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PERFORMANCE OF HONEY BEE COLONIES FED SOME PROTEINACEOUS DIET UNDER ISOLATED CONDITIONS

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ABSTRACT:

The investigation was carried out at Plant Protection Department, Collage of Food and Agriculture Sciences, King Saud University. The experiment was done using honey bee nuclei kept under isolated conditions and fed with five mixtures of proteinaceous diets. The rate of food consumption, ability of honey bee nuclei to rear brood and quality of produced honey bee were determined. The best consumption rate was recorded with diet 3 (Date past) followed by diet 4 (Feed Bee®), diet 2 (Mesquite) and diet 5 (Corn gluten), respectively. The sealed brood areas of honey bee nuclei were highly dependent on the contribution of suitable protein from food as well as on its quality. Bee bread is the best source of protein for honey bees. The mean number of sealed brood cells under natural condition was 1066 cells / nucleus after 42 days. It differed significantly with all areas in the colonies fed different proteinaceous diets. The diet 4 (Feed Bee®) was the best one among the tested diets (174.7 cells / nucleus) followed by diet 3 (Mesquite, 111 cells / nucleus). The poorest result was recorded for diet 5 (Corn gluten, 39 cells / nucleus). The fresh weight, dry matter and protein content of full grown larvae and newly emerged honey bee workers were determined. All parameters under artificial feeding were less than those produced under control condition (bee bread). The best results were obtained with feeding honey bee with Feed Bee® followed by diet 2 (Mesquite). Total soluble solids percentage (T.S.S. %) and total haemolymph count (T.H.C.) were varied among different diets administrated. Also, the haemolymph protein percentages were reduced significantly with feeding on artificial diets. These results reflect the suitability of used diets to honey bees. The artificial diets depend on the Date past and Mesquite pods flowers were more favorable than traditional pollen substitute based on soybean meal.

Key words: *honey bee – pollen substitutes - proteinaceous diets- Supplementary feeding – bee bread.*

INTRODUCTION:

The nutrients needed to grow honey bee populations and maintain their health depends mainly on nectar and pollen. Nectar provides carbohydrates while pollen supplies the remaining dietary requirements such as

proteins, lipids, vitamins and minerals (Brodschneider and Crailsheim, 2010). Lack of pollen in the field is a critical problem for beekeepers in Saudi Arabia especially in the central region because of inclement or dry weather in summer season. Supplying an alternative artificial source of protein (pollen substitutes) is a viable alternative to promote colony maintenance, development and multiplication (Herbert, 1992). Various studies have been made to develop an ideal protein diet for nutrition and observe their effect on honey bee physiology (Herbert, 1992; Cremonez, et al., 1998). Some criteria such as rate of food consumption, brood rearing activity and quality of honey bee are using as indicators for the goodness of artificial diets administration to honey bee colonies during period of pollen shortage.

The adequacy of pollen or pollen substitutes is normally evaluated by determining the quantity of diet consumed or by measuring brood production (Herbert et al., 1970 ; 1977). Herbert, (1992) compared pollen substitutes with varying quantities of protein using caged colonies. He demonstrated that ~ 20 – 23% protein is an ideal percent for normal growth of honey bee workers.

Shortage of pollen results in decreasing of brood rearing developmental abnormalities, decreased length of workers life and poor honey production (Haydak, 1970; Kleinschmidt and Kondos, 1978; Doull, 1980; Winston et al., 1983). Atallah et al. (1979), Omar. (1984) and Hofer (2008) concluded that feeding honey bee colonies with different pollen substitutes or supplements did not meet the requirements of nurse bees worker larvae older than three days.

Weight and nitrogen content of emerged bees is directly influenced by the pollen consumption of the nurse bees and the fluctuation in pollen income of the colonies (Haydak, 1935; 1970). The body protein can be influenced by a combination of factors including quantity of pollen, protein content and level of essential amino acids in pollen protein (Kleinschmidt, and Kondos, 1977). Mostafa, (2000) found that when honey bee colonies fed pollen substitutes under isolated condition, the fresh weight and dry matter of newly emerged bees reared were less than control (reared under free flight condition).

