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CONDITION OF THE WORKER HONEYBEES FED VARIOUS CARBOHYDRATE SYRUPS IN LABORATORY CONDITIONS

Summary. Various additives added to the sugar syrup as well as the decomposition of sucrose into simple sugars employing new technologies may all change its chemical composition, although this, by no means, must be associated with a positive influence on the condition of bees. The aim of this research project was to assess the survivability of individual bees in laboratory conditions and to determine the fresh and dry body mass content of worker bees as well as the content of the crude fat in the dry body mass following the ingestion of the sugar syrup supplemented with the addition of lactic acid, “Trilac” probiotic, “Apibiovit” and “Apilac” preparations or inverted syrup. The performed experiments revealed that the applied enrichment of the sugar syrup with lactic acid, “Trilac” probiotic preparation, “Apibiovit” and “Apilac” preparations or inverted syrup did not result in a deterioration of conditions of experimental honeybees. The syrup supplemented with the “Apilac” preparation exerted the most beneficial effect on the bee fresh body mass, whereas their dry mass was best affected by the “Trilac” probiotic preparation. The experimental bees were found to drink more readily the inverted syrup as well as syrups with the addition of lactic acid and the probiotic preparation than pure sugar syrup.

Key words: honeybee, consumption, condition, sugar syrup

Introduction

The replacement of honey – bee natural carbohydrate food – by sugar syrup has been practised for a long time in beekeeping (WOŹNICA 1967, BOBRZECKI 1976). Although bees process it in the same way as the flower nectar, it is much poorer with regard to its chemical composition. Various additives incorporated into the applied sugar syrup as well as the degradation of sucrose into simple sugars employing novel technologies can change its chemical composition but this does not always have a beneficial influence on the condition of honeybees (JACHIMOWICZ and SHERBINY 1975, OHE and DUSTMANN 1997, SOKÓŁ 2004).

The objective of the performed research project was to evaluate the survivability of individual bees in laboratory conditions and to determine the fresh and dry body mass content of worker bees as well as the content of the crude fat in their dry body mass following the ingestion of the sugar syrup supplemented with the addition of lactic acid, “Trilac” probiotic, “Apibiovit” and “Apilac” preparations or inverted syrup.

Material and methods

The experiment was carried out in the laboratory of the Department of Useful Insect Breeding on workers of the honeybee (*Apis mellifera carnica*). One-day old bees were collected from a brood frame which was kept in an incubator at the temperature of 33°C and air relative humidity of 80%. Groups of one hundred 1-day old bees were transferred into cages which were also kept in air-conditioned chambers at the temperature of 30°C and air relative humidity of 40% (SZYMAŚ and WÓJTOWSKI 1974). Six nutritional groups were established with six cages in each group. Liquid nourishment was supplied in syringes of 5 ml volume.

Bees in cages were fed for the period of 14 days with the inverted syrup or the syrups with some additives obtained by mixing beet sugar and water (1:1; weight:weight) and then boiling. Thus the following foods were given to the bees:

- inverted syrup “Bioinvert” of the Biowet Puławy Company Ltd. obtained enzymatically (sugar concentration – 50%)
- pure sugar syrup
- sugar syrup supplemented with the “Trilac” probiotic preparation of the Pharmacia & Upjohn Allergon AB Angelholm, Sweden; the preparation was added in the amount of 0.8 g for each 100 ml of the syrup
- sugar syrup acidified to pH 4.1 using for this purpose lactic acid
- sugar supplemented with the “Apibiovit” preparation of the Biofaktor Company Ltd.; it was added to the syrup in the amount of 0.5 g of the preparation for each 100 ml of the syrup
- sugar syrup supplemented with the “Apilac” preparation of the Biofaktor Company Ltd.; it was added to the syrup in the amount of 0.001 g of the preparation for each 100 ml of the syrup.

