Feeding stimulates functional abilities of queen bees of the Carpathian subspecies

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Abstract. The researches were conducted on queen bees of the Carpathian subspecies in conditions of Tajikistan. Four groups of similar families were formed, 10 in each group. In the control group, sugar syrup (1:2) was given as a stimulating feeding, in small portions of 700 ml. Bees of the first experimental group were fed with the sugar syrup, with the addition of drone larvae's homogenate. The second group was fed with the sugar syrup with addition of a feed mixture "Similak", the third group - sugar syrup with the addition of a compositional form consisting of a feed mixture "Similak" and the drone larvae's homogenate. In the experimental groups, in contrast to the control group, an increase in the egg production of queen bees and the brood breeding reflex by 1.3-1.44 times was found. In general, it has been established that to stimulate the physiological processes in bee's organism, growth and development of colonies in spring, it is necessary to use stimulating feeding by sugar syrup in combination with drone larvae's homogenate and feed mixture "Similak" 700 ml each.

1. Introduction
In many regions of the globe, currently, there is much concern about the death of bee colonies, which occurs as a result of a decrease in the level of adaptation of honey bees (*Apis mellifera*) to environmental factors, a high degree of their hybridization due to uncontrolled importation, environmental changes and the reduction of honey plants [1-6]. The presented facts lead to a gradual reduction in the global population of subspecies (*Apis mellifera mellifera*, *Apis mellifera carpatica*, *Apis mellifera ligustica* etc.) of the honey bee, and this, in turn, leads to a decrease in the numerical and species composition of agricultural and wild flora in countries and states [7-9].

In this regard, more and more beekeepers, specialists and scientists are interested in medicines prepared on the basis of natural sources of biologically active substances or their full synthetic analogues, used for the prevention and stimulation of vital activity, increasing immunity, resistance to stress factors and treatment of diseases [10].

The researchers note that many veterinary drugs have been produced, including antibiotics, which have a negative impact on pathogenic microorganisms, helping to avoid mass diseases of bee colonies.
However, they affect on the body of the bees themselves, suppressing the development of beneficial microflora of their intestines. As a result, the immune system weakens and becomes easily vulnerable to other diseases. At the same time, the stricter requirements for the environmental safety of beekeeping products imply the absence of antibiotics in them. In this regard, they need an alternative that does not harm the organisms. Therefore, probiotic drugs based on live microorganisms were begun to use.

The rapid development of fundamental sciences creates conditions for the creation of new pharmacological compositions that can effectively influence on the physiology and biology, development, safety and productivity of bees. New sources of obtaining such drugs significantly expand the fundamental possibilities of pharmacotherapy of their main diseases. Currently, to receive environmentally friendly products and increase the immunity of bees, drug-free methods of preventing and treating diseases are increasingly being introduced [11].

Unfortunately, despite the many available studies on the use of stimulating fertilizing in beekeeping to improve the economically useful, morphological, biological characteristics of working individuals of bees, there is practically no work on assessing their impact on bee queens and drones [12]. At the same time, it is known that the viability of bee colonies determines, first of all, the quality of queen bees. At the same time, the reproduction of productive bee breeds is considered one of the most important factors in increasing the productivity of apiaries.

The aim of the work was determination of the influence of a composite form of feeding consisting of sugar syrup, a feed mixture "Similak" and a homogenate of drone larvae on the functional activity of queen bees (Apis mellifera carpatica) in apiaries of the Republic of Tajikistan.

