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Nutritional effects of some supplementary diets on the activities of a honey bee, Apis mellifera L. (Hymenoptera: Apidae) colonies.

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ABSTRACT

Sixteen honey bee colonies with the same densities (4-5 bee frames) were randomly selected and then divided into four groups, comprising four feeding treatments [Sugar solution (control), Apricot juice+ sugar solution, Fermil + sugar solution, Corn flour+ sugar solution +skim milk]. The findings indicated that the most significant proportion of workers preferred consuming Feramil + sugar solution, with 622,480 workers inside the hives and 345,020 workers outside the hives. The average lifespan peaked at 45.310 days when the subjects were provided with a Fermil + sugar solution, while it dropped to its lowest point at 26.510 days whenever they were given a regular sugar solution. The workers' bodies had a protein content of 54.538% when supplied with Feramil+ sugar solution, the highest percentage. On the other hand, the lowest protein content of 40.268% was seen when the workers were given with Apricot juice+ sugar solution. The workers were administered Feramil and Apricot jounce and were able to withstand exposure to temperatures of 0°C, 4°C, 6°C, 8°C, and 15°C for durations of 25, 60, 72, 120, and 156 hours, respectively. This study was conducted to preserve honeybee colonies in fields that lack natural nectar and pollen grain, for continuing apiculture in Iraq-Kurdistan in which the spring season is short, and to assess the impact of certain supplemental foods on the behaviors of honeybees and another purpose of this research was to investigate the impact of certain supplementary foods on the activities of honeybees in a field setting.

***Keywords*:** activity; Honey bee; Supplementary food; worker bee.

INTRODUCTION

Beekeepers in the Kurdistan region face many challenges around the year due to the changing weather condition. Honeybees have shown to be affected by environmental factors such as temperature, abundance of nutrients, floral patterns, consequently, any change in these factors will affect the honeybee colonies in terms of activity, brood rearing, honey making, and many other aspects in their colonies. One of these factors being nutrient availability, can be controlled by supplying the colonies with artificial food supplements. Bees collect nectar from flowers and transport it to honeycombs, where it is processed into honey, a high-energy food source. Forager bees collect pollen from flowers and store it in the honeycomb, where it transformed into bee bread, which contains protein, fats, minerals and vitamins [1]. [2] stated that honeybees enter a state of cold-induced coma when the temperature falls under 10°C and are unable to recover on their own without external warming. The study conducted by [3] revealed that both Africanized honeybee *Apis mellifera Scutellata* and European honeybee *Apis mellifera Linnaeus* colonies experienced mortality whenever subjected to a temperature of 0°C. The workers endured varying degrees of frigid temperatures based on their dietary preferences. [4] and [5] said that the quantity of food consumed by honey bee larvae has an impact on the weight of adult bees.

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brood, European foul brood, Sac brood and Chalk brood diseases, brood rearing, honey making, and many other aspects in their colonies. One of these factors nutrient availability, can be controlled by

supplying the colonies with artificial food supplements. Bees collect nectar from plants and transfer it to honeycombs, where it undergoes processing to become honey, which serves as a rich source of high-energy food. Forager bees gather pollen from flowers and store it in a honeycomb, where it transforms bee bread. Bee bread contains protein, lipids, minerals, and vitamins [6]. The provision of protein food supplies, specifically royal jelly, to young bee larvae and the queen by worker bees, is significantly reduced during particular periods, such as winter and the dry season [7]. The primary objective of this study was to assess the nutritional effects of supplementary diets on honeybee behavior.

Materials and Methods

This investigation was carried out in 2023 at the apiary of the Grdarasha research station, located 10 km south of the College of Agricultural Engineering Science, Salahaddin University-Erbil. The purpose of this research was to investigate the impact of certain supplementary foods on the activities of honeybees in a field setting. Initially, sixteen colonies of Apis mellifera L. were chosen from the apiary based on the specified traits:

