SINAI Journal of Applied Sciences 14 (3) 2025 169-176

Available online at www.sinjas.journals.ekb.eg

SCREENED BY iThenticate Professional Plagiarism Prevention

SINAI Journal of Applied Sciences

Print ISSN 2314-6079
Online ISSN 2682-3527

ARU-EGYPT SJAS Trust Science | It Creates

# EVALUATION OF SOME SUPPLEMENTAL PROTEIN OR NECTAR DIETS DURING SEASONAL VARIATIONS TO ENHANCE THE BIOLOGICAL ACTIVITIES OF HONEYBEE COLONY

**Alaa S.S. Mostafa[1*]; M.N. El-Basiony[1]; H.M. Mahfouz[1] and Baraka A. Abd Elsalam[2]**

1. Dept. Plant Prod., Fac. Environ. Agric. Sci., Arish, Univ., Egypt.

2. Dept. Dairy Res., Food Technol. Res. Inst., Agric. Res. Cent., Giza, Egypt.

ARTICLE INFO

**Article history:**
Received: 19/05/2025
Revised: 04/06/2025
Accepted: 25/06/2025

Keywords:
Honeybee, supplement diet, chickpeas, soybeans, Carniolan, biological activities..

ABSTRACT

There is no doubt that nutrition has a great effect on honeybee colonies strength. So that, the experiment was carried out in fifteen colonies divided into five groups and fed two protein (chickpeas or fat-free soybeans) or two nectar (Essence or cinnamon) supplement diets during summer, spring and autumn. The obtained results showed that, the relationship between different nutrition diets and seasons had significant ($p \leq 0.05$) effect on various biological variables. Stored honey area recorded the highest value in Autumn for T3 fed Essence +sugar solution. The highest stored pollen area recorded for colonies fed (Chickpeas + powdered sugar + cinnamon + turmeric) and (Essence + sugar solution). The unsealed worker brood area recorded the highest value in T4(Cinnamon + sugar solution) followed byT1(Chickpeas + powdered sugar + cinnamon + turmeric) while, the sealed worker brood area recorded the highest value in T3(Essence + sugar solution) and T2(Fat-free soybeans + powdered sugar + cinnamon + turmeric) which means that the interaction between different types of nutrition and seasonal variation significantly affects biological activities.

## INTRODUCTION

Honeybees are social insects that live in colonies or hives. They have a complicated social organization that includes a queen bee, drones, and worker bees **(Salam and Marwaha, 2024).**

Honeybees create bee products to suit the demands of the hive year-round. Bees' principal food sources include bee pollen, royal jelly, honey, and bee bread. Others, such as propolis, serve a protective purpose by sheltering the hive from dangerous microorganisms **(Rzetecka *et al.*, 2024)**.

One of the most important aspects of maintaining a healthy hive is the nutritional condition of a honeybee colony. A honeybee colony's development is directly impacted by a lack of nectar and pollen flow, which creates space for pathogen growth and, as a result, lowers the colony's activity and Vigor. To resolve colony nutritional imbalances and achieve the desired outcomes, beekeepers must immediately employ more food supplements and/or alternatives in apiary management **(Falcão *et al.*, 2024).**

Currently, there are many different products (bee food additives) on the global market, each with a very different and sometimes even unclear composition. These products claim to have a variety of effects, including boosting brood, boosting energy, supporting queen rearing, lowering Varroa reproduction, improving bee gut microbiota, and preventing emesis **(Falcão *et al.*, 2024).** In North Sinai, there is a scarcity of nectar

*** Corresponding author: E-mail address:** ccena35@yahoo.com
https://doi.org/10.21608/sinjas.2025.362051.1307
2025 SINAI Journal of Applied Sciences. Published by Fac. Environ. Agric. Sci., Arish Univ. All rights reserved.

plants which is the main source of food, **Mahfouz (2021)** mention that El-Arish should be included in the sustainable beekeeping programs to improve biological activity and productivity of honeybee colonies. Therefore, th is study aims to determine the effect of two protein (chickpeas or fat-free soybeans) or two nectar (Essence or cinnamon) supplement diets during summer, spring and autumn on biological activities of honeybee colonies in El-Arish- North Sinai.

