



## Nutrition and Physiology

**Accelerating the rate of development of the bee colonies during the spring feeding with the addition of Mikro Veda Care Apis®**

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(Manuscript received 20 June 2022; accepted for publication 11 November 2022)

**Abstract.** *The development of the honeybee colony depends on the availability of pollen and nectar in nature. The nutritional needs of worker bees are supplied from nectar carbohydrates, proteins and other nutrients in the bee pollen. Proper management of the honey bees is very important for successful beekeeping. Some seasonal changes bring about variations in the availability of pollen and nectar for the bees. In this respect, the aim of the study was to determine the influence of Mikro Veda Care Apis® preparation on the development of bee colonies during the spring feeding. The experiment was conducted during the period 11 Apr 2019 – 10 June 2019 at the Experimental Apiary of the Research Centre of Stockbreeding and Agriculture – Smolyan, Bulgaria. The control group was fed with sugar solution (ratio sugar to water-1:1 ) without additives and the experimental group was fed with the product Mikro Veda Care Apis® at a dose of 10 ml/L sugar solution (ratio sugar to water-1:1). The bee colonies that received Mikro Veda Care Apis® have significant differences for the parameters strength of the bee colonies and sealed worker bee brood on 17 May 2019 and 10 June 2019 compared to the control group. We expect our study to be a starting point for a deeper understanding of productivity of the bee colonies during the spring feeding with the addition of Mikro Veda Care Apis®.*

**Keywords:** honey bees; plant extract; feeding; bee colony development

**Introduction**

Proper management of honey bees affects the development and productivity of the bee colonies. The development of the bee colonies and their productivity are influenced by a complex of factors such as meteorological conditions (temperature, humidity, cloudy and rainy periods), which cannot be controlled. One of the factors that can improve the productivity of bee colonies is stimulating feeding during the spring period of their development (Sharma et al., 2004; Skubida et al., 2008). In general, apiary management in most cases includes an initial feeding with carbohydrates and proteins. In the spring, sucrose syrup or high corn syrup can be used to replicate nectar flow and enhance brood rearing (Underwood et al., 2019; El-Seedi et al., 2022). The natural food of the honey bee consists of pollen, nectar or honey and water. In early spring and when pollen and nectar are not available in nature, supplemental feeding

can help the bee colony to survive (Bodla et al., 2009).

The nutritional stress has a long-term negative effect on the bee colonies and sometimes they are not well developed in the spring (Shumkova and Balkanska, 2021). In this respect, adequate nutrition is important for the growth and development of the bee colonies (Brodschneider and Crailsheim, 2010). In the early spring season the bee colonies that received a stimulating sugar diet and a pollen substitute supplement showed a good start to brood rearing. This led to densely populated bee colonies during the main pasture.

In order to increase the strength of bee colonies, stimulating feeding is usually applied. Most often it consists of sugar syrup, honey and sugar candies and pollen or their substitutes (Frizzera et al., 2020; Al-Ghamdi et al., 2021). There are a lot of studies on the additional nutrition of bee colonies with different formulas consisting of protein and vitamin mixtures. Application of the dietary amino acid and vitamin complex called "BEEWELL AminoPlus" decreases

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*Nosema ceranae* spore and protects honey bees from immune suppression by upregulating the expression of genes for immune-related peptides such as abaecin, apidaecin, hymenoptaecin, defensin and vitellogenin (Glavinic et al., 2017; 2021).

Various herbal infusions and extracts are used in the supplementary feeding of bee colonies, especially at different stages of their biological development. Mărghitaş et al. (2010) determined in the laboratory and in real conditions the effect of different plant infusions and extracts on honeybee colonies productivity. The supplements were nettle (*Urtica dioica*), Protofil® (purchased from the specialized stores for beekeepers, using 17 ml of extract in one kg of sugar syrup), onion (*Allium cepa*), garlic (*Allium sativum*), thyme (*Satureja hortensis*), Echinacea (*Echinacea sp.*). According to the results obtained, sealed worker bee brood increased compared to the control group after feeding with nettle infusion (*Urtica dioica*) followed by Protofil®, *Allium sativum*, *Allium cepa*, *Echinacea sp.* and *Satureja hortensis*. In a recent study by Al-Ghamdi et al. (2021), the effect of sugar supplemented food for bees with plant extracts from mint, cinnamon and chamomile on some parameters of bee colonies were studied to find out the best plant extract. Cinnamon extract reduces *Varroa* infestation rates and increases wax comb building. Chamomile extract enhances the development of the bee colonies. According to their effects on the development of bee colonies, the studied extracts can be arranged as follows: chamomile, cinnamon and finally mint. These plant extracts have a positive effect on bee survival and morphology.

