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PHYTOCHEMICAL IN DIFFERENT TYPES OF POLLEN AND THEIR EFFECTS ON HONEY BEES

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ABSTRACT:

In this study, the phytochemical analysis was performed for four major types of pollen namely broad bean (*Vicia faba*), date palm (*Phoenix dactylifera*), Egyption clover (*Trifolium alexandrinum*) and maize (*Zea mays*) which were collected by honey bee colonies from the study area. Phytochemical analysis showed that clover pollen occupied the highest total antioxidant capacity (TAC), flavonoid and tannins 6480.67, 7155.63 and 752.21 mg/100gm, respectively, comparead with the other pollen types, while the highest percentage of phenol was found in date palm pollens 734.13 mg/100gm. To determine the nutritional effects on some criteria such as food consumption rate, brood rearing, bee population, stored pollen and longevity of honey bee four types of pollen were supplied to honey bee colonies. Fifth group was fed on mixture from all pollen types at a rate of 25% of each type, whereas the sixth group was free from pollen and used as control. The highest food consumption was from date palm pollen, followed by broad bean, clover and maize. Concerning brood rearing and stored pollen, the highest mean of sealed brood area and stored pollen was found in colonies fed on mixture pollen, while the control had the lowest values. Feeding honey bee colonies on mixed pollen diet, broad bean and clover pollen gave the highest rate of population, with no significant differences ($p<0.05$). Supplying cage bees with different types of pollen had significant ($p<0.05$) differences on longevity. The bees that were fed on the mixture pollen lived for the longest possible period 30.63 days, followed by clover, broad bean, date palm and maize pollens (29.47, 26.22, 25.20 and 23.63 days, respectively). Also, it was noticed that feeding caged bees on sugar syrup only (control) shortened the longevity of honey bee workers (19.3 days only). This effect on longevity may be due to the phytochemical compounds that pollen contains, such as total antioxidants, including phenols, flavonoids, and tannins.

KEYWORDS:

Honeybee, pollen, antioxidants, consumption, sealed brood, bee population, longevity.

INTRODUCTION:

Adequate nutrition is the basis for growth and development of honey bee colony. However, the honey bees, depend mainly on nectar and pollen as sources of nutrients. Nectar provides the bees with carbohydrates

while pollen supplies them with the remaining dietary requirements such as proteins, lipids, vitamins, and minerals **(*Brodschneider and Crailsheim*, 2010).** Pollen are very important in apiculture as a source of proteins, fats and minerals to bees and as an excess produced from the apiary **(*de Arruda et al.*, 2013).** The major components of bee pollens are carbohydrates, crude fibers, proteins and lipids **(*Villanueva et al*., 2002).** Other minor components are minerals and trace elements, vitamins and carotenoids, phenolic compounds, flavonoids, sterols and terpenes **(*Bogdanov*, 2006)**. Pollen types from different plant had different effects on the physiological conditions of worker honey bee **(*Amro et al.*, 2015).** In addition the quantity and quality of pollen collected by honeybees affects, brood rearing and longevity, thus ultimately the productivity of the colony **(*Human and Nicolson*, 2006).** However, not all pollen contains adequate nutrition for colony development **(*Pernal and Currie*, 2000).** Hence, supplementary diets including pollen are sometimes necessary to provide the nutrients required for colonies to rear brood, increase their populations overwinter, and produce honey **(*Goodwin et al.*, 1994).** On the other hand the shortage of pollen can cause abnormal development of the brood, a decrease in the length of workers' life **(*Winston et al*., 1983).** Moreover, the presence of antioxidants in the pollen reduces the harmful effects of the free radicals in the cell and can slow oxidation reactions in food **(*Leja et al.*, 2007).** Researches showed that pollen had significant antioxidant activity that mostly depends on phenolic compounds. However, large deviations of the antioxidant activity were considerable and content of phenolic compounds between pollen grains taken from different plant species and different geographical regions are remarkable **(*Aličić et al., 2014*).** Bee pollen, like other bee products was due to the abundant, qualitatively and quantitatively of phenolic and flavonoid antioxidants related to botanical species and origin, valuable sources of these healthy beneficial constituents are characterized by high antioxidant activity **(*de Arruda et al*., 2013)**. There were numerous reports of bioactive substances in the pollen such as phenols, flavonoids, anthocyans, phospholipids and proteins. Phenolic compounds are one of the most critical ingredients related to antioxidant activity in pollen**.** Hence, antioxidant capacity of bee pollen, as well its other physico-chemical properties primarily depend on its botanical and geographical origin **(*Aličić et al.*, 2014).**