Two Langstroth frames were modified for assessment purposes. Each frame was divided into sections measuring 17 inches (43.2 cm) in length and 8 inches in width. Holes were created in each frame to secure silk wires. These wires were placed across the frame, with two wires of equal length and width, totalling one square inch. The total length of the wires used was 136 inches. The sugar solution for the control treatment was prepared by dissolving one kg of sugar crystals in one litre of water solution, which had been heated to a temperature of 70ºC. Each colony was then given one liter of this sugar solution, which had the same concentration, every week during various seasons. In summer, the concentration ratio was 1:2, but in spring and autumn, it was 1:1 [8]. The bees were nourished by dispensing prepared food into plastic bottles, which were then placed on the frames inside the hive. The bottle cover was punctured circularly to facilitate the gradual release of food. The bottle was placed on two wooden pieces to enable the bees to access and consume the food. The wooden support beneath the bottle measured 10 cm in length and 1.5 cm in width. Samples were collected from experimental colonies that contained a significant number of labelled workers with known ages during colony inspection [5]. The food preference and acceptance of honeybees were examined over four days, with observations conducted at three different times (9-10 am, 12-1 pm, and 3-4 pm) each day. The number of honey bee workers visiting the food sources inside and outside the hives was recorded for each replicate during a 45-minute observation period.

The study aimed to determine the longevity of honeybees by caging a specific number of workers (60 workers) of different ages in small cages. The cages contained small empty pieces of comb for water and the bees were fed the same prepared food. The caged worker bees, along with their food, were placed in a hive to monitor their lifespan. Dead bees were recorded and additional food was provided when necessary to prevent bee mortality due to food shortages [9]. The climatic data was obtained from the Erbil General Directorate of Metrology and Seismology through 2023.

Statistical analysis

The data were in statistical terms analyzed employing a factorial design with a total of four replicates. The statistical evaluation was conducted using the SAS program, specifically version 9.1 [10]. For assessing any discrepancies between means, Duncan's multiple range test was employed, with a significance level set at p-value<0.05 [11].

Results and Discussion

In accordance with the data presented in Table (1), the worker bees have a preference for consuming Faramil and sugar solution both inside and outside of the hive, followed by apricot juice and sugar solution, sugar solution, and ending with maize flour and sugar solution. The largest number of workers that preferred to consume the Feramil+sugar solution were 622,480 workers inside the hives, whereas outside the hives there were 345,020 workers. The statistical analysis revealed a significant difference at a significance level of 0.05 between the means of the treatments. The results indicated a preference for the foods treated with Feramil+sugar solution, which exhibited superiority over the other treatments.

Consistent with the findings of [12], honey bee colonies that were provided with a combination of yeast meals containing gluten or yeast exhibited a high level of palatability, comparable to that of naturally palatable commercial pollen. This aligns with the recommendation made by [13] to include soybean flour and yeast in candy as a suitable food source for colonies during the spring season. According to [14], the Carniola bee colonies that received supplementary feeding of pollen during the
experiment showed higher population density, brood rearing, pollen, and honey storage compared to the control colonies that only relied on natural food sources. Additionally, the number of combs covered with bees in colonies that received patty supplements increased gradually, according to [13], beekeepers frequently provide their colonies with substitute or supplementary food throughout the summer to compensate for the lack of both pollen and nectar.

Nutritional preference by honey bee workers inside and outside the hives during different times of day.

Types of food	Time of day (hours)		Means
	Inside	Outside	
Sugar solution (control)	545.756[c]	247.313[g]	396.618[c]
Apricot juice +sugar solution	595.313[b]	298.480[f]	446.896[b]
Fermi +sugar solution	622.480[a]	345.020[e]	483.750[a]
Corn flour +sugar solution	447.730[d]	196.230[h]	321.855[d]
Means	552.819[a]	271.760[b]	

Means that share the identical letter are not statistically significant at the 0.05 level.

The impact of additional food on caged honeybee workers is displayed in Table (2). For example, workers fed sugar solution in the hive for 26.510 days had an average age of 42.720 days and an average longevity of 17–44 days; workers fed apricot juice + sugar solution for 42.720 days had an average age of 45.310 days and an average longevity of 16–45 days, and workers fed maize flour + sugar solution for 36.220 days had an average longevity of 15–36 days. The Feramil + Sugar solution treatment resulted in the maximum average age of 45.310 days, whereas the lowest average age of 26.510 days was seen in the group fed on Sugar solution alone. The statistical analysis revealed significant differences at a significance level 0.05 between the Feramil + sugar solution and the other treatments. The findings were consistent with the research conducted by [15]. They discovered that worker bees had an average lifespan of 23.42 days when fed sugar syrup, 31.35 days when fed corn flour and sugar syrup, and 29.63 days when fed a mixture of skim milk, corn flour, and sugar syrup (in a ratio of 1:2). Additionally, worker bees that were fed brewer's yeast with skim milk, corn flour, and sugar solution had an average lifespan of 34.47 days [16]. The study conducted by [9] reported age rates for the cages as follows: 15.07 days for deist soybeans, 28.94 days for wheat germ, 23.0 days for dry yeast, 15.13 days for palm dates, and 16.31 days for sugar syrup. The wheat germ treatment was superior to the other treatments, possibly due to its higher protein content. [17] demonstrated that the newly emerged workers had the highest average age (16-18 days) when they consumed soybean cake as their food source. The study conducted by [18] demonstrated that honey bees kept in cages had the longest lifespan of 61 days when they were provided with a Wheat gluten supplement. On the other hand, the bees had the shortest lifespan of 9.2 days when not given any supplement.

