

Influence of biostimulating supplement on economically useful abilities of bees in the Udmurt Republic

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Abstract— The use of bioactive substances in apiculture as a composition of sugar supplements normalizes the course of the biological processes – it activates enzyme systems, increases the digestibility of nutrients and also increases immune resistance to adverse environmental factors. Beekeepers widely use mineral compounds, decoctions and tinctures of plant raw materials, which cause a certain physiological effect when given in small dosages, and contribute to the production of ecologically pure apiculture products. Stimulating supplement for bees based on sugar syrup, enriched with Taxifolin antioxidant (15 mg pr. beehive), once during autumn and twice during spring, contributed to an increase in the egg production of the queen bee and honey productivity of the experimental beehive, compared to the control beehive by 16.5-13.5% and 21.9 %, respectively.

Keywords— *bee, supplement, bioactive substances, Taxifolin, winter resistance, egg production, honey productivity.*

I. INTRODUCTION

The interest in bioactive apiculture products is dictated by their unique properties, which became popular in the 21st century – a century of environmental tension and high stress loads. The exceptional value of bee products lies in the fact that in the composition of these products, which the nature itself has created, the native elements are regulators of bioprocesses: they mobilize the immune’s defenses and normalize disturbed homeostasis [1-3].

It is a fact that the bee colonies are adversely affected by environmental degradation, which is especially obvious in the spring period after a long winter. Consequently, the search for ways to increase the stability of the organism of honey bees becomes the most urgent task in beekeeping [4-6].

Bees have a highly organized natural immune resistance, which manifests itself to the full extent under favorable conditions and the achievement of the optimal quantity of members in the beehive, but them being social insects living in a limited space – means that they need additional protection. The individual system of the natural resistance of bees is represented by several types of cells: secretory cells – the intestines and intestinal glands; hemocytes and reticulo-endothelial cells. These cells produce lysozyme, antibacterial peptides, lectins and serum complement; and the polyphenol

oxidase, glucose oxidase and intestinal proteases also have a protective effect. Injury or infection of insects increases the activity of the above factors tenfold. The increased activity of resistance factors persists in the body of bees for up to five days.

Factors derived from the immune system have many functions, but every factor has a special defense task in the organism: lysozyme dissolves gram-positive bacteria; antibacterial peptides destroy gram-positive and a number of gram-negative bacteria; lectins agglutinate microorganisms that enter the hemolymph; serum complement opsonizes bacteria and promotes phagocytosis. Intestinal proteases inhibit individual viruses. Polyphenol oxidase, activated by infectious agents, is a factor of immunity – under its influence quinones with bactericidal properties are released. Interact with thiol and amine groups, quinones form melanin, isolating microorganisms.

Almost all the protective substances and enzymes, produced by intestinal glands of honeybees, end up in the honey while preserving their functional characteristics. They are consumed with honey by the larvae that do not have their own developed glands.

Factors of natural resistance of bees determine such protection mechanisms as agglutination, phagocytosis, melanization, encapsulation, agglomeration and lysis. Hemocytes of the larvae are actively phagocytosing foreign substances. The majority of the infectious material is captured by plasma cells and excretory cells, some of which are then adjacent to the inner surface of the cuticle and rejected with it during a regular molt. Elimination of the infectious agent from the body of imago occurs mainly due to agglutination, lysis, and the release of decay products through malpighian vessels. Local melanization in the body of bees proceeds according to the principle of the antibody-independent cytolizing action of lymphocytes.

The beehive is a cohesive biological unit, in which separate individuals are interconnected both by one queen bee and by a community of living conditions. Preservation of the hive is ensured by swarming, removal from the infected nest, replacement of the queen bee, sanitary cleaning of combs and hives, storage of feed for future use. The main instincts of the bees is to achieve an optimal quantity of

members in the beehive, since only under this condition the thermal regime, reproduction, feed supply and effective protection are ensured.

Over the past decades, bee colonies are in a constant stressful situation due to systematic antibiotic treatments, intensive feeding of sugar syrup that leads to premature consumption of reserve substances of the body; depletion of the pharyngeal glands and reduced life expectancy of bees [7, 8].

Therefore, bees need to create optimal conditions that meet their biological needs, only in this case their vital energy will be saved throughout the entire winter period.

One of the ways to optimize biomass and stimulate the process of increasing the power of bee colonies, which determine the outcome of wintering, is the use of biologically active nutrients of plant origin [1, 9]. Bioflavonoid from the bark of Siberian and Dahurian larch has a high biological activity – Taxifolin, which has antioxidant, redox, antiparasitic, antibacterial, capillary-protective, anti-radiation and immunomodulating properties. Taxifolin is recognized as a powerful antioxidant, the most important of the P group vitamins. Numerous studies by scientists have confirmed that the bioconcentrate of the footing part of the larch regulates metabolic processes at the level of cell membranes, affects the microcirculatory, and is safe – does not possess cytotoxic action and mutagenic activity [10].

