The influence of cultivation of drone larvae on honey productivity of bee colonies

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Abstract. Homogenate is a source of a huge amount of biologically active substances. However, it is produced in a small number of apiaries, since the cultivation of drone brood negatively affects honey productivity. This paper aimed to study the influence of rearing drone larvae on the power and honey productivity of bee colonies since these issues are not widely addressed in scientific literature. Three groups (control, experimental 1, and experimental 2) of 10 bee colonies were formed by the method of pairs-analogs. One brood frame was placed in the bee colonies of the first experimental group, and two frames were placed in the colonies of the second experimental group. The brood frames were placed on June 12, the clipping was done on June 30, and the honey was collected on July 12. The power of colonies was taken into account after wintering (in March) and at the end of the pre-wintering season (in November). As a result of the research, it was revealed that the homogenate of drone brood can be obtained in apiaries of the Primorsky Krai. It was proved that when adding one brood frame to obtain a homogenate, the main production of the apiary-honey, does not decrease, and a negative effect on honey productivity was observed when adding the second brood frame.

1. Introduction

A bee colony is an economic and biological unit with a complex structure. Most drones rear mainly in spring and early summer, but a drone brood lives in a hive during the entire active beekeeping season. The number of drone broods depends on the age and parentage of the queen, the number of colonies, the active season duration, the volume of the average daily collection of nectar and pollen, the provision of colonies with protein food, the number of honeycombs with drone cells in the total volume of the nest, etc. [1-3].

To rear drones, bees build special drone cells, the size of which differ from that of bee cells. Their diameter is on average 6.25-7.00 mm, while the diameter of the cells for rearing worker bees is 5.0-5.5 mm. To ensure a greater depth of cells when rearing drones, bees seal the larvae with strongly convex caps. Drone cells are used to rear drones and store honey (Fig. 1) [4].
Drone brood rearing is a zootechnical method for the prevention and treatment of colonies from varroosis [4-8].

Drone milk (drone brood homogenate) is a unique and inimitable biologically active product that contains almost the same amount of protein as mushrooms and meat and has no equal in other nutritive elements [9].

Cooking extrusion studies by M. Ulmer et al. showed that expanded textured insect protein obtained from drone brood and soy concentrate is rich in protein (66% of protein) and can serve as a meat substitute [10].

The homogenate contains a large number of "live" components (enzymes, hormones), so it is very critical to the conditions of production and, especially, storage. In particular, the native (natural) homogenate loses its properties under the influence of direct sunlight, as well as when stored at room temperature for more than 1 hour. The native homogenate can be stored in a refrigerator at a temperature of +2 ... +5 °C for no more than 24 hours, and at a temperature of -15 ... -18 °C it can be stored up to 100 days. For longer storage periods, the homogenate should be frozen to -24 °C or lyophilized in gentle technological modes [11,12].

Despite the valuable qualities of the homogenate of drone brood, beekeepers practically do not harvest it, since the rearing of drone larvae distracts bees from their main activity - honey collection, thereby reducing the honey productivity of bee colonies. There is still very little information on how much honey productivity decreases when rearing drones for homogenate production.

Primorsky Krai is one of the leaders in the production of honey, and beekeeping is one of the most developed branches of agriculture in the Russian Federation. This paper aims to study the influence of rearing drone larvae on the honey productivity of bee colonies. In particular, the following tasks were set:

1) To study the possibility of producing a homogenate of drone brood in the conditions of the Primorsky Krai;
2) To determine the impact of rearing drone larvae on honey productivity and colonies power.

2. Materials and Methods
The studies were carried out at the apiary of Taiga Honey LLC, located near the village of Tikhorechnevo of the Anuchinsky District (Primorsky Krai). The bees were kept in the Dadant-Blatt hives system. It is based on a single-hulled hive with a Dadant frame on a 435 × 300 mm nesting frame and a 435 × 145 mm shop frame.

To achieve the set goal, three groups (control, experimental 1, and experimental 2) of 10 bee colonies were formed by the method of pairs-analogs. One brood frame was placed in the bee colonies
of the 1st experimental group, two brood frames were placed in the colonies of the 2nd experimental group. The brood frames were placed on June 12, the clipping was done on June 30. To determine honey productivity, honey was collected on July 12. The power of colonies was taken into account after wintering (in March) and at the end of the season before wintering (in November).

When forming groups, the internal characteristics of bee colonies (origin, physiological state) were taken into account. The Far Eastern breed of bees was used. For the homogeneity of the bee colonies, before the start of the experiment, all queens in the bee colonies participating in the experiment were replaced by queen-sisters. The following indicators were taken into account:

- The power of colonies - by counting the number of full streets occupied by bees;
- The amount of honey - by weighing the frames on a hand scale, followed by subtracting the mass of the frame with an empty honeycomb.
- The amount of drone brood homogenate - by weighing the squeezed drone brood homogenate.

3. Results and discussion

The homogenate of drone brood under the conditions of Taiga Honey LLC is obtained from 6-7-day-old larvae of bee drones when they are still in the stage of open brood. Honeycombs with drone larvae are cut into small pieces and choked with hands. Then the cake is set aside for subsequent melting, and the resulting liquid is filtered through a sieve (coarse filtration). After coarse filtration, a second finishing filtration is carried out through a fine sieve and the obtained mass is weighed. The result is a creamy homogeneous mass of light yellow color. The homogenate is packed in 110 ml glass containers and frozen at -20 °C. The process from squeezing to freezing the drone brood takes no more than 15 minutes. The whole process takes less than an hour. This technology has the most complete preservation of biologically active substances contained in the homogenate, which is confirmed by the study of N.V. Budnikova [4].