Description of the additives used in the performed experiment:

- “Trilac” – probiotic preparation; it contains three strains of lactic acid bacteria: *Lactobacillus acidophilus*, *Lactobacillus delbrueckii* subsp. *Bulgaricus* and *Bifidobacterium bifidum*
- “Apibiovit” – vitamin – amino acid preparation for bees; it contains the following vitamins: A, D3 E, B1, B2, B5, B3, B6, B12, H, K3, folic acid, choline chloride as well as all endo- and exogenous amino acids
- “Apilac” – vitamin preparation containing B1, B2, B3, B5, B6, C vitamins and live cultures of lactic acid bacteria for bees which include: *Lactobacillus acidophilus*, *Streptococcus faecium*.

The experimental design is presented in Table 1.

Table 1. Experimental design
Tabela 1. Układ doświadczenia

Group	Feed	Number of repetitions per group
Control (C)	50% sugar syrup	6 cages × 100 workers
Experimental (E1)	50% inverted syrup	
Experimental (E2)	50% sugar syrup + Trilac	
Experimental (E3)	50% sugar syrup + lactic acid	
Experimental (E4)	50% sugar syrup + Apibiovit	
Experimental (E5)	50% sugar syrup + Apilac	

Throughout the experiment, deaths of bees as well as the quantity of the consumed food calculated on the basis of the mass difference between the feeder with the liquid nourishment prior to its placement in the cage and after its removal from the cage, which occurred the next day, were calculated. After two weeks of feeding, bees were put to sleep and fresh as well as dry body mass of 30 bees selected randomly from each nucleus were determined. Experimental results were elaborated statistically using the ANOVA and Student's t-test, $\alpha = 0.05$.

Results

It is clear from the data presented in Table 2 that the nourishments that the worker bees consumed most readily in the laboratory conditions were: the inverted syrup (E1) and the sugar syrup which contained 50% saccharose supplemented with the Trilac probiotic preparation (E2). The consumption in these groups differed significantly in comparison with the consumption in the remaining groups. The syrup supplemented with lactic acid was the next the bees found most attractive, whereas the syrup which contained the vitamin preparation with live bacteria cultures of lactic acid called Apilac (E5) was consumed by bees least willingly.

Table 2. Average consumption of food by bees (mg/bee/day) and bee losses (%)
Tabela 2. Średnie spożycie pokarmu przez pszczoły (mg/pszczołę/dzień) oraz upadki pszczół (%)

Group*	Consumption (mg/bee/day)	$\alpha = 0.05^{**}$	Death rate (%)	$\alpha = 0.05^{**}$
C	0.0277	ab	10	a
E1	0.0402	c	9	a
E2	0.0394	c	8	a
E3	0.0329	b	11	a
E4	0.0280	ab	15	b
E5	0.0243	a	18	b

* For explanation see Table 1.

** Values marked with different letters differ significantly (Student's t-test).

Table 3. Mean fresh body mass (mg/bee) and dry body mass of a worker bee (%)
 Tabela 3. Średnia świeża masa (mg/pszczołę) oraz sucha masa pszczoły robotnicy (%)

Group*	Fresh body mass (mg/bee)	$\alpha = 0.05^{**}$	Dry body mass (%)	$\alpha = 0.05^{**}$
C	112.4	a	23.5	a
E1	111.3	a	27.23	bc
E2	113.9	a	28.81	c
E3	113.1	a	24.92	ab
E4	117.8	a	25.03	ab
E5	127.9	b	25.44	ab

* For explanation see Table 1.

** Values marked with different letters differ significantly (Student's t-test).

The greatest number of dead bees were recorded in the group fed on the sugar syrup supplemented with the Apibiovit (E4) and Apilac (E5) preparations.

The highest fresh body mass were observed in workers eating the sugar syrup with the Apilac preparation (E5), while the highest dry body mass was found in bees from the E2 group which were given the sugar syrup with the Trilac preparation and inverted syrup (E1). On the other hand, the lowest dry body mass, differing significantly from groups E2 and E1, was observed in group C fed on sugar syrup.

Discussion

The condition of bees nourished exclusively on sugar is considerably worse than those fed on protein food (MAURIZIO 1954, SZYMAŚ 1977). However, in the case of food shortages of bee families, sugar syrup is fed to them much more often than pollen or pollen substitute – the protein nourishment (WOŹNICA 1967, BOBRZECKI 1976, GROMISZ 1985, SZYMAŚ 1994, PEDERSEN et AL. 1996, SKUBIDA 1998).