Some criteria such as food consumption rate, brood rearing activity, bee population, stored pollen area and longevity of honey bee workers were studied as indicators for the quality of pollen diets presented to honey bee colonies during periods of pollen shortage.

MATERIALS AND METHODS:

The present work was conducted in a private apiary located at Tanda village, Mallawy district, Minia Governorate,

Experimental honey bee:

First hybrid Carniolan bees (*Apis mellifera carnica*) were used in the present study. Pollen types were collected every 3 days by pollen traps 30% efficiency from January to September 2018 and 2019. Reference slides of pollen grains were prepared by collecting pollen grains directly from the opened flowers of the coincided flowering plants around the apiary and was the morphology of each species of pollen grains compared with those of pollen pellets obtained from pollen trap using a light microscope according to ***Dimou***

***and Thrasyvoulou* (2007).** Pollen types were stored under freezing temperature (-18°C) for phytochemical tests procedure **(*Kirk*, 1994).** Four samples from the dominant pollen in trap (Table 1) were subjected for phytochemical tests. The phytochemical tests of pollen samples were performed at the Lab. of organic Agriculture, Agriculture Research Center, Mallawy Research Station.

Table (1): Classifications of main pollen sources in the study area during 2018-2019 season

Classifications of main pollen sources		
Common name	**Family name**	**Scientific name**
Broad bean	Fabaceae	*Vicia faba* L.
Date palm	Arecaceae	*Phoenix dactylifera* L.
Egyptian clover	Fabaceae	*Trifolium alexndrinum* L.
Maize	Poaceae	*Zea mays* L.

Phytochemical tests of pollen

- Determination of total antioxidant capacity:

It was done as phospho -molybdenum method with some modifications **(Kanika et al., 2015).** 0.3 ml extract was combined with a mixture of 3 ml of reagent solution (0.6 M sulfuric acid, 28 mM sodium phosphate and 4 mM ammonium molybdate). The tubes containing the reaction solution were then capped and incubated at 95 °C for 90 minutes. After the samples had cooled at room temperature, the absorbance of the solution was then measured at 695 nm against blank. Methanol (0.3 ml) in the place of extract is used as the blank. The antioxidant activity was expressed as mg of equivalents of ascorbic acid.

- Estimation of phenolics:

Total phenolics were analyzed spectrophotometrically using the modified Folin–Ciocalteu **(*Singleton et al.*,1999).** Each sample (0.5 g) was extracted with 50 mL methanol for 1 h, and then the methanolic extract (ME) was diluted 1:5 (v/v) with distilled (DI) water. 125 µL of the diluted extract was mixed with 0.5 mL of DI water in a test tube followed by addition of 125 µL of Folin–Ciocalteu reagent (FCR) and was allowed to stand for 6 min. Then, 1.25 mL of 7% sodium carbonate solution was added and the final volume was made up to 3 mL with DI water. Each sample was allowed to stand for 90 min at room temperature and was measured at 760 nm using UV/Vis spectrophotometer. The linear reading of the standard curve was from 0 to 600 µg of gallic acid per mL.

- Estimation of flavonoids:

Total flavonoids content of the pollen extracts were determined using a modified colorimetric method which was described by ***Dewanto et al*., (2002).** Both the methanolic extract (250 µL) and catechin standard

solutions were mixed with 1.25 mL DI water and 75 µL of 5% NaNO2 solution, then allowed to mix for 6 min. After that, 150 µL of 10% AlCl3 solution was added and mixed for 5 min. The finally 0.5 mL of 1 M NaOH was added and the total volume was made up to 2.5 mL with DI water. Sample absorbance was recorded measured at 510 nm against a prepared blank using UV/ visible spectrophotometer.

