

Efficiency of probiotic supplements in the dynamics of economically useful indicators of honey-bee colonies

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Abstract. In the modern world, the problem of honey-bee colonies' death is acute. An intensive search is underway for environmentally friendly preparations that could stimulate the bees' resistance to various diseases, as well as have a beneficial effect on the body, thereby contributing to an increase in honey productivity. Preparations based on live probiotics bacteria of *Lactobacillus* and *Bacillus subtilis* genus are currently becoming increasingly popular. The use of probiotics in beekeeping allows to destroy pathogenic microflora, strengthen immunity and activate the body's metabolic processes. The aim of the study was to determine the influence efficiency of probiotic preparations complex ApiVrach, SpasiPchel, PcheloNormoSil during the period of spring development on the economically useful traits of honey-bee colonies. Studies have found that when probiotics are added to sugar syrup in the spring, the brood growth of bee colonies and their honey productivity are activated. The flight activity of bees when feeding with probiotic preparations increased by 43.6% from the control group. When assessing the dynamics of the bee colony's strength, it was found that the usage of "ApiVrach" + "PcheloNormoSil" combination allows increasing the amount of sealed brood by 4 times, and the strength of the bee colony - by 1.5 times. Also, this combination of preparations made it possible to obtain the largest amount of total honey yield by 19.2% more than the control group, by 3.0% more than the group that received the ApiVrach + SpasiPchel complex and by 1.1% more than when using ApiVrach.

1 Introduction

At present, there is a massive disappearance of bee colonies all over the world, which was given the name "collapse of bee colonies". In recent years, beekeepers of the Udmurt Republic, like many other regions of Russia, have especially acutely felt their death caused by the uncontrolled use of pesticides, sharp climatic changes, as well as the spread of various bee diseases. The destruction and death of colonies causes serious damage to honey production, but even more to pollination of plants, which seriously worries the world community of scientists and beekeepers [1-3].

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In winter, when unfavorable living conditions of bees reach a peak, and in early spring with a meager honeyflow, the body of bees is especially weakened and most susceptible to diseases. Bees' treatment from various infectious and invasive diseases often occurs with the use of antibiotics and insecticides that destroy not only the pathogenic microorganisms, but also the beneficial intestinal microflora, which inevitably leads to the metabolic processes' inhibition of the bee's body, the loss of its resistance to diseases, production limitation of organic honey and other beekeeping products [4,5].

Weakened bee colonies develop slowly in the spring, build up their strength with a significant delay and, accordingly, do not provide marketable products. Therefore, special attention should be paid to the prevention of diseases, strengthening the immunity of bees. For this, beekeepers use various supplements providing bee colonies with the necessary amount of nutrients in the spring; these nutrients activate metabolic processes and the body's defense systems [6-8].

In order to obtain environmentally safe beekeeping products without the risk of losing bee colonies in the modern world, the use of supplements based on live microorganisms - probiotics - is being actively introduced. Probiotic bacteria are used to stimulate natural physiological processes in the bees' bodies activating their own resistance mechanisms. They are antagonists for pathogenic microflora that has lost sensitivity to antibiotics, as well as a constant source of highly assimilable protein [9-11].

The most common are probiotic bacteria of the genus *Lactobacillus*, *Bifidobacterium* and *Bacillus Subtilis*. Their positive effect is manifested in the possibility of obtaining environmentally friendly products, the absence of side reactions from the animal, metabolic and anti-inflammatory effects, as well as the stimulation of local immunological protection [12,13].

Probiotic preparations are used in beekeeping both for a complex effect on the bee's body and as a prophylactic preparation against infectious and invasive diseases, as well as for the treatment of a specific disease. The use of probiotics as a stimulating supplement in beekeeping allows a targeted effect on the dynamics of morphological and functional parameters of the body, contributes to the successful growth of a bee colony and its better preparation for the main honey yield [14,15].

2 Materials and methods

The purpose of this study was to identify the efficiency of feeding probiotic preparations in the spring period for economically useful indicators of bee colonies. We studied the preparations "ApiVrach", "SpasiPchel" and "PcheloNormoSil" developed by LLC "NVP" BashIncom".

ApiVrach preparation contains 5 strains of live bacteria *Bacillus subtilis*; as a result, the preparation has an antibiotic effect on the body against pathogenic microflora in viral, bacterial, fungal infections, stimulates bees' immunity, accelerates the growth and productivity of bee colonies, increases resistance to common diseases and metabolic processes' activation in bees' bodies.

SpasiPchel probiotic preparation based on 2 natural strains of *Bacillus Subtilis* genus bacteria suppresses pathogenic bacteria and fungi, stimulates the immunity and digestion of bees.