A number of commercial supplements with plant extracts (Hive Alive™, Api-Bioxal® and ApiHerb®, Protofil®, Nozemat Herb® and Nozemat Herb Plus®) have been tested for anti-*Nosema ceranae* activity (Charistos et al., 2015; Cilia et al., 2020; Cristina et al., 2020; Shumkova et al., 2021). ApiHerb® is a supplement for bees which contains dextrose, garlic, cinnamon, peppermint oil, flavorings, vitamin B1, vitamin B2, Vitamin B6. It has been found to significantly reduce the spore load of *Nosema ceranae* (Charistos et al., 2015). ApiHerb® increases the egg laying activity of the bee queen (Tsvetanov, 2020). Porrini et al. (2017) studied the effect of the application of two essential oils of oregano and rosemary on the survival of honey bees. Oregano essential oil (carvacrol, 27.6%) does not cause toxicity. However, the purified carvacrol, showed toxic effects at the highest dose tested (6666 mg/kg) when administered to non-infected individuals. Rosemary oil contains mainly  $\beta$ -myrcene (25%) and 1,8-cineol (9.1%). These two main components separately did not cause any effect on honey bee survival.

Nowadays, the study of herbal extracts is aimed at reducing the impact of pathogens and boosting the immune system of honey bees. Natural compounds

have been tested in laboratory conditions and among these are thymol showing a *Nosema*-inhibiting effect and thymol and resveratrol showing a positive impact in increasing bee longevity (Costa et al., 2010). Feeds containing *Brassica nigra* and *Eruca sativa* with different amounts of glucosinolates (GSLs), reduced the *Nosema ceranae* infection (Nanetti et al., 2021). Formato et al. (2022) summarizes the main strategies for the prevention and control of nosemosis. Bravo et al. (2017) found the essential oils of *Cryptocarya alba* to be effective in controlling *Nosema ceranae* *in vitro*. *Eleutherococcus senticosus* extract contains eleutherosides that have an impact on the honey bee immune system (Ptaszyńska and Żaluzki, 2020). Eleutherosides increase phenoloxidase in hemolymph and inhibit the development of fungal spores. The piperine (an alkaloid in the roots of the Piperaceae family) and curcumin (a natural phenol produced by *Curcuma longa*) are known as natural supplements which increase the activity of the antioxidant system in honey bees (Strachecka et al., 2015; Schulz et al., 2019). They promote the activities of antioxidant enzymes such as superoxide dismutase, peroxidase, catalase and glutathione S-transferase, which reduces oxidative stress (Tasleem et al., 2014). Moreover, it is observed that these herbal supplements exhibit hydroxyl radical scavenger action in honey bees, suppressing the destructive effects of the free radicals and reactive oxygen species (Umar et al., 2013). *Nosema ceranae* is able to induce oxidative stress in bees (Kurze et al., 2016), piperine and curcumin are potential candidates regarding antinosemosis therapy. According to Chen et al. (2019), 1% decoction of *Andrographis paniculata* significantly reduced the number of *N. ceranae* spores 7 days after infection. This product was found to protect the intestinal tissues of infected workers from damage caused by *N. ceranae*.

It can be summarized that herbal extracts and their components were studied in laboratory conditions on honey bees. The aim of the study was to determine the impact of Mikro Veda Care Apis® on the development of the bee colonies in spring stimulating feeding in real conditions.

## Material and methods

Mikro Veda Care Apis® was used for the spring stimulating feeding of the bee colonies. It is a concentrate of herbal extracts with effective microorganisms and lactic acid probiotic cultures, intended for the prevention of bee diseases. It is used to increase the egg-laying activity of the queen bee and to improve the viability of the worker bees. The manufacturer Kevelaer <http://www.mikroveda.eu/>, with importer for Bulgaria Bio-engineering Ltd. indicates that it contains anise, basil, savory, nettle, dill, angelica root, elderberry, ginger, chamomile, celery, oregano, mint, rosemary, sage, licorice, incense.