- Estimation of tannins:

-The total tannins content was determined using the method of Schanderl **(Parimala and Shoba, 2013).** One millilitre of the hydroethanolic pollen extract or standard was taken and the volume was made up to 1 mL with distilled water. 0.5 mL Folin's (phenol reagent) was added to the mixture followed by 5 mL of 35% sodium carbonate and kept at room temperature for 5 min. The blue color formed was measured at 640 nm using UV/visible spectrophotometer.

Experiment of design

Eighteen colonies were selected among the colonies of the apiary. Colonies were equalized in strength and headed by sister queens. The tested colonies were divided into 6 groups, three colonies in each group. Each of the four pollen types in Table (1) was introduced to a different group. Fifth group was fed on mixture from all pollen types at a rate of 25% of each type. Each pollen type was prepared in the form of pollen cake (50% pollen + 30% powdered sugar+20% honey) and knead it until become homogeneous as described by ***Williams et al*., (2013).** Pollen diets were served in the dearth period, whereas the sixth group without supplying pollen was used control.

Measurements:

Food consumption

The amount of pollen diets consumption was calculated as the difference between the fresh weight of the diet and the weight at 6 day after providing it to the experimental colony (g/colony). The calculations were repeated every 6 days for each diet type **(*Amro et al*., 2015)**.

Brood rearing activity

The sealed brood area (inch^2/ colony) was measured using a typical langstroth frame divided into 17x8 inches at 12 days intervals according to ***Al-Tikrity et al*., (1971).**

Colony population density

Wax combs covered with bees from both sides of the experimental colonies were measured at 12 days intervals and colony bee population was recorded **(*Taha*, 2007).**

Stored pollen area

The experimental colonies were inspected at 12 days interval to measure stored pollen areas by using the wired grade frame. The stored pollen areas/inch^2 was counted and recorded **(Hassan, 1998).**

Estimating longevity of workers

This experiment was conducted in the experimental wooden cages of 15×15×5 cm. dimensions with a glass side and other covered with black muslin, (each cage contains 50 workers). Newly emerged honeybee workers (0–6 h old) were obtained from a single colony selected from among the apiary colonies during the period

extended from October to January 2018-2019 season, the bees that appeared were randomly selected from brood combs and entered into the test cages.

The tested cages were divided into 6 groups, three cages in each group. Each of the four pollen types in Table (1) was introduced to a different group. Each pollen type was prepared in the form of pollen cake (50% pollen + 30% powdered sugar+20% honey) and knead it until become homogeneous as described by **(*Williams et al*., 2013).** Fifth group was fed on mixture from all pollen types at a rate of 25% of each type, the diets were changed in cages every 3 days, whereas the sixth group without pollen diet was served as control. Each cage was provided with water source and sugar solution 50% and a piece of bees wax at the top of each cage. In addition, all cages were held in darkness under hive conditions **(*Williams et al.,* 2013).** Dead bees in each cage were counted and removed every 3 days interval until of all honeybee were died. Longevity was calculated according to ***Snedecor and Cochran* (1967)** formula: $x^{-} = \frac{\sum x}{n}$

x^{-} = Longevity

$\sum x$ = Total sum hit (the number of dead bees × number of corresponding days)

n = Number of lnitral bees in each treatment

Statistical Analysis:

Data were statistically analyzed using Costat program software with ANOVA and Duncan's test to examine the differences among means and their interactions **(*Mead et al.,* 1993)**.

RESULTS AND DISCUSSION:

Phytochemical tests of pollen types:

Data in Table (2) showed phytochemical measurements (total antioxidant capacity, phenolics, flavonoids and tannins) of four main types of pollen collected by honey bee colonies in the study area.