The digestive process influences the body composition of the bees, including the percentages of glycogen, lipids and protein. (Hrassnigg and Crailsheim, 2005). The haemolymph of honey bee workers is an accurate method to evaluate the efficiency diets (Cremonez, et al., 1998). Lack of pollen sources might affect biochemical alterations of haemolymph components. The total haemocyte count, differential haemocyte count and total solid content are indicators for the haemolymph functional efficiency (Glinski and Klimont, 1987). Rogala and Szymas (2004) reported that the highest number of haemocytes occurred in the bees haemolymph that received and improved pollen substitute with all lacking L-amino acids. The food source of the bees has been found to affect haemolymph composition (Bounias and Morgan, 1990). Cremonez et al., (1998) found that the protein values reflected

the quantity and usability of protein in the diets and not the consumption which was similar for all protein diets used. El Mohandes et al., (2010) reported that feeding honey bee colonies with different feeding diets caused differences in haemolymph protein content.

The present work aimed to develop pollen substitutes for better physiological performance of honey bee colony.

MATERIALS AND METHODS:

The investigation was carried out at the apiary of Plant Protection Department, Collage of Food and Agriculture Sciences, King Saud University, Riyadh region.

1- Honey bee colonies used:

Hybrid Carniolan honey bees imported from Egypt were used. An isolator (3.5 × 6.5 × 4 m dimensions) covered with nylon net (16 × 16 meshes) was designed. Fifteen honey bee hives were introduced into the isolator and painted with different colors for better orientation of honey bee workers. Each hive contains five combs free of any pollen. Every hive was provided with 1000 gm. young Carniolan hybrid honey bee workers. All colonies were headed by young sister queens. The honey bee colonies were divided into five groups, 3 colonies per each group, against 3 colonies kept under free flight conditions outside the isolator and provided with access from bee bread (2 combs) as a control. The period of experiment was extended for six weeks from May to June 2014.

2- Proteinaceous diets dministration:

Seven materials that are rich in their protein content and are available in local area were selected for testing their efficiency as pollen substitute. They are described in Table (1). Total protein of these raw materials was determined by Kjeldahl method (Kirk, 1950).

Five proteinaceous mixtures were prepared from the raw materials as described in (Table 2). Feed Bee® is a commercial substitute tested by Saffari et al., (2006). Centrum® is a medicinal product (multivitamins and minerals) produced by Pfizer company (formerly Wyeth).

Amount from paste diets (100 gm. /colony) was put into perforated polyethylene bag and put over the top of middle frames. The diet was changed with new one every 6 days. Also, supplementary feeding with sugar syrup (250 ml 1:1 w/v) was administrated every 3 days in order to stimulate the honey bee activity. In addition, the isolator was provided with water source.

3- Measurements:

a- Food consumption:

The quantities of consumed diet (in gm.) were determined every 6 days by weighing the pollen substitutes past before and after application.

b- Brood rearing activity:

The sealed brood areas (sq. Inch /colony) were recorded after two generation (42 days) using a frame divided into square inches. The number of sealed brood cells was calculated.

c- Honey bee quality:

Samples of full grown larvae and newly emerged honey bee were taken after two generation. Fresh weight, dry matter, water

content percentage and total protein were determined. Fresh samples were dried in an oven at 65 °c for 36 hours or for reaching the constant weight. The water content in bee body was calculated by subtracting the dry weight from fresh weight.

Dry samples of larvae and honey bee workers were ground to a fine powder then 100 mg of powdered material was used for total nitrogen determination by using the micro-Kjeldahl method according to Kirk (1950), then the nitrogen values will be multiplied by the conversion factor of 5.6 to obtain the total protein content (Rabie et al., 1983).

Three samples as replicates were used from each treatment.

d- Haematological studies:

To test the suitability of pollen substitutes for honey bee feeding, haemolymph samples were collected from full grown larvae (6-days old) by puncturing the larval cuticle with a fine hypodermic needle. The total soluble solids percentage (T.S.S. %) in haemolymph was determined using hand refractometer. Three readings of T.S.S. (%) per treatment were taken. The total haemocyte count (T.H.C.) per mm3 of haemolymph was determined using Neubauer haemocytometer. The total number of haemocytes per mm3 of haemolymph was calculated using the formula of Predetshensky et al. (1950):

$$THC = \frac{ax4000xb}{C}$$

Where:

THC: the number of haemocytes per mm3 of haemolymph

a: the number of haemocytes in 100 large squares

b: the haemolymph dilution

C: the number of small squares in 100 large squares.

