

The effect of nutrition type on the hygienic behavior of bee *Apis mellifera* L. colonies tested using the pricking method

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Abstract

The study of honey bees' healthy behavior was adopted as an indicator in the field of bee resistance to pests (parasites) by introducing new natural materials that can contribute to increasing the performance of worker bees and their healthy activity through the quality of food and measuring its nutritional effectiveness in building workers with good, healthy behavior.

This study investigated the healthy behaviors of honey bees, specifically focusing on how feeding with natural materials influenced the percentage of bees cleaning hexagonal hives that had been pricked. After 18 days of observation, the results showed that a mixture for making ice cream and candy led to the highest percentage of cleaned hexagonal hives, at 96.67%, followed by the treatments of candy mixture, tea tree oil, and Arica solution, recording 96.67, 97.67, and 97.33, respectively. In contrast, the control treatment had a significantly lower percentage, with only 72.00% of hexagonal hives being cleaned.

As for studying the effect of the healthy behavior of bees fed during a month on natural food types, the results showed that there was superiority for the three treatments (peanut paste + candy mixture and Mixture for making ice cream + candy mixture) as they reached 24.00 and 19.33, respectively, over the rest of the treatments and decreased in the control treatment as they reached 2.33, and this is clear evidence of the effect of the nutrition factor on the healthy life performance of workers in colony management.

Key words: *Apis mellifera* L., healthy behavior, candy mixture, tea tree oil.

1. Introduction

Honey bees (*Apis mellifera* L.) are economically important insects that help maintain natural balance worldwide. Recent studies show that approximately 80-95% of crops, vegetables, and fruit trees depend on insects, particularly honey bees, for pollination. This process significantly enhances their yields (1). Additionally, honey bees produce various natural products, including honey, wax, royal jelly, propolis, pollen, and bee venom, which are essential for

treating many diseases and are used in producing medicines, cosmetics, and food. The global revenue from honey alone exceeds \$6 billion (2)(3). Honey bees (*Apis mellifera* L.) are globally exposed to many pests and diseases that cause severe economic damage to beekeeping and agriculture. These pests and diseases have led to many deaths of healthy beehives and the loss of beehive products (4). The most important pest is the varroa mite, which belongs to the phylum arthropods, the family Varoidae, under the order

Mesostigmata (5)(6). It causes many diseases known as Varroosis, which infects the larvae, pupae, and adults of the European honey bee *Apis mellifera* L. Beekeeping scientists believe that Varroa mites significantly contribute to hive disorder and collapse (7). A high density of Varroa mites within hives can damage bee tissues, reduce reproduction rates, lead to the death of pupae, cause deformities in wings, legs, and abdomens, and shorten the lifespan of worker bees (8). Additionally, Varroa mites transmit various deadly pathogens, which further contribute to the death and destruction of bee colonies (9).

The problem of pest infestation in beekeeping has led beekeepers to look for quick fixes, often relying on chemical pesticides. However, the ability of this parasite to develop resistant strains to these pesticides has led to their indiscriminate use, highlighting the need to find alternative solutions to reduce the toxic residues of chemical pesticides and their overuse. Alternative solutions to this problem include encouraging healthy bee behavior, which is crucial to reducing the spread of Varroa, through good nutrition that contributes to increased worker bee activity. There are nutritional strategies that can also help to promote this healthy behavior, which in turn increases bee activity and helps eliminate Varroa.

.2Materials and methods

The study was conducted in the laboratories of the Plant Protection Department from 2023 to 2024 to investigate the infection of the apiaries of Salah al-Din Governorate with the Varroa destructor parasite, one of the most dangerous pests for honey bees, *Apis mellifera*, through a survey study.

.1 .2Preparation of hives

Hive preparation eighteen colonies of hybrid Carniolan bees (*Apis mellifera*) were prepared in the researcher's apiary located in Tikrit city on 6/16/2023. Each hive contained four frames and all colonies were of equal strength and belonged to the same strain. The queens were mated at the same age. The hive boxes and frames were made of the same type of wood and had the same design. In addition, the colonies were free from diseases and pests to prevent any negative effects on their activity and effectiveness. They were also free from Varroa mites and all queens were the same age.

.2.2Stimulating healthy behavior of honey bees

.1 .2.2Nourishment treatments

For three days, each of the three hives of honey bees was nourished with a specific treatment. The nourishment treatments were distributed randomly by placing food comprising candy mixture, candy mixture plus peanut, or candy mixture plus Mixture for making ice cream above the honey bee hive frames.

.1 Candy mix treatment: it consists of 1 kg of candy dough only and no secondary additives.

.2 The treatment of the peanut and candy, involved combining one kilogram of candy paste with fifty grams of peanut paste made from honey, sugar, salt, and soybean oil sourced from India. They were mixed until becoming homogeneous.

.3 Treatment of Mixture for making ice cream and candy mixture: One kg of candy dough was mixed with 50 g of Mixture for making ice cream until the mixture was homogenized.