The highest total antioxidant capacity (TAC) percentage (6480.67) was in Egyptian clover, in comparison with the other pollen types, while date palm pollen had the lowest percentage (5403.47 mg/100gm). These results were similar to those obtained by ***Barbieri et al*., (2020),** with values ranged from 1477 to 19027 mg/100gm. Moreover, the highest percentages of phenol (734.13 and 696.85 mg/100gm) were determined in date palm and maize pollens, respectively, with significant differences, while the lowest percentages (641.97 and 641.24 mg/100gm) were determined in broad bean and clover pollen grains, respectively with no significant differences. Results were similar to those obtained by ***Barbieri et al.,* (2020),** who showed that the total phenolics' content ranged between 578 to 2015 mg /100g of bee pollen, while the values were lower than those obtained by ***Feás et al*., (2012),** where they were ranged from 1290 to 1980 mg /100g. The highest percentages of flavonoid (7155.63 and 3952.70 mg/100gm) were determined in clover and broad bean pollens, respectively, with statistically significant differences ($p<0.05$), while the lowest percentages (1537.90 and 939.13 mg/100gm) were found in maize and date palm pollen grains, respectively, with statistically significant differences ($p<0.05$). These data were similar to those obtained by ***Pascoal et al*., (2014),** who found that the total flavonoids content ranged from 3710 to 10140 mg /100g of bee pollen. In addition, the highest percentage of Tannins (752.21 mg/100gm) was determined in clover pollen, while the lowest

percentages (447.10 mg/100gm) were found in maize pollen with statistically significant differences ($p<0.05$) between all pollen types.

Generally, the results of this study were support ed by ***Almaraz-Abarca et al*., (2004)** and ***Carpes et al*., (2007)** who indicated that pollen of different botanical conditions possess different antioxidant activities which is related to their content of phenolic acids and flavonoids.

Table (2): Phytochemical analysis of different types of pollen.

Pollen source	Phytochemical test			
	TAC mg/100gm	Phenol mg/100gm	Flavonoid mg/100gm	Tannins mg/100gm
Broad bean	6128.00 b	641.97 c	3952.70 b	659.16 b
Date palm	3576.33 d	734.13 a	0939.13 d	550.70 c
Clover	6480.67 a	641.24 c	7155.63 a	752.21 a
Maize	5403.47 c	696.85 b	1537.90 c	447.10 d
L.S.D	103.94	29.53	332.55	55.78

Means marked by the same letter at the same column are not significantly different at ($P > 0.05$).

Data in Table (3) and illustrated in Fig. (1) of the first season, 2018-2019 showed clearly that there were significant differences in the mean amounts of consumption (gm./colony/6days) of different types of pollen by honey bees colonies. The highest food consumption was recorded when honey bees colonies were fed on date palm pollen and pollen mixture (47.67 and 47.27 gm.) respectively, with no significant differences, followed by broad bean, clover and maize pollens (43.20, 40.27 and 35.47 gm.), respectively with significant differences ($P \leq 0.05$).

Colonies fed with mixed pollen diet had the highest mean of sealed brood area (227.67 sq. inch/colony/12 days), with statistically significant differences ($P \leq 0.05$), followed by colonies fed with broad bean, clover, and date palm pollen (192.00, 191.00, and 175 sq. inch/colony/12 days), respectively with no significant differences, followed by colonies fed on maize pollens (162.67 sq. inch/ colony/12 days), as compared with the lowest worker brood area (118.83 sq. inches/ colony/12 days) in the control.

Concerning the number of wax combs covered with bees in the experimental colonies, the results in Table (3) and Fig. (3) showed that feeding honey bee colonies on mixed pollen diet, broad bean and clover pollen gave the highest rate of population (4.59, 4.43, and 4.35 wax comb covered with bees/colony/12 days) respectively, with no statistical significance, followed by colonies fed on maize and date palm pollens (3.89 and 3.85 wax combs covered with bees/colony/12 days) respectively. The lowest population (3.41 wax combs covered with bees/colony/12 days), was recorded in the control with statistically significant differences.

In terms of stored pollen area, the results in Table (3) and Figure (4) for the first season 2018 / 2019 revealed that feeding honey bee colonies with mixed pollen diet, clover pollen, and broad bean pollen recorded the highest rate of stored pollen area (55.67, 49.17, and 45.17 sq. inches/colony) respectively. Colonies fed on maize and date palm pollens came in the second (36.17 sq. inch/colony), but the control set had the lowest values (28.17 sq. inch/colony). There were significant differences ($p<0.05$) in stored pollen area among

feeding treatments during the dearth periods and control, but they were non-significant between mixed pollen, and clover pollen, also broad bean and clover pollen, as well they were non-significant between maize and date palm pollens.

