals, analgesics	[8]
Oregano	Antiviral, antimicrobial, antidiabetic, anti-inflammatory, antioxidant	[9]
Cinnamon	Anti-inflammatory, antidiabetic, antioxidant, antimicrobial	[10]
Caraway	Antibacterial, antifungal, antispasmodic, antioxidant, antiseptic, antitussive, antiviral	[11]
Incense	Antiseptic, therapeutic, carminative, astringent, sedative, digestive, diuretic, decongestant, expectorant, antiproliferative for tumor cells	[12]
Juniper	Antifungal, antimicrobial, anti-inflammatory, anti-proliferative, anti-carcinogenic	[13]
Peppermint	Powerful antivirals, antimicrobials, significant antioxidants, anesthetics, analgesics, antitumor drugs	[14]

The research carried out by [22], by applying aerosols with **thyme and sage oil**, has shown their effectiveness against the *Varroa destructor* mite. The experiment carried out led to a mite mortality of 95%, compared to 99% in the case of amitraz use. Similar results were obtained by [23], who studied the effects of thyme essential oil in concentrations of 25.50 and 100%. [24], believe that terpenes and acetates are present in thyme nectar and pollen, the latter having a higher content. Bees tested with thyme essential oil responded more strongly to geraniol and trans-sabinatate hydrate compared to carvacrol and thymol. Following the experiments carried out by [25], by spraying thyme extract on the bees, at hive temperature of 30° and atmospheric temperature of 33°C, the number of mites has been reduced, the method having a minimum risk of death on the bees. [26,27], they aimed to use the essential oils in

carried out by [21], using oregano essential oil in 20 ml electric vaporizers, it was found that approximately 0.85 g oregano / day essential oil vapour in the hive provides 60% of mite control.

the control of the *Varroa destructor* mite, thus demonstrating through the studies carried out the effectiveness of the thyme oil in the control of this. According to the researches conducted by [28], on the antibacterial potential of **lavender essential oil**, it has been shown that it inhibits the growth of infected areas between 8 and 30 mm in size, with amounts of lavender oil between 1 and 20 µL. [29], experimented the tolerance of lavender essential oil in bees by introducing a filter paper containing 10% lavender oil dissolved in acetone, until evaporation. The results obtained after 7 hours denote the change in the behaviour of the bees only at the highest oil concentrations. Recent studies for the control of the *Varroa destructor* mite have been undertaken by [30], who tested lavender essential oil introduced to a bee family. The experiments were conducted in 2 autumn seasons and one spring season. The results of their studies showed a

percentage of effectiveness in controlling *Varroa destructor* in the first autumn season of 76.4%, in the spring season 83.8%, and the percentage registered in the following autumn was 76.6%. The authors concluded that the period of treatment did not have a negative influence on the bees because there were no abnormal losses between the tested periods.

The experiments performed by [31], showed that **basil essential oil** has a moderate efficacy in combating *Varroa* saplings at concentrations between 700 and 1000 µg /ml. [32], studied the effectiveness of basil essential oil in blends with other oils for treating, inhibiting or preventing American foulbrood. The results obtained from the experiments were not satisfactory for the basil oil mixed with other oils, which was not effective at any of the doses used. Further research by [33], showed that basil essential oil had moderate results at concentrations of 800 µL / L against *Varroa* sapling. The essential oil of basil has a low risk of toxicity, is used for the control of the mite *Varroa destructor*, but it is recommended that the treatments carried out with it be carried out outside the periods of production or storage of honey in the hive to avoid its contamination [34]. The experimental studies carried out by them were effective by using the basil essential oil impregnated in the dose of 1 ml / band, for the control of the *Varroa destructor* mite. In recent studies by [35], several essential oils were tested against *Tropilaelaps clareae*, in doses of 25, 50 and 100%. This experiment followed the percentage of mite mortality, honey production and the percentage of bee infestation with mites. The results of the studies showed a favorable effect against the mites when the oil dose was 100%. Basil essential oil generated a mite mortality of between 64.37% and 84.33%. Regarding honey production, after applying the treatment with basil essential oil, it registered an increase, respectively 7.7 kg compared to the control lot where the production was of 3.8 kg of honey.

