# The Effects of Using Some Energetic Syrups on Bees Deprived from Natural Picking

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**Abstract**

Recipes used for supplementary bee feeding and their consequences on colonies development are still the subject of numerous researches worldwide. This study examines the effects of using three types of energy syrups (2:1 sugar syrup, respectively corn syrup and syrup of enzymatic inverted sugar) on some morpho-productive indicators of bee families maintained in bee lofts (deprived from natural picking). The values of these parameters (the amount of wax produced in 9 weeks, the amount of food supplies at the beginning and end of the cold season) were statistically processed and then compared with those of some bee families maintained in the field (with access to natural picking). Regarding the bees deprived from natural picking, those fed with the 2:1 sugar syrup recorded the lowest values, while those fed with enzymatic inverted sugar syrup recorded the highest values of the monitored indicators. The values of these morpho-productive parameters were higher for the bee families in the field than those obtained from the bees from lofts, due to the quality of the food and the stress caused by the restriction of flight.

**Keywords**: ***words:*** bees, corn, sugar, syrup, wax

## 1. Introduction

The development of bee colonies is influenced by many stress factors, among which diseases and pests, chemicals used in agriculture and industry, and last but not least ingredients used in the preparation of supplementary bee feeds [1]. Among the factors mentioned, the most disturbing are the chemicals in agriculture, whether used in flowers sprays or those with which plant seeds are treated [2]. We need to keep these stress factors under control because we all know the importance of bees for growing agricultural crops and wildlife biodiversity [3]. However, administering additional feed to bee families has direct and obvious effects on beekeeping, reproduction, health and, of course, on their development processes [4].

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By colecting and preparing their own food, bees prove their independence from man in terms of nutrition. However, for economical efficiency even in years that do not offer climate conditions appropriate to the development of bee colonies [5] or in the case of flight surface insufficiency caused by too much hives in a certain area [6], beekeepers it has to replace the natural sources of energy (mana, nectar) and pollen with some additional feeds for bees (energy syrups, protein flours).

Corn hydrolyzate syrup, enzymatic inverted sugar syrup and sugar syrup prepared by beekeepers at various concentrations are the most commonly used energy syrups for bees.

Enzymatic transformation of energy syrups into honey by bees is also influenced by the ingredients they contain from manufacturing process [7].

Sugar, used as an ingredient for bee families feed systems since the eighteenth century by Réaumur and its stimulating effects have been the subject of numerous studies on supplementary bee feeding

[8]. Certain disadvantages of sugar syrup (risk of crystallization, fermentation, working time, storage space) caused its replacement in some regions with hydrolyzed corn syrup (HFCS), especially to provide honey reserves needed by bee colonies during the cold season [9].

However, some energy syrups contain toxic substances for bees that originate from the raw material used in their production [10], which is also claimed by some European institutions in the control of apiculture products [11].

Produced since 1960, corn syrup(high-fructose corn syrup=HFCS) is a cheap source of carbohydrates used in beekeeping, although honey from its processing has a negative effect on bees and humans [12].

Companies that produce food for bees also offer the enzymatic inverted sugar syrup on the market as a substitute for corn syrup, which is also unaware of the consequences of using it; beekeepers are the ones who take the consequences of using these syrups in supplementary feeding [13].

Worldwide apiculture practitioners and researchers are still interested in characterizing the ingredients of the additional feed of bees and the effects of its use on the overall state of colonies and, of course, on the economic efficiency of this sphere of activity.

Regarding these aspects, the purpose of this study was to determine and characterize the effects of using three types of energy syrups (2: 1 sugar syrup, respectively corn hydrolyzate and enzymatic inverted sugar syrup) on some morpho-productive indicators (the amount of wax deposited in 9 weeks, the amount of feed reserves at the beginning and end of the cold season) of some bee families isolated from natural food collecting (maintained in bee lofts/bee isolators).

## 2. Materials and methods

The studied biological material was represented by adult quenelles bees, (Apismellifera, 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 (1,5x1x2 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).