Measurements of the second season 2019-2020

The same trend was noticed in the second season 2019/2020 (Table, 3) where data showed that there were significant differences in the mean amounts of consumption (gm./ colony/ 6 days) of different types of pollen by honey bees colonies. The highest food consumption rate was recorded when honey bees colonies were fed on date palm pollen and mixed pollen diet (45.13 and 44.40 gm.) respectively, with no significant differences, but the broad bean and clover pollens came in the second (38.33 and 35.53 gm.) respectively, while maize pollen had the lowest consumption rate which was (32.27gm.) with statistically significant differences ($P \leq 0.05$).

The results of this study are consistent with that of ***Schmidt and Johnson (*1984)** who reported that food consumption by worker bees was not related to pollen quality (eg protein concentration), but was influenced by their physical or chemical cues. As for the sealed brood area, it was observed that the data had the same direction with the first season, where data of Table (3) and Fig. (2) showed that colonies fed with mixed pollen diet had the highest mean of sealed brood area (217.50 sq. inch/colony/12 days), followed by colonies fed with broad bean, clover, and date palm pollen (196.00, 190.00, and 172.50 sq. inch/colony/12 days), respectively, with no statistically significant differences. Colonies fed with maize pollen came in the third (152.67 sq. inch/ colony/12 days), while the control recorded the lowest worker brood area (111.00 sq. inches/ colony/ 12 days) with statistically significant differences.

Table (3): Effect of feeding with different types of pollen on some productivity and activity of the honey bee colonies during 2018-2019 and 2019-2020 seasons.

Pollen source	Consumption (gm/colony) /6days		Sealed brood area (sq. inch)/ colony/ 12 days		Bee population (No. of wax combs covered with bees) /colony/ 12days		Stored pollen area (sq. inches)/ colony/ 12 days	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season
Broad bean	43.20 b	38.33 b	192.00 b	196.0 ab	4.43 a	4.24abc	45.17 b	43.17 b
Date palm	47.67 a	45.13 a	175.0 bc	172.5 bc	3.85 b	4.04 bc	36.17 c	39.33 bc
Clover	40.27 c	35.53bc	191.00 b	190.0 ab	4.35 a	4.33 ab	49.17 ab	51.50 a
Maize	35.47 d	32.27 c	162.67 c	152.67 c	3.89 b	3.82 c	36.17 c	38.17 c
Pollen mix	47.27 a	44.40 a	227.67 a	217.50 a	4.59 a	4.66 a	55.67 a	50.33 a
Control	-	-	118.83 d	111.00 d	3.41 c	3.07 d	28.17 d	27.83 d
L.S.D	1.72	5.41	24.97	26.84	0.29	0.45	6.94	4.01

Means marked by the same letter at the same column are not significantly different at ($P > 0.05$) .

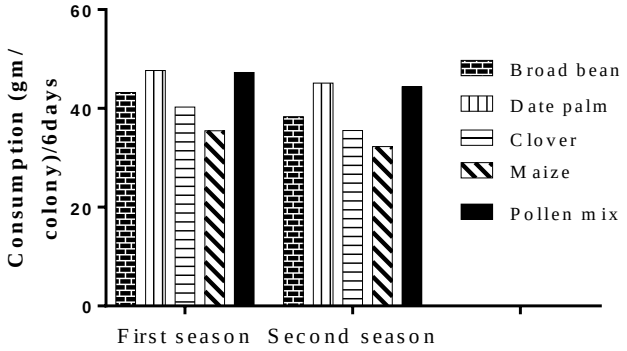

Fig. (1) Consumption of different types of stored pollen provided to honey bee colonies during 2018-2019 and 2019-2020 seasons.