Haemolymph pools of 20-100 individuals were sampled from different experimental colonies and were continuously held in an ice bath.

A few crystals of phenyl thiourea were added to each pool to prevent melanization. The haemolymph pools were stored at -20 °C. No protein degradation could be observed prior to sample analysis. Method by Lowry et al., (1951) was used to determine the protein concentration of haemolymph spectrophotometrically at 500 nm using standard curve determination.

Statistical analysis:

The experimental was designed as random complete block design (RCBD).

ANOVA was performed and means were compared by using Duncan's multiple range test at 5% level of probability (Duncan, 1955).

RESULTS AND DISCUSSION:

The investigation was subjected on honey bee nuclei kept under isolated conditions and fed on a certain mixture proteinaceous diets against nuclei under free flight condition. Criteria of food consumption and ability of honey bee nuclei for rearing brood and quality of newly emerged workers were estimated to evaluate the suitability of the tested diets.

Food consumption:

Data presented in Table (3) show that all the tested diets were consumed in different

amounts. The great amount of diet consumption was recorded during the second feeding period (7-12 days). By the progress of investigation, the rate of food consumption of all diets decreased gradually through other feeding periods intervals. It should be noticed that the nuclei which fed on diet 1 (traditional substitute, Soybean meal) consumed their feeding in a low rank of consumption. The best consumption rate of tested diets was recorded with diet 3 (Date paste) followed by diet 4 (Feed Bee®), diet 2 (Mesquite) and diet 5 (Corn gluten) respectively .The total consumption from each diet during the experimental period (42 days) was calculated. The honey bee nuclei consumed 213.2 gm. /nucleus from diet 3 (Date past) followed by 173.6 gm. /nucleus from diet 4 (Feed Bee®). A significant amount of diet 2 based on Mesquite pods flour was more favorable than diet 1 and diet 5 based on soybean and Corn gluten. The consumption rate of diet 1 (Soybean meal) declared a lowest record among the compared diets (87.4 gm. /nucleus).

Brood rearing activity:

The honey bee nuclei free from any sealed brood were fed on selected proteinaceous diets under isolated condition to explain their ability for rearing brood. The experimental period extended for 6 weeks. The sealed brood areas were measured at the end of experiment. The obtained results were presented in Table (4) and Figure (1). The highest total number of sealed brood cells (1066.7 cells / nucleus) was recorded in nuclei of control which kept under free flying conditions and depended on sufficient stored bee bread areas. The honey bee nuclei fed diet 1 (Soybean meal) under isolated condition has no ability to rear complete brood until emergency of adult. The queens of this treatment continued to lay eggs during seven weeks of investigation, whereas, there is any observation during the experimental period for recording sealed brood cells. The high significant differences were recorded among the compared treatments. Diet 4 (Feed Bee®) was the best among the tested diets for brood rearing enhancement which reached to 174.7 cells/nucleus at the end of experiment. The sealed brood areas of 111 and 94 cells/nucleus were induced by feeding nuclei with diet 2 (Mesquite) and diet 3 (Date past) (Table 4). The poorest value (39 cells/nucleus) was recorded for diet 5 (Corn gluten).

From the present results obtained, it is clear that the activity of honey bee nuclei to rear brood is highly dependent on the contribution of a suitable protein in food as well as on its quality to activate their hypopharyngeal glands. Bee bread, the stored pollen, in honey bee colonies, is the best source of protein for honey bees. Brood rearing activity in honey bee colonies submitted to some feeding cannot be achieved under the administration of traditional substitute because this material did not meet the nurse bees requirements which were feeding brood only older than 3 days but brood rearing activity only was possible when using proteinaceous diet containing suitable protein. These results confirm the data obtained with respect to the simulative capacity for the hypopharyngeal glands under the administration of different

diets under laboratory conditions (Amro, et al., 2015).

