

The efficiency of using hydrocarbon-protein feeding for honey bees

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Goal. To determine the effectiveness of carbohydrate-protein feeding, namely: the impact of protein feed (bee pollination) on the development of bee colonies and physiological parameters of bees in the period of its absence or low level of receipt. **Methods.** Laboratory — to determine the mass of larvae and bees, zootechnical — to account for the growth and strength of the bee family, statistical — for biometric processing of experimental data. Biometric data processing was performed on a PC using MS Excel software. **Results.** The influence of the use of carbohydrate and protein fertilization on the spring growth of bee colonies and their preparation for the effective use of the honey collection is studied. The expediency of using carbohydrate-protein feeding for the bee colonies to improve the physiological parameters of bees is shown. **Conclusions.** Carbohydrate protein feeding in the spring significantly affects the growth of bee colonies, allowing them to build strong families before the honey harvest. Carbohydrate-protein feeding of bees in early spring promotes the production of larger larvae, which, in turn, contributes to the production of high-grade bees. The proposed method of feeding bee colonies in the spring in the form of a paste (candy), which includes: powdered sugar, liquid honey, bee pollen, water, is a simple and effective one and can be recommended to increase the number of bees in the spring in preparation for honey harvest. The use of carbohydrate-protein feeding helps to increase the honey productivity of bee colonies and increase the intensity of egg-laying of queen bees. However, carbohydrate-protein feeding makes sense only before the start of the main honey harvest, i.e. in the conditions when there is a lack of bee pollen in the nest.

Key words: *bee family, bee pollination, carbohydrate-protein feeding, bee brood, larva, newborn bees.*

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The annual cycle of the development of the bee family in our climatic conditions can be described briefly in this way: during the warm time of the year young bees in the first days of their lives are intensively feeding on bee pollen and bee bread. Thanks to that, they are developing hypopharyngeal glands and the premise of the increase in life expectancy is created. With the start of brood raising the nutrient reserves in the bees' bodies are expended, the bees are ageing and become short lived «summer bees». If for some reason the brood is limited or bees are not raising it at all (for example with the loss of the queen bee and termination of the laying of eggs due to disease, swarming, bad weather) the nutrient reserves are accumulated in their bodies and the life expectancy is increasing.

The bee family is providing its own food, however each beekeeper should be able to manage that process as well as the methods of bees' feeding. [1, 2]. It should be remembered that in evolution the bees developed the instinct of the food stocks economy. The issue of the correct provision of fodder is of great economic importance since the price of the feed for bees accounts for 40–50 % of total expenditure. In spring bees don't have enough honey of their own, some classes of honey are fully candied until spring, and therefore insects are deprived of nutritious food [3]. After the spring flight the active life starts in the nest. The beekeeper's task before the beginning of the honey collection is to increase the number of bees and to strengthen the bee family. With this goal in mind, it is necessary to increase the queen bee's egg laying process. For that purpose the feeding of various types is used [4, 14].

The balanced nutrition of bees facilitates their high resistance and productivity [4-6, 13] with the conglomeration of the necessary reserves of nutrients that are actively deposited in the summer-autumn period in the fat body of the insects [7]. It is confirmed experimentally that the life expectancy of the working bees is directly proportional to the degree of development of the fat body [8]. In case of lack of natural food that occurs in the spring and summer-autumn periods of the bees' nutrition, the artificial feeding is implemented with the use of protein, lipid and mineral components [9, 10, 11].

The availability of food plays an important role in the activity of the bee families and obtaining the high-grade offspring. The feeding of bees is providing them with additional carbohydrate and (or) protein feeds. [10, 12, 13]. Sugar or honey syrups or their mixture are mainly used as carbohydrate feeds, while bee bread, pollen and substitutes (soya flour, yeast, milk etc.) are used as protein feed

Carbohydrate-protein feeding is also used in spring for stimulation of brood raising. Such a feeding is conducted in small portions every day or every other day, which creates the illusion of flow among bees and they increase the numbers of brood. The feeding of bees in spring has many advantages, because it helps beekeepers to prepare bee families for honey collection and also to make them healthier and stronger [14]. The insects should preferably fully recover and create strong families by early July [15].