The experiment was conducted in the period 11 Apr 2019 – 10 June 2019 at the experimental apiary of the Research Centre of Stockbreeding and Agriculture – Smolyan, Bulgaria. Two groups with 10 bee colonies were formed – experimental and control. Prior to the experiment, all bee colonies had an equal start in the number of bees (strength), brood and food supplies (sealed honey and bee pollen in the beehive).

The control group was fed with sugar solution (ratio sugar:water-1:1) without additives and the experimental group was fed with the product at a dose of 10 ml/L Mikro Veda Care Apis in the sugar solution (ratio sugar:water-1:1). All bee colonies received a total of 5 L at intervals of 2 – 3 days in the feeder.

During the study period, the parameters were measured six times.

The following parameters were identified characterizing the development of the bee colonies:

- amount of sealed worker bee brood (number of cells) – measuring frame is used. In 1 cm<sup>2</sup> of honey comb there are 4 work cells, and in each of the squares of the measuring frame area of 25 cm<sup>2</sup> the cells are 100;
- average daily egg-laying of queen bees (number of cells) – it is determined by the amount of sealed brood at

estimated 100 worker cells with sealed brood in a square of the measuring frame.

$$\text{Average daily egg-laying} = (\text{number of squares with sealed brood} \times 100) / 12$$

Where:

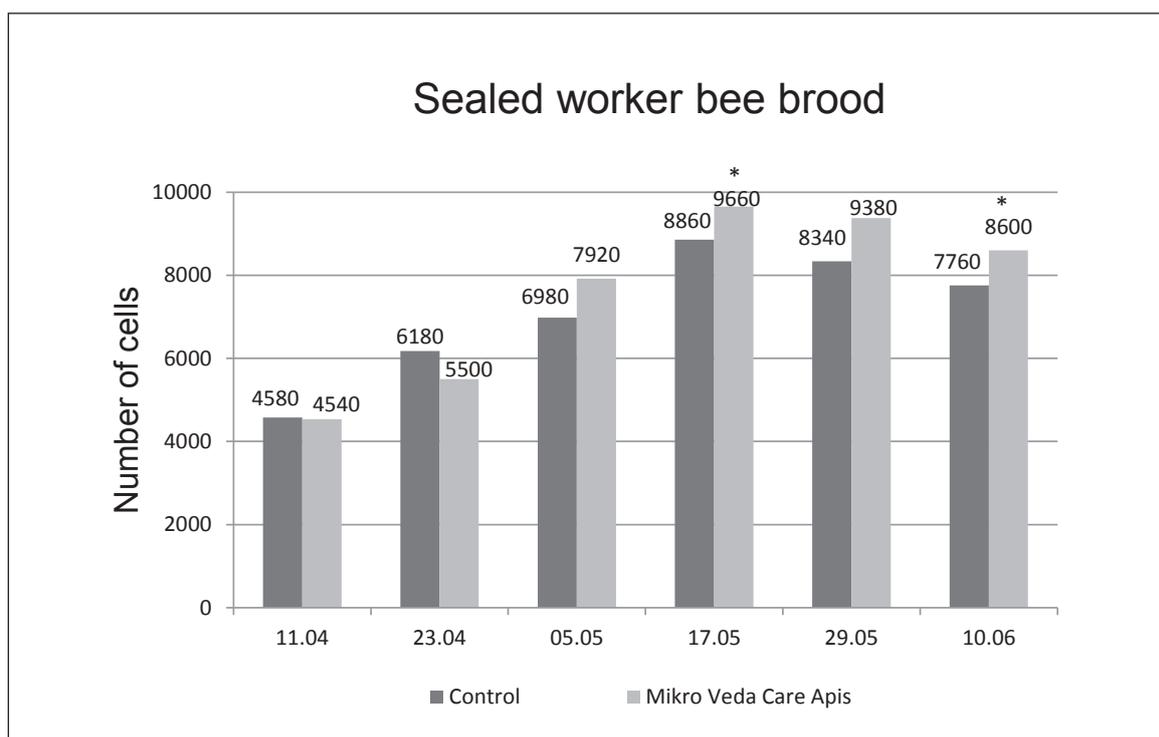
- 12: number of days when the honeybee is in a phase before cocoon and cocoon stage (sealed brood).
- amount of bees (strength of the bee colony), kg – approximately in number of frames occupied by bees and calculating the mass in a statement of one frame in the multihull hive containing approximately 200 g of bees after control measurements.