Table 2. The effect of nutritional supplements on the lifespan of adult worker bees inside the hive.

Type of food	Number of workers	Range of days	Means of workers' longevity
Sugar solution(control)	60	13-41	26.510[c]
Apricot juice +sugar solution	60	17-44	42.720[a]
Fermi +sugar solution	60	16-45	45.310[a]
Corn flour +sugar solution	60	15-36	36.220[b]

Means that share the identical letter are not statistically significant at the 0.05 level

Effect of Supplemental Foods on Nitrogen Content and Total Protein in the Body of Workers: The results of the effect of supplemental food treatments on nitrogen and protein contents in the bodies of

honey bee workers are presented. Table (3) demonstrates that the highest mean value of nitrogen content was (8.780 %) when the colonies received the feeding treatment Feramil +sugar solution, while the lowest percentage of nitrogen content was (6.800 %) when concerning the total protein content, it was noticed that the highest value was (54.538 %) when the bees fed with Feramil + sugar solution, however, the lowest value was (41.786 %) in the case of control feeding treatment sugar solution. In both circumstances, there were significant differences (p-value≤0.05) in nitrogen content (total protein) in the body of honey bee workers. The total protein content was determined using the technique mentioned in [19]and the Biuret reagent, the same trend was also confirmed by [20] when they fed honey bees with proteinous material from potatoes and fish.

Table 3. Effect of Supplementary diets on moisture, Nitrogen, Protein, and lipids percentage

Type of food	Moisture content %	Nitrogen content %	Protein content %	Lipid content %
Sugar solution (control)	80.325	6.800	41.786	7.125
Apricot juice +sugar solution	78.765	7.620	40.268	8.794
Feramil +sugar solution	77.792	8.780	54.538	8.357
Corn flour +sugar solution	80.448	7.830	48.318	7.537

The influence of certain additional nutrition on the honeybee worker's ability to tolerate low temperatures is as follows: as revealed in table (4), table (5), table (6), table (7), and table (8) show that the honeybee worker's tolerance of low temperatures according to the type of food consumed by bee workers exposed to the temperature of (15°C) withstand a more extended period than (156 hours) for all foods, and survival rates reached 10.1, 17.6, 14.4 and 10.7% for foods Sugar solution, apricot juice + sugar solution, Feramil + sugar solution and corn flour + sugar solution respectively. It also reached (120 hours) when exposed to 8C and reached (72 hours) when exposed to 6°C then reached (60 hours) when exposed to 4°C it reached (120 hours) when they were exposed to a temperature of 8°C, and the results that the workers who fed on Apricot juice + sugar solution were more tolerant of, and the reason for the superiority of apricot juice and Feramil is that these substances contain vitamins, minerals, and proteins, the workers fed with vitamin C with sugar solution it survived for five days at 5°C inside the refrigerator. However [2] showed that worker bees die below 10°C without external heating. [3] found that both African and European bees die when the temperature reaches (30°C), and [20] showed that African bees can withstand cold temperatures (0°C), as the workers remain alive for three hours when they are placed in a refrigerator.

Table 4. The honey bee workers mortality fed on some supplementary diets at 15ºC.

Type of Food	Honey bee workers mortality %											Total
	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120	120-132	132-144	144-156	
Sugar Solution(control)	0.3	0.7	2.1	4.4	5.0	6.1	12.3	18.8	25.0	15.2	10.1	100 %
Apricot juice +sugar solution	0.2	0.8	2.0	3.2	5.2	9.7	9.9	15.7	20.4	15.3	17.6	100 %
Fermil+sugar solution	0.7	0.6	1.5	2.4	6.6	10.2	13.8	17.6	18.7	13.5	14.4	100 %
Corn flour +sugar solution	0.8	0.3	2.1	4.2	5.2	10.1	15.6	20.7	19.0	11.3	10.7	100 %

Table 5. The honey bee workers mortality fed on some supplementary diets at 8 ºC.