# MATERIALS AND METHODS

## Experimental Design

The present study was carried out at the apiary of honeybee research centre, Faculty of Environmental Agricultural Sciences, Arish University, North Sinai, Egypt. This experiment was conducted from March to December 2023.

## Supplemental Diets

This experiment was carried out to assessment some different pollen supplements on honeybee colonies and their activities. Fifteen colonies in the same strength of honeybee Carniolan were chosen. Colonies divided into five groups (each three colonies). Pollen grains were not prevented from entering the cells naturally. Diets were used as follows:

The colonies of control and treatments received one litter of 50 percent sugar syrup every 12 days.

## Biological Activities of Honeybee Colony

The following biological activities of honeybee colonies were recorded every 12 days intervals for all the fifteen honeybee colonies during the tested seasons: spring, summer and, autumn.

## Measurements

### Area average of stored honey, stored pollen, unsealed and sealed brood

The areas (square inches) of stored pollen, stored honey and the worker's sealed or unsealed brood were measured at an interval of 12 days using a grid with 5 cm x 5 cm squares that covered the entire side of a comb. The grid was placed over each side of a comb and the number of squares with brood or pollen stores was counted. Measurements of all frames with brood or pollen stores were summed for each colony **(Taha, 2007).**

## Statistical Analysis

All the experimental design in the present work was completely randomized design; results were analysed using SAS **(SAS Institute, 1989).** Mean was compared by Duncan's new multiple range test and Least Significant Difference (LSD) at p = 0.05.

# RESULTS AND DISCUSSION

## Effect of Different Supplemental Diets on Various Biological Variables

Effect of different supplemental diets on various biological variables (honey, pollen grains, unsealed brood and sealed brood) are presented in Table 2 and Fig.2.

Data of different supplemental diets had significant ($p \leq 0.05$) effect on various biological variables.

The highest values of honey were observed on essence diet compared to other diets followed by control, chickpeas, cinnamon, and soybeans (988.39, 956.06, 844, 711.23 and 606.92 $in^2$/colony respectively).

Also, the essence diet recorded the highest values of pollen (100.33), followed by cinnamon (90.71), chickpeas (80.53), soybeans (80.14), and control (40.79). However, there were no significant ($p>0.05$) differences in unsealed brood values. While sealed brood values had significant ($p \leq 0.05$) differences, essence diet showed the highest value (284.82), followed by soybeans (249.52), control (230.91), cinnamon (218.12), and chickpeas (195.38).