Determination of these bee quality assessment indicators was made by specific means, namely the counting of the cells with food reserves and periodic weighing of the beehive frames; besides weighing the frames, we also used the average weight values of a honey cell (0.39 g) to determine the food reserves.

We determined the amount of wax by the difference between the weight of the frames made by bees and the weight of the frames before being introduced into the beehives.

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 (232x175x165 mm) with 5 wax frames (10x10cm); 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 $m^3$) and were fed with pollen powder (adlibitum), water (adlibitum) and various energy syrups (150 ml x 2 times a week/bee family): group A1 with 2: 1 sugar syrup, corn hydrolyzed syrup on lot A2 and group A3 with enzymatic invert sugar syrup.

Beginning with the end of August, to supplement the honey reserves, we have administered a double volume of energy feed to the bees in the bee lofts/izolators (for each 300 ml x 2 halves/week x 4 weeks); the bees in the field were fed with silver linden honey: 200 ml x 2 times/week x 4 weeks.

Simultaneously with the development of colonies, they were additionally added 2 additional cats with 5 frames each (with wax honeycombs for each frame).

**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 150 ml/week on that 9 weeks when amount of wax request -2 times feeding x 300 ml/week on that 4 weeks of amount of honey request | | |
| Follow-up indicators | the amount of wax deposited in 9 weeks the amount of food reserves at the beginning and end of the cold season | | | |

The research was made over a period of 10 months and assumed the determination first the amount of wax after 63 days from experimental lots formation and then determination of honey reserves in October 2017 and February 2018.

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

## 3. Results and discussion

Regarding the quantity of food reserves we can see in table 2 that the values of this parameter recorded an evolution in all the lots during the first five weeks of control; this was due to the steady feeding regimen and at the same time to the bee's natural behavior, which means that by the end of the active season, the queen bee reduces the laying eggs (less bee brood means also the need for a smaller amount of nutrients) and the bee family to orient much to storing a sufficient amount of food reserves onframes, necessary to go through the cold season.

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 batch had a more agitated state, caused by the smell of sugar syrup. In week 1 there were very significant differences between control group (A0) and experimental feeds with sugar syrup (A1) and corn syrup (A2) with regard to the amount of food supplies, when group A0 had 1254.16±87.44 g of honey versus 424.83±27.15 g of honey in lot A1 and 470.16±21.6 g of A3; this week, between A0 and A3 (enzymatic inverted sugar syrup) were recorded significant differences: 1254.16±87.44 (A0) vs 504.83±20.29 (A3).These differences were due to the abundance of nectar and pollen in nature from that period of the A0 lot. Very significant differences were recorded in control week 2 when the food stock was higher in lot A0 than in all 3 experimental lots: 1459.03±67.09 (A0) vs 704.03±35.65 (A1) vs. 763.86±19.79 (A2) vs 806.03±20.12 (A3). At the last check of the active season (week 5-beginning of the cold season) there were significant differences between the control lot and the experimental lots;so the group that had acces to natural picking had 2486.96±68.48 g of honey reserves compared to 1848.50±51.91 g in the group fed with sugar syrup 2: 1, 1892.56±41.49 g at the one fed with corn syrup and 1944.46±50.50 g at the one fed with enzymatic inverted sugar syrup. As in the beginning, at the end of the cold season there were significant differences between lot A0 and the other three groups: 869.80±75.27 g (A0) vs 196.83±83.02 (A1) vs. 211, 76±44.83 (A2) vs. 315.86±29.51 g (A3).

These differences between the results obtained in the control lot and those obtained from the experimental lots are due to the superior quality of the honey from the natural picking to the honey obtained from the processing of the three types of energy syrups used.

