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Influence of soy flour and its processed products on the essential amino acids content in the bees body

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Contents

Abstract

Providing bees with benign and sufficient protein feeds is the key to successful beekeeping. Protein feed significantly affects on certain functions of individuals and the vital activity and productivity of the bee colonies. So, as a result of increased consumption of protein feed during the first days of life the supply of proteins in the body significantly increases in young bees, hypopharyngeal glands and other organs become developed, which provides the ability to perform various tasks depending on age and living conditions. Older bees consume protein for tissue renewal with new cells and metabolic processes. Bees raised on low protein feeds become physiologically defective and do not live long. In conditions of protein starvation, brood rearing stops and bees throw larvae out of their cells. The article presents the results of studying the effect of using soy flour and its processed products in bee feeding on the essential amino acids content in their body. It was found that the use of soy peptone in bee feeding contributes to a greater accumulation of essential amino acids in the bees body in different periods of their development, in compared to soy milk, defatted soy flour and roasted soy flour which indicates a higher efficiency of its use as partial substitutes for protein feeds.

Key words: bee colonies, soy peptone, bee pupae, bees, roasted soy flour, soy milk.

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1. Introduction

Productivity of bee colonies largely depends on the influence of exogenous factors. The most important of them are: the presence of a honey base, climatic conditions, environmental ecology and more. This significantly affects on the families growth and their subsequent productivity (Vishchur et al., 2016; Kovalskyi et al., 2018; Vishchur et al., 2019; Kovalchuk et al., 2019; Piven et al., 2020).

Recently, due to the restriction of seeding nectar-bearing plants and environmental pollution with harmful chemicals, it has become increasingly difficult to provide bee colonies with protein food (bee bread). Bees experience a particular shortage of feed in early spring. During this period, as a rule, a few honey plants blooming and the weather conditions do not always allow bees to fly out of hive. In this case, protein feed reserves are quickly exhausted, which leads to a growth delays and development of bee colonies (Pendolovskij, 1987; Polishhuk, 2001).

It is known that proteins are a group of substances (proteins and amides) containing nitrogen, providing metabolic processes of living organisms, including honey bees. Under the action of proteases-enzyme in the midgut, proteins are split into amino acids and then to simpler compounds are amino groups. Due to biochemical reactions, some amino acids are converted into others through amino groups. The more diverse the amino acid composition of protein feed are, the more complete the body's nutrition is. Simple substances are formed during the digestion of protein feed are absorbed by the epithelial cells of the midgut, and then carried by hemolymph to various organs. In bees, amino acids are used to build their own body, and also in milk form are used to feed the brood (larvae) and queen (Dejneka, 1997; Birman et al., 2000; Ivchenko, 2005). Protein feed significantly affects on certain functions of individuals and the vital activity and productivity of the bee colonies. So, as a result of increased consumption of protein feed during the first days of life the supply of proteins in the body significantly increases in young bees, hypopharyngeal glands and other organs become developed, which provides the ability to perform various tasks depending on age and living conditions. Older bees consume protein for tissue renewal with new cells and metabolic processes. The reserve of amino acids is created mainly in fat body. It is especially increased in bees that hatch in late summer and prepare for winter. Bees raised on low protein feeds they become physiologically defective and do not live long (Bilash, 1990; Solayman et al., 2016; Hung et al., 2018). In conditions of protein starvation, brood rearing stops and bees throw larvae out of their cells. The reserve of nutrients in their body for milk production is not enough for long (Rutner, 1981; Ivchenko, 2002).

Numerous studies have established the dependence of queen oviposition and brood breeding on protein feed feeding. Drones raised in colonies with sufficient protein feed reserves are capable of mating. Bee brood is characterized by a higher level of assimilation of the limiting amino acids from feed compared to adult bees, which causes their rapid growth at different stages of development. The assimilation of feed amino acids by honey bees is characterized by high absolute values.

Soy flour is fed together with bee pollen in the following ratio of 75 % and 25 %, as a partial substitute for protein feed. Good results are obtained by feeding this substitute in the form of a doughy mass. Good results are obtained by feeding bee colonies with a feed additive which consists of three parts – defatted soy flour, milk powder and dry yeast (Taranov, 1986; Eremeja, 1987; Bilash, 2003).

Pollen amino acids are used by bees in the first period of adult life for protein biosynthesis. In addition to participating in metabolic processes, some of amino acids that enter to the body with food are used for energy purposes in honey bees (Sinickij & Levchenko, 1973).

2. Materials and methods

The research was conducted in the beeyard of "Agro-Etalon" PLC in Tyvriv Raion of Vinnytsia Oblast.

For research, five groups of bee colonies of the Ukrainian breed were formed on the principle of analogues groups, 5 bees in each. The bee colonies were kept in long hive, the care of which was the same during research period. The difference between the groups was only in bees feeding: the first control group was fed by powdered sugar at 250 g/day, in the form of a doughy mass; the second experimental group was fed by powdered sugar at 250 g/day and 5 % soy peptone; the third experimental group was fed by powdered sugar at 250 g/day and 5 % soy milk; the fourth experimental group was fed by powdered sugar at 250 g/day and 5 % defatted soy flour; the fifth experimental group was fed by powdered sugar at 250 g/day and 5 % roasted soy flour. The feeding period lasted from 24.03 to 24.04. Feeding of this feed was carried out in the form of a doughy mass, which included powdered sugar and partial protein substitutes (Table 1).