Data obtained by Doull (1973) explained that feeding substitutes, without adding pollen to it, to honey bee colonies proved colonies to rear larvae from less than 20% only of laid eggs, but when an extract of pollen added to substitutes, larvae reared from 91% of laid eggs. Also, the present data obtained are in agreement with that reported by Herbert and Shimanuki (1980). They declared that under isolated condition the bees reared most brood and consumed more diet when offered pollen, followed in decreasing order by whey yeast wheast, bees feast and pollenex. Spencer-Booth (1960), Moeller (1967) and Standifer et al. (1973) found that the mixture of soybean flour with Brewer's yeast was regarded as about equivalent to average pollen in brood rearing. Herbert (1981) concluded that the rate of brood rearing depends on the protein percent in tested pollen substitutes.

Omar (1984) mentioned that feeding honey bee colonies, under isolated condition, using proteinaceous diets with various amounts of single cell protein (SCP from Torula candida) and stored pollen showed that the brood rearing activity cannot be achieved under the administration of SCP exclusively (50% as a paste) but brood rearing activity was possible only when proteinic diets used with low amount of SCP in mixtures with pollen in view of increasing the degree of attractiveness which is lacking to this product.

Herbert et al. (1977) recorded that the optimum protein amount of brood continually to be reared by bees fed on diets containing 23% and 30% protein. Fewell and Winston, (1992) found that brood production increased significantly when colonies were given more extensive pollen stores. Imdorf, et al. (1988) reported that honey bee colonies that were kept from pollen foraging by being placed under aware mesh tent, reduced and finally stopped brood rearing. As a consequence, the numbers of workers become significantly lower in these colonies than in colonies which were allowed to forage honey bees respond to the availability of pollen by adjusting brood production. Also, Mostafa (2000) concluded that the ability of honey bee nucleus to rear brood is highly dependent on the contribution of suitable protein from food as well as on its quality. Bee bread is the best source of protein for honey bee workers. He found that diet contains Date palm pollen added to the traditional substitute was the best among the tested diets. The poorest record of total sealed brood area was recorded when honey bee nuclei preferred diet based on Faba bean meal.

Quality of honey bee:

As shown in table (5), the fresh weight and dry matter content of full grown larvae (6-days old) were lower in tested individuals under feeding with all administrated diets as compared to control larvae reared under natural conditions. The fresh weight and dry matter of full grown larvae reared under natural condition were 132.7 and 31.9 mg / larvae, respectively. Fresh weight and dry matter of honey bee larvae reared under feeding

by diet 4 (Feed Bee®) (123.6 mg/larva and 29.5 mg. / larva) were significantly different in comparison to the control. Results of diet 2 (Mesquite) and diet 3 (Date past) were less than the control. The bee larvae fresh weight produced from feeding colonies with diet 5 (Corn gluten) was significantly lower than the all weights produced under the treatments. The dry matters of full grown larvae of all tested treatments were lower than the control with significant difference. The lowest dry matter was obtained with feeding diet 5 (Corn gluten) (112.4 mg / larvae).

As shown in table (5) the fresh weight of adults and dry matter content were lower in tested individuals as compared to the control reared under natural conditions. The fresh weight and dry matter of newly emerged bees reared under natural condition were 111.8 and 16.90 mg/adult. The fresh weight of honey bee workers reared under feeding by diet 4, 2, 3 and 5 were significantly lower than adult weigh of control. Also, the dry matters of all tested diets were significantly lower than control.

The changes in weight of different developmental stages of honey bee were considered as criteria in studying the honey bee nutrition (Haydak, 1970).

The highest percentage of dry matter and lowest percentage of water content in honey bee was noticed in 6-day old larvae. The dry matter decreased during pupal stage and the water content increased (Ryamova, 1976, Hussein, 1978 ; Omar, 1979). Adult bees from brood reared under shortage of pollen had less dry substances and less protein content (Dustmann and Von der Ohe, 1988 ; Kunert and Crailsheim, 1988).

