Scientific Papers. Series D. Animal Science. Vol. LXIV, No. 2, 2021
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

INFLUENCE OF ESSENTIAL OILS ON BIOPRODUCTIVE INDICES AND HEALTH OF BEE COLONIES

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Abstract

The productivity of bee colonies is strongly influenced by genetics and age of the queen, by health status of bee colonies, the honey potential of the area where they are maintained, but also by the meteorological factors that condition the capitalization of the honey source. Scientific research in beekeeping, carried out in recent years, has been aimed at improving the genetics of existing biological material in order to improve productive performance and disease resistance, but also to use technological measures of maintenance to achieve these objectives. The use of essential oils as a technological measure in the stimulation of bee colonies has shown favorable effects on the prolificacy of the queen (essential oils of thyme, basil, oregano, mint, rosemary, juniper), improvement of the health of bees (essential oils of juniper, thyme, basil, oregano, cinnamon) correlated with the increase in honey production.

Key words: *bees, bioproductive indices, disease prophylaxis, essential oils.*

INTRODUCTION

The intensification of agriculture, pollution and climate change have led to the increase of factors with a negative influence on bee families, which favor the emergence of their diseases. The use of drugs in the treatment of diseases in bees should be limited due to the negative effects on the longevity of bees, the vitality of the brood, the emergence of resistance to them (Boudegga et al., 2010), but also to the negative effect on the quality of bee products (Isman, 2000). It is necessary to find alternative solutions to the use of antibiotics (El Shafai, 2012; Pătruică & Moț, 2012).

Essential oils are found in almost all plants (Imdorf et al., 1999), the components being very different, varying from one species to another, but the composition can be very different even in the case of the same essential oil, due to genetic and environmental factors (Flamini, 2003).

The researches conducted by Bakkali et al. (2008) shown that essential oils and the main compounds in their composition represent a broad spectrum of bioactivity. Studies on the use of essential oils on health of bees have shown the important role in reducing mites (Damiani et al., 2009). Also, Bailac et al. (2006) showed that essential oils have a high content in benzene compounds, and these determine their antimicrobial activity. Porinni et al. (2017) highlighted the effects of the use of essential oils on the productivity and survival of bee families. In the studies performed by Arbia & Babbay (2011), we may note that essential oils can be an important method in preventing the development and spread of pathogens.

The aim of this paper is to investigate the influence of some essential oils administered in the supplementary feeding of bee families, in the spring, on the stimulation of the egg laying of queen, the improvement of health and productivity, materialized in the production of honey.

MATERIALS AND METHODS

The researches were undertaken in Murani locality, Timiș County, România, on 90 bee colonies of medium power and queen of the same age, and each experimental group was represented by 10 bee colonies. Eight experimental batches were fed with sugar syrup and essential oil, and the control group was fed only

with sugar syrup. The 1:1 sugar syrup was administered over 3 weeks in an amount of 1 l/week/family, the dose of essential oil being 2 drops/l syrup. The essential oils of thyme, basil, rosemary, juniper, oregano, mint, cloves, cinnamon were used.

Before testing on bees, the essential oils were analyzed in terms of chemical composition, in the chemistry laboratory of the Banat's University of Agricultural Sciences and Veterinary Medicine "King Mihai I of Romania" from Timisoara, the Interdisciplinary Research Platform "Ecological agriculture and food safety". For their chemical examination we used the gas chromatograph-mass spectrometer, model GCMS-QP2010PLUS, equipped with 4000 GC/MS/MS system and flame ionization detector (FID). The chromatogram interpretation was performed using the NIST database identifying the compound for each drop of essential oil.

From each family of bees we collected, at the beginning of the experiment and at 21 days, 10 working bees in order to perform the microbiological examination of the small intestine. The microbiological examination was performed according to the method described by Pătruică & Moț (2012).

In order to evaluate the influence of essential oils on the degree of development of bee families, at the beginning of the experiment, at 10 days and 21 days, the area occupied with brood was assessed using the Netz frame.

The evaluation of the rapeseed honey production was made by appreciating the surface occupied with honey on honeycombs with the help of the Netz frame and its transformation into kilograms.