2. Materials and methods

The researches were conducted in 2016-2020 in the conditions of the Gissar and Rogun districts of Central Tajikistan. The object became bee families of the Carpathian subspecies (Apis mellifera carpatica). Four groups of similar families were formed, 10 in each group. Experimental and control bees had 3.5 kg of bees, 8 kg of feed honey, a queen at the age of one, a closed brood on three frames and two frames with an open brood. In the control group, sugar syrup (1:2), prepared on boiled water, was given to the bees as a stimulating feeding, in small portions of 700 ml, in a day, 7 times, using a ceiling feeder. Bee colonies of the first experimental group (Group 1) were fed with sugar syrup, with the addition of drone larvae’s homogenate. The second experimental group (Group 2) was fed with the sugar syrup with the addition of a feed mixture "Similak". The third experimental group (Group 3) was with sugar syrup with the addition of a compositional form consisting of a feed mixture "Similak" and the drone larvae’ homogenate. Drone larvae’ homogenate (DLH) was obtained by pressing (squeezing) pieces of honeycomb with drone larvae, just sealed or still open. DLH was used as a supplement to sugar syrup and candy (honey mixture with powdered sugar) in spring and autumn feeding of bees and for their growth. Bees in all groups were fed at the same time, with the same multiplicity, but with different drugs. To account for the egg-laying capacity of the queens a 5x5 cm frame with cells was used and the number of printed brood was determined. The frame with cells contains 100 bee cells. The printed brood (hundreds of cells) was counted by applying a frame with cells to the honeycombs with the brood.

The effect of stimulating feeding on the functional activity of queen bees was established. At the same time, the greatest efficiency was revealed in usage of a compositional form consisting of sugar syrup, a feed mixture "Similak" and a drone larvae’ homogenate. In the experimental groups, in contrast to the control group, an increase in the egg production of queen bees and the brood breeding reflex by 1.3-1.44 times was found. In general, it can be noted that to compensate for the protein deficiency and stimulate the physiological processes of the queen bee organism, increase the growth and development of bee colonies in spring, it is necessary to use stimulating feeding by sugar syrup in combination with drone larvae homogenate and feed mixture "Similak" 700 ml each.

The digital material of the experiments was processed by the method of variation statistics on the reliability of the difference in the compared indicators (P<0.05-0.001) using a personal computer in
the Microsoft Excel program.

3. Results and discussion

The results of our experiments show that in the control group, where the bee colonies received only sugar syrup as a stimulating feeding, the average daily egg-laying capacity was the lowest, ranging from 1350.0 to 1650.0 eggs/day (table 1).

| Accounting dates | Control Group | Group 1 | Group 2 | Group 3 |
|------------------|---------------|--------|--------|--------|
| 6.III            | 1400.0±20.0   | 1633.3±32.0* | 1541.7±15.0 | 1750.00±21.0* |
| 18.III           | 1491.7±15.0   | 1716.7±27.0** | 1666.7±13.0* | 1766.7±10.0** |
| 30.III           | 1625.0±29.0   | 1766.7±17.0** | 1741.7±10.0* | 1875.0±20.0** |
| 12.IV            | 1641.7±35.0   | 1825.0±19.0** | 1758.3±25.0* | 1916.7±24.0** |
| 24.IV            | 1616.7±12.0   | 1733.3±15.0* | 1625.0±19.0 | 1991.7±23.0*** |
| 6.V              | 1350.0±11.0   | 1666.7±20.0*** | 1608.3±17.0** | 1808.3±12.0*** |
| 18.V             | 1441.7±20.0   | 1858.3±14.0*** | 1766.7±12.0** | 1908.3±17.0*** |
| 30.V             | 1600.0±19.0   | 1891.7±31.0*** | 1800.0±26.0** | 2208.3±33.0*** |
| 12.VI            | 1583.3±25.0   | 2150.0±19.0*** | 2058.3±14.0*** | 2283.3±18.0*** |
| 24.VI            | 1650.0±30.0   | 2241.7±10.0*** | 2091.7±19.0*** | 2300.0±25.0*** |
| 6.VII            | 1541.7±26.0   | 1875.0±37.0** | 1691.7±18.0* | 1925.0±36.0** |
| 18.VII           | 1416.7±33.0   | 1666.7±30.0* | 1625.0±29.0 | 1858.3±21.0** |
| 30.VII           | 1483.3±30.0   | 1750.0±19.0*** | 1616.7±27.0* | 1816.7±15.0*** |

*p≤0.05; **p≤0.01; ***p ≤0.001.