It should be mentioned that the protein feeding of bees is the most popular. The protein feeding includes bee bread, pollen or their synthetic substitutes [16]. The activity of the honey bee family, particularly brood raising, successful wintering, disease resistance, flight-collecting and pollinating activity, is largely dependent on the stocks in the nest and the flow of the protein feed – bee pollen [4, 15]. Early in spring bees are often lacking bee pollen and it leads to protein starvation of the bee families, resulting in termination of brood raising and decreasing of life expectancy of adult bees. Under conditions of protein starvation the brood raising is terminated, the bees throw larvae out of the cells. Sometimes the diseases occur– protein starvation or dystrophy of bees [17]. Those bees have low weight, short period of life, the wax and honey productivity in families are decreasing [18].

Bees are developing most actively during the period of the flow of the nectar and bee pollen into the nest during the natural collection. However the feeding with carbohydrate feed (syrup (water with honey), sugar syrup) or protein (bee pollen) also has a positive impact on the development of bee families [19, 21].

With a deficit of protein feed bees are slowly developing hypopharyngeal glands and thus the level of feeding of larvae is decreasing. As a result, in such families the bees with a lower body mass are born and their hypopharyngeal glands cease to function quickly enough leading to reduced ability to transform the nectar into honey [22, 23].

The stocks of protein food in the nest is an important factor that has a significant impact on the activity of bee families, particularly during the period of spring reproduction .

Goal. To study the influence of the carbohydrate-protein feeding on the development of bee families and physiological rates of bees in the period of low flow level of the bee pollen to the nest of the bee family

Materials and methods of research. In order to complete the task, in spring, after the cleansing flight the two groups of bees were formed– with 10 families in each group (experimental and control groups). Initially (before conducting the research) the bee families with the same numbers of bees and brood, honey and bee bread food stocks in the nest were chosen.

The bee families met the conditions of the standard of the Ukrainian steppe breed, as confirmed by the results of the exterior evaluation. All bee families were kept in the long hives for 20 standard frames measuring 435x300 mm. Caring for the bee families of both groups was conducted in the same way, according to the generally accepted methodologies [24].

Accounting the growth of the bee families was performed before the start of the research and every 12 days while taking into account the number of sealed brood (hundreds of cells). For the conduction of the research the combframe was used (the square size being 5x5 cm, containing 100 bee cells). The power of families in the bee spaces was transferred on the standard frame (435x300 mm), which contains up to 300 g of bees. The egg-laying capacity of the queen bee was determined by photographing the sealed brood from both sides of the comb and counting the brood on the enlarged image and then the total was divided by 12. The mass of the newborn bees was determined on torsion scale VT-500. For ease of weighing, the bees were placed into previously weighted foil envelope and after the weighing the mass of envelope was subtracted from the total mass. The mass of the six-day larvae was determined in the following way. Larvae was pulled out of the cells using spatula, rinsed with water, dried and weighed in groups of 10 at a time on the analytical balance accurate to the 0,01 mg.

To reduce time spent for feeding, to avoid cooling of the nests in the cold spring days and disturbing the bee families too often, on the second day after the flight and accounting, the bee families received the feeding in the form of paste (candy) consisting of powdered sugar –500 g, liquid honey –125 g, bee pollen–155 g, water – 30 ml. Before preparation of candy the bee pollen was soaked in water for six hours. The bee families of the control group received the same feeding, but without adding of bee pollen. Before handing out candy, all the honey- bee bread combs of the bee families without the brood were removed from the nests and replaced with the empty ones. In this way, at the beginning of the research, before handing out protein-carbohydrate feed, all the nests of the bee families were completely emptied of the supplies of protein feed. This allowed to keep them under identical initial conditions (total lack of feed) and also to provide the accuracy of the results in the further study. Candy was given to bees in the polyethylene bags placed on the upper blocks of frames above the nest. To create the necessary conditions for the flow of the food into the nest, its each next portion was given to the bee families right after consuming of the previously offered one. The collecting of honey by the bee

families was accounted by weighing the honey that was extracted and honey that was left for the bees in the combs.. The quantity of honey that was extracted and the one that was left in the nest was determined with the help of dynamometer subtracting the mass of the frame with empty comb from the total mass (the frame measuring 435×300mm with the empty comb weighs about 500g). This data was statistically processed using methods of variational statistics with consistency check of results.