.2 .2.2Immunity treatments, sprayed on all hive parts.

Spray directly once every two days for three times only. All parts of the honey bee hive were sprayed (adult insects, open brood, closed brood, pollen, and open and closed honey).

.1 ARICA PROMIX treatment: It consists of 2.28% total sugar, 0.34% protein, 0.24% ash, 0.20% cellulose, 0.00% oil, 0.02905% sodium, 0.01328 calcium, 0.00343% phosphorus in addition to water, minerals, vitamins, herbal extracts, and probiotics, manufactured by the Temel Petek company.

.2 Tea Tree Oil Treatment: Produced by a British company, it was used at a ratio of 2 ml of tea tree oil to 1 liter of water.

.3 Control treatment: without any addition

.3.2 Making holes in the closed brood

Holes were made in the beehive frames at a rate of 100 holes per hive. The number of hexagonal hives the bees cleaned was recorded for three days. After applying nourishment and immunity treatments by spraying, the process of pricking the closed brood was repeated 21 days later. Data were again recorded over three days, calculating the number of hexagonal hives cleaned by the honey bees. This data was then compared with the results from the initial pricking process, which occurred before the nourishment and immunity treatments were applied.

.3 Results and discussion

.1 .3 Effect of nourishment with natural materials on the percentage of bee cleaning of hexagonal hives treated through pricking after 18 days of treatment

Table 1 illustrates a variation in the percentage of hexagonal hives cleaned by the worker bees and the treatment of pricking according to the type of nutritional mixture and its effect a month after the treatment. The mixture for making ice cream + candy recorded the highest percentage of hexagonal hive cleaning, followed by the treatments of candy mixture, tea tree oil, and Arica solution, recording 96.67, 97.67, and 97.33%, respectively; in comparison, the percentage decreased to 72.00% in the control treatment. From the table, we observe significant differences between all the averages of the treatments and, in particular, comparing them with the control treatment. The treatments (tea oil, Arica, Mixture for making ice cream+ candy, and peanut + candy) exhibited the highest percentage, attaining 90.50, 90.17, 89.00, 88.83, and 82.67, respectively. The statistical analysis showed a significant difference between the grand average and the percentage of cleaned hives before and after the treatment. It is also observed that all treatments affected the healthy behavior of bees

Table 1. Effect of pricking and nourishment treatments on the cleaned hive percentage of Hive with perforated capping during one month of treatment

Treatment	Cleaned hive percentage of hives with perforated capping's		
	Pre-treatment	Post-treatment	Mean
Candy Mix	81.00 ^{cd}	96.67 ^{ab}	88.83 ^a
Peanut paste + Candy Mix	70.67 ^d	94.67 ^{a-c}	82.67 ^a
Mix for making ice cream+ Candy Mix	79.33 ^d	98.67 ^a	89.00 ^a
Tea Tree Oil	83.33 ^{b-d}	97.67 ^{ab}	90.50 ^a
ARICA Solution	83.00 ^{b-d}	97.33 ^{ab}	90.17 ^a
Control	71.33 ^d	72.00 ^d	71.67 ^b
Mean	78.11 ^b	92.83 ^a	
L.S.D 0.05	Treatment effect 10.652	Time effect 6.15	Interaction 15.065

2.3 Effect of the healthy behavior of bees nourished on types of natural food during a month

The results in Table 2 demonstrated a variation in the difference between the average number of hexagonal hives that honey bee workers cleaned and those that were treated with pricking (with a needle) and nourishment according to the type of mixture they fed. The second and third treatments (peanut paste + candy mixture, Mixture for making ice cream + candy mixture) were superior, recording 24.00 and 19.33, respectively, followed by the other three treatments (candy mixture, tea oil, and Arica solution), and their effect was similar with values of 15.67, 14.33, and 14.33, respectively. The control treatment showed a decrease in performance, indicating a decline

in the behavioral performance of the bees and indicating that these treatments' superiority boosted the health ability of the worker

bees, which is reflected in their functional and healthy behavioral performance. The highest recorded value after the treatment, which included a month-long feeding period for the workers, showed a significant increase in the reproduction of

new individuals responsible for cleaning. This treatment resulted in a peak value of 92.83, compared to an average of 87.11 before the treatment. This finding clearly demonstrates the nourishment factor's positive effect on the workers' healthy life performance in managing the colonies.

Table 2. Effect of the type of nutritional mixtures on the percentage of healthy behavior of bees using the pricking method in closed brood of honey bees.

Treatment	Mean	SE	Range
Candy Mix	15.67 ^{AB}	4.933	19 – 10
Peanut paste + Candy Mix	24.00 ^A	8.888	21 – 17
Mix for making ice cream+ Candy Mix	19.33 ^A	12.741	34 -11
Tea Tree Oil	14.33 ^{AB}	7.505	22 – 7
ARICA Solution	14.33 ^{AB}	13.316	29 – 3
Control	2.33 ^B	1.528	4 – 1
Grand mean	15.00		
L.S.D 0.05	16.267		

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