II. LITTERATURE REVIEW

A number of researchers emphasize that obtaining maximum honey productivity is possible under the condition of a large number of bees in the hive before the main honey harvest, since only strong beehives are able to fully live up to their potential. It was revealed that the presence in the nest of at least 50 thousand individuals is able to collect the nectar and pollen in the greatest quantity. The colony can develop such an amount of bees by consuming a sufficient amount of nutrients and balanced high-quality feeds. To do this, bees need to add dietary supplements to the feed, which have a positive effect on the physiological parameters of bees.

The use of bioactive substances in beekeeping helps to normalize the course of biological processes – to activate enzyme systems, to increase the digestibility of nutrient nutrients and the immune's resistance to adverse environmental factors [1, 2, 7, 1-13]. Beekeepers widely use mineral compounds, decoctions and tinctures of plant raw materials, which cause a certain physiological effect when given in small dosages.

Scientists M.M. Ivaylova, A.Z. Brandorf, A.V. Pralnikov discovered the need to use mineral substances of organic origin as a stimulating feed. Stimulating feeding of bees with sugar syrup with the addition of organic colloidal calcium contributed to an increase in the reproductive functions of queen bees by 20.0%, such colonies were distinguished by high winter resistance – by 60.0% more than in the control group that did not received stimulating feed. Scientists also discovered an effect of the “Apicar” product, which contains calcium, folic acid, vitamin B12 – it increased the strength of the bee colony and increased the honey productivity [10].

M.K. Chugreev, A.A. Mosolov developed the protein-vitamin-mineral composition “Eliteol”, which in the amount of 2 grams (as a part of sugar syrup) had a positive effect on

the honey productivity of bee colonies, the difference with the control group was at 18.0%. The composition of “Eliteol” includes the bio-additive “Elite”, which is obtained from baking yeast, which has a high biological value, and zeolite flour of organic origin, which contains a number of essential minerals: potassium, iron, silicon, manganese, titanium, magnesium, sodium, calcium and B group vitamins [12].

The use of the “Eco-stimulus” supplement, the main component of which is the natural bioflavonoid – taxifolin; that helps to increase the physical endurance and vitality of the bees, stimulate the fertility of the queen bee and increase the honey productivity [11].

Our purpose of this research was to determine the effectiveness of the use of antioxidant plant raw materials in winter resistance and productivity of bee colonies in the conditions of the Udmurt Republic.

III. METHODS

Studies were conducted in the central zone of the Udmurt Republic in the stationary apiary of the Uvinsky district in 2017-2018. The object of the study was cross bees. We were guided by the methodological recommendations “Methods for conducting research in beekeeping” while conducting the research [6]. Studies were conducted in two stages. At the first stage, the winter resistance of bee colonies was determined against the background of bioadditive application – taxifolin. For this purpose, the control and experimental groups of 10 bee colonies were formed, which were identical in age of the queen bee, strength of the colony, amount of honey and sealed brood, hive design. The control group received sugar syrup; the experimental group received an antioxidant supplement with syrup at the rate of 15 mg pr. beehive. Feeding of bees was carried out once in September. Maintenance of bee colonies at the apiary were in the wintery ($t = 0 \dots + 40C$). The beehive with bees was brought in the first decade of November, and brought out in the second decade of March. The development of bee colonies was taken into account from the early spring three times every 21 days. The amount of brood was determined by the method of V.V. Malkova – according to the number of cells occupied by broods, with the help of a frame-grid (a square of 5x5 cm includes 100 cells of bee brood).

The obtained positive results became a prerequisite for the further research – determination of the effect of different dosages of taxifolin on the honey productivity of bee colonies. The control and three experimental groups of 10 bee colonies in each were similarly formed for the spring research. The control group received sugar syrup and the experimental groups received taxifolin with the syrup according to the research scheme (Tab. 1). Stimulating feeding of bees was carried out twice, with a frequency of 12 days. Honey productivity was determined by the gross harvest of honey. Statistical data processing was performed using Microsoft Office Excel.

The most difficult and crucial period in the life cycle of a bee colony is wintering, the outcome of which is determined by the preparation of colonies, and is decisive in the spring-summer development of bees and their productivity. Bees are not adapted to the accumulation of a large amount of nutrients in their bodies, fat accumulation is not more than 2.0%, therefore, the quality of feed and stimulating supplements play an important role in creating favorable

parameters of beekeeping in the winter period [4, 5, 9]. In the last decades of the twentieth century and the beginning of the twenty-first century, in order to maintain the vital activity of bees in the spring, scientists and beekeepers recommend enriching sugar syrup with organic products based on plant raw materials, the use of which will help to obtain ecologically pure apiculture products [1, 3, 7, 9, 12, 13]. Taxifolin is not a substitute for feed – it intensifies their digestion by activating carbohydrate, protein, lipid and mineral metabolic processes.

