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Development and productivity of honeybee colonies administered food supplements in spring

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Summary

The aim of the study was to assess the effect of the diet supplements BeeTonic, Beeodine and Immunbee solution on the quality of honeybee colonies in the spring. The administration of dough containing Beeodine to bees may have had a positive effect on their vitality, thanks to which they occupied the largest space in the nest (4.1 inter-comb spacer, on average) on April 15, and in late April the occupied space in this group increased almost 2.5 times. The observed colonies had a similar number of cells with brood at the 1st and 2nd measurements. They also showed a similar growth of brood. The colonies given cake with Beeodine were characterized by the highest unit productivity (4.6 kg). Similarly, the production of brood, bees and wax was stimulated by the addition of Immunbee solution (4.3 kg), whereas BeeTonic did not produce such an effect.

Keywords: food supplements, Apis mellifera, BeeTonic, Beeodine, Immunbee

In the spring, honeybee colonies, weakened after the winter, face a difficult task: brood rearing (2, 15). Only those bees which are in good condition are able to meet the challenge. There are many factors that affect the quality of bee colonies in the spring. A major factor that determines the spring build-up of bee colonies is the availability of high quality food (12), which, unfortunately, can sometimes be reduced by weather conditions or the location of the apiary. Therefore, beekeepers support bees by supplementing their diet (4, 9, 13). The most common reason for the use of food additives in bees is an inadequate pollen supply or its poor composition (10, 11). Such deficits can be made up for by introducing pollen substitutes (5, 7) or ready-made mineral-vitamin-aminoacidic preparations (6, 8). Some supplements for honeybees are also intended to enhance disease control, but their efficacy is not always scientifically confirmed (3). The findings of Matilla and Otis (10) clearly show that the administration of food supplements is justified only in cases when, e.g., bees have no access to natural food in the spring because of unfavorable weather conditions.

New diet supplements that have recently appeared on the Polish market are BeeTonic, Beeodine and Immunbee. The first preparation is a mixture of 20 amino acids. Each 1 L of Beeodine contains 35.000 mg of Iodine, 15.000.000 IU of Vitamin A and herbal extracts. Each 1 L of Immunbee contains 5.000 mg of Zinc, 40.000 mg of Vitamin C and herbal extracts.

The aim of the study was to assess the effect of the diet supplements BeeTonic, Beeodine and Immunbee solution on the quality of honeybee colonies in the spring. Among the parameters assessed were the growth and productivity of bee colonies, as well as the health of bees fed with the additives compared with the health of control colonies administered honey-sugar dough without any additives.

Material and methods

The assay was carried out at the Apiculture Division of the University of Warmia and Mazury in Olsztyn, Poland, over the period from March 5, 2013, to June 6, 2013. In the assay, we used 120 bee colonies in 4 different apiaries, 30 colonies in each. The colonies were randomly assigned to 5 groups:

• group I (B) was given honey-sugar cake with Beeodine (4 × 6 = 24 colonies),

• group II (I) was given honey-sugar cake with Immunbee Solution (4 × 6 = 24 colonies),

• group III (T) was given honey-sugar cake with BeeTonic (4 × 6 = 24 colonies),

• group IV (C) was given honey-sugar cake without additives (4 × 6 = 24 colonies),

• group V (K) was given no cake and no additives (4 × 6 = 24 colonies).

Honey-sugar cake was made by mixing powdered sugar and blended honey at a proportion of 1 : 4 in a kneading trough. Diet supplements were added to the cake at the rates recommended by the manufacturers of the preparations, i.e.: Beeodine – 1 ml/1 kg, Immunbee solution – 5 ml /kg, BeeTonic – 5 ml/kg. Each bee colony from groups I-IV was given 2 kg of the cake in four doses, 0.5 kg each, every 11 days. The cake was administered for the first of time on March 4, and for the last time, on April 15.

In the course of the assay we examined:

• the growth of bee colonies by assessing the number of inter-comb spaces occupied by bees, and the number of brood cells in May;

• the infestation of bees with Nosema sp. spores (To test this parameter, we collected and killed 30 bees from each colony. Then we ground the abdomens of the dead bees in a mortar and prepared a water solution of the homogenized abdomens to observe the microscope preparation at 400 × magnification and record the mean number of spores from three fields of vision.);

• the productivity of bee colonies by assessing the amount of harvested honey and other products (The brood and bees taken from colonies, as well as the wax, were converted into honey units as follows: 10 dm^2 of brood = 1 kg of honey, 1 kg of bees = 2.5 kg of honey, wax added to one foundation comb = 0.17 kg of honey.).

