EUROPEAN ACADEMIC RESEARCH
Vol. IX, Issue 4/ July 2021

Impact Factor: 3.4546 (UIF)
DRJI Value: 5.9 (B+)

ISSN 2286-4822
www.euacademic.org

Influence of the optimal quantity of pollen substitute applied during spring on development of honey bee colonies

LUMTURI SENA
SABAH SENA
Animal Science Department
Faculty of Agriculture and Environment
Agricultural University of Tirana, Albania

Abstract

The effect of using different concentrations of Feedbee on the development of bee colonies was studied and evaluated. This study was conducted in an apiary on the outskirts of Tirana for a period of 3 months (February 1-April 30), divided respectively into two stages of 45 days each. Three experimental groups with 7 bee colonies each were created. In the first group (G1) Feedbee with 4% concentration was applied, in the second one (G2) with 10% concentration, while in the third group (G3) with 35%. All colonies involved in the study were similar in terms of strength and age of the queen (1 years old). Data were kept on food consumption, size of capped brood area, strength of honey bee colonies. In both inspections, there were no noticeable differences between the groups regarding the number of brood frames. At the end of the first stage, the increase in Feedbee concentration ranging from 4% to 10% and 35% affected the doubling of the sealed brood areas. Since for this stage the differences between G2 and G3 were statistically not proved ($p < 0.05$), it would be more economical to use Feedbee with 10% concentration saving 2.42 Euro/bee colony. At the end of the second stage, the data analysis showed insignificant differences between groups on the brood area and since bee flora is also abundant, it would be sufficient to give a minimum concentration of 4%, saving 3.4 Euro/bee colony.

Keywords*:* bee colony, capped brood area, Feedbee concentration, inspection.

INTRODUCTION

A balanced diet is recommended for healthy and strong bee colonies (Schmidt et al. 1995; Pernal and Currie 2000; Somerville and Nicol 2006). Balanced nutrition based on the diversity of spontaneous plants and crops is an optimal source of protein and vitamins for bees (Decourtye et al, 2010). When this is not possible, supplemental feeding is recommended, through which essential nutrients can be provided (Brodschneider R, Crailsheim K, 2010), consequently, continuity in egg laying, generation growth and strengthening of the bee colony is enabled (Bilal Ahamad Paray et al., 2021).

This is why new beekeeping technologies around the world are increasingly paying attention to and recommending the use of industrial proteins and pollen substitutes (DeGrandi-Hoffman et al., 2008; Saffari et al, 2010; Sena et al, 2012; Kumar et al al, 2013; Amro et al, 2016; Wijayati et al, 2019). These substitutes contain a variety of components, mainly soybean meal (Kulinčević et al, 1982), yeast micelles and often also powder milk (Zaytoon et al, 1988; Rana et al, 1996). With prolonged storage time, yeast and pollen lose their nutritional values. Even long-lasting soy flour can become toxic to bees. A new diet called Feedbee produced in Canada is practically balanced. Feedbee is consumed and digested naturally by bees both in Spring and Autumn in all forms (powder, liquid or in dough form). It is a balanced diet, rich in protein (Saffari et al, 2010). It is a very good substitute for natural pollen (Colā F and Colā M, 2012), which cannot be easily found in nature, in specific places and periods. Feedbee was easily accepted by the bees and positively influenced on their performance during the spring season (Sena L et al, 2012).

In Albania, the Feedbee has been used efficiently for almost 10 years. It is prepared in the form of dough with 0.5 kg packages in different concentrations, starting from 4% to 50% (which is being prepared recently). But often beekeepers prefer to buy packages with a concentration of 4%, because they have the lowest price in the market. The purpose of this study is to compare and evaluate the effectiveness of application of three different Feedbee concentrations (4%, 10% and 35%) in the development of bee colonies during the spring.

MATERIAL AND METHODS

The effect of using different Feedbee concentrations as a pollen substitute for the recovery and strengthening of bee colonies during the period 1 February-30 April, was assessed in an apiary, located in the outskirts of Tirana.

Based on the Comparative Analogy principles, from the breed point of view, queen's age (1 years old), family strength, etc., the 21 best colonies of the apiary were selected. All bee colonies were kept in standard Langstroth hives (497mm x 420mm x 241mm) with 10 frames each (448mm x 232mm). Before the start of the experiment, the bee families were equalized.

