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THE USE OF SOME ENERGETICS SYRUPS ON BEES DEPRIVED ON NATURAL PICKING AND ITS EFFECTS ON SOME MORPHOLOGICAL AND PRODUCTIVE PARAMETERS

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Abstract

Many research about use of energy syrups in bee nourishment show advantages and disadvantages of each ingredient. The aim of this study was to analyze the influence of three types of such energy supplements (sugar syrup 2:1, corn syrup and enzyme inverted sugar) on some parameters of bee families deprived by natural picking. These parameters (the number of bees, the amount of food supplies and the number of brood cells) were determined for 9 weeks, and the recorded values were processed and analyzed statistically for comparison with the results of other bee families maintained in the field. Values obtained from bees with access to natural picking were superior to those obtained from bees deprived on it. The colonies fed with enzymatic invert sugar syrup registered higher values of the monitored parameters and the lowest values were recorded in those fed with sugar syrup 2:1. Smaller values obtained from bees deprived by natural picking may also be caused by quality of food sources and the stress caused by the restriction of their flight.

Key words*: bee nourishment, brood, corn, sugar.*

INTRODUCTION

Is true that bees are very important for maintaining wild plants biodiversity and for increasing crop production (Double, 2014), but we also have to know that at present bees are disturbed by many stress factors, among which chemical substances from agriculture, diseases and pests, to which we can also add inappropriate supplementary food recipes (Alaux et al., 2010).In agriculture, are not only dangerous chemicals that are sprayed on flowering plants, but also those that are used in the treatment of seeds (Rolke, 2016).

The additional feed of bees influences directly and obviously not only the level of apiculture production, but also the reproduction, the health status and implicitly the processes of development of bee colonies (Pop, 2006).

By feeding point of view, bees are independent of man because they collect and prepare their own food. In the years that do not provide optimal conditions for the development of bee colonies (Pătruică, 2013) beekeepers must compensate the lack of energy (manna, nectar) and protein (pollen) from nature by feeding bees; this process is also necessary in the event of insufficient flight surface, sometimes caused by too many bee colonies in that area (Sammataro and Weiss, 2013).

The most commonly used energy syrups are those of sugar, prepared by beekeepers in different concentrations or those of enzymatic inverted sugar and corn hydrolysed syrup. The use of sugar has been the subject of numerous studies that have highlighted the stimulating effects of this product on the development of bees (Moraru, 2006); it was first used on feeding bees by Réaumur on 18th century.

It is well known that all energy syrups are enzymatically transformed by bees into honey (Hausmann, 2005) and therefore they must contain ingredients to facilitate this process. Due to the disadvantages of its use (risk of crystallization, fermentation, working time, storage space), sugar syrup is successfully replaced in many areas of the world by hydrolyzed corn syrup, especially to provide the necessary food supplies during cold season (Ruiz-Matute et al., 2010).

However, studies show that some energy syrups contain toxic chemicals for bees (insecticides, neonicotinoids) that come from the raw material used in the manufacturing

process (Kessler, 2015). In fact, the European Commission also presents information about the risk of transmitting such substances to syrups used in bee-keeping (Rondeau, 2014).
Corn hydrolysed syrup/high-fructose corn syrup (HFCS), produced since 1960 (Schorin, 2005), is an inexpensive source of carbohydrates for bee-feeding, and therefore its excessive use is found in apiculture, although various studies show the negative effects of honey from its processing to consumers (Ferder, 2010); nowadays the producing industry calls it corn syrup.
An alternative to sugar syrup that avoids the use of corn syrup is the enzymatic invert sugar syrup produced by specialized companies from market, but which is also not a proven safe source for the health of bees or people who consume resulting honey.
In view of these considerations, we can state that not all the advantages and disadvantages of the medium and long term use of these types of energy syrups in feeding bees have been elucidated and that's why the beekeepers are the ones who take the feeding option.
Beekeepers and researchers are further concerned with determining the quality of supplementary feed bee recipes and, of course, with determining their influence on the profitability of beekeeping, which is based on health, queens prolificity, production.
In this context, the purpose of this study is to analyze the impact of three types of energy syrups (2: 1 sugar syrup, hydrolysed corn syrup and enzymatic invert sugar syrup) on some morpho-productive parameters such as the number of bees, food supplies and number of brood cells, of some bee families isolated from natural food collecting (maintained in bee lofts) during 9 experimental weeks.

MATERIALS AND METHODS

The studied biological material was represented by adult queen less bees (*Apis mellifera*, Carpathian ecotype), collected in June 2017 from two bee families in Deleni (Vaslui, Romania) and then stored for 24 hours in a room (18ºC, dark, without food). The following day were placed in 12 wooden boxes (120-130 g bees/box) together with a paired queen bee, and then stored for 48-60 hours in a room (18°C, 55% U, dark).