Research results. For the use of the potential of the meliferous base in its entirety by the bee families, the ability of bees to develop actively and obtain the highest level of development by the period of beginning of honey collection developing the maximum productivity as a result, is important. The ability of the bee family to develop actively depends on its capacity for reproduction as in raising the new generations of bees with increasing intensity. This ability is determined by various scientifically proven and evidence-based factors. In particular, these include reproductive capacity of the queen bee, physiological state of working bees, feeding provision (the availability of the meliferous base), the strength of the bee family, ratio of the specific age groups in the nest and a number of other.

The dynamics of the development of the bee families was determined according to the results of the measurements of the sealed brood areas in the control and experimental groups of families (table 1).

1. The dynamics of the spring development of the bee families under carbohydrate-protein feeding, ($M\pm m$, $n=10$), quadrants

The date of accounting	Control group		Experimental group	
	$M\pm m$	%	$M\pm m$	%
March 29	78.5±2.42	100	78.0±2.40	100
April 10	118.2±5.84	100	144.2±5.06	120.3
April 22	150.8±5.03	100	192.9±8.77	127.9
May 4	194.5±9.12	100	264.0±7.64	135.7
May 16	233.8±10.94	100	318.4±9.76	136.2

According to the results of the experimental study, provided in the table 1, it was determined that in all periods of accounting bee families of the experimental group raised more brood than the ones of the control group. The above-cited results don't have the reliable difference ($P>0,05$) between the control and research groups. During the period of the control measurements of the sealed brood areas, the bee families of the control group that, unlike experimental group, didn't receive the feeding in the form of candy with bee pollen, raised 22,3% of brood less on the average than the similar bee families of the research group.

The above-cited results convincingly demonstrate that carbohydrate-protein feeding in early spring (April and the first half of May) has a positive impact on the quantity of the raised brood.

The most effective was the use of the carbohydrate-protein feeding in April and the first half of May. During this period the flow of the bee pollen was reduced due to adverse weather conditions and the small quantity of flowering pollen sources. As for May period, it can be characterized as the beginning of the main honey collection from *Robinia pseudoacacia* and also the period when most of the pollen sources and honey sources were blooming.

One more important factor learned from the research should be noted as it had a negative impact on the conditions of the families from experimental and control groups. The bee families of both groups that regularly received the carbohydrate-protein feeding throughout the spring-summer period haven't stopped their development and none of the families went into a swarming state.

This conclusion is important for the practical beekeeping because swarming of bee families reduces the production.

One of the indicators of vitality and normal activities of bees is their mass. For this purpose we conducted the research to determine the influence of the carbohydrate-protein feed on the live weight of the six year old larvae and newborn bees. The research data can be found in the table 2.

2. The influence of the carbohydrate-protein feeding on the mass of larvae and bees

Indicator	n	Candy without the bee pollen (control)	Candy+bee pollen (experiment)
		M±m	M±m
The weight of six year old larvae, mg	150	146.35±0.87	154,96±0.60
P	<0.001		
The live weight of the newborn bees, mg	250	90.45±0.43	93.02± 0.59
P	<0.001		

It should be noted that as a result of feeding of the families of experimental group with candy containing bee pollen the live weight of six year old larvae averaged 154,96±0,60 mg, which is 8,61mg larger than in the control group – 146,35±0,87 mg. The difference is statistically accurate (P<0,001).

The live weight of the newborn bees of the families of control group averaged 90,45±0,43 mg, while the weight of the newborn bees of experimental group that were getting the protein feeding averaged accordingly 93,02±0,59 mg, which is 2,57 mg larger than the weight of the bees of the control group. The difference is statistically accurate (P<0,001).