In recent years, various kinds of substitute carbohydrate nourishments for bees have been introduced in the bee management and they include both inverted syrups as well as syrups acidified with the assistance of organic acids of low concentration (CEKSTERYTE and RACYS 2006). However, it should be mentioned here that it was already in 1960s that Jachimowicz from the Bee-keeping Institute in Wien recommended citric acid as an acidifier of sugar syrups because syrups prepared in this way exhibited higher stability and bees consumed more readily syrups with lower pH and, equally importantly, they were ill less frequently.

In our own investigations presented in this study, which were carried out in laboratory conditions, it was found that bees took up more willingly those syrups which were inverted, acidified or enriched with the probiotic preparation. This observation is in keeping with the earlier study by SZYMAŚ and MALISZEWSKA (1998) in which they reported that lactic acid added to a substitute affected its palatability. On the other hand, our current research results failed to corroborate investigations by KAZNOWSKI et AL.

(2005) that the Trilac probiotic preparation does not improve the food attractiveness with regard to its palatability.

SOKÓŁ (2004) demonstrated the suitability of the application of salicylic acid to improve the condition of bees. He also found that at higher doses, i.e. over 3 mg/ml of syrup, it can result in the death of bees.

The supplementation of experimental syrups with Apilac and Apibiovit preparations reduced slightly the survivability of bees. It is possible that this was associated with a faster filling of the large intestine with faeces as well as the applied laboratory conditions which made it impossible for bees to carry out their cleansing flights (SZYMAŚ 1994).

The supplementation of syrups fed to bees with various additives did not influence negatively the condition of the experimental insects. The worst condition of the insects expressed by their dry body mass was recorded in the group which was fed sugar syrup not modified and without any additives.

Conclusions

1. The enrichment of the sugar syrup with lactic acid, “Trilac” probiotic preparation, “Apibiovit” and “Apilac” preparations as well as the application of inverted syrup did not exert a negative influence on the condition of bees.

2. The “Apilac” preparation added to the sugar syrup was found to exert the most beneficial impact on the fresh body mass of bees, while the “Trilac” probiotic preparation – on their dry body mass.

3. Bees were found to take up more readily the inverted syrup as well as syrups supplemented with lactic acid and the probiotic preparation than the pure sugar syrup.

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KONDYCJA ROBOTNIC PSZCZOŁY MIODNEJ ŻYWIANYCH W WARUNKACH LABORATORYJNYCH RÓŻNYMI SYROPAMI WĘGLOWODANOWYMI

Streszczenie. Różne dodatki do syropu cukrowego, jak również rozkład sacharozy do cukrów prostych z wykorzystaniem nowych technologii mogą zmienić jego skład chemiczny. Nie zawsze jednak wpływa to korzystnie na kondycję pszczoł. Celem pracy jest ocena przeżywalności osobników pszczelich w warunkach laboratoryjnych oraz określenie świeżej i suchej masy ciał robotnic, a także zawartości tłuszczu surowego w suchej masie ciała po spożyciu syropu cukrowego z dodatkiem kwasu mlekowego, probiotyku „Trilac”, preparatów „Apibiovit” i „Apilac” bądź syropu inwertowanego. W wyniku przeprowadzonego doświadczenia stwierdzono, że wzbogacenie syropu cukrowego kwasem mlekowym, preparatem probiotycznym „Trilac”, preparatem „Apibiovit” i „Apilac”, a także zastosowanie syropu inwertowanego nie wpłynęło negatywnie na kondycję pszczoł. Podanie do syropu preparatu „Apilac” wpłynęło najkorzystniej na świeżą masę pszczoł, a na suchą masę lepiej oddziaływał preparat probiotyczny „Trilac”. Pszczoły chętniej wypijały syrop inwertowany oraz syrop wzbogacony kwasem mlekowym i preparatem probiotycznym, niż czysty syrop cukrowy.

Słowa kluczowe: pszczoła miodna, spożycie, kondycja, syrop

Szymaś B., Łangowska A., Giejdasz K., 2007. Condition of the worker honeybees fed various carbohydrate syrups in laboratory conditions. *Nauka Przyr. Technol.* 1, 2, #40.

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