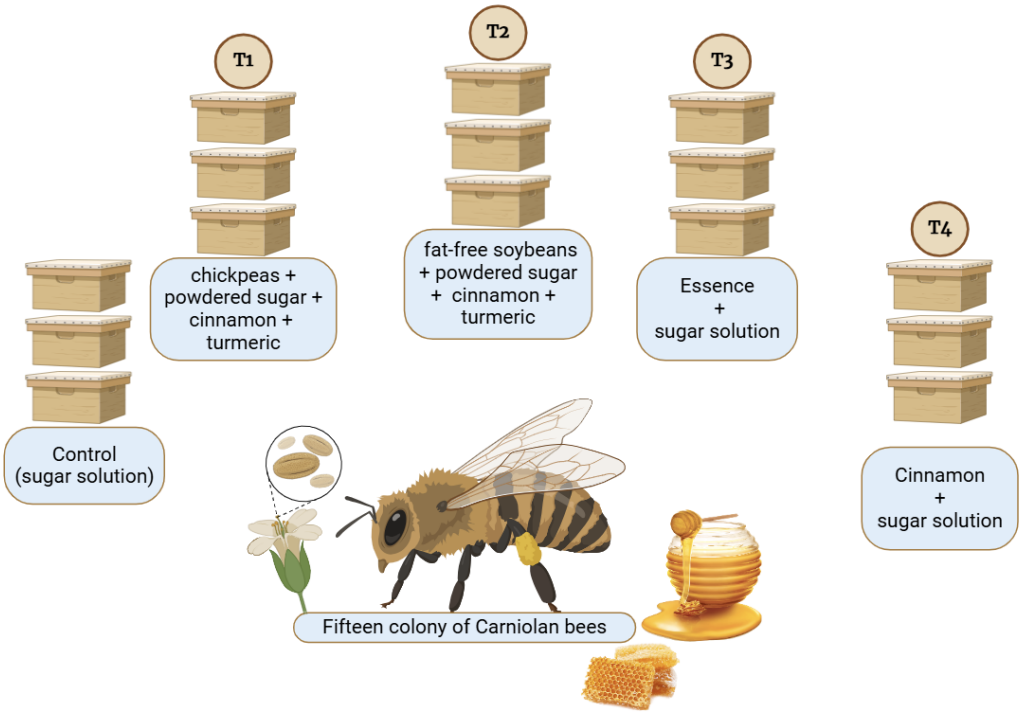


**Fig.1. Supplemental protein diets were used as follows on Graphical experimental design**

**Table 1. Diets for honeybee colonies**

| Diets | Ingredients |
|---|---|
| | Control (sugar solution) |
| **Diets -1** | 30g chickpeas + 60g powdered sugar + 5g cinnamon + 5g turmeric |
| **Diets -2** | 30g fat-free soybeans + 60g powdered sugar + 5g cinnamon + 5g turmeric |
| **Diets -3** | Essence + sugar solution (1:1) |
| **Diets -4** | Cinnamon + sugar solution (1:1) |

**Table 2. Effect of different supplemental diets on various biological variables (in²/colony)**

| Diet | Honey | Pollen | Unsealed brood | Sealed brood |
|---|---|---|---|---|
| **Control** | $956.06^{ab}$±49.08 | $40.79^{b}$±7.40 | 22.50±2.01 | $230.91^{ab}$±21.29 |
| **Chickpeas** | $844.00^{b}$±48.60 | $80.53^{a}$±11.94 | 22.41±2.54 | $195.38^{b}$±18.91 |
| **Soybeans** | $606.92^{c}$±32.90 | $80.14^{a}$±6.95 | 25.23±1.83 | $249.52^{ab}$±19.21 |
| **Essence** | $988.39^{a}$±56.64 | $100.33^{a}$±7.31 | 27.62±2.48 | $284.82^{a}$±20.64 |
| **Cinnamon** | $711.23^{c}$±45.13 | $90.71^{a}$±6.55 | 28.41±3.21 | $218.12^{b}$±19.90 |

Values mean ± SE and different letters at same row indicate significant difference ($p \leq 0.05$).

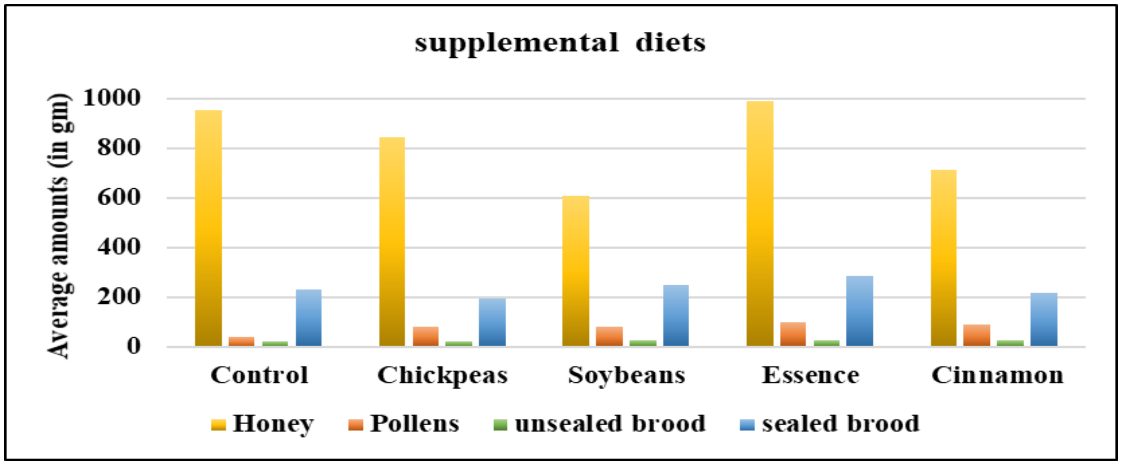


**Fig. 2. Effect of different supplemental diets on various biological: honey, pollen grains, unsealed brood and sealed brood collected by honeybee colonies during the season of 2023**