In this study the selected and equalized colonies were divided into three experimental groups with 7 bee colonies each: the first group (G.1) consumed Feedbee with a concentration of 4%, the second group (G.2) with a concentration of 10%, while the third one (G.3) consumed Feedbee with a concentration of 35%. The study was divided into two stages (S): The first, stage February1st – March the 15th, and the second stage March the 15th – April the 30th. At the end of each stage, each group was inspected, regarding the number of brooded frames per colony and the size of capped brood area for each side of each frame. At each stage, each bee colony was supplied with 2 kg Feed-bee. So, for the whole testing period, 4kg Feed-bee/colony were consumed.

The bags with the dough form prepared Feedbee, weighing 0.5Kg/each, were cut with scalps in square shape and placed above the frames to facilitate their consumption by the bees. Feedbee bags were inspected every 3-4 days.

At the end of each stage (March the 15th and April the 30th) the hives were inspected. During this inspection, the number of brood frames /colony was observed and all brood frames (from both sides) were photographed. 316 photographs and edits were performed in Photoshop, respectively 120 photographs in the first inspection and 196 in the second one.

The recorded parameters:

- Feedbee consumption was recorded for each bee colony in three groups (when it was placed in the beehive and when it was fully consumed). At the end, the total feed consumption was calculated accordingly.

- The colony growth rate (for each individual colony in three groups). The number of frames with brood at the start and the end of the trial. The colonies' strength was estimated and recorded during the Spring inspections.
- The total area of capped worker brood cells in the colony.

Measurement of worker brood area was determined by measuring capped brood to the nearest cm^2 using Adobe Photoshop CS3, Version 10.0. This method based estimating capped and uncapped brood (Knopp et al, 2006; Berna Emsen, 2006). Through this operation, two figures were captured: number of pixels which represents the capped brood area (A) and the number of pixels which are included within the image (B). Based on these data, the total amount of the capped brood area was calculated and given as a percentage (C) of the total frame's area (C = A/Bx100%).

All the recorded results were statistically processed and tested through Anova and descriptive analyses, while the comparisons were done thrugh the *t Test*.

RESULTS AND DISCUSSION

Average number of brooded frames per bee colony in both inspections

Table 1 shows the number of brooded frames during the two inspections, performed in March and April respectively for the three study groups (21 bee colonies).

Table 1: Number of brooded frames per each colony in both inspections

Groups	Number of inspections	M± SD	Variance
G1	1	3,20±0,81	0,66
	2	4.43±0.53	1.95
G2	1	2,80±0,57	0,32
	2	4.50±0.42	1.25
G3	1	2,60±0,54	0,29
	2	4.50±0.64	2.83

At the end of the first inspection, it was found that the number of brooded frames is small for all the three groups. The first group (4% Feedbee) dominates with 0.4 frames, or 12.5% more than the second one and with 0.6 frames, or 18.8% more than the third group. In the

second measurement, G.2 and G.3 have an equal number of brooded frames per generation (4.5 frames each), while G.1 is presented with 1.56% fewer brooded frames than the other two groups. Differences were statistically significant for $p < 0.05$ in both inspections.

For a period of 1.5 months, the increase in fertility of the queen, is clearly observed, extending it from one frame to the other. The application of Feedbee as soon as the bees emerge from the winter, in the most critical period, showed and clearly demonstrated its positive effect on the recovery and strengthening of the bee colony. This intervention, facilitated the queen's fertility from one inspection to the other one, to expand the brooding respectively to 1.23 frames in the first group, 1.7 frames in the second group and 1.9 frames in the third one.

Containing high nutritional values, Feedbee has positively impacted the strengthening of bee colonies. This is also confirmed by literature sources (Peter G Kevan, 2005). But nevertheless, to give the final assessment regarding this factor we have to rely on the measurement of the average capped brood areas for each frame in each group.

The capped brood area's size (in cm^2)/frame (digitally measured)

The following table shows the capped brood areas on each side of the frame per colony, and study group.

Table 2. A summary of the brood size (in pixel cm^2) as measured via the Adobe Photoshop CS3 10.0 in both inspections

Groups	Number of inspections	Mean/frame's side	Mean/colony	Mean/group
G.1	1	15.4±10.1	98.4	689
	2	70.0±5.99	621	4344
G.2	1	29.5±11.2	165	1158
	2	69.3±3.62	624	4368
G.3	1	35.2±2.08	183	1281
	2	70.6±2.60	636	4450

At the end of the first inspection, the effect of increased Feedbee's concentration on the expansion of capped brood area is clearly evidenced. Thus, with the increase of Feedbee's concentration from 4-35%, the capped brood area/frame, increases more than twice (47.8%

more in G2 and 56.3% more in G3 compared to G1). Whereas the advantage of G3 compared to G2 is only 16.2%. The differences are significant ($p < 0.05$) in comparing G1 with the other two groups, but not in comparing G2 with G3 (tCrit = 1.78 and tStat = -1.32). If we make the comparison for the capped brood area per colony, or group we find that G1 has an area 40.4% smaller than G2 and 46.2% smaller than G3. The capped brood area per colony, or per group at G3 is only 9.8% larger compared to G2.

