UDC 638.145.4:612.397.23

Fat-acid content of tissues, breeding capacity and honey productivity of bees at feeding with sunflower seed oil

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The purpose. To position the link between fat-acid content of tissues and productive attributes of honeybees at different amount of sunflower seed oil in feed additive. To determine replicated ability of queen bees and honey productivity of workers. **Methods.** Probe of breeding capacity of queens was spent according to F.A. Lavrekhin and S.V. Pankova procedure. Amount of the gained commodity honey they determined by method of weighting honey taken from honeycomb jacks before and after pump down. In feed additive and tissues of honeybees they determined presence and content of fatty acid of common lipids using method of gas-liquid chromatography (I.F. Rivis with co-authors). The content of fatty acids of common lipids in feed additive and probed tissues of bees they determined by method of extraction of lipids by chloroform-methanol mixture. **Results.** Feeding of feed additive, enriched with sunflower seed oil in amount of 10 and 20 g essentially increased concentration of saturated, monononsaturated and polynonsaturated fatty acids of common lipids in tissues of abdomen, chest and head of honeybees of the Ist and especially the IInd probed groups. It testified to substantial growth of security of tissues of honeybees with power and structural materials. Thus in probed tissues of bees the ratio of content of polynonsaturated fatty acids of family -3 (linolenic row) to polynonsaturated fatty acids of family -6 (linolic row) was diminished. **Conclusions.** Changes in fat-acid content of tissues of abdomen, chest and head of honeybees of the Ist and especially the IInd probed groups were accompanied by changes of breeding capacity of queens and honey productivity of workers. In particular at queens of these groups grew ovi-production, and at workers — honey productivity.

Key words: *honeybees, feed additive, fatty acids, breeding capacity of queens, honey productivity of bees.*

DOI: https://doi.org/10.31073/agrovisnyk201907-6

Fatty acids amount and composition in feed directly and rapidly affect on fatty acids composition and functional activeness of bees cell membranes [1–4]. In turn, tissues fatty acids are responsible for the above-pointed insects reproductive ability and productivity characteristics [1, 3, 5, 6]. This is due to the fact that the fatty acids, depending on their amount and composition, are able to change the provision of a bee organism with energetic, structural, and biologically active material [6–8].

Bee tissues are not able to synthesize polyunsaturated fatty acids [1, 4, 9]. That is why, such polyunsaturated fatty acids as linoleic and linolenic ones, should enter their body with the feed. The basic source of indispensable (essential) linoleic and linolenic acids in bee ration is a feed [1, 7, 8]. In the feed fatty acid composition, the above-mentioned polyunsaturated acids are the dominating ones [1, 10]. The general features of α-linoleic and α-linolenic acids deficit in bee organism are: lower growth rate, decrease in effectiveness of a feed nutrients assimilation, immunity suppression, and reduction of reproductive ability and productive characteristics [1, 3, 4, 8].

In literature, data are absent concerning fatty acids content in honey bees tissue depending on the formers' amount and composition in feed. The data are absent as well about tissues fatty acids composition and bees reproductive ability and honey productivity depending on the above-pointed feed indexes. The given research work topic relevance is due to this.

The research goal — to establish a connection between tissues fatty acid composition and honey bees productivity characteristics at various amount of sunflower oil in a feed supplement.

Research materials and methods. Experimental trials were carried out in spring-summer period at a private apiary «Bosovik» of Zastavna district, Chernivtsy region, on clinically healthy honey bees of Carpathian breed.

By principle of analogues, 3 groups of bee families have been formed (3 bee families in each group). Every week, during the period of 36 days, the families of control group have been feeding on a supplement consisting of 100 g defatted natural soybeans flour (soya variety Chernivetska-9), and 100 g sugar syrup (correlation sugar-water 1:1). The families of I and II trial groups have been getting additionally sunflower oil in amount respectively 10 and 20 g/bee family/week. During the trial, the queens reproductive ability and workers honey productivity have been controlled.