Also as shown in Table (5) the protein contents of full grown larvae and newly emerged bees were directly influenced by the types of diet administrated for feeding their colonies. The protein percentage of larval dry matter of (6-day old) was 38.05% for control. The protein percentage was reduced significantly in all treated colonies which depended on artificial diets for 6 weeks. The protein percentages were 34.67, 31.62, 28.35 and 23.89 with diets 4, 2, 3 and 5, respectively. The protein percentage determined in dry matter of newly emerged honey bee workers of control was 55.92%. The protein percentage was reduced significantly with feeding honey bee colonies only on artificial diet 3 and 5 under isolated condition. The best result (53.66%) was obtained with feeding honey bee colonies on diet 4 (Feed Bee®) followed with samples taken from colonies fed on diet 2 (Mesquite) 51.22%.

This result reflects the digestive process after artificial diet feeding which influenced the body composition of bees. The present results indicate that the protein content can be influenced by the combination of some factors including quality of administrated proteinaceous diet. Adult bees from brood reared under protein shortage had less protein content (Dustmann and Von der Ohe, 1988 ; Kunert and Crailsheim, 1988). Wille and Imdorf (1983) reported that lower dry weight and nitrogen contents may result from having no or little access to pollen after honey bee workers emergence. Protein make up 66-74% of dry matter of adult workers (Hrassingg

and Crailsheim 2005). The present result was in agreement with that obtained by Mostafa (2000). He found that there is no complete replacement for natural pollen. However certain proteinaceous food stuff will improve nutrition and ensure continued honey bee colonies development in placed and times of pollen shortage.

The characteristics of larval haemocytes count living in standard colonies in the field and other kept under isolated conditions are presented in Table (6).

In the haemolymph of bees fed with artificial diets, there was a lower total haemocytes count in all treatments compared with the total haemocytes of bees fed with pollen (control). The same result obtained by Szymas and Jedruszuk (2003).

They found that the pollen substitute caused a decrease of total haemocyte count.

The determination of total soluble solids (T.S.S.) and protein concentration in haemolymph of full grown larvae of honey bee was used as an accurate method to evaluate the efficiency of protein diets. The influence of the different diets on the T.S.S. of larval haemolymph was recorded in table (6). T.S.S. values were varied among different diets administrated.

The means of total protein in the larval haemolymph fed on bee bread and some artificial diets were recorded in Table (6). The data show a considerable variability in total protein percentage in the haemolymph of bees fed on different diets. The protein percentages of larval haemolymph were reduced significantly with artificial diet feeding. The total protein concentration (2080 mg/100 ml) was significantly high in larval haemolymph collected from free flying honey bee colonies (control feed on bee bread) in comparison to other treatments. From present data, the best result was obtained with feeding diet 4 (Feed Bee®) 2034 mg/100 ml followed with diet 2 (Mesquite) 1974 mg/100 ml .

The protein level of the haemolymph is influenced by the nutritional value of the feed ingested by the insect (Konopacka, 1974; Konopacka and Muszynska, 1981). Cremonez et al., 1998 reported that total protein measurement in haemolymph is sufficient for the determination of diet quality. Gregory (2006) reported that bees fed Feed Bee® supplement had higher haemolymph protein levels than bees fed on Bee-Pro® diet. De Jong et al. (2009) measured the protein content of the haemolymph of newly emerged honey bee workers exclusively fed some commercial pollen substitute Feed Bee® (non soy based diet), pollen, acacia pod flour diets and protein free control. They found that all four proteinaceous diets were significantly superior to sucrose alone.

CONCLUSION:

In beekeeping practices, supplying an alternative artificial source of protein during shortage of pollen is available alternative to promote honey bee colony maintenance and development. Developing ideal protein diet depends on its physiological effects on honey bee workers and ability of honey bee colony to rear

brood. These indicators depend on the protein quality and presence of essential amino acids in administrated diet. From the present investigation, the artificial diets depend on the Date past and Mesquite pods flower were more favorable than traditional pollen substitute.

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Table (1): Total protein percentages of raw materials used for pollen substitutes.

Raw materials for pollen substitutes	Total protein %
Soybean meal (Glycine max (L.) Merr.)	39.88 c ± 0.13
Brewer's dried yeast	40.57 b ± 0.19
Skimmed milk powder	29.87 d ± 0.13
Corn gluten	55.94 a ± 0.07
Dates paste (Phoenix dactylifera)	24.55 f ± 0.26
Flour of Mesquite pods (Prosopis juliflora (Sw.) DC.)	16.58 g ± 0.27
Feed Bee®	28.82 e ± 0.19

Table (2) : Description of mixed proteinaceous diet administrated to honey bee workers.