So, the increase in Feedbee's concentration has positively impacted the growth and strengthening of the bee colonies and the increase in queen's fertility in the early Spring period. Even according to Saffari et al, (2010); Sena et al, (2012), the increase in Feedbee's concentration has stimulated the increase of the capped brood area size. In other studies, (De Grandi Hoffman et al, 2008; Sihag and Gupta, 2011) the capped brood area was increased in cases where pollen substitutes were used. So, using Feedbee at 10-35% concentration has encouraged brooding increase by doubling it.

On the second inspection, it was observed that the group who received the 35% concentrated Feedbee, has a slight advantage, compared to the other two groups (pixel area cm^2). If we analyze the capped brood area per frame, G3 has an area of 0.86% larger than G1 and 1.88% larger than G2. Even in the comparison of capped brood area per colony and group, a slight advantage of G3 is noticed over the other two groups (G1 and G2) respectively with 2.42% and 1.92%.

During the second inspection, a notable expansion of capped brood areas was observed compared to the first inspection, $p < 0.05$. This is explained by the strengthening of bee colonies during April, which is associated with more favorable temperatures, abundant fodder base and supplementary feed (Feedbee) consumed by bees (Decourtye et al, 2010). Given that during April there is an abundant amount of nectar and pollen in nature, it would be better to use the minimum dose of Feedbee as a supplementary feed.

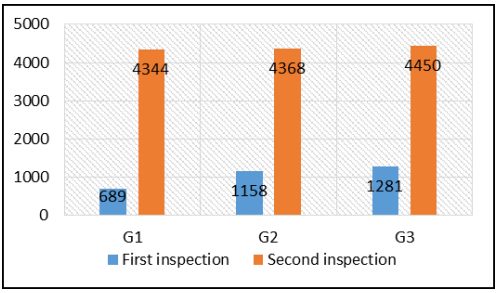

Figure 1: Size of capped brood area/group (in pixel cm²) in both inspections

The most appropriate Feedbee concentration to be applied for each month:

For March, although the best result was in G3, but since the differences were not statistically proven with G2, it would be good to use Feedbee with 10% concentration.

For April, although a slight advantage was observed in G3 over the other two groups, the differences in value were statistically unverified, so it would be good to use Feedbee with the minimum concentration (4%).

The Feedbee's price in the Albanian market according to the concentrations is 1.28 Euro/kg for the 4% concentration, 1.77Euro/kg for the 10% concentration and 2.98 Euro/kg for the 35% concentration. For 2 kg of Feedbee used for each phase are spent respectively: 2.56, 3.54, 5.96 Euro/bee colony. Since for the first stage, the differences between G2 and G3 were inconsequential, then the use of 10% concentrated Feedbee, instead of 35%, will save 2.42 Euro/bee colony.

2kg Feed-bee/colony were also consumed for the second phase. Using Feedbee with the minimum concentration (4%) for this period would save 3.4 Euro/colony with the same result in strengthening bee colonies.

CONCLUSIONS

The use of Feedbee in all three study groups, from the first phase to the second one, improved brood rearing and influenced the strengthening of the bee colony. At each stage, the use of different Feed-bee's concentrations didn't show any impact on increasing the number capped brooded frames per hive. For the first phase, the use of Feedbee

with 10% concentration, proved to be more effective by doubling the size of the capped brooded areas. For the second phase, since the natural habitats are rich in nectar and pollen it is more economical to use Feedbee in the minimum concentration on brood production.