The investigation of queen bees reproductive ability has been carried out by F. A. Lavryohin and S. V. Pankova [11]. For this, the quantity of print brood has been calculated each 12 days with the help of a special frame-net with squares size 5×5 cm. The amount of the obtained commodity honey has been determined by means of weighing honeycombs taken out of clusters before and after pumping. After finishing the feeding for laboratory research, samples of feed supplement and of honey bees abdomen, thorax, and head tissue have been taken. In the above-pointed bio-material, common lipids fatty acids content and composition have been determined by gas-liquid chromatography by J. F. Rivis and co. [12].

The common lipids fatty acids content in the feed supplement and researched bee tissues have been determined by means of lipids extraction with a mixture chloroform-methanol (2:1 by volume). The lipids liberated from chloroform have been saponified, and the obtained fatty acids have been methylated. Methyl esters of the fatty acids have been put into a gas-liquid chromatographic apparatus evaporator. Fatty acids methyl esters separation have been conducted on a chromatograph «Chrom-5» («Laboratorni pristroje», Praha).

The obtained digital material has been processed by variation statistics method, using the Student criterion. The average arithmetic value has been calculated (M), as well as the arithmetic mean errors (±m). The changes have been considered reliable at $p<0,05$. For calculations, a computer program Origin 6.0, Excel (Microsoft, USA) has been used.

Research results. It is established, that in a natural feed supplement consisting of defatted soybean flour and sugar syrup, there is a certain amount of common lipids fatty acids (table 1). As a result of adding to the above-mentioned supplement 10 and 20 g of sunflower oil containing 61,8 % biologically active linoleic acid, in the supplement, there is a significant increase of lauric, myristic, pentadecanoic, palmitic, palmitoleic, stearic, oleic, linoleic, linolenic, arachic, and eicosanic acids content.

1. Common lipids fatty acids content in feed supplement without- and with sunflower oil, g/kg of natural mass

Fatty acids and their code	Feed supplement (FS)	FS + 10 g sunflower oil	FS + 20 g sunflower oil
Lauric, 12:0	0,01	0,06	0,11
Myristic, 14:0	0,02	0,11	0,20
Pentadecanoic, 15:0	0,04	0,22	0,41
Palmitic, 16:0	0,51	2,56	4,63
Palmitoleic, 16:1	0,04	0,22	0,40
Stearic, 18:0	0,38	1,95	3,53
Oleic, 18:1	2,65	14,22	26,08
Linoleic, 18:2	6,82	34,34	62,20
Linolenic, 18:3	0,23	1,17	2,12
Arachic, 20:0	0,04	0,21	0,37
Eicosanic, 20:1	0,03	0,17	0,30

The increase of common lipids fatty acids content in the feed supplement causes significant increase of common lipids saturated, monounsaturated, and polyunsaturated fatty acids concentration in I and II trial groups honey bee tissues (table 2).

The above-mentioned points to a significant increase in honey bee tissues provision with energetic and structural material [8]. Herewith, in honey bee tissues of trial groups I and II, compared to tissues of the control group, the correlation of polyunsaturated fatty acids content of family ω-3 (linolenic series) to that of polyunsaturated fatty acids of family ω-6 (linoleic series) is decreasing. The acids of family ω-6 are extremely necessary for queens high reproductive ability, as well as for workers honey productivity.