After 60 h bee boxes were distributed as follows: 9 bee boxes were deprived by natural picking and 3 bee families had access to the nature (natural food sources).
The depriving by natural picking involved the introduction of beehives in lofts (1,5 x 1 x 2 m) made of metal mesh with rhombic holes (3 mm), equipped with 3 cylindrical plastic bottles (150 ml capacity), for energy syrup, water and pollen powder (Table 1).

Table.1 Experimental research scheme

Specification	Lots of experience *Apis mellifera carpatica*			
	A0	A1	A2	A3
Operating system	With access to natural picking	No access to natural picking (bee lofts - 3 m³)		
Food used	Natural food (nectar, pollen)	Pollen powder, water at all + A1- sugar syrup 2: 1 A2- corn syrup A3- Enzymatic invert sugar syrup -2 times feeding x 150ml / week		
Follow-up indicators	- the number of bees			
	- the amount of food supplies			
	- brood cells number			

Determination of these bee quality assessment indicators was done by specific methods, namely counting of brood cells and cells with food supplies and periodic weighing of individuals from colonies; knowing one bee average weight (100 mg) we determined the total bees number of each colony (nr. of bees= total bees weigh/100) and knowing one honey cell average weight (0.25 g) we determined the total food supplies (total honey = number of honey cells x 0.25).
The experiment consisted in the organizing of 4 lots (A0, A1, A2, A3) of 3 bee colony each, with 1200-1300 individuals (working bees, drones), maintained in beehives (232 x 175 x 165 mm) with 5 wax frames (10 x 10 cm); after growing by bees, the interior of each frame had 1 dm² surface, meaning around 400 cells on one face/ around 800 cells on both faces.
The bees in the A0 group had access to the natural picking and the bees from the other lots (A1, A2, A3) had the flight restricted by the volume of lofts into which they were introduced (3 m³) and were fed with pollen

powder (*ad libitum*), water (*ad libitum*) and various energy syrups (150 ml x 2 times a week/bee family): group A1 with 2: 1 sugar syrup, corn hydrolyzate syrup on lot A2 and group A3 with enzymatic invert sugar syrup. Simultaneously with the development of colonies, they were additionally added 2 beehive boxes, with 5 frames each (assembled with wax honeycombs).

This research was made over a 63 days period and required weekly counts of the number of bees in each family, the number of brood cells and the amount of food supplies.

The recorded data was statistically processed by calculating the estimators (arithmetic mean, standard deviation of mean and coefficient of variation.)

RESULTS AND DISCUSSIONS

Regarding the quantity of food supplies, we can see in Table 2 that the small values of this parameter oscillated with the large ones throughout the experiment and this was due to the different moments when colony required nutrients for wax production of young bees (which are the wax-secreting) or for feeding and warming brood from frames we've added.

This indicator recorded the smallest values in the group fed with 2:1 sugar syrup at all times of control and this because the bees of this lot had a higher irascibility condition caused by the smell of sugar syrup. Significant differences between the control and experimental groups on this parameter were recorded in week 2 when the A0 group had 33.25 ± 6.16 g of honey compared to 86.58 ± 9.38 g of honey in the group fed with sugar syrup, 109.33 ± 9.68 g to corn hydrolyzate syrup and 113.83 ± 12.85 g to the enzymatic invert sugar syrup. These differences were due to the lack of natural picking in nature from that period of lot A0 (Table 2).

Table 2. Amount of honey reserves (grams) in bee colonies

Specification	n	A0	A1	A2	A3	Compared groups	Significance
Week 1	3	68.66±9.89	25.58±5.35	40.33±8.78	44±7.85	A0 vs A1 A0 vs A2 A0 vs.A3	* (p<0.05) ns (p>0.05) ns (p>0.05)
Week 2	3	33.25±6.16	86.58±9.38	109.33±9.68	113.83±12.85	A0 vs A1 A0 vs A2 A0 vs.A3	** (p<0.01) ** (p<0.01) ** (p<0.01)
Week 3	3	254.16±15.15	226.66±15.57	272.83±15.79	286.60±15.87	A0 vs A1 A0 vs A2 A0 vs.A3	ns (p>0.05) ns (p>0.05) ns (p>0.05)
Week 4	3	192±9.38	93.75±12.33	133.33±11.41	164.16±13.88	A0 vs A1 A0 vs A2 A0 vs.A3	** (p<0.01) * (p<0.05) ns (p>0.05)
Week 5	3	129.16±8.95	14.75±5.06	26.00±3.40	36.58±8.52	A0 vs A1 A0 vs A2 A0 vs.A3	ns (p>0.05) ns (p>0.05) ** (p<0.01)
Week 6	3	362.33±17.65	388.66±19.78	447.33±22.97	484.83±21.45	A0 vs A1 A0 vs A2 A0 vs.A3	ns (p>0.05) * (p<0.05) * (p<0.05)
Week 7	3	434.33±20.72	95.91±9.69	125.66±9.88	149.33±14.54	A0 vs A1 A0 vs A2 A0 vs.A3	*** (p<0.001) *** (p<0.001) *** (p<0.001)
Week 8	3	651.83±33.22	24.33±7.22	51.66±8.51	69.25±15.63	A0 vs A1 A0 vs A2 A0 vs.A3	*** (p<0.001) *** (p<0.001) *** (p<0.001)
Week 9	3	1254.17±87.44	424.83±27.15	470.16±21.60	504.83±20.29	A0 vs A1 A0 vs A2 A0 vs.A3	*** (p<0.001) *** (p<0.001) ** (p<0.01)