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

| Specification | n | A0 natural picking | A1 sugar syrup | A2 corn syrup | A3 enzymatic inverted sugar | Compared groups | Significance |
|---|---|---|---|---|---|---|---|
| Week 1 | 3 | 1254.16±87.44 | 424.83±27.15 | 470.16±21.6 | 504.83±20.29 | A0 vs A1<br>A0 vs A2<br>A0 vs.A3 | ***<br>(p<0.001)<br>***<br>(p<0.001)<br>** (p<0.01) |
| Week 2 | 3 | 1459.03±67.09 | 704.03±35.65 | 763.86±19.79 | 806.03±20.12 | A0 vs A1<br>A0 vs A2<br>A0 vs.A3 | ***<br>(p<0.001)<br>***<br>(p<0.001)<br>***<br>(p<0.001) |
| Week 3 | 3 | 1586.96±37.67 | 968.23±24.00 | 1070.83±26.35 | 1106.23±46.07 | A0 vs A1<br>A0 vs A2<br>A0 vs.A3 | ***<br>(p<0.001)<br>***<br>(p<0.001)<br>** (p<0.01) |
| Week 4 | 3 | 2017.03±58.78 | 1421.83±42.72 | 1485.43±11.41 | 1510.46±24.86 | A0 vs A1<br>A0 vs A2<br>A0 vs.A3 | ** (p<0.01)<br>** (p<0.01)<br>** (p<0.01) |
| Week 5<br>Start of cold season | 3 | 2486.96±68.48 | 1848.50±51.91 | 1892.56±41.49 | 1944.46±50.50 | A0 vs A1<br>A0 vs A2<br>A0 vs.A3 | ** (p<0.01)<br>** (p<0.01)<br>** (p<0.01) |
| Week 6<br>End of cold season | 3 | 869.80±75.27 | 196.83±83,02 | 211.76±44.83 | 315.86±29.51 | A0 vs A1<br>A0 vs A2<br>A0 vs.A3 | ** (p<0.01)<br>** (p<0.01)<br>** (p<0.01) |

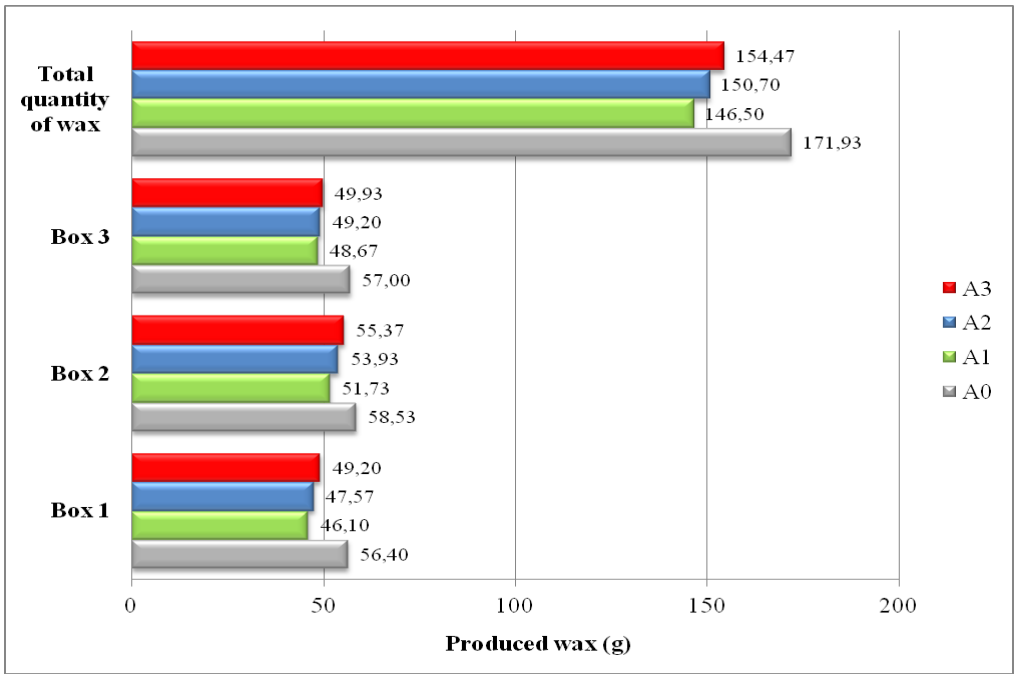


**Figure 1.**The amount of wax produced

The amount of beeswax (Figure 1) registered higher values during the entire study period in the group that benefited from natural picking (A0), and this was due to the quality of natural food sources superior to those used in the experimental groupes from bee lofts. The lowest values of this indicator were recorded in the group fed with sugar syrup (A1), in all the bee boxes that formed the hives of the experiment (5 frames/box).The amount of wax deposited in box 1 recorded the