At the same time, the queen bees of this group have three peaks of rise and three peaks of falling average daily egg-laying capacity. The first peak of the rise in egg-laying capacity of the described group is recorded in the period from March 6 to April 12. Thus, for the accounting period, the egg-laying capacity of female bees in the Group 1 increased by 1.17 times (from 1400.0 to 1642.0 eggs/day). The second peak of the rise in egg-laying capacity fell on the period from 6th to 30th May. Here it increased from 1350.0 to 1600.0 eggs/day.

The third peak in the increase in the level of the average daily egg-laying capacity of the queen bees of the described group is observed from June 12 to June 24 by 1.04 times. In the subsequent periods of observation, a regular decline in the egg production of the queen bees of this group is recorded. The maximum parameter of egg-laying capacity of queen bees recorded on June 24 exceeded the same initial indicator of the group observed on March 6 – by 1.18 times.

The peaks of the rise in the average daily egg-laying capacity of the queen bees in the control group alternated with their decline. A very noticeable drop in the level of egg-laying capacity was recorded between April 24th and May 6th. The rate of decrease in egg-laying capacity over this period of time was 1.2 times (from 1616.0 to 1350.0 eggs/day). At the same time, the second decline from May 30 to June 12 was very slight. During this period, the average daily egg-laying capacity of queen bees in this group decreased from 1600.0 to 1583.33 eggs/day. The third decline in the egg production of queen bees was natural and was recorded on the eve of the main honey flow from June 24 to July 18. Here, the rate of decrease in average daily egg-laying capacity was 1.16 times.

In the experimental groups, the average daily egg-laying capacity of the queen bees had a slightly different character. Firstly, here we recorded two peaks of rise noticeable in terms of the level and two
decreases in the described indicator (average daily egg-laying capacity), in comparison with similar data in the control group. Secondly, the level of the maximum average daily egg-laying capacity in the Groups 1 and 3 was higher than the same value in the control one. Thirdly, despite the decline before the main honey flow in the level of egg-laying capacity of queen bees in the described groups, it was significantly higher than those of the control group.

Thus, the first peak of the rise in the egg-laying capacity of the Groups 1 and 2 was recorded during a similar control period, with the maximum value on April 12th. In group 3, this indicator continued to rise and peaked a week later by April 24th. At the same time, the average daily egg-laying capacity of queen bees of the Group 1 by the indicated date was 1.11 times higher than the same control value, – 1.07 and 1.23 times, respectively, in the Group 2 and Group 3. The second peak of the increase in the level of egg production in the groups described is observed by June 24. Here, the described parameter by the given observation period was higher than the control figure: by 1.36, 1.27 and 1.39 times, in the Group 1, Group 2 and Group 3, respectively.

By the beginning of the main honey flow, the level of egg-laying capacity of queen bees in the groups described decreases. So, by July 30, the average daily egg production in the control group was 1483.33 eggs/day. At the same time, the egg production of the queen bees of the Group 1 was 1.18 times higher than the control value, the Group 2 – 1.09 times and the Group 3 – 1.22 times.

We also judged the expediency of carrying out stimulating feedings by the average daily egg production of queen bees in the formed layering families (Table 2).

**Table 2. Egg production of queen bees in families of layering.**

| Accounting dates | Control Group | Group 1 | Group 2 | Group 3 |
|------------------|--------------|--------|--------|--------|
| 12.IV            | 1333.0±23.0  | 1333.0±12.0 | 1333.0±15.0 | 1333.0±20.0 |
| 24.IV            | 1542.0±15.0  | 1617.0±24.0 | 1583.0±17.0 | 1658.0±11.0* |
| 6.V              | 1625.0±19.0  | 1708.0±20.0* | 1658.0±29.0 | 1867.0±15.0* |
| 18.V             | 1708.0±12.0  | 1867.0±17.0* | 1800.0±30.0 | 1975.0±10.0* |
| 30.V             | 1858.0±11.0  | 2042.0±14.0** | 1883.0±16.0 | 2158.0±15.0** |
| 12.VI            | 1867.0±24.0  | 2225.0±17.0** | 2092.0±39.0** | 2283.0±11.0*** |
| 24.VI            | 1842.0±17.0  | 1942.0±16.0* | 1908.0±18.0 | 2008.0±15.0** |
| 6.VII            | 1750.0±19.0  | 1875.0±27.0* | 1808.0±20.0 | 1917.0±18.0* |
| 18.VII           | 1625.0±13.0  | 1717.0±15.0* | 1667.0±27.0 | 1767.0±19.0* |