PcheloNormoSil biopreparation based on 4 strains of lactic acid bacteria *Lactobacillus plantarum*, enterococci and yeast-saccharomycetes, which produce several useful biologically active substances that prevent the development of putrefactive processes and opportunistic microflora, helps to make carbohydrate supplements easily digestible and nutritious.

For the experiment, 4 groups of bee colonies were formed in the apiary of the Zavyalovsky district of the Udmurt Republic by the method of pairs and analogs, 10 colonies in each, with queens of the same age. Bee colonies of the control group received sugar syrup in a ratio of 1: 2, colonies of the first group - sugar syrup with ApiVrach preparation, colonies of the third group - sugar syrup with ApiVrach and SpasiPchel preparations, the fourth group - sugar syrup with ApiVrach and PcheloNormoSil preparations.

Preparations' supplementing was carried out in the following way: the first feeding in all three experimental groups was carried out three times with an interval of 3 days with ApiVrach probiotic in the amount of 2 ml per 1 liter of 50% sugar syrup. The second feeding was carried out two weeks later with three preparations in different groups: the first experimental group was also fed with ApiVrach three times in the same dosage every 3 days, the second - SpasiPchel twice after 5 days in an amount of 1 ml per 1 liter of 50% sugar syrup, the third - PcheloNormoSil in a dose of 5 ml per 1 liter of 50% syrup three times with an interval of 3 days.

Assessment of the state and productivity of bee colonies was carried out according to the methodology of scientific research in beekeeping [16]. The amount of brood was determined every 12 days using a grid frame (a 5x5 cm square includes 100 cells of bee brood or 75 cells of drone brood).

The flight activity of bees was recorded 10 days after the feeding under the conditions of a small honeyflow daily and during the period of maximum release of flower nectar. The flight intensity was determined by counting the number of bees that arrived in the hive in 3 minutes in 3-fold repetition.

The obtained data were subjected to statistical processing by methods of variation statistics on a personal computer using Microsoft Excel.

3 Results

Bees' flight activity during the period of flower nectar release can be considered a peculiar characteristic of the bees' honey yield activity. Flight activity is a direct indicator of bees' building activity since their wax release increases the amount of food received by the colony per day in direct proportion. It directly depends on the weather, the colony's strength, the amount of brood raised, honeyflow presence in nature.

The study of the flight activity of bee colonies was carried out at an ambient temperature of at least 25°C in clear weather under conditions of maximum illumination. Bees are most active in these meteorological conditions (Figure 1).

The flight intensity of worker bees for a series of experiments in the control group averaged to 72.3 bees, in experimental group 1 - 100.3 bees, in experimental group 2 - 95.0 bees, and in experimental group 3 - 100.0 bees.

The timing of the flight activity of bees showed that in the afternoon (14:00), the intensity of bees' flight reached its peak. The highest flight activity was noted in bees of the experimental groups fed with the preparations ApiVrach and PcheloNormoSil - 135 and 134, respectively, which was higher than the control group by 43.6%, and the group fed with SpasiPchel preparation - by 9.8%.

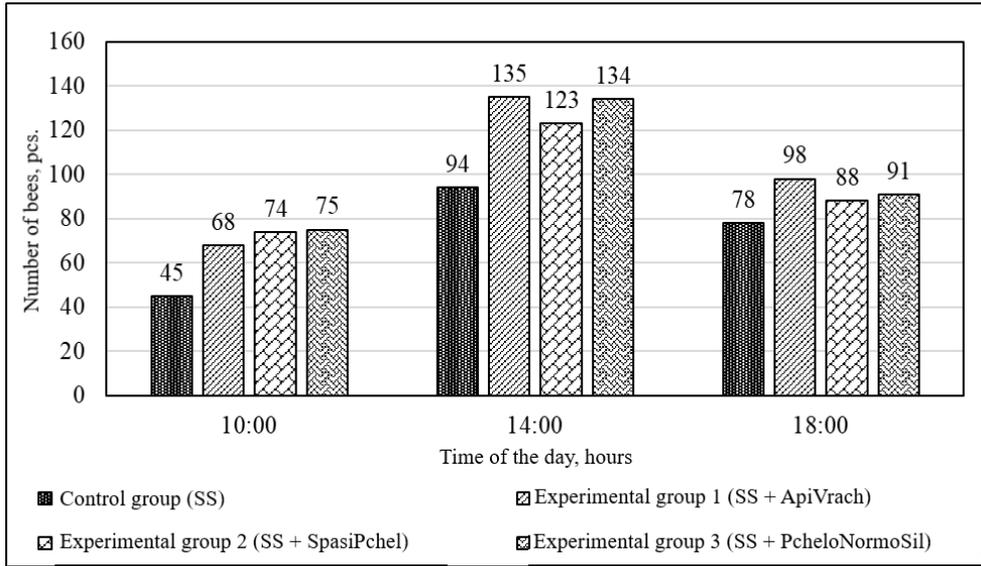


Fig. 1. Flight activity of bees during the study period.