The data obtained from the experiments were processed using the program IBM SPSS Statistics Version 21. For statistical analysis we applied Paired-Samples T-Test with 95% Confidence Interval of the Difference.

RESULTS AND DISCUSSIONS

Following the chemical analyzes performed on the 8 essential oils, it was found that: thyme essential oil has in its composition Borneol 17.15%, Alfa terpineol 6.05%, Camphene 14.41%, and the rosemary essential oil 52.82% Eucalyptol, Alfa pinene 17.56%, Camphor 10.01%. Basil essential oil contains Estragol 55.73%, Linalool 38.64%. According to the results, juniper essential oil has as main components Alfa-pinene 49.75%, Beta-pinene 16.70%, Beta-myrcene 9.27%, and the oregano essential oil contains Karvacrol 33.42%, O-cymene 22.98%, Gamma terpinene 17.44%. The peppermint oil has within its content Menthone 30.73%, Neomenthol 17.37%, Limonene 9.52%. Clove essential oil contains active compounds such as Eugenol 85.17%, Carryophillene 8.15%, Eugenol acetate 5.44%, and cinnamon essential oil has in its composition Cinnamaldehyde (E) 69.28%, Cinnamaldehyde-o-methoxy 14.30% and Cinnamil acetate 6.55% (Figure 1).

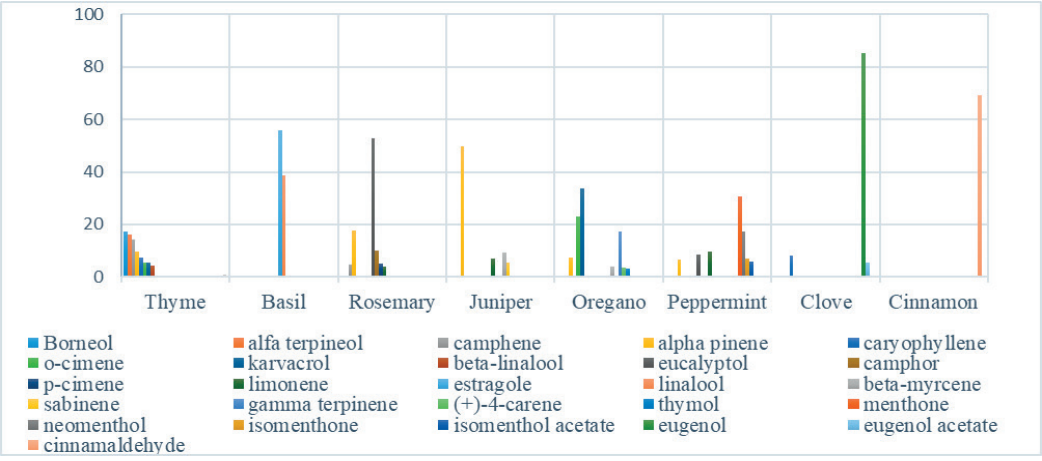

Figure 1. Chemical composition of the analyzed essential oils

Similar studies conducted by Porrini et al. (2017) highlighted in the composition of oregano essential oil 27.7% Karvacrol, in rosemary essential oil 15.2% Camphor, and in the cinnamon essential oil, identified as the main active compound Cinnamaldehyde (79.3%). Feeding bee colonies in the spring with sugar syrup in which we incorporated an essential oil (thyme, basil, rosemary, oregano, juniper, mint, cloves, cinnamon) had the effect of reducing the total number of germs in the intestine of worker bees, stimulating the queen prolificity, correlated with higher honey production (Table 1).