lowest values in lot A1 (46.1 g) and the highest values for lot A0 (56.4 g). Regarding the other two lots, the one fed with enzymatic inverted sugar syrup (A3) recorded higher values of the quantity of wax in box 1 than those of the corn syrup (A2) fed: 47.57 vs 46.10 g.

As in the first box, in the second and third boxes the bees who deposited the highest quantities of wax were the ones in the field, while the bees in the bee lofts fed with sugar syrup recorded the lowest values; the results (in descending order) in box 2 were 58.53 g (A0) versus 55.37 g (A3) vs. 53.93 g (A2) vs. 51.73 g (A1); the results in box 3 were 57 g (A0) vs. 49.93 g (A3) vs. 49.2 g (A2) vs 48.67 g (A0). The superiority of the natural sources of food to the benefits for wax production can also be observed in the total amount of wax at the end of the control period, when the following values were recorded: 171.93 g (A0) vs 154.47 (A3) vs 150.7 (A2) vs 146.5 (A1).

Even though the wax quantities are pretty good corresponding to the four batches of this experiment, we mention that in the total amount of wax we also took into account the possible wax deposits on the floor and walls of the bee boxes; the bees who had access to natural picking were more organized and waxed more on the frames than on the floor or on the walls. The built frames of the bee families from lofts were not as large as those in the field in terms of the built honeycomb surface. At the same time, on the floor and the walls of the boxes in the experimental lots were collected higher quantities of waxes than those from the control group. This situation could be caused by the general state of agitation of the beehive families from lofts and, of course, by the superiority of the natural food compared to that administered by us.

## 4. Conclusions

This research study analyzed the influence of 3 energy sources (2: 1 sugar syrup, respectively corn syrup and enzymatic inverted sugar syrup) on some bee quality indicators (the amount of food reserves at the beginning and the end of the cold season, the amount of wax produced by the bees in 9 weeks) of some bees deprived by natural picking (maintained in isolators). Interpreting the results of this experiment will bring more information to beekeepers about the wear of the prepared sugar syrup or that of the commercial energy 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 lot that benefited from the natural picking (from field) in all the control periods.

Noteworthy was the second week of control, when there were very significant differences between the group that benefited from the natural picking and those who had the restricted flight of the lofts. Regarding the quantity of food reserves from the beginning of the cold season, significant differences were recorded between the control group of the 3 experimental groups; the same situation was encountered at the end of the winter season. Analyzing these results, we have highlighted the superior quality of honey from natural sources of food to that of honey that comes from the collecting an transformation by bees of energy syrups we had used.

By the point of view of the amount of wax, we can say that the best food for bees is the natural one. This aspect could bee seen in the results of the amount of wax from each of 3 boxes and implicitly invalues of total wax quantity.

The evolution of the two monitored indicators was favorable for the control group compared to the experimental groups and this particularly was due to general behavior of the bees in the experimental groups, who tried to escape from lofts and thus created a state of continuous agitation flight performed in that volume.

Also noteworthy was the more agitated state of the minifamilies of bees fed with sugar syrup prepared in the experimental holding, caused by the smell of this artificial food recipes. Beekeeping practice as well as specialized literature highlights that sugar syrup is very attractive to bees and determines the honey theft of bees during additional feeding..

Generally, the two morpho-productive para-meters observed had higher values in the group that had access to natural picking (A0) and lower values in the group that was deprived by the natural picking and was fed with sugar syrup 2: 1 (A1). Closer values than those of the control group of these indicators were recorded in the group fed with enzymatic inverted sugar syrup (A3), while the lot fed with corn syrup (A2) was in terms of the values between the groups A1 and A3.

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 research field continues to be interesting an important for humanity.

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