## Relationship Between Different Supplemental Diets and Seasons (Autumn, Spring and Summer) on Some Biological Activities

Table 3 displays the relationship between different supplemental diets and seasons (spring, summer and autumn) on various biological variables collected from Carniolian honeybee during 2023 seasons. Analysis of the relationship between different supplemental diets and seasons had significant ($p \leq 0.05$) effect on various biological variables.

### Stored honey area

The highest values of honey were observed on Essence and Control diet (1321.48 and 1204.48 in²/colony respectively) in Autumn compared with various seasons. While Cinnamon and Soybeans recorded the lowest values of honey on Spring (429.38 and 472.76 in²/colony respectively). As shown in Fig. 3. a., there is a close relationship between different types of supplemental diets and seasonal variation which affects honey production.

### Stored pollen grains area

The highest values of Pollen were recorded on Chickpeas (168.67 in²/colony) follow by Essence diet (129.10 in²/colony) in Spring compared with different seasons. While Control recorded the lowest values of Pollen on Autumn and Summer (13.57 and 29.25in²/colony respectively). As shown in Fig.3. b. which means that protein supplemental diets significantly affect pollen collection.

### Unsealed brood area

The highest values of unsealed brood were recorded on cinnamon (50.76 in²/ colony) follow by chickpeas diet (43.33 in²/ colony) in Spring compared to other seasons. While Chickpeas and cinnamon showed the lowest values of unsealed brood on Autumn (7.33 and 11.14 in²/colony respectively). As shown in Fig.3. c.

### Sealed brood area

The highest values of sealed brood were recorded on Essence (439.43 in²/colony) follow by soybeans diet (399.62 in²/colony) in Spring compared to other seasons. While chickpeas and cinnamon showed the lowest values of sealed brood on Autumn (40.57 and 60.86 in²/colony respectively). As shown in Fig.3. d.

**Table 3. Relationship between different nutrition diets and seasons (autumn, spring and summer) on various biological variables collected from Carniolian honeybee during 2023 seasons**

| Seasons | Nutrition diets | Biological Activities | | | |
|---|---|---|---|---|---|
| | | Honey | Pollen | Unsealed brood | Sealed brood |
| Spring | Control | $564.05^{fgh}\pm101.11$ | $81.19^{cde}\pm19.90$ | $36.38^{bc}\pm4.28$ | $391.48^{ab}\pm32.84$ |
| | Chickpeas | $540.10^{fgh}\pm77.77$ | $168.67^{a}\pm28.95$ | $43.33^{ab}\pm5.19$ | $342.67^{bc}\pm26.38$ |
| | Soybeans | $472.76^{gh}\pm80.59$ | $134.33^{ab}\pm9.29$ | $31.86^{cd}\pm3.23$ | $399.62^{ab}\pm24.74$ |
| | Essence | $544.14^{fgh}\pm93.74$ | $129.10^{b}\pm10.61$ | $38.43^{bc}\pm4.51$ | $439.43^{a}\pm30.60$ |
| | Cinnamon | $429.38^{h}\pm74.33$ | $138.57^{ab}\pm10.39$ | $50.76^{a}\pm7.42$ | $376.90^{ab}\pm27.18$ |
| Summer | Control | $1081.71^{bc}\pm32.19$ | $29.25^{gh}\pm5.19$ | $20.75^{efg}\pm1.92$ | $232.04^{e}\pm26.06$ |
| | Chickpeas | $849.00^{de}\pm44.40$ | $42.75^{fgh}\pm5.15$ | $17.29^{fgh}\pm1.63$ | $201.96^{e}\pm22.18$ |
| | Soybeans | $657.96^{efg}\pm41.34$ | $59.96^{defg}\pm11.57$ | $28.71^{cde}\pm2.84$ | $255.96^{de}\pm22.17$ |
| | Essence | $1085.67^{bc}\pm44.64$ | $69.92^{def}\pm10.36$ | $30.92^{cde}\pm4.13$ | $305.42^{cd}\pm18.50$ |
| | Cinnamon | $742.13^{ef}\pm46.21$ | $89.25^{cd}\pm8.99$ | $23.96^{def}\pm2.43$ | $216.79^{e}\pm24.63$ |
| Autumn | Control | $1204.48^{ab}\pm36.73$ | $13.57^{h}\pm1.45$ | $10.62^{gh}\pm1.10$ | $69.05^{f}\pm7.85$ |
| | Chickpeas | $1142.19^{abc}\pm80.16$ | $35.57^{fgh}\pm3.73$ | $7.33^{h}\pm0.93$ | $40.57^{f}\pm4.78$ |
| | Soybeans | $682.76^{ef}\pm31.24$ | $49.00^{efgh}\pm3.65$ | $14.62^{fgh}\pm2.19$ | $92.05^{f}\pm12.01$ |
| | Essence | $1321.48^{a}\pm73.50$ | $106.33^{bc}\pm14.02$ | $13.05^{gh}\pm1.69$ | $106.67^{f}\pm12.53$ |
| | Cinnamon | $957.76^{cd}\pm73.56$ | $44.52^{fgh}\pm1.59$ | $11.14^{gh}\pm1.29$ | $60.86^{f}\pm3.63$ |