Type of Food	The honey bee workers mortality %										
	8-10	19-12	12-24	36-48	48-60	60-72	72-84	84-96	96-108	108-120	120-132
Sugar Solution(control)	0.7	2.1	4.4	6.1	12.3	18.8	20.0	19.5	6.1	0.0	100 %
Apricot juice +sugar solution	0.8	2.0	3.2	5.7	7.6	18.0	19.1	17.2	11.4	9.0	100 %
Fermil+sugar solution	0.6	1.5	2.4	4.2	8.8	19.6	20.7	20.3	10.2	5.1	100 %
Corn flour +sugar solution	0.3	1.1	3.2	7.1	8.6	20.7	20.0	22.6	8.6	2.6	100 %

Table 6. Percentage of honey bee workers mortality fed on some diet supplement at 6ºC.

Type of Food	Honey bee workers mortality %								
	6-8	8-10	10-12	12-24	24-36	35-48	48-60	60-72	72-84
Sugar Solution(control)	2.1	8.6	10.2	35.3	10.3	20.2	10.1	3.2	100 %
Apricot juice +sugar solution	0.4	6.7	9.7	29.2	11.6	22.4	8.2	11.8	100 %
Fermil+sugar solution	0.4	7.1	11.4	38.4	13.2	20.8	7.1	1.6	100 %
Corn flour +sugar solution	1.0	9.5	10.4	30.4	14.2	21.1	9.4	4.0	100 %

Table 7. The percentage of honey bee workers mortality fed on some supplement diet at 4ºC.

Type of Food	Honey bee workers mortality %							
	6-8	8-10	10-12	12-24	24-36	36-48	48-60	60-72
Sugar Solution(control)	16.2	12.5	10.3	25.4	24.3	11.3	100 %	
Apricot juice +sugar solution	12.3	11.4	9.6	22.2	25.4	10.2	9.9	100 %
Fermil+sugar solution	9.5	10.6	13.4	22.1	26.7	13.2	5.4	100 %

Corn flour +sugar solution	11.2	11.2	11.0	25.2	25.6	13.6	100 %

Table 8. The honey bee workers mortality which fed on some supplementary diets at 0ºC.

Type of Food	Honey bee workers mortality %					
	4-6	6-8	8-10	10-12	12-24	25-36
Sugar Solution(control)	24.1	30.3	36.3	10.3	100 %	
Apricot juice +sugar solution	19.3	22.6	31.92	15.4	11.3	100 %
Fermil+sugar solution	21.2	23.4	33.5	14.7	11.2	100 %
Corn flour +sugar solution	24.7	31.0	25.2	11.6	7.5	100 %

References:

[1] Morais MM, Turcatto AP, Premier RA, Francoy TM, Guidugli-Lazzarini KR, GoncalvesLS. 2013; Protein levels and colony development of Africanized and European honey bees fed natural and artificial diets. Genetics and Molecular Research. 2013;12(4):6915-6922.

[2] Heinrich, B.1979; Thermoregulation of African and European honey bees during foraging, attack and hive exist and returns.J.Exp.Biol.80: 217-229.

[3] Dietz, A., Leitner, J. F., Vergara, C. and Mejia, M.1989; Effect of prolonged confinement in a refrigerator chamber on the survival of Africanized and European honey bee colonies. Amer. Bee J.,129: 815.

[4] Daley, H.V. and Morse, R. A.1991; Abnormal sizes of workers honey bees (Apis mellifera L.). reared from drone comb (Hymenoptera: Apidae). J. Kansas Entomol. Soc., 64: 193-196.

[5] Bas, S. M. A.2013; A study of the effect of some pollen supplemental food on body organs of honey bee workers and their activities Apis mellifera L. (Hymenoptera: Apidae). M.Sc. Thesis, College of Agriculture. Niv of Dohuk. 139.

[6] Shamdin, Z.N. 2003; Effect of supplemental protein and vitamins on the development of specific tissues with special concern to their fine structures in relation to the activity of honey bee workers *Apis mellifera* L. (Hymenoptera: Apidae). M.Sc. Thesis. College of Agriculture.Univ. of Dohuk 101.

[7] Saleh, A.H. 2017; Effect of Some Supplemental Food on Bioactivity of Honey Bee *Apis mellifera* L. Colonies (Hymenoptera: Apidae). M.Sc. Thesis Salahaddin University Agri.College.

[8] Abou El-Enain, H. T.; R. E. Omar; M. M. Khattap; M. M. Azap and M. S. Younis 2006; Effect of pollen substitutes on some different activities in honey bee colonies. J. Agric. Sci.Mansoura Univ., 31(8): 5407-5416.