Tab. 1. Number of occupied inter-comb spaces at consecutive measurements

Group	n	Apr. 15	Apr. 30	May 15	May 30	Jun. 15
B	24	$4.1^{Aa} \pm 0.9$	$10.1^{Aa} \pm 3.0$	$18.5^{Aa} \pm 4.7$	$26.2^{A} \pm 7.8$	$29.6^{a} \pm 4.6$
I	24	3.8 ± 1.0	$8.8^{b} \pm 1.5$	$16.5^{ab} \pm 3.9$	$25.5^{A} \pm 6.1$	27.5 ± 4.4
T	24	$3.5^{b} \pm 0.8$	$8.2^{B} \pm 1.8$	$15.3^{bc} \pm 3.8$	22.1 ± 6.9	26.7 ± 5.6
C	24	3.8 ± 1.0	$8.9^{ab} \pm 2.3$	$16.5^{ab} \pm 4.5$	$23.8^{a} \pm 7.7$	28.3 ± 5.6
K	24	$3.4^{B} \pm 0.8$	$7.3^{Bc} \pm 1.9$	$13.3^{Bc} \pm 4.3$	$19.4^{Bb} \pm 5.7$	$25.8^{b} \pm 5.0$
Total/Mean	24	3.7 ± 0.9	8.7 ± 2.3	16.0 ± 4.5	23.4 ± 7.2	27.6 ± 5.2

Explanation: B – cake with Beeodine, I – cake with Immunbee Solution, T – cake with BeeTonic, C – cake with no additives, K – no cake. Different capital and lowercase letters denote significant differences (p = 0.01 and p = 0.05, respectively).

Results and discussion

The Growth and Productivity of Bee Colonies. The highest average number of inter-comb spaces occupied by bees was noted on April 15 in group B – 4.1 (Tab. 1). Significantly fewer spaces were occupied by bees in group K – 3.4, on average, and in group T – 3.5, on average. At the same time, bees in groups I and C occupied 3.8 inter-comb spaces, on average, which did not differ statistically from the other groups (Tab. 1).

By May 15, the number of inter-comb spaces occupied by bees in the observed colonies doubled. Significantly more inter-comb spaces were still occupied by bees in group B (18.5, on average), as compared to groups K (13.3, on average) and T (15.3, on average). The inspection on May 30 showed significantly more inter-comb spaces occupied by bees in groups B and I (26.2 and 25.5, respectively, on average), as compared to group K (19.4). On June 15, a similar number of occupied inter-comb spaces were observed, and the differences noted between the means for the groups were not statistically significant.

No significant differences between the groups were noted regarding the average number of cells with brood at the 1st measurement of brood ($F_{4, 119} = 1.142$ at p = 0.340). The largest quantity of brood was noted in the colonies from group C (13.0 thousand), and the lowest number in the colonies from group K (10.1 thousand – Tab. 2). Similarly, no significant differences between the groups were noted regarding the quantity of brood at the 2nd measurement of brood ($F_{4, 119} = 0.3596$ at p = 0.837). The most were observed in the colonies from group I (24.8 thousand), and the least in the colonies from group K (22.3 thousand – Tab. 2). The growth of brood in the observed colonies ranged from 11.2 to 12.8 thousand, and the differences noted between the means for the groups were not statistically confirmed ($F_{4, 119} = 0.1433$ at p = 0.9656 – Tab. 2).

Tab. 2. Average number of brood cells (in thousands of cells)

Group	n	Brood measurement 1 Apr. 22	Brood measurement 2 May 13	Growth of brood area (2-1)
B	24	11.6 ± 5.3	23.8 ± 8.6	12.2 ± 8.2
I	24	12.0 ± 4.8	24.8 ± 6.6	12.8 ± 5.1
T	24	10.4 ± 5.1	22.4 ± 10.3	12.0 ± 7.4
C	24	13.0 ± 6.4	24.3 ± 9.9	11.2 ± 7.8
K	24	10.1 ± 6.1	22.3 ± 9.7	12.2 ± 7.4
Total/Mean	120	11.4 ± 5.6	23.5 ± 9.0	12.1 ± 7.1

Explanation: B – cake with Beeodine, I – cake with Immunbee Solution, T – cake with BeeTonic, C – cake with no additives, K – no cake. No significant differences between the means were noted.