Values mean ± SE and different letters at same row indicate significant difference ($p \leq 0.05$).

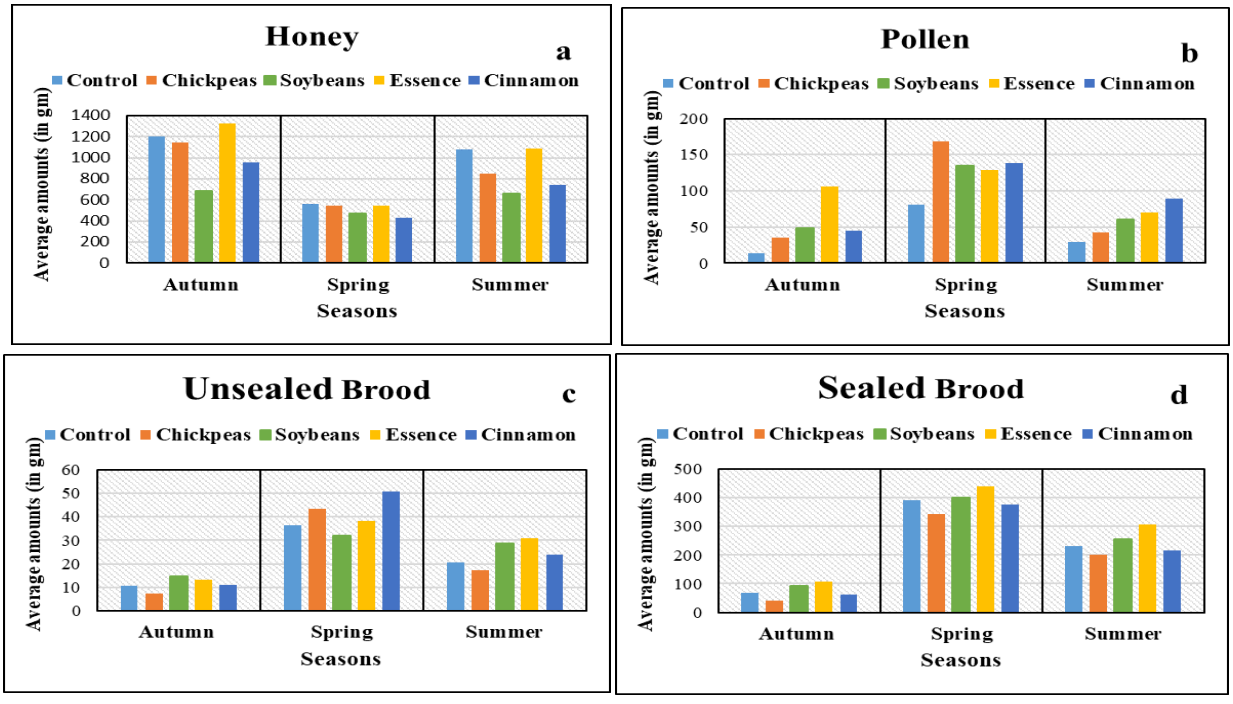


**Fig. 3. Relationship between different nutrition diets and seasons (autumn, spring and summer) on average amounts of some biological variables: honey (a), pollen(b), Unsealed brood (c), and Sealed brood(d) collected from Carniolian honeybee during 2023 seasons.**