[9] SAS. Statistical analysis system. 2003; User's guide for personal computer. Release V.9.1 SAS Institute Inc. Cary, NC, USA.

[10] Duncan, D. B., 1947; Significance Tests for Differences between Ranked Variates Dirawn from Normal Populations," Iowa State College Ph.D. thesis, 117 pp., 1947.

[11] Al-Anssari, O.M.N. 1998; The bees in honey production and crops pollination. AL-Askandaria University, Egypt, 1336. (In Arabic).

[12] Hayes, J.V. 1984; Supplemental feeding of honey bees. Amer.Bee J.1: 35-37.

[13] Al-Ghamdi, A. 2002; The effect of pollen supplementary feeding on some activities of honey bee colonies during summer season in Riyadh, Saudi Arabi. Saudi J.Biolo.Sci.,9: 85-93.

[14] El-banby, M.A. and Gorgui, W.A. 1970. Development of trany bees whose colonies are fed on sugar syrup nutrition and pollen substitutes. Apiacta 1: 3-8.

[15] Abdulla, M.A. 1988; Effect of diet with high protein content on the activity of honeybee (Apis Mellifera L.). M.Sc. Thesis, Mosul.University.155.

[16] El-Hady, A. M. E. 2012; Influence of some pollen substitutes on brood rearing of honey bee and workers longevity. Plant Prot. Path., Mansoura Univ., 3(3): 299 – 306.

[17] Irandoust, H. and Ebadi, R. 2013; Nutritional effects of high protein feeds on growth, development, performance and overwintering of honey bee (Apis mellifera L.). Int. J. Adv. Biol. Biom. Res.,1(6):601-613.

[18] Gornal, A.G., Bardawil, C.J. and David, M.M. 1949; Determination of serum protein by means of the biuret reaction.J.Biol.Chem.,177:751.

[19] Szyma B. and Przybyi A. 1996; Physiological condition of worker bee Apis mellifera L. after consumption of pollen substitute. Pszczeln. nauk., zesz., 40(2): 109-117.

[20] Abramson, C. l.; Aquino, l. S. A.; Zeredo, G. A., and Price, M. 1997; Some preliminary studies on the ability of Africanized honey bees Apis mellifera L. to tolerate cold temperatures when placed inside refrigerator. Psychol. Rep., 81: 706-18.

تأثير الغذائي لبعض الأغذية المكملة في نشاط مستعمرات نحل العسل *Apis mellifera* L. (Hymenoptera: Apidae).

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الخلاصة

تم اختيار ستة عشرة مستعمرة نحل بنفس الكثافة 4–5 إطارات وقسمت عشوائيا وقسم الى اربع مجاميع تضم اربع معاملات تغذية المحلول السكري (كونترول) وعصير مشمش + المحلول السكري وفيراميل + المحلول السكري ودقيق الذرة +المحلول السكري. أظهرت النتيجة ان أكبر عدد من شغالات النحل يفضلون التغذية على مادة الفيراميل+المحلول السكري وبلغ عدد الشغالات622,420 شغالة داخل خلايا النحل و345,020 شغالة خارج خلايا النحل وبلغ اعلى متوسط طول العمر للشغالات التغذية على مادة الفيراميل والمحلول السكري 45,310 يوما. واقل معدل طول العمر للشغالات المتغذية على المحلول السكري 26,510 يوما. وسجل اعلى نسبة البروتين في جسم الشغالات المتغذية على الفيراميل مع المحلول السكري 54,538% وأدنى نسبة البروتين سجلت في الشغالات المتغذية على مادة عصير المشمش والمحلول السكري 40,268 %. وسجل درجة التحمل للشغالات المتغذية على الفيراميل مع المحلول السكري كانت ،25، 60، 72، 120 و156 ساعة عند درجات الحرارة صفر مْ، 4 مْ، 6 مْ، 8 مْ و 15 مْ على التوالي. أجريت هذه الدراسة لحماية طوائف نحل العسل في مناطق التي تقل فيها الرحيق وحبوب اللقاح. ولاستمرار مهنة النحالة في كوردستان العراق لكون موسم ربيع تكون قصيرة. الهدف الأساسي لهذه الدراسة لمعرفة تاثير بعض مكملات الأغذية على سلوك ونشاطات لأفراد النحل في الحقل.

الكلمات المفتاحية : نحل العسل، مكملات الغذاء، أنشطة شغالات النحل.