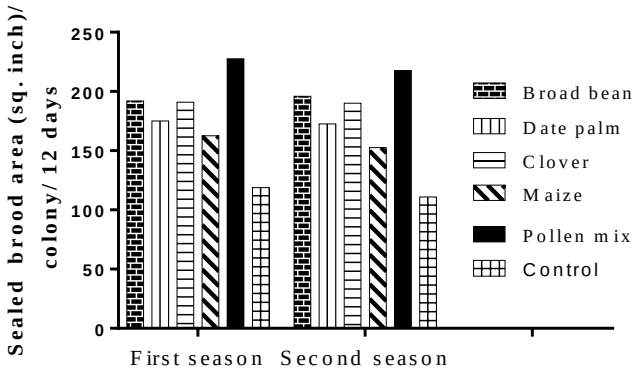

Fig. (2) Worker brood area in honey bee colonies fed with different types stored pollen during 2018-2019 and 2019-2020 seasons.

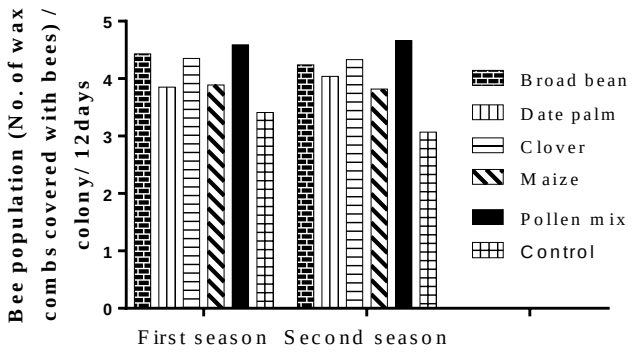

Fig. (3) Population density of honey bee colonies fed with different types stored pollen during 2018-2019 and 2019-2020 seasons.

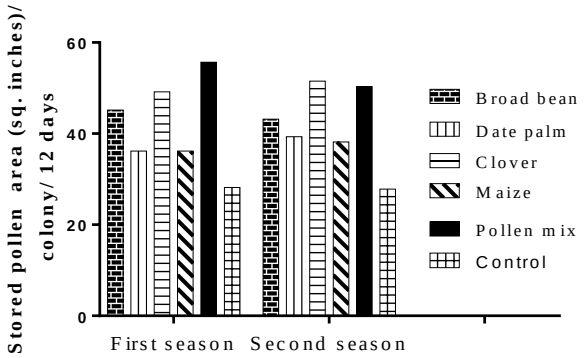

Fig. (4) Pollen area in honey bee colonies fed with different types stored pollen during 2018-2019 and 2019-2020 seasons.

Concerning the number of wax combs covered with bees of the experimental colonies results in Table (3) and Figure (3) in the second season 2019 / 2020 showed that feeding honey bee colonies on mixed pollen diet gave the highest rate of population (4.66 wax comb covered with bees/colony), followed by colonies fed with broad bean, clover, and date palm pollens (4.24, 4.33 and 4.04 wax combs covered with bees/colony) respectively, with no statistically significant differences. Colonies fed maize pollen came in the third (3.82 wax combs covered with bees/colony), while the control recorded the lowest number of wax combs covered with bees (3.07 wax combs covered with bees), with statistically significant ($P \leq 0.05$) differences among all pollen diets and control. In terms of stored pollen area, it was observed that the data had in the same direction with the first season, where data in the same Table (3) and illustrated in Figure (4) revealed that feeding honey bee colonies with clover pollen and mixed pollen diet gave the highest stored pollen area, (51.50 and 50.33 sq. inches/colony) respectively, followed by colonies fed with broad bean and date palm pollen (43.17 and 39.33 sq. inches/colony) respectively. At the same these colonies fed with maize pollen came in the third (38.17 sq. inch/colony) while the control had the lowest values (27.83 sq. inch/colony). There was significant difference ($p<0.05$) in stored pollen area between feeding treatments and control. These results were similar ***Decourtye et al.,* (2010)** who indicated that blanced nutrition is the best supported by growing a diversity of plants, as a

natural mixture of different pollens is the optimal source of proteins and vitamins for honey bees, when this is not possible, feeding adequate supplemental diets is recommended of natural pollen. In this context, ***Jevtic et al.*, (2009)** indicated that the amount of pollen and brood in the colony reflects its status and can be used to expect the honey yield produced at the end of the season, It also proved the existence of positive correlation between stored pollen and brood production. Also, ***Human and Nicolson* (2006)** indicated that the quantity and quality of pollen collected by honeybees affects reproduction, brood rearing and longevity, thus ultimately the productivity of the colony. On the other hand, ***Crailsheim* (1992)** confirmed that pollen is also important at the colony level, since it enables the production of jelly by young workers, that is used to feed larvae, the queen, drones and older workers. This tends to confirm previous studies which showed that Phenolic acids and flavonoids were considered as natural constituents of bee pollen, which are responsible for its biological activity **(*Rzepecka-Stojko et al.*, 2015).**