*p≤0.05; **p≤0.01; ***p ≤0.001

We found that the queen bees in the layers, against the background of stimulating feedings, developed a dynamic egg production recorded by observation time. At the same time, the graphs of the average daily egg production of queen bees, both in the control and experimental groups, were characterized by a single-peaked peak observed by June 12th. By the indicated observation period, the average daily egg production of female bees was 1867.0 eggs/day in the control group, 2225.0 eggs/day in Group 1, 2092.0 eggs/day in Group 2, and 2283.0 eggs/day. Compared to the initial level, the egg production of queen bees by June 12 increased 1.4 times in the control group, 1.67 times in Group 1, 1.56 times in Group 2, and 1.71 times.

In the subsequent observation periods, starting from June 24, in the level of the average daily egg production of the queen bees of the control and experimental groups, a gradual process of its level decrease is observed. So, the average daily egg production by June 24 in the control group decreases from 1867.0 to 1842.0 eggs/day, in the Group 1 – from 2225.0 to 1942.0 eggs/day, in the Group 2 – from 2092.0 to 1908.0 eggs/day, in the Group 3 – from 2283.0 to 2087 eggs/day. This process continued until the onset of the main honey flow. At the same time, two weeks before the main honey flow...
flow, the average daily egg production was maximum in the Group 3 – 1767.0 eggs/day, only by 50 pieces. This indicator was less in the Group 2 (1717 eggs/day), in the Group 3 it was less by 100 pcs. (1667 eggs/day), in the control – 142 pcs. (1625 eggs/day). The multiplicity of the excess in the level of average daily egg production in comparison with the control figure by the given observation period was 1.06 times in the Group 1, 1.03 times in the Group 2, and 1.09 times in the Group 3.

The reflex of brood rearing recorded by the number of printed brood with a grid frame (sides of a 5x5 cm square) allows us to note that they differed by groups (table 3). The analysis of the indicators allows us to conclude that the most intensive process of brood rearing is recorded in the control and Group 3.

Table 3. Dynamics of the printed brood.

| Accounting dates | Control group | Group 1 | Group 2 | Group 3 |
|------------------|---------------|---------|---------|---------|
| 18.III           | 168.0±2.0     | 196.0±3.0*** | 185.0±0.2** | 210.0±0.5*** |
| 30.III           | 179.0±3.0     | 206.0±4.0** | 200.0±0.3*   | 212.0±0.9** |
| 12.IV            | 195.0±2.0     | 212.0±2.0 | 209.0±0.1    | 225.0±0.8*  |
| 24.IV            | 197.0±2.0     | 219.0±2.0 | 211.0±0.2    | 230.0±0.5*  |
| 6.V              | 194.0±1.0     | 208.0±1.0 | 195.0±0.4    | 239.0±0.6*  |
| 18.V             | 162.0±2.0     | 200.0±2.0*** | 193.0±0.3** | 217.0±0.7*** |
| 30.V             | 173.0±3.0     | 223.0±4.0*** | 212.0±0.2** | 229.0±0.9*** |
| 12.VI            | 192.0±2.0     | 227.0±2.0** | 216.0±0.4*   | 265.0±0.8*** |
| 24.VI            | 190.0±4.0     | 258.0±3.0** | 247.0±0.5*   | 274.0±0.7*** |
| 6.VII            | 198.0±3.0     | 269.0±1.0** | 251.0±0.2*   | 276.0±0.6*** |
| 18.VII           | 185.0±4.0     | 225.0±4.0** | 203.0±0.3    | 231.0±0.9*** |
| 30.VII           | 170.0±2.0     | 200.0±2.0** | 195.0±0.2    | 223.0±0.8*** |
| 12.VIII          | 178.0±1.0     | 210.0±1.5** | 194.0±0.4    | 218.0±0.5** |