Tab. 3. Productivity of bee colonies in particular groups (in kg)

Group	n	Productivity		
		honey	unit	total
B	24	10.6 ± 4.8	$4.6^{a} \pm 2.6$	$15.2^{a} \pm 6.2$
I	24	8.9 ± 5.4	$4.3^{a} \pm 3.1$	13.2 ± 7.8
T	24	8.5 ± 5.3	3.2 ± 3.9	11.7 ± 7.9
C	24	9.6 ± 4.5	$4.3^{a} \pm 4.3$	13.9 ± 8.4
K	24	8.0 ± 4.2	$2.0^{b} \pm 3.5$	$10.0^{b} \pm 6.9$
Total/Mean	120	9.1 ± 4.9	3.7 ± 3.6	12.8 ± 7.6

Explanation: B – cake with Beeodine, I – cake with Immunbee Solution, T – cake with BeeTonic, C – cake with no additives, K – no cake. Different lowercase letters denote significant differences (p = 0.05).

No significant differences between the groups were noted regarding the average number of kilograms of honey harvested in the spring ($F_{4, 119}$ = 1.0119 at p = 0.4043). The highest amount of honey was harvested from the colonies in group B (10.6 kg, on average), and the lowest amount from the colonies in group K (8.0 kg – Tab. 3). Bees, brood and rebuilt foundation sheets were converted into honey, achieving unit productivity. A significantly higher unit productivity was found in groups B (4.6 kg), I (4.3 kg) and C (4.3 kg), as compared to group K (2.0 kg – Tab. 3). The highest total productivity was achieved in group B (15.2 kg), and it was significantly higher than the total productivity in the colonies from group K (10.0 kg – Tab. 3). The total productivity in the remaining colonies ranged from 11.7 to 13.9 kg, and the differences noted between the means for the groups were not statistically significant.

The Health of Bee Colonies. Before the beginning of feeding, about 50% of bee colonies in all groups, except for group T, showed symptoms of infestation with *Nosema spp.* In group T, which was treated with BeeTonic, the percentage of infected colonies was higher, reaching 70% (Tab. 4).

The highest degree of infestation with *Nosema spp.* was observed in bees from group C (129 spores in the field of vision), and it was significantly higher than in group I (43.9 spores), as well as in the other groups (B – 68 spores, T – 89 spores, K – 73 spores).

After feeding, the number of colonies infected with nosemosis increased in most groups to over 62%, decreasing only in group T to the level of 58.3%.

We also observed that the infestation of bees in each group decreased after feeding in relation to the number of spores noted at the beginning of the assay. In group K, not provided with cake, the number of spores in the field of vision decreased by over a half, i.e. from 73 to 32 spores, on average. The highest level of infestation with *Nosema sp.* post feeding, i.e. 94 spores, as well as prior to feeding, was observed in group C, and it was significantly higher than in groups I and K, where the degree of infestation with *Nosema sp*. was, respectively, 37 and 32 spores, as well as in group B, where 46 spores were found (Tab. 4).

Colonies were given the first doses of cake after the first flight of bees at the beginning of March. However, because of a sudden return of winter with snow and temperatures below 0°C, which lasted until the first decade of April, the cake administered to bees at this time did not stimulate the growth of the colonies but was used to replenish food supply. With weather conditions improving in the latter half of April, the last doses of cake could stimulate the growth of bee colonies.

The administration of dough containing Beeodine to bees may have had a positive effect on their vitality, thanks to which they occupied the largest space in the nest (4.1 inter-comb spacer, on average) on April 15, and in late April the occupied space in this group increased almost 2.5 times. Dough with other additives did not have such a distinct effect on the colonies, although the colonies fed with dough containing Immunbee solution, similarly to group B colonies, occupied a significantly larger space in the nest on May 30, as compared with non-fed colonies.

All colonies had a similar number of cells with brood at the 1st and 2nd measurements. They also showed a similar growth of brood. It was probably due to the fact that stronger colonies used the nest space for storing food in greater measure. This resulted in a bigger honey production. More honey was always harvested from the colonies fed with cake than from the colonies that did not receive cake. Although this difference was not statistically confirmed, on a larger scale it could affect the profitability of apiaries. Herbert and Shimanuki (8) examined the supplementation of the bee diet with fat-soluble vitamins. They found that colonies administered vitamin A reared twice as much brood as control colonies. In our assay we showed no effect of the preparation containing vitamin A (Beeodine) on the number of cells with brood, which probably resulted from the fact that all bee colonies used in the experiment had free access to natural flower pollen and thus also to the natural source of vitamin A.