Table 1. The results of the use of essential oils in the supplementary feeding of bee colonies

Experimental variants	Essential oil used	Tracked indicators						
		Total no. of germs		Bee family development			Honey production	
		At the beginning of experiment	At 21 days	At the beginning of experiment (cells)	At 10 days (cells)	At 21 days (cells)	At 21 days (kg)	After rapeseed picking (kg)
Control group	---	664.40	719.00	2110	4290	7200	1.590	25.096
EG_1	Thyme	644.00	472.80*	1900	4800	10800***	2.145	31.753***
EG_2	Basil	598.80	479.20*	2050	6000**	10800***	2.590	31.685***
EG_3	Rosemary	872.40	574.20	1770	5030	8530*	1.683	30.013
EG_4	Oregano	734.60	474.00*	1780	5220	10150**	2.720	32.161***
EG_5	Juniper	881.80	618.60**	1970	5350	9150*	1.596	27.196
EG_6	Mint	861.60	658.40	1920	5160	9350**	2.003	32.905***
EG_7	Clove	831.00	624.20	1890	4730	8410	1.746	27.156
EG_8	Cinnamon	654.80	491.40*	2080	4830	8080	1.893	26.987

$p<0.001$***
$p<0.01$**
$p<0.05$*

From a microbiological point of view, after 3 weeks of administration of sugar syrup with essential oils, a significant reduction in the total number of germs was observed, namely: in the groups fed with thyme essential oil, the number of germs in the intestine decreased by 34.25% compared to the control group, oregano essential oil had an effectiveness of 34.08%, basil reduced the number of germs by 33.36%, cinnamon oil caused a decrease in germs by 31.66% compared to the group witness. Similar results were obtained with the use of oregano essential oil, which reduced the total number of germs by 24.26% and thyme, which reduced the total number of germs in the small intestine by 20.68% (Pătruică et al., 2018). The administration of essential oils of thyme, basil, rosemary, oregano, juniper, mint, cloves, cinnamon in the supplementary feeding of bee colonies in autumn, reduced the total number of germs in the intestine of bees by 32.54% in the case of essential oil of oregano, 29.95% in the case of peppermint essential oil, and thyme essential oil reduced the total number of germs in the intestine by 25.43% (Lazăr et al., 2021). The administration of rosemary essential oil had the effect of reducing by 20.14% the total number of germs compared to the control group, juniper oil reduced the total number of germs by 13.97%, followed by clove essential oil by 13.19 %. Peppermint essential oil reduced intestinal germs by 8.43% compared to the control group (Figure 2).

The reduction in the total number of germs in the intestine of worker bees is correlated with a better health of bee colonies.

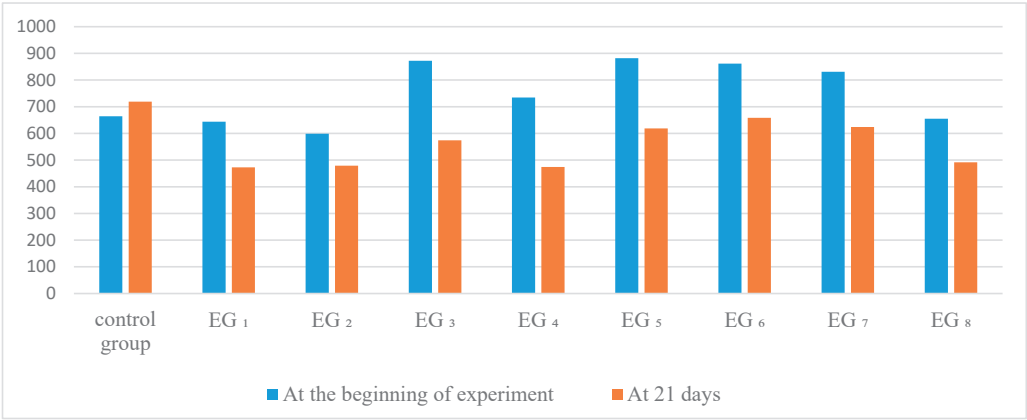

Figure 2. Evolution of the total number of germs during the experiment

Regarding the influence of essential oils on the queen's egg, there was a significant increase in the number of brood cells after feeding them with sugar syrup and essential oils (Figure 3), so we can say that the use of essential oils of thyme, basil, oregano, mint, rosemary and juniper showed a stimulating effect on queen prolificacy.

After 10 days of administration of sugar syrup with addition of essential oils, there was an increase in the number of cells with brood by 11.88-39.86%, the best results being obtained when we administrated basil essential oil ($p<0.001$).