REFERENCES

1. Amro Abdulraouf, Omar Mohamed, Al-Ghamdi Ahmed. "Influence of different proteinaceous diets on consumption, brood rearing, and honey bee quality parameters under isolation conditions". Turkish Journal of Veterinary and Animal Sciences. 40, (2016): 468-475.
2. Berna Emsen. "Semi-automated measuring of capped brood areas of honey bee colonies". Journal of animal and Veterinary Advances 5(12), (2006): 1229-1232.
3. Bilal Ahamad Paray, Indu Kumari, Younis Ahmad Hajam, Bharti Sharma, Rajesh Kumar, Mohammed Fahad Albeshr, Mohammad Abul Farah, Javed Masood Khan. "Honeybee nutrition and pollen substitutes: A review". Saudi Journal of Biological Sciences. Vol. 28. Issue1, (2021):1167-1176
4. Brodschneider R, Crailsheim K. "Nutrition and health in honey bees". Apidologie 41, (2010): 278-294.
5. Cola Florica, Cola Mugurel. "Protein feeding effect of stimulation of bee families". Analele Universității din Craiova, seria Agricultură – Montanologie – Cadastru (Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series) Vol. XLII 2012/2: 73-78
6. Decourtye A., Mader E., Desneux N. "Landscape scale enhancement of floral resources for honey bees in agro-ecosystems". Apidologie 41, (2010): 264–277.
7. De Grandi-Hoffman Gloria, Gordon Wardell, Fabiana Haumada- Segura, Thomas Rinderer, Robert Danka and Jeff Pettis. "Comparisons of pollen substitute diets for honey bees: consumption rates by colonies and effects on brood and adult populations". Journal of apicultural research. Vol 47. Issue 4, (2008): 265-270.
8. Knopp J, Saffari A M, Kevan P G, Bonne J. "Semi-automated measuring of capped brood areas by digital photography: How to make the photography stand, take the pictures and analyze them quickly and easily". Bee culture. (2006): 19-22.
9. Kulinčević J M, Rothenbuhler W C, Rinder T E. "Effect of certain protein sources given to honey bee colonies in Florida". American Bee Journal 122 (3), (1982): 181-189.
10. Kumar R, Mishra R. C, Agrawal O.P. "Effect of feeding artificial diets to honey bees during dearth period under Panchkula (Haryana) conditions". Journal of Entomology Research 37, (2013): 41-46.
11. Pernal S.F., Currie R.W. "Pollen quality of fresh and 1-year-old single pollen diets for worker honey bees (*Apis mellifera* L.)". Apidologie 31, (2000): 387–409.
12. Peter G Kevan 2005 "The bee Diet (Feed Bee®): A positive report on progress". (2005). http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.612.5588

13. Rana V K, Gopal N P, Gupta J K "Effect of pollen substitute and two queen system on royal jelly production in Apis Mellifera L." Indian Bee Journal. 58(4), (1996): 203-205.
14. Saffari A M, P G Kevan, J L Atkinson. "Consumption of three dry pollen substitutes in commercial apiaries". Journal of Apicultural Science. Vol 54, No1, (2010): 5-13
15. Saffari A M, P G Kevan, J L Atkinson. "Palatability and consumption of patty-formulated pollen and pollen substitutes and their effects on honey bee colony performance". Journal of Apicultural Science. Vol 54, No2, (2010): 63-72
16. Schmidt L.S., Schmidt J.O., Rao H., Wang W., Xu L. "Feeding preference and survival of young worker honey bees (Hymenoptera: Apidae) fed rape, sesame, and sunflower pollen". Journal of Economic Entomology 88, (1995): 1591–1595.
17. Sena L, Sena S, Hoda A "Feeding efficiency of pollen substitutes in a honey bee colony". Third International Scientific Symposium "Agrosym Jahorina, Bosnia and Herzegovina 2012. Book of proceedings (2012): 509-513.
18. Sihag, R.C. and M. Gupta "Development of an artificial pollen substitute/supplement diet to help tide the colonies of honeybees (*Apis mellifera* L.) over the dearth season". Journal of Apicultural Research. 55(2), (2011): 15-29.
19. Somerville D.C., Nicol H.I "Crude protein and amino acid composition of honey bee-collected pollen pellets from south-east Australia and a note on laboratory disparity". Australian Journal of Experimental Agriculture 46, (2006): 141–149.
20. Wijayati, N., Hardjono, D.S., Rahmavati, M., Kurniawati, A. "Formulation of winged bean seeds as pollen substitute for outgrowth of honeybees (Apis mellifera L)". Journal of Physics: Conference Series, Volume 1321, Issue 2, (2019). https://doi.org/10.1088/1742-6596/1321/2/022040 .
21. Zaytoon A A, Matsuka M, Saaki M "Feeding efficiency of pollen substitutes in a honey bee colony: Effect of feeding site on royal jelly and queen production". Applied Entomology and Zoology. Volume 23, Issue 4, (1988): 481-487. https://doi.org/10.1303/aez.23.481