In the current study, all studied diets were did not have the same effect to stimulate of various biological variables (honey, pollens, unsealed brood and sealed brood). Whereas, feeding bee colonies with essence diet recorded the highest values of various biological variables. **DeGrandi-Hoffman *et al*. (2008)** indicated that even when consumption rates are identical, the amount of brood that may be raised depends on variations in the nutritional content of the diets (i.e., levels of protein and carbohydrates) and possibly the digestibility and accessibility of their nutrients to worker bees.

To maintain their biological functions, bees need a diet that is balanced in terms of lipids, proteins (such as pollen), carbs (such as nectar and honey), vitamins, and minerals. Our results proved that diets such as essence and control resulted in higher honey production, especially in Autumn. This suggests that these diets provide optimal carbohydrate resources for energy storage, similarly **(Wright *et al*., 2018).**

Our study found that depending on seasonal resource availability, Bees adjust their foraging behaviour. In Spring, Pollen collecting is their priority to support brood rearing, while in Autumn, they focus on nectar collection for honey storage which agrees with **(Danner, 2017).** Also, protein nutrition increases the number of brood similar to previous studies **(Irandoust and Ebadi, 2013; Di Pasquale *et al*., 2013; Gemeda, 2014; Kösoğlu *et al*., 2019).**

## Conclusion

The results illustrate the necessity of focusing on both types of nutrition and seasonal variation in beekeeping techniques. By modifying diets to suit seasonal requirements, beekeepers may boost hive output and ensure the health and sustainability of their colonies. The underlying mechanisms (such as dietary nutritional content and environmental factors) causing these reported effects might be investigated further.

# REFERENCES

**Danner, N. (2017):** Honeybee foraging in agricultural landscapes (Doctoral dissertation, Universität Würzburg).

**DeGrandi-Hoffman, G.; Wardell, G.; Ahumada-Segura, F.; Rinderer, T.; Danka, R. and Pettis, J. (2008):** Comparisons of pollen substitute diets for honeybees: consumption rates by colonies and effects on brood and adult populations. J. Apicult. Res., 47 (4): 265 - 270.

**Di Pasquale, G.; Salignon, M.; Le Conte, Y.; Belzunces, L.P.; Decourtye, A.; Kretzschmar, A. and Alaux, C. (2013):** Influence of pollen nutrition on honeybee health: do pollen quality and diversity matter? PloS One, 8 (8): e72016.

**Falcão, S.I.; Bocquet, M.; Chlebo, R.; Barreira, J.C.; Giacomelli, A.; Smodiš Škerl, M.I. and Quaglia, G. (2024).** Composition and Quality of Honeybee Feed: The Methodology and Monitoring of Candy Boards. Anim., 14 (19) 2836: 1-13.

**Gemeda, T.K. (2014):** Testing the effect of dearth period supplementary feeding of honeybee (*Apis mellifera*) on brood development and honey production. Int. J. Adv. Res., 2 (11): 319-324.

**Irandoust, H. and Ebadi, R. (2013).** Nutritional effects of high protein feeds on growth, development, performance and overwintering of honeybee (*Apis mellifera* L.). Int. J. Adv. Biol. and Biomed. Res., 1 (6): 601-613.

**Kösoğlu, M.; Topal, E.; Tunca, R.İ.; Yücel, B. and Yıldızdal, İ. (2019).** Bal Arılarında Kışlama Öncesi Farklı Beslemenin Koloni Gelişimine Etkileri. ANADOLU Ege Tarımsal Araştırma Enstitüsü Dergisi, 29 (2): 85-92.