Table 1
The experimental scheme

Groups of bee colonies	Number of bee colonies	Features of feeding	Feeding period
1 control group	5	Powdered sugar at 250 g/day	24.03 to 24.04
2experimental group	5	Powdered sugar 250 g/day + 5 % soy peptone	24.03 to 24.04
3 experimental group	5	Powdered sugar 250 g/day + 5 % soy milk	24.03 to 24.04
4 experimental group	5	Powdered sugar 250 g/day + 5 % defatted soy flour	24.03 to 24.04
5 experimental group	5	Powdered sugar 250 g/day + 5 % roasted soy flour	24.03 to 24.04

The amino acids content in the bees body was determined in laboratory of Palladin Institute of Biochemistry of the National Academy of Sciences of Ukraine on the automatic analyzer TTT 339 using cation-exchange resin LG ANB with active group SO_3. All laboratory tests were conducted in paired determinations.

3. Results and discussion

Analysis of the results obtained indicates significant intergroup differences in the essential amino acids content in the bees body during spring feeding.

The data from Table 2 indicate that the soy peptone addition in amount of 5 % in different periods contributed to increase the essential amino acids content in the bees body, compared to analogues of the control group.

In particular, it was found that the use of soy peptone in bee feeding during different periods caused changes in the amount of lysine accumulation in the body. During the bee pupae periods, the bees before leaving the cell and bees 2–3 days after leaving the cell, there was an increase of lysine content in the bees body compared to the control group by 19.9 %, 15.4 %, and 5.0 %.

It should also be noted that during the bee pupae period, in the bees body of the second experimental group, there was an increase in the content of arginine by 25.6 %, phenylalanine by 12.4 %, leucine by 23.1 %, isoleucine by 23.6 %, methionine by 12.7 %, valine by 19.5% and threonine by 9.9 %, compared with the control group.

During the period before leaving the cells, in the bees body of the second experimental group also noted an increase the content of essential amino acids, namely, arginine by 26 %, phenylalanine by 26.6 %, leucine by 26.5 %, isoleucine by 28.6 %, methionine by 39.6 %, valine by 38 % and threonine by 24.8 %, compared to analogues of the control group.

Table 2
The essential amino acids content in the bees body for use of soy peptone in their feeding, % of air-dry matter

Amino acids	Bee pupae		Bees before leaving the cells		Bees are 2–3 days after leaving the cell	
	1 control group	2 experimental group	1 control group	2 experimental group	1 control group	2 experimental group
Lysine	1730.1	2075.2	1407.7	1624.1	2930.7	3078.0
Arginine	1509.4	1893.4	1408.2	1774.2	4835.2	5002.4
Phenylalanine	1234.5	1387.7	1234.7	1563.4	2641.7	2831.7
Leucine	2504.7	3083.7	3009.1	3807.2	2005.2	2170.5
Isoleucine	1434.8	1773.1	1734.5	2231.5	2034.9	2134.7
Methionine	270.1	304.4	407.2	568.7	703.4	731.5
Valin	1734.5	2073.5	2004.2	2765.3	2834.2	3078.4
Threonine	1208.1	1327.7	1437.0	1793.5	2107.1	2260.5

During the bee period of 2–3 days after leaving the cell, the content of arginine, phenylalanine, leucine, isoleucine, methionine, valine and threonine in the body increased by 3.5 %; 7.2; 8.2; 4.9; 4.0; 8.6 and 7.3 %, compared to the bees of the control group.

Analyzing the data from Table 3, it should be noted that the use of soy milk in bee feeding of the third experimental group contributed to an increase the essential amino acids content in the body, during the bee pupae period: lysine by 4.2 %, arginine by 1.8 %, phenylalanine by 4.9 %, leucine and isoleucine by 0.9 %, methionine by 1.5 % and threonine by 1.7 %, compared to the control group. At the same time, the valine content decreased in the bees body of this group. The difference was 0.3 % in compared to the control group.

Table 3
The essential amino acids content in the bees body for use of soy milk in their feeding, % of air-dry matter

Amino acids	Bee pupae		Bees before leaving the cells		Bees are 2–3 days after leaving the cell	
	1 control group	3 experimental group	1 control group	3 experimental group	1 control group	3 experimental group
Lysine	1730.1	1802.7	1407.7	1424.3	2930.7	2944.5
Arginine	1507.4	1534.5	1408.2	1418.2	4835.2	4894.1
Phenylalanine	1234.5	1294.7	1234.7	1241.2	2641.7	2648.4
Leucine	2504.7	2528.4	3009.4	3019.4	2005.2	2008.5
Isoleucine	1434.8	1448.1	1734.5	1738.5	2034.9	2042.1
Methionine	270.1	274.2	407.2	409.1	703.2	709.7
Valin	1734.5	1730.0	2004.2	2001.2	2834.2	2851.0
Threonine	1208.1	1228.2	1437.0	1439.7	2107.1	2144.5

In the period of the bees before leaving the cells, the content of some essential amino acids was also higher in the bees body of the third experimental group, in particular, lysine by 1.2 %, arginine by 0.7 %, phenylalanine by 0.5 %, leucine by 0.3 %, isoleucine and threonine by 0.2 %, methionine by 0.5 %, compared to the control group. And the valine content, on the contrary, decreased by 0.1 %.