Longevity of honey bee workers

Supplying cage bees with different types of pollen had significant differences in the mean longevity of honey bee workers. However data tabulated in Table (4) and illustrated in Figure (5) showed that newly emerged honey bee workers that were fed with mixed pollen diet lived significantly longer (30.63 days). Generally, it was observed a significant influence of different types of pollen on longevity of honeybee workers with the following order from the highest to the least effect : clover, broad bean, date palm and maize pollens (29.47, 26.22, 25.20 and 23.63 days) respectively. On the other hand, feeding caged bees on sugar syrup only (control) shortened the longevity of honey bee workers, led to the survival of bees for 19.3 days only, with statistically significant differences among all treatments.

Table (4): Effect of feeding caged worker bees with different types of pollen on longevity

Pollen source	**Longevity of honey bee workers**			
	R1	**R2**	**R3**	**Mean**
Broad bean	26.64	26.70	25.32	**26.22 c**
Date palm	25.62	25.38	24.60	**25.20 d**
Clover	29.94	29.58	28.92	**29.47 b**
Maize	24.26	23.64	23.04	**23.63 e**
Pollen mix	30.48	30.72	30.66	**30.63 a**
Control	19.68	20.04	19.68	**19.80 f**
L.S.D				**0.92**

(days) of honeybee workers.

Means marked by the same letter at the same column are not significantly different at (P > 0.05).

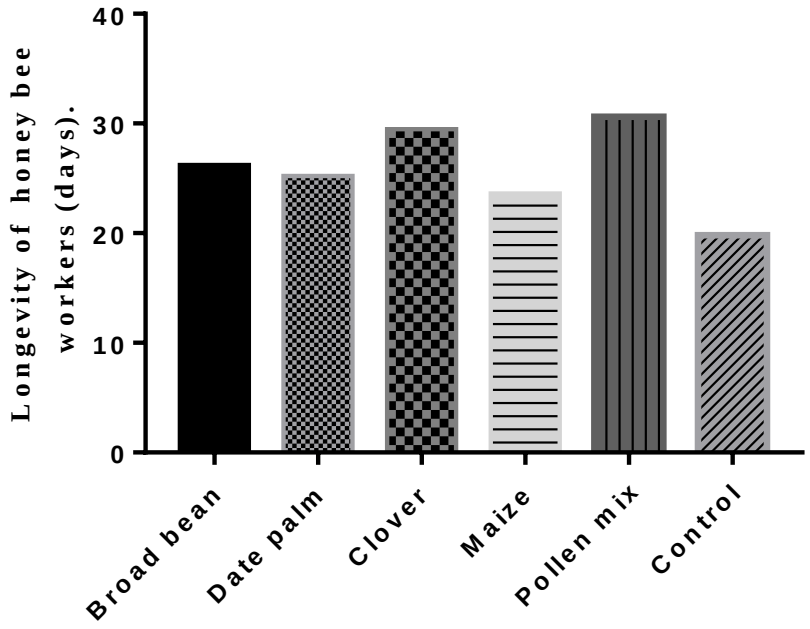

Fig. (5): Effect of feeding caged worker bees with different types of pollen on longevity (days) of honey bee workers.

The results of this study are consistent with that of ***Schmidt et al., (1987*)** who noticed that bees fed the pollen mixtures lived longer than control which was fed on sugar syrup only. The increase in survival was related to the amount of pollen consumed and protein content of the pollen. The simplest explanation of these observations is that protein deficiency affects some process related to aging .