Very significant differences were recorded in the last 3 weeks of control when the amount of food supplies was higher in the A0 lot than in the experimental lots. At the last check there were very significant differences between the groups A0 and A1 and A2, respectively, so the

group that had access to natural picking had 1254.17 ± 87.44 g of honey reserves versus 424.83 ± 27.15 g in the group fed with sugar syrup 2:1, 470.16 ± 21.60 g to corn syrup; significant differences were between A0 and A4 (1254.17 vs 504.83 ± 20.29 g of honey). Additional feeding of bees plays an important role in the number of brood cells and implicitly in the general development of the bee colony (Brodschneider and Craislheim, 2010).

The number of brood cells recorded higher values during the entire study period in the group that benefited from natural harvesting and this was due to the quality of the natural food sources, superior to those used in the groups maintained on lofts.

The smallest values of this indicator were recorded in the group fed with sugar syrup at all control moments. In the first week there were no significant differences between the 4 values, thus recording 1153 ± 40,25 brood cells at A0, 952 ± 85,11 at A1, 1069.7 ± 65.64 for A3, respectively 1119 ± 56.78 of brood cells to A4 (Table 3).

Table 3. The number of brood cells from bee colonies

Specification	n	A0	A1	A2	A3	Compared groups	Significance
Week 1	3	1153±40.25	952±85.11	1069.7±65.64	1119±56.78	A0 vs A1 A0 vs A2 A0 vs.A3	ns (p>0.05) ns (p>0.05) ns (p>0.05)
Week 2	3	2242.70±35.47	1994.70±74.19	2272.70±41.70	2373.7±46.05	A0 vs A1 A0 vs A2 A0 vs.A3	* (p<0.05) ns (p>0.05) ns (p>0.05)
Week 3	3	2972.70±59.08	2251±86.50	2611±58.89	2832.70±38.55	A0 vs A1 A0 vs A2 A0 vs.A3	** (p<0.01) * (p<0.05) ns (p>0.05)
Week 4	3	2755.70±66.21	1999.70±128.86	2459.70±78.17	2574.30±69.26	A0 vs A1 A0 vs A2 A0 vs.A3	** (p<0.01) * (p<0.05) ns (p>0.05)
Week 5	3	3698.67±51.10	3455.33±37.95	3450.33±32.37	3543±83.82	A0 vs A1 A0 vs A2 A0 vs.A3	* (p<0.05) * (p<0.05) ns (p>0.05)
Week 6	3	4559.33±78.30	4203.33±95.91	4223±100.85	4289.33±71.88	A0 vs A1 A0 vs A2 A0 vs.A3	* (p<0.05) ns (p>0.05) ns (p>0.05)
Week 7	3	5873±55.19	5372.66±48.50	5463±44.10	5715±55.24	A0 vs A1 A0 vs A2 A0 vs.A3	** (p<0.01) ** (p<0.01) ns (p>0.05)
Week 8	3	6279.33±60.88	5538±82.61	5887±98.14	6146.33±106.76	A0 vs A1 A0 vs A2 A0 vs.A3	** (p<0.01) * (p<0.05) ns (p>0.05)
Week 9	3	6147.66±95.88	5083±92.08	5538±117.93	5813.33±109.15	A0 vs A1 A0 vs A2 A0 vs.A3	** (p<0.01) * (p<0.05) ns (p>0.05)

In the seventh week we observed significant differences between the control group (5873 ± 55.19) and the group fed with sugar syrup (5372.66 ± 48.50) as well as one fed with corn syrup (5463 ± 44.10), while insignificant differences (5873 ± 55.19 vs 5715 ± 55.24) of the target indicator were recorded between the control group and the one fed with enzymatic sugar syrup. In fact, the values recorded in lot A4 were the closest to the values recorded at A0 throughout the experiment.