2. Common lipids fatty acids content in honey bee tissues, g/kg raw mass (min.–max., n=3)

Fatty acids and their code	Control group (feed supplement – FS)	I experimental (FS + 10 g sunflower oil)	II experimental (FS + 20 g sunflower oil)
Caprylic, 8:0	0,02–0,07	0,03–0,08	0,03–0,09
Capric, 10:0	0,03–0,04	0,04–0,05	0,04–0,06
Lauric, 12:0	0,04	0,05	0,06
Myristic, 14:0	0,06–0,08	0,07–0,09	0,08–0,10
Pentadecanoic, 15:0	0,10–0,12	0,11–0,14	0,12–0,15
Palmitic, 16:0	1,15–1,37	1,24–1,48	1,27–1,53
Palmitoleic, 16:1	0,06–0,07	0,07–0,08	0,08
Stearic, 18:0	0,98–1,24	1,12–1,35	1,19–1,39
Oleic, 18:1	3,38–3,73	3,58–4,13	3,67–4,19
Linoleic, 18:2	2,64–2,72	2,86–3,17	2,96–3,29
Linolenic, 18:3	3,03–3,91	3,16–4,11	3,25–4,19
Arachic, 20:0	0,16	0,17–0,19	0,18–0,21
Eicosanic, 20:1	0,23–0,24	0,25–0,29	0,27–0,30
Eicosadic, 20:2	0,18–0,26	0,20–0,30	0,21–0,32
Eicosatric, 20:3	0,12	0,14–0,16	0,16–0,18
Arachidonic, 20:4	3,05–3,33	2,14–3,64	2,33–3,76
Eicosapentaenoic, 20:5	2,06–2,35	2,14–2,57	2,23–2,65
Docosadienoic, 22:2	0,19–0,26	0,23–0,30	0,24–0,33
Docosatric, 22:3	0,20–0,29	0,22–0,30	0,23–0,33
Docosatetraenoic, 22:4	0,30–0,44	0,36–0,51	0,37–0,54
Docosapentaenoic, 22:5	0,46–1,20	0,49–1,30	0,52–1,34
Docosahexaenoic, 22:6	0,51–1,42	0,54–1,52	0,57–1,56
Total content of fatty acids	20,81–21,83	22,39–23,75	23,41–24,47
Including saturated	2,86–2,91	3,11–3,22	3,23–3,37
monounsaturated	3,67–4,03	3,90–4,49	4,02–4,57
polyunsaturated	13,92–15,36	14,96–16,72	15,61–17,21
ω-3/ω-6	1,13–1,41	1,09–1,42	1,09–1,40

Changes in fatty acid content of honey bee tissues in I and especially II trial groups, compared to honey bee tissues of control group, cause changes in queens reproductive ability and honey productivity of workers. Particularly, the oviposition of queens (group I and II) increases during the experimental period,

compared to those of control group (table 3). However, honey productivity of workers increases in I (14,5±0,40 kg, p<0,01) and II (15,7±0,34, p<0,001) trial groups, compared to those of control group (12,4±0,36 kg).

3. Queen bees reproductive ability, eggs per day (M±m, n=3)

Control group (feed supplement – FS)	I trial group (FS + 10 g sunflower oil)	II trial group (FS + 20 g sunflower oil)
Preparatory period, April, 5		
201,2±10,89	206,9±16,35	202,3±17,49
Trial period, April, 17		
757,4±19,12	830,4±24,99	896,7±16,11**
Trial period, April, 29		
856,0±18,56	956,1±24,59**	1108,0±20,17***
Trial period, May, 11		
893,1±14,50	1018,0±24,76**	1163,8±24,84***
All together for the trial period, April 17 — May 11		
2506,5	2804,5	3168,5

Note. ** P<0,01; *** P<0,001.

Conclusions

As a result of adding to a feed supplement consisting of defatted soybean flour and sugar syrup, sunflower oil in amount of 10 and 20 g, the common lipids saturated, monounsaturated, and especially polyunsaturated fatty acids content increases in it dosage-dependently. Feeding on the supplement enriched with sunflower oil in amount of 10 and 20 g, causes a dose-dependent concentration increase of common lipids saturated, monounsaturated, and polyunsaturated fatty acids in tissues of honey bees abdomen, thorax and head of I and especially II experimental groups. Herewith, in the above-mentioned honey bees investigated tissues, the content correlation decreases of polyunsaturated fatty acids of family ω-3 (linolenic series) to polyunsaturated fatty acids of family ω-6 (linoleic series). Changes in fatty acids composition of honey bees investigated tissues in I and especially II experimental groups are accompanied by changes in queens reproductive ability, as well as workers honey productivity. Particularly the queens oviposition in the mentioned groups increases, as well as honey productivity of worker bees.

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