In this context, ***Knox et al.,* (1971)** showed that the longevity of adult honey bees was dependent on the type of pollen. On the other hand, ***Wang et al.,* (2014)** confirmed that pollen extended worker longevity, suggesting that they may improve the nutritional conditions of bees or contain health and longevity-promoting factors. This was confirmed by ***Liao et al*., (2017)** and ***Bernklau et al*., (2019),** that phytochemicals in pollen influence honey bee longevity and promotion of pathogen tolerance, while improving immune competence and stress tolerance in bees.

CONCLUSION:

The results of this study support that the nutritional quality and diversity of pollen nutrition can shape bee health and increase its activity and longevity. Indeed, it was found that bee physiology is depending on the type of pollen diet and the phytochemical compounds contained in pollen such, as total antioxidants phenols, flavonoids, and tannins, suggesting that not only does the availability but also the quality of environmental resources matter.

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الملخص العربي

المركبات الكيميائية النباتية في أنواع مختلفة من حبوب اللقاح وتأثيراتها على نحل العسل

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في هذه الدراسة، تم إجراء التحليل الكيميائي النباتي لأربعة أنواع رئيسية من حبوب اللقاح التي جمعتها طوائف نحل العسل من منحل خاص بقرية تندة مركز ملوي محافظة المنيا وذلك لتحديد التأثير الغذائي على بعض المعايير مثل معدل استهلاك الغذاء ، تربية الحضنة ، الكثافة النحلية ، ومساحة حبوب اللقاح وطول عمر الشغالات وكانت حبوب اللقاح كما يلي: االفول البلدي (*Vicia faba*) ونخيل البلح (*Phoenix dactylifera*) والبرسيم المصري (*Trifolium alexandrinum*) والذرة الشامية (*Zea mays*) وأظهر الفحص الكيميائي النباتي ما يلي:

احتلت حبوب لقاح البرسيم أعلى معدل لمضادات الأكسدة والفلافونويد والتانينات 6480.67، 7155.63، 752.21 مجم / 100 جم على التوالي مقارنة بأنواع حبوب اللقاح الأخرى، بينما كانت أعلى نسبة من الفينول 734.13 مجم / 100 جم موجودة في حبوب لقاح النخيل. تم تقديم هذه الأنواع الأربعة من حبوب اللقاح لطوائف نحل العسل والمجموعة الخامسة تغذت على خليط من جميع أنواع حبوب اللقاح بمعدل 25٪ من كل نوع ، بينما المجموعة السادسة تغذت على المحلول السكري فقط كمجموعة كنترول. وكان أعلى استهلاك من حبوب لقاح النخيل يليه الفول البلدى والبرسيم والذرة على التوالي. وفيما يتعلق بتربية الحضنة وتخزين حبوب اللقاح، كان أعلى متوسط لمساحة الحضنة المغلقة وحبوب اللقاح المخزنة في الطوائف التي تم تغذيتها على خليط حبوب اللقاح، بينما كان لمجموعة الكنترول أقل مساحة. في حين أعطت تغذية طوائف نحل العسل على حبوب اللقاح المختلطة والفول البلدي وحبوب لقاح البرسيم أعلى كثافة نحلية مع عدم وجود فروق معنوية. وكان لإمداد الشغالات داخل الأقفاص بأنواع مختلفة من حبوب اللقاح اختلافات معنوية في طول العمر. حيث عاش النحل الذي تم تغذيته على خليط حبوب اللقاح لأطول فترة ممكنة 30.63 يومًا، تليها حبوب اللقاح البرسيم والفول البلدي ونخيل البلح والذرة الشامية (29.47، 26.22، 25.20، 23.63 يومًا، على التوالي). كما لوحظ أن تغذية النحل في الأقفاص على المحلول السكري فقط (الكنترول) قصر من طول عمر الشغالات، حيث أدى إلى بقاء النحل على قيد الحياة 19.3 يوم فقط. وتفسير التأثير الإيجابي ذلك قد يكون بسبب المركبات الكيميائية النباتية التي تحتوي عليها حبوب اللقاح، مثل مضادات الأكسدة الكلية، بما في ذلك الفينولات والفلافونويدات والتانينات.