Analysis of the bee colonies' development dynamics depending on the type of used supplement showed that feeding with probiotic preparations indicates their beneficial effect on the processes of spring development, namely, it contributes to an increase in the amount of grown sealed brood (Figure 2).

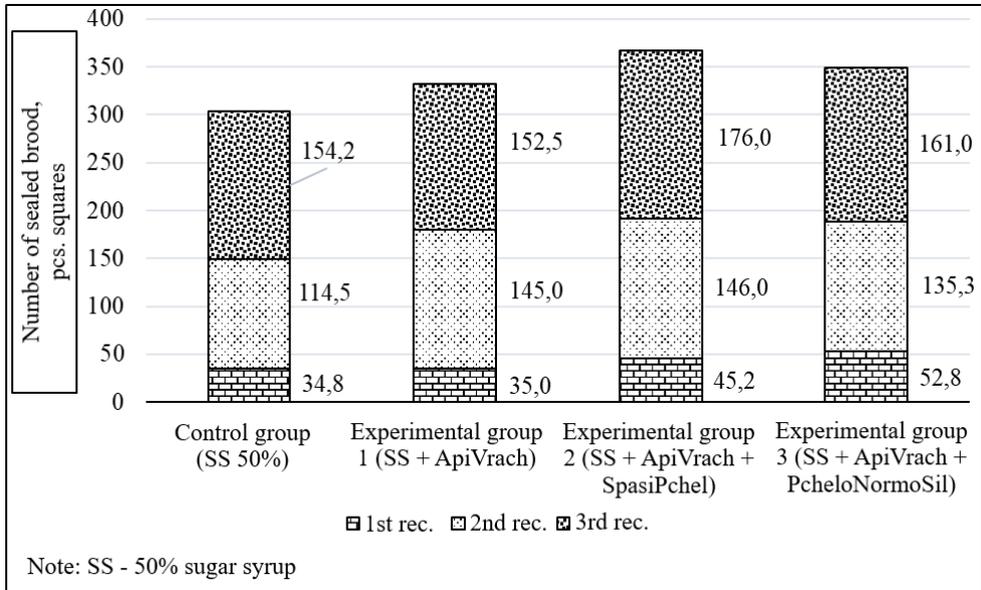


Fig. 2. Development dynamics of honey-bee colonies in the spring.

Thus, the combination of ApiVrach and SpasiPchel preparations gave the highest result in grown brood - by 20.99% more than in the control group. Feeding the combinations of ApiVrach and ApiVrach + PcheloNormoSil preparations also increased this indicator in comparison with the control group by 9.56% and 15.02%, respectively ($P \geq 0.999$). Thus, feeding with probiotic supplements has a positive effect on brood rearing, and, consequent-

ly, on the dynamics of the strength of the bee colony, which ensures its readiness for the honey yield period.

In 2020, the swarming season on the studied apiaries began on May 25-31 and lasted until the main honey yield on June 29-30. It is known that the stronger the swarm, the more honey it will collect. The profitability of the apiary depends on how many strong colonies there are in the apiary. During the swarming period of bee colonies, 2 new colonies were separated in control group 1 and one from each experimental group. The swarm of experimental group 3 (ApiVrach + PcheloNormoSil complex) had the largest mass - 4 kg, surpassing the swarms of the control group by 1.1 kg, and the swarm of group 1 fed with ApiVrach - by 1.8 kg (Table 1).

Table 1. Swarming of honey-bee colonies of the studied groups.

Indicator	Control group	Experimental group 1	Experimental group 2	Experimental group 3
Number of swarms, pcs.	2	1	1	1
Swarm weight, kg	2,9±1,34	2,2	2,8	4

By the beginning of the honey yield period, the colonies' strength of the control group was 9.2 kg (Figure 3). In the 1st and 2nd experimental groups, this indicator was lower than the control value by 5.4%, and in the 3rd group it was higher - by 1.1%. Among the experimental groups, the advanced growth of strength was shown by ApiVrach + PcheloNormoSil complex (group 3).