Materials	Composition in diets (gm)				
	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Soybean meal (*Glycine max*)	150				
Mesquite pods powder (*Prosopis juliflora*)		150			
Date paste (*Phoenix dactylifera*)			150		
Feed Bee®*				250	
Corn gluten					250
Dried skim milk	50	50	50		
Brewer's yeast	50	50	50		
Sugar powder	225	225	225		225
Fresh mixed pollen pellets	25	25	25		25
Multivitamins and minerals (Centrum®) **		2.5	2.5		
Coriander oil (ml)		5	5		
Sucrose solution (2:1) (ml)				400	
Honey (ml)	10	10	10	10	10
Water (ml)	85	65	30		80
Total	595	582.5	547.5		590

*** Commercial substitute tested by Saffari, 2006.**

**** Produced by Pfizer (formerly Wyeth)**

Table (3): Mean of food consumption by honey bee colonies fed some proteinaceous diets under isolated conditions.

Diets	Mean of food consumption (gm./colony/6days)							Total gm./colony/ 42 day
	1-6 days	7-12 days	13-18 days	19-24 days	25-30 days	31-36 days	37-42 days	
Diet 1 (Soybean meal)	29.36±1.18 f	27.40±1.82 fg	14.77±1.46 kl	7.13±1.12 no	4.73±0.67 op	2.70±0.62 p	1.33±1.00 p	**87.4±9.61 D**
Diet 2 (Mesquite)	33.67±1.68 de	31.07±2.38 ef	16.73±0.96 jk	14.13±0.83 kl	11.73±0.56 lm	9.53±0.27 mn	7.20±0.30 no	**124.1±7.81 C**
Diet 3 (Date past)	37.86±1.62 bc	58.83±3.06 a	33.87±1.26 de	29.43±0.98 f	22.33±0.63 hi	16.80±0.68 ik	14.10±0.80 kl	**213.2±2.40 A**
Diet 4 (Feed Bee®)	27.47±1.79 fg	40.70±1.95 b	29.03±1.36 f	24.37±0.55 gh	19.90±1.45 ij	17.47±0.75 jk	14.67±1.67 kl	**173.6±13.62 B**
Diet 5 (Corn gluten)	14.13±1.66 kl	36.53±1.72 cd	17.17±0.43 jk	12.10±1.15 lm	9.43±1.09 mn	4.47±0.14 op	1.83±0.17 p	**95.7±3.73 D**

Means followed by the same letter do not differ significantly at the 5% level of probability

Table (4): Effect of certain proteinaceous diets on sealed brood area of honey bee nuclei under isolated condition after feeding period (42 day).

Treatments	Number of sealed brood cells
Diet 1 (Soybean meal)	0.00 ± 0.00 *
Diet 2 (Mesquite)	111 ± 3.0 cd
Diet 3 (Date past)	94 ± 5.0 d
Diet 4 (Feed Bee®)	174.7 ± 8.0 b
Diet 5 (Corn gluten)	39.0 ± 3.0 e
Control	1066.7 ± 62.9 a

Means followed by the same letter do not differ significantly at the 5% level of probability
*** No sealed brood was recorded**