The number of bees in the 12 colonies of the experiment recorded close values taken in the control weeks, but also in view of this indicator, we observed the superiority of the group that had access to the natural picking to the groups maintained in bee lofts; this was generally due to stress caused by the restriction of the flight of the bees.

In the last week, there was a greater difference between the results of the A0 lot and the other three lots, of which the lot A4 (enzymatic inverted sugar syrup) came closest to the control group from the point of view of this parameter (number of bees) (Figure 1).

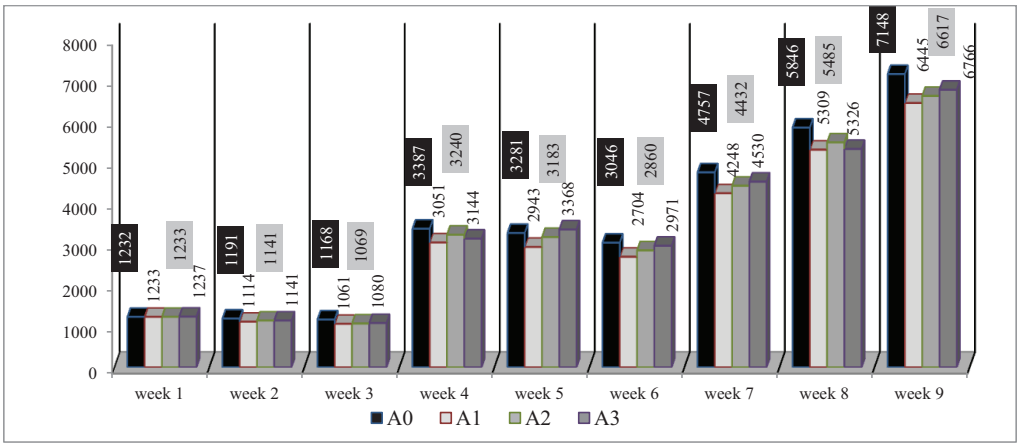

Figure 1. Number of bees from colonies

CONCLUSIONS

This research study examined the influence of energy sources (2:1 sugar syrup, corn syrup and enzyme invert sugar) on 3 quality indicators (number of bees, number of brood cells and the weight of the food supplies) of bees without access to natural food and we hope interpreting the results of it will bring more information to beekeepers about the wear of the prepared sugar syrup or of the commercial syrups on the bees who process it.

Regarding the quantity of food reserves, we noticed that the lowest values of this indicator were recorded in the group fed with sugar syrup, and the highest values in the group that benefited from the natural picking, in all control periods, except for the weeks 2 and 6 when the weather conditions were not favorable for the natural food collecting of the bees in the field; the superiority of nature was better remarked on the last week of control, when there were very significant differences between the group from field and those fed with sugar syrup 2:1 and corn syrup.

The number of brood cells is an indicator of appreciation of the quality of bees that reflects concretely the development status of the colony. Considering to it, we have noticed that the highest values were recorded in lot A0 and the lowest in lot A1 during the entire period. The group fed with enzymatic inverted sugar syrup was the one that had the closest values to those of the group with access to the natural picking, with insignificant differences between them during all the control periods; for example, at the last control, when bee families were already developed on 3 hive boxes, the A0 group had 6147.66 ± 95.88 brood cells and the A4 group had 5813.33 ± 109.15.

The number of bees recorded close values at all 12 bee families throughout the experiment, with the exception of the last control, when there were larger differences between the field group and those 3 groups from bee lofts.

The evolution of all the monitored indicators was favorable to the control group compared to the experimental lots and this was especially due to general behavior of the bees from experimental groups, who tried to escape from the lofts all the time and thus created a state of continuous agitation in those spaces.

It was also significant the more irascibility state of the bees from lofts fed with sugar syrup prepared by us, caused by the smell of this artificial food recipe.

Besides, apiculture practice as well as literature suggests that sugar syrup is very attractive to bees and determines the honey theft of bees during additional feeding.

Generally, the three morpho-productive parameters observed were higher in the group that had access to natural picking (A0) and lower values in the group that was maintained on bee lofts and fed with sugar syrup 2:1 (A1). Closer values to those of the control group were recorded on the group fed with enzymatic invert sugar syrup (A4), while the group fed with corn syrup (A3) recorded values between those of groups A1 and A4.

The use of energy syrups in bee nourishment is not yet fully elucidated with regard to the long-term health consequences of bees and humans, and therefore this domain of research continues to be an interesting subject for beekeepers and specialists around the world.

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