Following the carbohydrate-protein feeding, the accounting of the strength of the bee families was held and it was found that through the research period the strength of the bee families was gradually increasing. As a result of the better development of the experimental families, their strength in comparison to the control group was 2,5 bee spaces larger on average as evidenced by data in table 3.

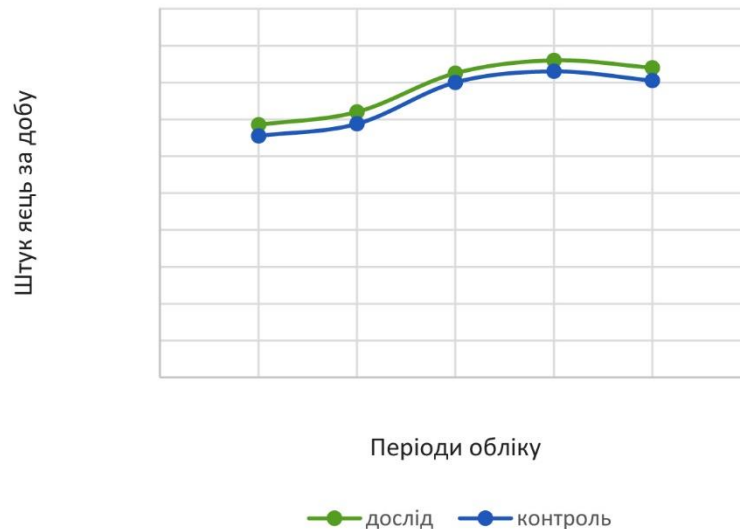
1. The state of the bee families in the period of feeding, M±n, n=10

Groups of families	The strength of families, bee spaces	The quantity of feed	
		Honey, kg	Bee bread, quadrants
April 22			
Control	8,5±1,03	7,8±1,32	4,2±2,34
Experimental	8,5±0,78	7,5±1,09	3,8±2,41
May 4			
Control	8,6±1,05	10,8±0,85	25,4±3,42
Experimental	8,9±0,86	9,2±0,81	24,7±2,25
May 16			
Control	10,1±0,51	14,1±1,35	27,6±1,25
Experimental	10,5±0,41	19,7±1,06	27,7±3,52

According to the results of research, in two weeks after the first accounting, the strength of the bee families of the experimental group increased by 5,2%, third date of the accounting – by 23,5% (p<0,001).

The use of carbohydrate-protein feeding contributed to increased rates of honey productivity of the bee families of the experimental group on the honey collection. The honey collection of the bee families of the experimental group averaged 19,7 kg of saleable honey vs 14,1 kg of the saleable honey of the families of the control group, which 5,6 kg less.

The carbohydrate-protein feeding enhanced the increased intensity of the egg-laying of the queen bees.



The intensity of the egg-laying of the queen bees

In the control group the increase of this rate was observed on the level 9,9%, in the experimental – 20,4%. That is to say, the addition of the bee pollen to the candy composition in the period of spring development of bees increased the intensity of the egg-laying of the queen bee by 11,3% comparing to the control. The number of the eggs laid by the queen bees through the whole research period highlights the positive impact of the carbohydrate-protein feeding on their reproductive function.

Conclusions

Consequently, carbohydrate-protein feedings in spring under terms of the lack of bee pollen source significantly affects the growth of the bee families giving the opportunity to develop strong families before the honey collection. But they make point only before the start of the main honey collection, in particular in the conditions when there is the limited flow of the bee pollen into the nest.

That is why we recommend collecting the part of the bee pollen using pollen catchers in the period of its sufficient flow to the families, preserving it and then using it for preparing the protein mixtures and giving to bee families in spring. Using the bee pollen for feeding is possible strictly under conditions of the absence on the apiaries of infectious and invasive diseases.

The data provided leads to the conclusion that carbohydrate-protein feeding in the early spring leads to increasing the larger larvae, which in turn contributes to obtaining more viable bees.

The conducted research confirmed the relevance of carbohydrate-protein feeding. The inventive method is simple and effective and can be recommended to beekeepers for developing bees in spring in preparation for honey collection.

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