The productivities of bee colonies of the control and experimental groups are shown in Table 1.

| Characteristics | Control | 1 Experimental | 2 Experimental |
|-----------------|---------|----------------|---------------|
| The power of colonies before honey collection, streets | 5.2±0.056 | 5.0±0.0 | 5.2±0.056 |
| The power of colonies after honey collection, streets | 8.2±0.197 | 7.6±0.221 | 7.3±0.153 |
| The amount of honey, kg | 25.7±0.650 | 26.7±0.579 | 23.5±0.341 |
| The amount of homogenate of drone brood, kg | - | 0.48±0.055 | 0.94±0.069 |

The number of brood frames significantly influenced honey productivity. The best productivity was shown by the 1st experimental group, its honey productivity was 1.0-3.2 kg higher compared to the control and the 2nd experimental group (P≥0.999 and P≥0.99, respectively). The power of colonies before winter in the 1st experimental group was less than in the control for 0.6 streets, but these differences did not show reliability. The amount of homogenate in this group was less than in the 2nd experimental group by 0.46 kg.

The data on honey productivity in the 2nd experimental group were consistent with the results of M. Ulmer et al. (2020) and significantly differed from the data obtained by T.D. Seeley (2002) [8,10]. M. Ulmer found that rearing drone brood for the production of expanded textured insect protein reduces honey productivity by 8% if the drone brood is excreted as a honey by-product [10].

T.D. Seeley (2002) concluded that rearing drone brood distracts worker bees from collecting pollen, thereby reducing honey harvest. In his research, bee colonies without frames with drones produced 23.6 kg more honey than with drone frames [8].
Overall, the performed studies show that the use of a brood frame for rearing drone brood decreases the power of colonies, and the power of colonies after harvest is inversely proportional to the number of frames. The honey productivity of bee colonies was negatively influenced only when using two building frames.

4. Conclusions
The performed study allowed us to draw the following conclusions:
1. The homogenate of drone brood can be effectively produced using brood frames in the apiary of Taiga Honey LLC (Primorsky Krai, Russia). Such frames are quickly settled with drone brood.
2. For the production of drone brood homogenate, it is advisable to use one brood frame. In this case, the honey productivity per season increased by 4% with an insignificant decrease in the power of colonies. The use of two frames doubled the production of drone brood homogenate but led to a significant decrease in honey productivity and colonies power at the end of the season.

References
[1] Prikhodko Anna, Yankina Olga, Kim Natalya, Koltun Guli and Skolov Andrey 2020 Chemical composition of the far eastern homogenate of drone brood (E3S Web of Conferences vol 203) p 04015 DOI: https://doi.org/10.1051/e3sconf/202020304015
[2] Rhodes J 2002 Drone honey bees – rearing and maintenance DAI/112 Available at: https://powell.ca.uky.edu/files/drone-bee-rearing-and-maintenance_002_0.pdf
[3] Sidor Ewelina and Dzugar Malgorzata 2020 Drone Brood Homogenate as Natural Remedy for Treating Health Care Problem: A Scientific and Practical Approach (Molecules vol 25) p 5699
[4] Budnikova N V 2011 Improvement of the technology of production and storage of drone brood of honey bees: thesis for the degree of candidate of agricultural sciences (Divovo: All-Russian Research Institute of Horse Breeding) p 162
[5] Budnikova N V 2007 Features of the composition of drone brood of Central Russian bees of the Prioksky breed type: materials of international scientific-practical conference Beekeeping in the 21st century ”The Dark Bee of Russia” (Moscow) pp 98–101
[6] Sattarova A A 2010 Economically useful traits of honey bees when using drone brood homogenate: thesis for the degree of candidate of agricultural sciences (Ufa, Bashkir State Agrarian University) p 23
[7] Sharipov A 2012 Increase of reproductive and productive properties, development of an effective management system for the vital activity of honey bees in the Republic of Tajikistan: thesis for the degree of doctor of agricultural sciences (Moscow Agricultural Academy named after K A Timiryazev, Tajik Academy of Agricultural Sciences, Tajik Agrarian University n a Sh Shotemur, Moscow) p 39
[8] Thomas D Seeley 2002 The effect of drone comb on a honey bee colony’s production of honey (Apidologie, Springer Verlag, vol 33 (1)) pp 75–86 Available at: https://hal.archives-ouvertes.fr/hal-00891902/document
[9] Karomatov I D 2020 Drone brood as a remedy (literature review) (Biology and integrative medicine no 4 (44)) pp 85–96
[10] Ulmer Magdalena, Smetana Sergiy and Heinz Volker 2020 Utilizing honeybee drone brood as a protein source for food products: Life cycle assessment of apiculture in Germany (Resources, Conservation and Recycling vol 154) p 104576
[11] Drone homogenate (drone milk), Paseka-Makholinykh: website Available at: http://www.myod-tutaevskij.rf/articles/124736, accessed: 01.02.2021
[12] Prokhoda I A 2009 Obtaining apidoproducts from bee larvae (Beekeeping no 8) pp 48–50