In the research conducted by [23], the effect of **peppermint essential oil** in concentrations of 25, 50, respectively 100% and formic acid 65% on the mite *Varroa destructor* has been tracked. By using the concentration of 25% peppermint oil and formic acid applied to the bee brood, there was a reduction of infestation with *Varroa destructor* of 41.49% compared to the control group. At the concentration of 50% peppermint essential oil and

formic acid, a reduction of infestation by 58.69% was obtained, and at the concentration of 100% the reduction was 60.91%. When applying the same concentrations to bees, a reduction of infestation was obtained by 49.94% at 25% concentration, 51.35% at 50% concentration and 70.47% at 100% concentration. Studies by the same authors have highlighted the positive effect of increased concentration of peppermint oil in addition to formic acid on honey production.

In the experimental studies conducted by [23], **rosemary essential oil** with addition of formic acid was used in percentages of 25, 50 and 100%. Applying 25% rosemary oil and formic acid on bee brood reduced the infestation rate with *Varroa destructor* with 53.37%, followed by the 50% concentration with a 65.82% reduction of the infestation with mites, and at the concentration of 100%, the reduction was 70.81%. The same concentrations were applied to bees where, for 25%, there was a reduction of the *Varroa destructor* infestation of 40.92%, at a concentration of 50% the reduction of the infestation with mites was 45.66%, and at a concentration of 100%, the infestation with mites was reduced by 60.82%. The experiments highlighted that a high concentration of rosemary oil with addition of formic acid results in a high percentage of mite mortality, the effects being positive also on honey production.

According to the researchers [36], undertaken with **pine and juniper essential oils** under laboratory conditions, determining bee tolerance and residual toxicity, it was observed that using juniper and pine essential oil dissolved with acetone in doses of 10-40 µl / Petri dish and introducing bees into them, toxic effects were recorded at the dose of 24 µl / Petri dish with juniper oil.

[37], conducted an experiment according to which 10 bees carrying one mite each were introduced under a wax-based glass containing 0.1, 1 and 10% cinnamon essential oil. The conclusions of the study did not reveal significant results compared to the control group, regarding mite mortality. [2], showed in the studies carried out the absorption of cinnamon oil components in bee larvae. Recent studies have also been conducted to control the American foulbrood, undertaken by [38], in which the bees were treated with cinnamon essential oil in two doses of 1000 µg / ml per hive. The minimum inhibition activity of the cinnamon essential oil was of 50 µg / ml. The results recorded after 24 and 31

days show a decrease of the diseased larvae with values between 7.89% and 52.42% compared to the control group. Obtaining these results thus demonstrates the use with minimal toxicological risks of cinnamon oil and its potential in controlling the disease.

The control of *Varroa destructor* mites using **clove oil** was evaluated through the researches conducted by [39]. The experiments consisted of the introduction of mites in a 60 mm diameter Petri dish. The essential oil of cloves was added to the lid of the vessel. The dose recommended by [40], was 1 µl of clove oil, this being the quantity that does not cause bee toxicity. The results showed a mortality of 20% of the mites, which indicates control potential and their inhibition by using the essential oil of cloves. [41], experimented during the period June-October, for 2 years, the use of clove oil in combination with other oils (peppermint, thymol, camphor) for combating *Varroa destructor* mites. They introduced 2 ml of clove oil in combination with other oils and 10% white paraffin into beehives. In the first year, the essential oil of cloves had the effect of mortality of mites of 62.3%, in the following year registering the percentage of 74.8% mortality. Similar studies were also carried out by [42], which showed that by using the clove oil, in bees, for a 3-week period to combat the *Varroa destructor* mite, the mite mortality values are between 66.54% and 77.54%, and the growth of the brood reaches 21,7%.

Recent studies by [5], show that the use of essential oils is an encouraging method, proving their properties and capabilities to prevent the growth of different types of bacterial strains. Researchers such as [43,44], conducted various studies which showed that infections with different diseases occur after the spores infest the digestive tract and larvae. The pathogen can also be transmitted to other bee families through beekeeping equipment. The studies by [45,46], showed that bee infections occur when the young is disturbed by biological, physical and chemical factors and in areas with high humidity.

3. Conclusions

Essential oils can be a valuable and effective treatment in preventing or controlling bee diseases. Studies have shown that the beneficial effects of essential oils administered in supplemental feeding of bee families should be increased using a variety

of methods. In exchange for conventional chemical drugs, alternatives with natural products should be favored because they do not have harmful effects on individuals in the bee family. The results show that these essential oils not only have the ability to prevent infestation with various diseases, but they can also represent possible alternative methods to the use of antibiotics to control diseases. It is necessary to continue the studies by using the essential oils (given the few researches) in the additional feeding of the bee families and to track their effect in the prophylaxis of the diseases and in the improvement of the productive performances.

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