**Mahfouz, H.M. (2021).** Sustainable Beekeeping in North Sinai Region by Monitoring The Biological Activity and Productivity of Honeybee Colonies in Bir El-Abd and Sheikh Zowied Zones Comparing with El-Arish Province. J. Plant Protec. and Pathol., 12 (10): 717-724.

**Rzetecka, N.; Matuszewska, E.; Plewa, S.; Matysiak, J. and Klupczynska-Gabryszak, A. (2024).** Bee products as valuable nutritional ingredients: Determination of broad free amino acid profiles in bee pollen, royal jelly, and propolis. J. Food Comp. and Anal., 126: 105860.

**Salam, F.A. and Marwaha, L. (2024).** The Utilization of Bee Products in Therapy, 21: 25-35.

**Taha, E.A. (2007):** Importance of Banana Musa sp. (Musaceae) for honeybee *Apis mellifera* L. (Hmenoptera: Apidae) in Egypt. Bull. Ent. Soc. I: 125-133.

**Wright, G.A.; Nicolson, S.W. and Shafir, S. (2018).** Nutritional physiology and ecology of honeybees. Ann. Rev. Entomol., 63 (1): 327-344.

## الملخص العربي

# تقييم بعض الوجبات التكميلية من البروتين أو الرحيق خلال التغيرات الموسمية لتعزيز الأنشطة البيولوجية لخلايا نحل العسل

**آلاء سالمان سليمان مصطفى[١]، محمد نجيب البسيونى[١]، حاتم محمد محفوظ[١]، بركة أبواليزيد عبدالسلام[٢]**

١. قسم الإنتاج النباتي، كلية العلوم الزراعة الزراعية البيئية، جامعة العريش، مصر.

٢. قسم بحوث الألبان، معهد بحوث تكنولوجيا الأغذية، مركز البحوث الزراعية، الجيزة، مصر.

تلعب التغذية دورًا حيويًا في تحديد قوة طوائف نحل العسل، أجريت التجربة في خمسة عشر طائفة مقسمة إلى خمس مجموعات وتم تغذيتها على نوعين من المكملات الغذائية من البروتين (حمص، فول الصويا خالي الدسم) ونوعين من المكملات الغذائية الرحيقية (منكهات صناعية، القرفة) خلال الربيع والصيف والخريف. أظهرت النتائج المتحصل عليها أن العلاقة بين انواع التغذية المختلفة والمواسم لها تأثير معنوي ($p\leq 0.05$) على العديد من المتغيرات البيولوجية. سجلت مساحة تخزين العسل أعلى قيمة في الخريف للخلايا المغذاة على نكهة صناعية + محلول السكر. سجلت أعلى مساحة تخزين حبوب اللقاح للخلايا المغذاة على (حمص + سكر بودرة + قرفة + كركم) و(نكهة صناعية + محلول السكر). وسجلت منطقة حضنة الشغالات المفتوحة أعلى قيمة في المجموعة الرابعة (محلول القرفة + السكر) تليها المجموعة الاولي (حمص + سكر بودرة + قرفة + كركم) في حين سجلت منطقة حضنة الشغالات المغلقة أعلى قيمة في المجموعة الثالثة (نكهة صناعية + محلول السكر) والمجموعة الثانية (فول الصويا خالي الدسم + سكر بودرة + قرفة + كركم) مما يعني أن التفاعل بين أنواع التغذية المختلفة والاختلاف الموسمي يؤثر بشكل كبير على الأنشطة البيولوجية.

**الكلمات الاسترشادية:** نحل العسل، النظام الغذائي التكميلي، هجين الكرنيولي، الأنشطة البيولوجية.

**REVIEWERS:**
**Dr. Asmaa A. Eissa** | asmaa.anwer111@gmail.com
Dept. Pesticides Residues and Environ. Pollution, Central Agric. Pesticides Laboratory, Agric. Research Center, Dokki, Giza, Egypt.
**Dr. Ayman Ahmed Owayss** | aao01@fayoum.edu.eg
Dept. of Plant Prot., Fac. of Agric., Fayoum Univ., 63514, Egypt.