The colonies given cake with Beeodine were characterized by the highest unit productivity (4.6 kg). Similarly, the production of brood, bees and wax was stimulated by the addition of Immunbee Solution (4.3 kg), whereas BeeTonic did not produce such an effect. BeeTonic

Tab. 4. Number and percentage of colonies infested by spores in particular groups and the average number of *Nosema sp*. spores

Group	n	Infestation			
		prior to feeding		post feeding	
		No and % of infested colonies	average number of spores	No and% of infested colonies	average number of spores
B	24	13 (54.2)	68^{b} ± 66	15 (62.5)	46^{b} ± 44
I	24	13 (54.2)	44^{B} ± 43	15 (62.5)	37^{B} ± 29
T	24	17 (70.8)	89^{b} ± 84	14 (58.3)	61 ± 56
C	24	12 (50.0)	159^{Aa} ± 108	16 (66.7)	94^{Aa} ± 65
K	24	11 (45.8)	73^{b} ± 63	18 (75.0)	32^{B} ± 25
Total/Mean	120	66 (55)	86 ± 73	78 (65)	54 ± 46

Explanation: B – cake with Beeodine, I – cake with Immunbee Solution, T – cake with BeeTonic, C – cake with no additives, K – no cake. Different capital and lowercase letters denote significant differences (p = 0.01 and p = 0.05, respectively).

can be treated as a pollen substitute because it is mostly composed of amino acids naturally contained in flower pollen. Therefore, the addition of this preparation may not have had any insignificance in our assay, in which all assay groups had free access to natural pollen. Matilla and Otis (10) showed that supplementation with pollen had a significant effect only in the spring when it visibly enhanced the growth of bee colonies and increased the production of young worker bees over the period from mid-April to the first decade of May. On the other hand, the researchers did not observe a significant effect of pollen substitutes on annual honey production. Madras-Majewska et al. (9) found pollen supplementation to be entirely pointless when natural pollen was available. Therefore, it is only worthwhile to use BeeTonic in the early spring, when there is no bee bread in honeycombs, and natural pollen is unavailable.

The highest total productivity was achieved in the colonies administered cake with Beeodine (15.2 kg of honey). The other colonies fed with cake gave from 1.9 to 3.9 kg of honey more than the non-fed colonies (10.0 kg). Although this difference was not confirmed statistically, it could, on a larger scale, affect the profitability of apiaries.

The average number of *Nosema sp.* spores in individual groups post feeding differed statistically. This could be due to the effect of cake additives. However, the analysis of the average number of spores prior to feeding showed similar statistical relationships between the groups. The fact that significant differences between the average numbers of spores in groups occurred prior to the assay is entirely accidental, as the groups were created randomly.

The average number of *Nosema sp.* spores post feeding decreased in all groups, including the control groups. It has long been a scientifically confirmed fact that together with the growth of bee colonies in spring, infestation gradually decreases, especially in the case of *Nosema apis* infections (1).

The number of colonies showing nosemosis symptoms changed. In most colonies from all assay groups, *Nosema sp.* spores were found prior to the administration of cake, as well as post feeding. It was also observed that in some colonies diseased before the assay, no *Nosema sp.* spores were found after the administration of cake, and vice versa. These results clearly indicate that there is no relationship between the percentage of colonies infested with *Nosema sp*. and the mode of spring feeding. Iodine-containing Beeodine, used in the assay, is recommended by the manufacturer as a preparation supporting anti-nosemosis treatment. Our study, however, did not confirm this effect. Similarly, Botíasa et al. (3) did not observe a therapeutic effect of another iodine-containing preparation, Nosestat, which they tested.

Conclusions:

1. The administration of cake with the addition of Beeodine or Immunbee Solution to bees probably increased their vitality, which resulted in their more intense spring growth.

2. The colonies given cake with Beeodine were characterized by the highest unit and total productivities.

3. Under field conditions, no effect of the feed additives on the course of nosemosis was observed. In order to better explore this subject, laboratory studies with the use of cage tests should be performed.

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