*p≤0.05; **p≤0.01; ***p ≤0.001

According to the research results, the peak of brood rearing in groups registered by the number of squares occupied by printed brood is observed on July 6. By the indicated date (July 6), the printed brood in the control group was 198.0 squares, in Group 1 – 269.0 squares, in Group 2 – 251.0 squares, in Group 3 – 276.0 squares. The maximum level of this indicator recorded in the Group 3 when giving to bee colonies a compositional stimulating feeding consisting of a feed mixture "Similak" + homogenate of drone larvas’ was 1.4 times higher than the same value of the control figure. In Group 1, when bee colonies were given a homogenate of drone larvas’ in a sugar syrup, it was 1.36 times higher than the control. In the Group 2, where the bee colonies received sugar syrup with the "Similak" feed mixture, the described indicator was 1.27 times higher than the values of the control group. A general analysis of the dynamics of brood rearing allows us to note that in the context of groups, it obeys the same biorhythmological laws that were recorded in relation to the egg production of queen bees. Here, the biorhythmological peaks of the rise and fall of the brood rearing level were shifted 12 days later. In the control group, there are three biorhythmological peaks of rise and three peaks of decline in brood rearing. In the experimental groups, only two biorhythmological peaks of rise and two declines in brood rearing were recorded.

The results of the analysis of the rates of brood rearing in layering families are presented in table 4.
Breeding of brood in layering families dynamically occurred both in the control and in 2 and 3 experimental groups. In biorhythmological terms, here we recorded one peak of rise and one decline in the level of brood cultivation. At the same time, the maximum peak in brood cultivation in all the studied groups was observed on June 24 (table 4). By the specified period of the experiment, the maximum level of printed brood was recorded in Group 3 – 274.0 squares, and in the control group – 224.0 squares. By the onset of the main honey flow, the number of printed brood significantly decreased in all the studied groups.

The data obtained by us on the effect of stimulating top dressing on economically useful signs of bee colonies are consistent with the materials of a number of domestic and foreign researchers, which reflect the positive biological and economic effect obtained when using various additives [11-13].

Thus, it can be noted that the average daily egg production of queen bees and the breeding of brood are subject to biorhythmological patterns, where the peaks of the rise and fall of the studied parameters are distinguished. The components of biorhythmological parameters, especially the peaks of ascent, are influenced by compositional stimulating top dressing with sugar syrup with a feed mixture of Similak in combination with drone larvae homogenate (Group 3) or sugar syrup in combination with drone larvae homogenate.

### 4. Conclusion

The effect of stimulating feeding on the functional activity of queen bees was established. At the same time, the greatest efficiency was revealed in usage of a compositional form consisting of sugar syrup, a feed mixture "Similak" and a drone larvae' homogenate. In the experimental groups, in contrast to the control group, an increase in the egg production of queen bees and the brood breeding reflex by 1.3-1.44 times was found. In general, it can be noted that to compensate for the protein deficiency and stimulate the physiological processes of the queen bee organism, increase the growth and development of bee colonies in spring, it is necessary to use stimulating feeding by sugar syrup in combination with drone larvae homogenate and feed mixture "Similak" 700 ml each.

The data obtained by us on the effect of stimulating fertilizing on the functional activity of queen bees are consistent with the materials of a number of domestic and foreign researchers [11-16]. Scaling up the results of apiary research in the future opens up new opportunities for strengthening the immunity of bees, reducing the effects of adverse environmental factors, increasing the yield of marketable products and the transition of this industry to an ecological path of development.
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