At the end of the experiment, the administration of thyme and basil essential oil resulted in an increase in the area occupied by brood by 50% compared to the control group.

Oregano essential oil increased the number of brood cells by 40.97%, followed by peppermint essential oil by 29.86%. Juniper essential oil increased the amount of brood by 26.08%, and in the case of rosemary essential oil there was an increase in the number of brood cells of 18.47% compared to the control group. In the case of the other essential oils used, there was an increase in the number of brood cells by 12.22% (cinnamon) and 16.80% (cloves) compared to the control group, at statistically insignificant differences.

Similar results were recorded following the research undertaken by Pătruică et al. (2018), succesive to the use of oregano and basil essential oils.

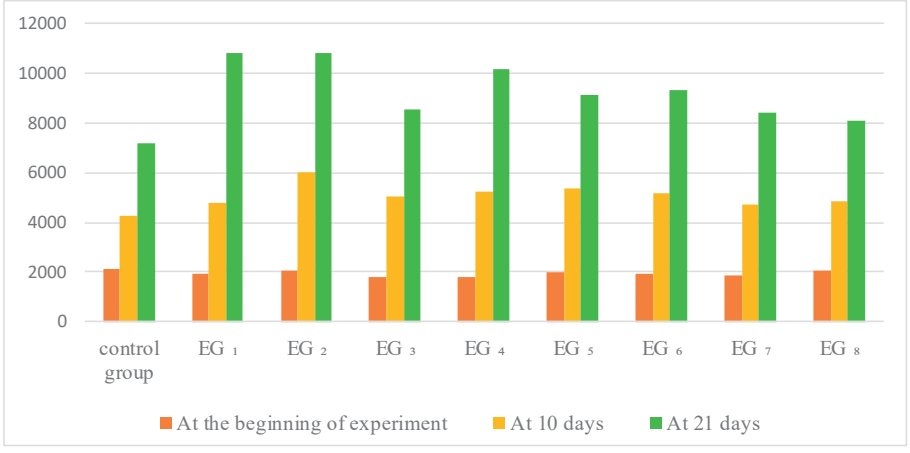

Figure 3. The evolution of the number of brood cells following the administration of essential oils

After the control carried out 10 days after the administration of the supplementary feeding, it was found that the essential oil of oregano caused an increase in the number of frames occupied by bees by 50%, compared to the control group, followed by the essential oils of thyme, basil and mint, which increased the amount of bees by 33.33%. In the case of the other oils used (rosemary, juniper, cloves, cinnamon) no statistically significant results were shown.

At the control performed at the end of the experiment, the amount of bee increased by 66.66% in the case of batches where thyme, basil and oregano essential oil was administe red. Peppermint essential oil increased the amount of bees by 50%, and the oils of rosemary, juniper, cloves and cinnamon by 33.33%, compared to the control group (Figure 4).

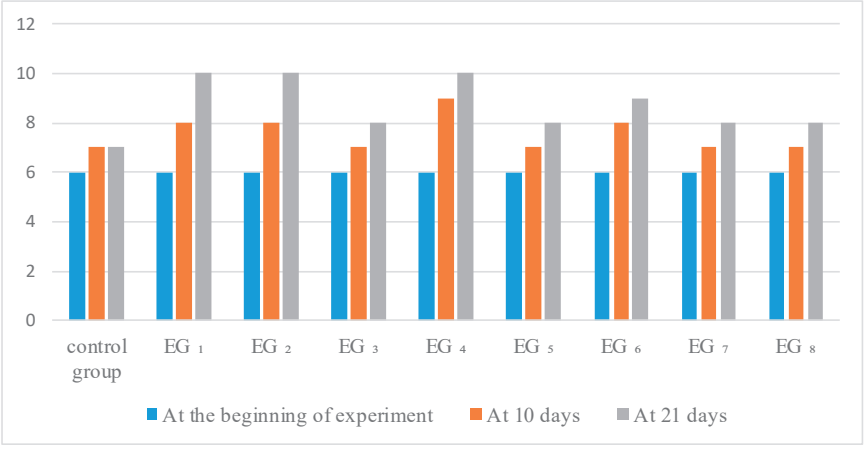

Figure 4. The evolution of the development of bee families following the administration of essential oils

Regarding honey production, after the end of the rapeseed harvest, a significant increase was observed in the groups which were given essential oil of thyme, basil, oregano and mint (Figure 5).