Influence of biostimulating feeding on winter resistance and productivity of bee colonies			
Control group		Experimental group	
Sugar syrup (1:1)		Sugar syrup (1:1) + Taxifolin 15 mg / beehive	
Wintering of bee colonies inside: the brood quantity			
Control group	Experimental group 1	Experimental group 2	Experimental group 3
Sugar syrup (1:1)	Sugar syrup (1:1) + Taxifolin 5 mg / beehive	Sugar syrup (1:1) + Taxifolin 10 mg / beehive	Sugar syrup (1:1) + Taxifolin 15 mg / beehive
Honey productivity of the beehive: gross, marketable honey			

Fig. 1. The general research scheme

The results of determining the egg production of queen bees, which regulate the vital activity of bees, are presented in Tab. 2.

TABLE I. THE DYNAMICS OF BEE BROOD IN SPRING-SUMMER PERIOD, HUNDREDS OF CELLS

Sample	Control group	C, %	Experimental group	C, %
<i>Wintering inside</i>				
1	169.2±3.89	5.14	166.4±3.6	4.83
2	244.8±12.1	11.1	285.2±5.61	4.4
3	339.8±3.6	6.35	385.6±6.8	3.9

A comparative analysis of the content of bee colonies revealed that the use of taxifolin made it possible to increase the number of brood to the second dimension by 40.4 hundred cells or by 16.5%. By the third dimension, this difference in favor of the experimental group was 45.8 hundred cells or 13.5%, which indicates the manifestation of the physiological effect of the bioadditive on the interior indicators of bees.

The experience of advanced farms shows that the successful development of beekeeping largely depends on the presence in each farm of a sustainable forage base, which provides the bees throughout the beekeeping season. A well-organized forage base, if used properly, creates conditions for obtaining commercial honey on apiaries, even in unfavorable climatic conditions.

The natural honey base, which gives the majority of marketable honey in the apiary of the Uvinsky district of the Udmurt Republic, is represented by small-leaved linden, which occupies 288 hectares of area, which is 37.0% of the total forest area.

It is a fact that in terms of the secretion of nectar, ripe and overmature linden trees are the best. In the study area of the apiary, these kinds of linden trees occupy 62.4 hectares, where the share of the young trees is 56.9 hectares (19.8%), the middle-aged lindens - 122 hectares (42.3%), the maturing lindens - 46.7 hectares (16.2%). It should also be noted that lindens in large quantity do not practically occur in the apiary – mainly it is a small-leaved linden tree that grows in a mixture with other coniferous and deciduous species (Norway maple, Scots Elm, Silver Birch, Grey Alder, Hackberry, Rowan, Spruce, Fir).

Equally important is the nearest presence of apiaries with herbs that can provide bees with additional nectar and pollen for obtaining sustainable honeyflow. In order to ensure a stable forage base even in lindens, it is necessary not only to preserve such areas not covered with forest, as plains and wedges, but to create in addition to them crops of honey bearing plants at the rate of not less than 5 hectares of honey bearing plants for every 100 bee colonies. The study also revealed that only 13 specimens of honey plants mainly form supporting honeyflow on hayfields, glades, clearings, pastures and other territories occupied by herb communities.

TABLE II. HONEY PRODUCTIVITY OF ONE BEEHIVE

Groups	Marketable honey, kg	Gross honey, kg
Control	10.2±0.89	31.5±1.43
Experimental 1	11.9±1.12	32.6±1.23
Experimental 2	12.4±0.84	34.7±1.67
Experimental 3	14.6±0.97	38.1±1.82

The honey productivity in both marketable and gross honey between the studied groups was higher in the experimental groups. Moreover, the beehives that consumed the maximum dose of the supplement (15 mg / beehive) had a more significant increase: the 3rd experimental group exceeded the 2nd and 1st experimental groups by 3.4 kg and 5.5 kg in the gross honey, and the control beehives – by 6.6 kg. The productivity of bee colonies is determined not only by the number of brood, but also by their functional activity. The use of a biological product in the composition of sugar syrup had an indirect effect on the restoration of disturbed processes, enhancing the function of the organism, which as a result contributed to an increase in its resistance to unfavorable environmental factors, and as a result, the activation of the nectar-collecting ability of bees.

IV. CONCLUSION

1. The use of an antioxidant supplement increased the immune resistance of honeybees to external factors, the accumulation of nutrients in the body and their even consumption in the winter period: the number of brood at the main honeyflow was increased by 13.5-16.5%.

2. The use of taxifolin as a part of stimulating feeding increases the honey productivity of bee colonies: the gross

honey harvest in the 3rd experimental group was higher than in the bee colonies of the control group by 6.6 kg (17.3%).

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