#### Statistical analysis

The data were expressed as mean ± standard deviation calculated with SPSS software (version 23 for Windows). Significant differences were considered at p<0.05.

### Results and discussion

The results for the amount of sealed worker bee brood of the bee colonies after feeding with Mikro Veda Care Apis® are presented in Figure 1.



**Figure 1.** Average amount of sealed worker bee brood (number of cells)

At the beginning of the study (11.04.) the bee colonies from the experimental group did not differ from the control group for this parameter. There is an increase in the amount of sealed worker bee brood in all bee colonies, which is due to the good conditions of nectar and pollen import from the honey plants during this period. The highest values were recorded on 17 May in bee colonies receiving Micro Veda

Care Apis® supplement. Significant differences (p<0.05) were found one month after applying the product. Two months after using the supplement for bees (on 10 June), the difference in the values is also significant.

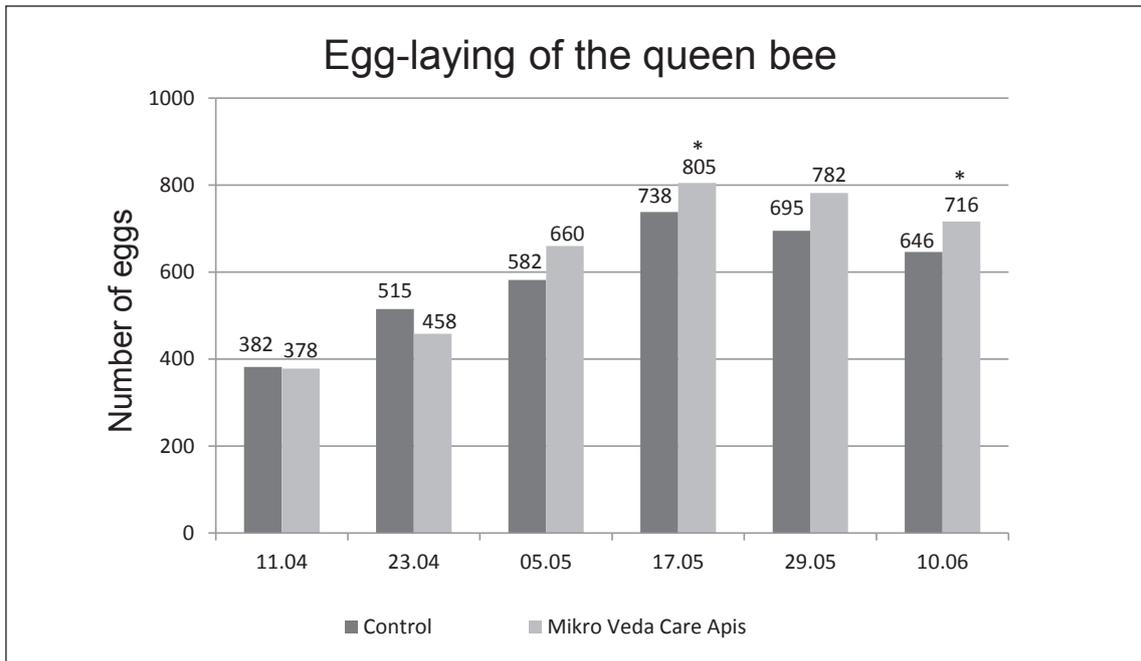
This proves that the increase in the sealed worker bee brood is not only due to the natural influx of food but also possibly to the effect of the product.

At the end of the research on 10 June the amount of sealed worker bee brood in the experimental group is  $8600 \pm 711$ , and in the control group it is  $7760 \pm 270$ , this being 10.8% more for the experimental group.

It is noticed that from the beginning of the experiment

to the end, in the experimental group, the amount of sealed worker brood increased by 4060 cells, while in the control group it was 3180, which is 1.3 times more.

The results for the average daily egg-laying of queen bees are presented in Figure 2.