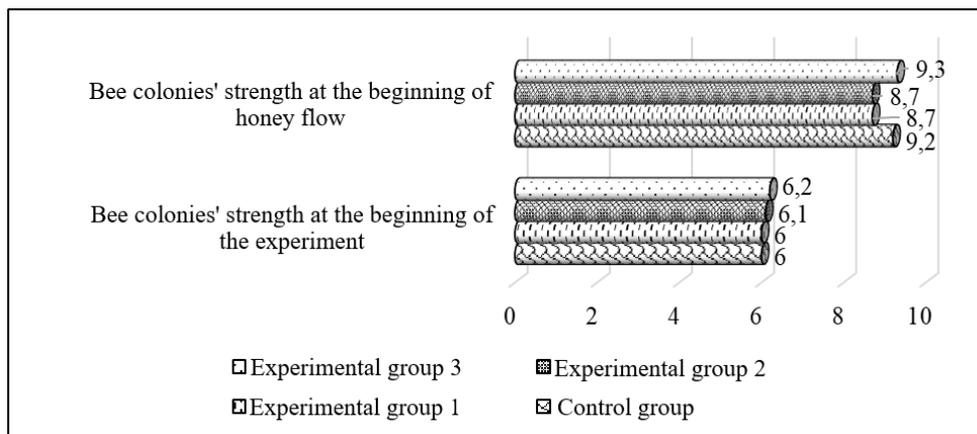


Fig. 3. Strength dynamics of honey-bee colonies.

An increase in the strength of bee colonies allows to get a larger amount of marketable honey from the apiary (Figure 4).

The largest amount of commercial honey was obtained when using a combination of feed supplements ApiVrach and PcheloNormoSil (experimental group 3) - 28.21 kg, which is 9.87 kg more than in the control group fed only with sugar syrup.

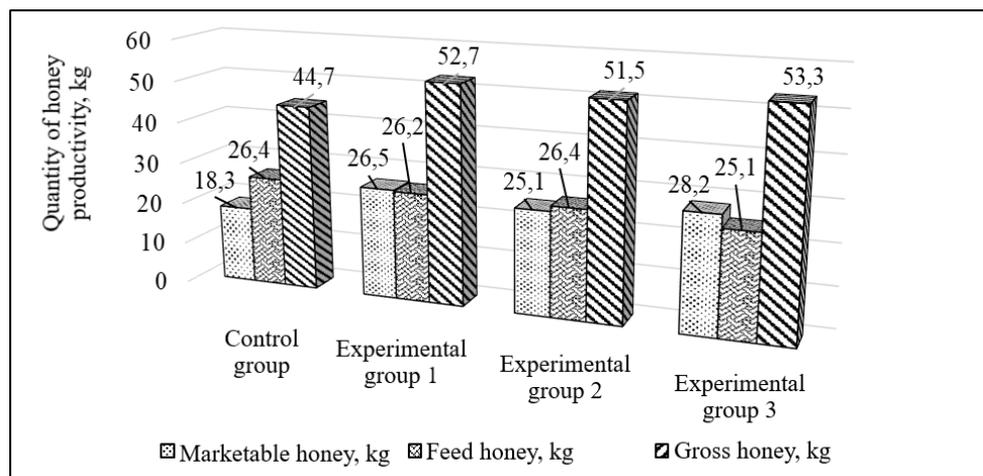


Fig. 4. Production indicators of the studied groups.

With ApiVrach and ApiVrach + SpasiPchel complex feeding, more commercial honey was also obtained - by 8.22 kg and 6.8 kg than in the control, respectively ($P \geq 0.999$). To ensure a comfortable wintering, an average of 26 kg of honey was left to bee colonies as food for the winter period.

4 Discussion

Studies have shown that in spring, probiotic preparations have a better effect on the vital activity of bee colonies than when feeding with 50% sugar syrup. It was found that when probiotics are added to sugar syrup in the spring, the brood growth of bee colonies and their honey productivity are activated.

The flight activity of bee colonies increased significantly with the use of probiotic supplements - up to 43.6% of the control group. Accordingly, preparations on a probiotic basis are stimulants of bees' flight activity.

At the same time, of all the considered preparations' complexes, the use of ApiVrach + PcheloNormoSil combination proved to be the best: it allowed to increase the number of sealed brood for the period under consideration by 4 times, the strength of bee colonies increased by 1.5 times despite that the largest sealed brood number was observed in the group consuming the ApiVrach + SpasiPchel complex (9.3% more).

The largest volume of honey productivity was obtained from colonies fed with a combination of ApiVrach + PcheloNormoSil receiving sugar syrup, ApiVrach probiotic, ApiVrach + SpasiPchel complex, by 19.2%, 1.1% and 3.0%, respectively.

5 Conclusion

Based on the studies carried out, it can be concluded that the use of the probiotic preparation ApiVrach, either on its own or in combination with the preparations SpasiPchel and PcheloNormoSil can increase flight activity, stimulate the strength of bee colonies and increase the volume of honey productivity.

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