During the bees period of 2–3 days after leaving the cell, there was a tendency to increase the essential amino acids content in the bees body of the third experimental group. The difference in the content of lysine, arginine, phenylalanine, leucine, isoleucine, methionine, valine, and threonine compared to the control group was 0.5 %; 1.2; 0.3; 0.2; 0.4; 0.9; 0.6 and 1.8 %, respectively.

When using defatted soy flour in amount of 5 % during feeding bees of the fourth experimental group, the content of some essential amino acids in their body was lower during the bees period of 2–3 days after leaving the cell than in the bees body of the control group, in particular, lysine by 0.8 %, isoleucine by 0.2 % and methionine by 0.4 % (Table 4).

Table 4
The essential amino acids content in the bees body for use of defatted soy flour in their feeding, % of air-dry matter

Amino acids	Bee pupae		Bees before leaving the cells		Bees are 2–3 days after leaving the cell	
	1 control group	4 experimental group	1 control group	4 experimental group	1 control group	4 experimental group
Lysine	1730.1	1800.1	1407.7	1410.7	2930.7	2907.8
Arginine	1507.4	1507.2	1408.2	1410.3	4835.2	4841.3
Phenylalanine	1234.5	1256.2	1234.7	1237.5	2641.7	2651.2
Leucine	2504.9	2500.1	3009.4	3009.8	2005.2	2008.1
Isoleucine	1434.8	1439.1	1734.5	1739.5	2034.9	2030.5
Methionine	270.1	272.5	407.2	409.8	703.2	700.7
Valin	1734.5	1735.2	2004.2	2000.7	2834.2	2841.5
Threonine	1208.1	1220.5	1437.0	1439.2	2107.1	2109.5

Analyzing the data from Table 4, it is not difficult to see that the bees of the fourth experimental group, during the bee pupae and bee periods before leaving the cells, the lysine content in the body is dominated by analogues from the control group by 4.0 and 0.2 %, respectively.

The data from Table 5 indicate that during the bee pupae period, the bees before leaving the cells and the bees are 2–3-day period after leaving the cell, the use of roasted soy flour in feeding bees of the fifth experimental group contributes to increase in their body the lysine content by 1.9 %, 3.9 and 1.6 %, arginine by 3.0 %, 1.7 and 0.5 %, phenylalanine by 1.2 %, 2.9 and 0.1%, leucine by 2.4 %, 3.3 and 0.5 %, isoleucine by 2.3 %, 1.6 and 0.9 %, methionine by 3.6 %, 8.0 and 1.1 %, valine by 2.3 %, 1.7 and 1.0 %, threonine by 2.1 %, 2.9 and 0.7 %.

Table 5
The essential amino acids content in the bees body for use of roasted soy flour in their feeding, % of air-dry matter

Amino acids	Bee pupae		Bees before leaving the cells		Bees are 2–3 days after leaving the cell	
	1 control group	5 experimental group	1 control group	5 experimental group	1 control group	5 experimental group
Lysine	1730.1	1762.7	1407.7	1462.1	2930.7	2977.0
Arginine	1507.4	1552.1	1408.2	1432.7	4835.2	4861.2
Phenylalanine	1234.5	1249.2	1234.7	1271.0	2641.7	2643.1
Leucine	2504.7	2565.0	3009.1	3108.2	2005.2	2015.7
Isoleucine	1434.8	1468.2	1734.5	1762.1	2034.9	2054.0
Methionine	270.1	279.8	407.2	439.7	703.2	711.1
Valin	1734.5	1774.1	2004.2	2039.1	2834.2	2862.0
Threonine	1208.1	1234.2	1437.0	1478.2	2107.1	2122.5

Providing bees with benign and sufficient protein feeds is the key to successful beekeeping. Bees reproduction and royal jelly formation decreases with insufficient provision of protein food to bee colonies. Worker bees quickly get tired and become disabled and also die earlier. In bees, as a result of increased consumption of protein feed, their life expectancy increases. In addition, it was found that providing bees with a sufficient amount of protein has a positive effect on the fat body development, which is a depot of amino acids in the body. There are reports in the scientific literature of many scientists about the reduction of life expectancy and lower fat body weight with insufficient levels of protein nutrition.

4. Conclusions

It was found that the use of soy peptone in bee feeding contributes to a greater accumulation of essential amino acids in the bees body in different periods of their development, in compared to soy milk, defatted soy flour and roasted soy flour which indicates a higher efficiency of its use as partial substitutes for protein feeds.

Conflict of interest
The authors declare that there is no conflict of interest.

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