**Figure 2.** Average daily egg-laying of queen bees (number of cells)

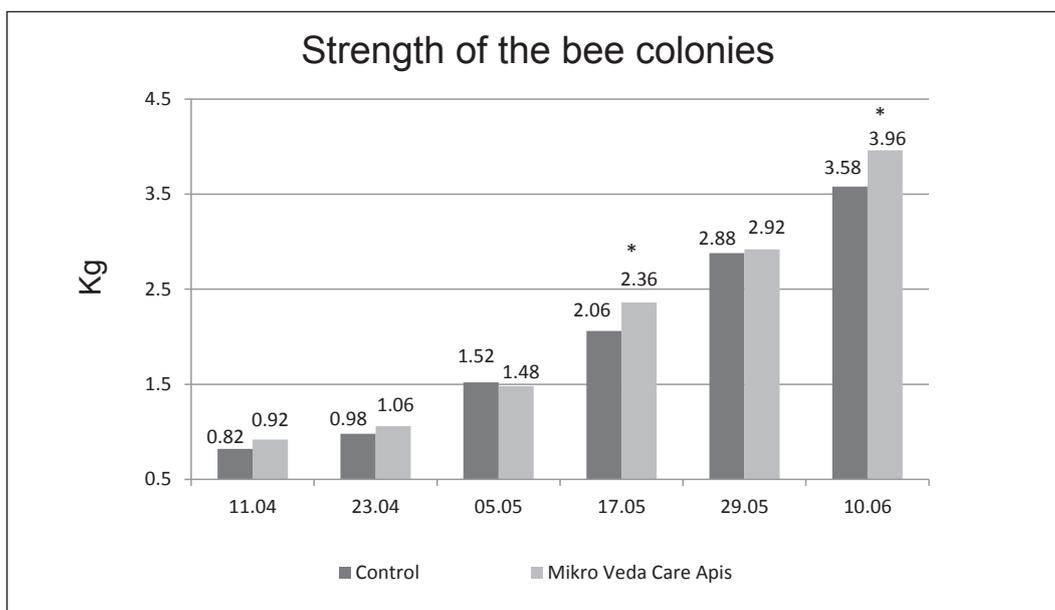
The estimated mean values for mean daily egg-laying activity were similar to changes in the amount of sealed worker bee brood.

Feeding of bee queens with royal jelly leads to intense laying of eggs (between 1500 and 2500 eggs per day). The bee queen from colonies fed with Mikro Veda Care Apis® showed the highest laying activity on 17 May and 10 June 2019 (Figure 2). It can be assumed that the bee colonies which received Mikro Veda Care

Apis® have well developed hypopharyngeal glands that produce royal jelly for the bee queens.

The more intensive egg-laying activity of the queen bee leads to higher amount of sealed worker bee brood, the appearance of more young bees, the strength of the bee colony and higher honey and wax supplies.

The results about the average strength of the bee colonies are presented in Figure 3.



**Figure 3.** Average values for the strength of the bee colonies (kg)

At the beginning of the experiment the colony strength was about 0.80 kg in the control and experimental groups of bee colonies. In all measurements, the colony strength of the group fed with Mikro Veda Care Apis® liquid syrup was higher than the control one. At the end of the experiment (10 June), the strength of the bee colonies increased and in the experimental group it was 3.96 kg. Colony strength from the experimental group bee colonies showed significantly higher values ( $P < 0.05$ ) for measurements on 17 May and 10 June (Figure 3).

The bee colonies in the experimental group grew by 3.04 kg since the beginning of the experiment. The control group increased colony strength (i.e. the amount of bees in the beehives) by 2.76 kg. Although they were grown under the same conditions, the experimental group had a higher value for this parameter.

The increase in the number of bees in the beehives is a normal biological process for their spring development which is stimulated by suitable food products (Shumkova and Zhelyazkova, 2013; Shumkova and Balkanska, 2021).

At the end of the study, a larger number of young honey bees were reported in the experimental group. They are an indication that the bee colony has more bees for the upcoming main pasture, when the bee colony supplies food for the winter.

The intervention of the beekeeper is necessary at the end of winter for starving bee colonies but it gives a very good effect in their growth in spring and autumn. The relationship between food – bees – bee queen – sealed worker bee brood, must be maintained in an active state throughout the whole period of the bee colony growth and especially in preparation for the main pasture.

## Conclusion

The bee colonies that received Mikro Veda Care Apis® have significant differences for the parameters strength of the bee colonies and sealed worker bee brood compared to the control group. We expect our study to be a starting point for a deeper understanding of development of the bee colonies during the spring feeding with the addition of Mikro Veda Care Apis®. The product Mikro Veda Care Apis® has a stimulating effect on the development of the bee colonies. It is recommended as a supplement feeding of the bee colonies.

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