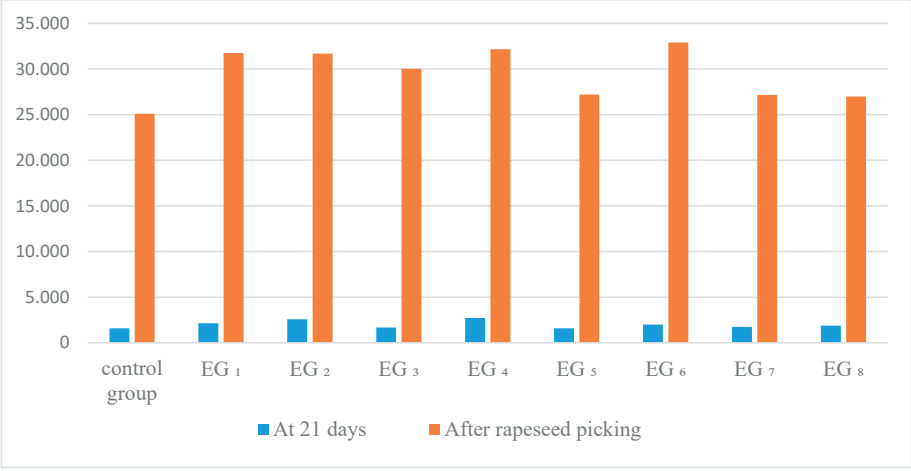

Figure 5. Honey production obtained from rapeseed harvest

According to the results obtained, all essential oils had a positive influence on honey production by increasing it, compared to the control group. Peppermint essential oil increased honey production by 35.41%, oregano essential oil increased honey production by 27.76%, and basil essential oil obtained an increase in honey production by 26.06%, compared with the control group. In a percentage of 25.82%, there was an increase in the production of honey in the case of the thyme essential oil. Honey production, in the case of experimental groups in which rosemary essential oil was administered, increased by 17.66%, followed by juniper essential oil which caused an increase in honey production by 7.77%. In the batches in which cinnamon essential oil was administered, an increase in honey production was obtained by 6.03%, and clove oil determined a percentage increase of 5.54%. The increase in honey production is correlated with the development of bee colonies that participated in rapeseed harvesting with a significantly higher number of working bees.

CONCLUSIONS

1. Following the chemical analyzes performed, it was observed that the essential oil of thyme is predominated by Borneol 17.15%, that of basil by Estragole 55.73%, the essential oil of rosemary has a content of 52.82% Eucalyptol, the essential oil of juniper contains 49.75% Alpha pinene, oregano essential oil contains 33.42% Karvacrol, mint essential oil contains 30.73% Menthone, clove essential oil has 85.17% Eugenol, and cinnamon oil contains 69.28 Cinnamaldehyde.

2. The administration of sugar syrup with addition of essential oil had the effect of significantly reducing the number of germs in the intestine, correlated with a better health of bee colonies. The experimental variants with the best results were the batches fed with sugar syrup with addition of juniper essential oil ($p<0.001$), thyme ($p<0.05$), basil ($p<0.05$), oregano ($p<0.05$) and cinnamon ($p<0.05$).

3. Basil essential oil administered in the supplementary feeding of bee colonies determined after 10 days a statistically significant increase ($p <0.05$) in the number of cells occupied with brood. At the end of the experiment, statistically significant differences compared to the control group, regarding the number of cells with capped and non-capped brood were recorded in the groups fed with sugar syrup and thyme essential oil ($p<0.001$), basil ($p<0.001$), oregano ($p<0.01$), mint ($p<0.01$), rosemary ($p<0.05$) and juniper ($p<0.05$).

4. All the essential oils used had positive results, statistically significant in terms of rapeseed honey production. The best results were recorded when using thyme essential oil ($p<0.001$), basil ($p<0.001$), oregano ($p<0.001$), mint ($p<0.001$).

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