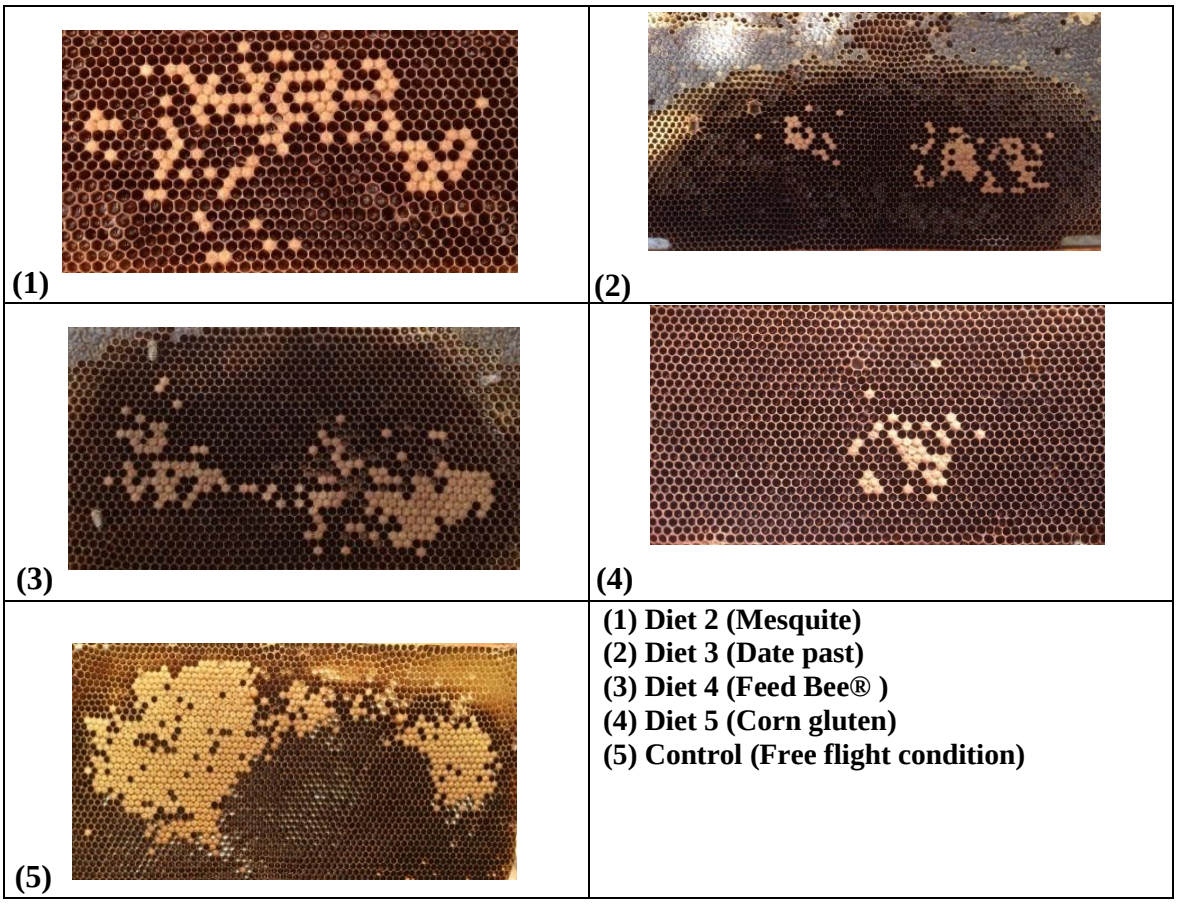

Fig (1): Brood rearing areas after administration of proteinaceous diets to honey bee nuclei under isolated condition.

Table (5): Mean of fresh, dry weight, water content% and total protein percentage of full grown larvae and newly emerged honey bee workers fed with different proteinaceous diet under isolated condition.

Treatment	6-days old larvae				newly emerged adult			
	Fresh weight (mg)	Dry weight (mg)	Water content (%)	Total protein %	Fresh weight (mg)	Dry weight (mg)	Water content (%)	Total protein %
Diet 2 (Mesquite)	124.7 ± 2.0 bc	28.0 ± 1.3 d	77.55	31.62±0.31 c	95.9 ± 2.8 c	14.7 ± 0.8 cde	84.63	51.22±0.39 c
Diet 3 (Date past)	113.2 ± 2.8 de	28.1 ± 1.1 cd	75.18	28.35±0.28 d	89.8 ± 2.0 d	14.0 ± 0.7 e	84.43	48.55±0.46 d
Diet 4 (Feed Bee®)	123.6 ± 1.9 c	29.5 ± 1.0 bc	76.13	34.67±0.35 b	96.5 ± 1.5 bc	15.0 ± 0.8 bcd	84.41	53.66±0.29 b
Diet 5 (Corn gluten)	112.4 ± 2.4 e	26.4 ± 1.3 e	76.51	23.89±0.50 e	82.8 ± 1.9 e	14.2 ± 0.5 de	82.87	44.08±0.43 e
Control	132.7 ± 2.9 a	31.9 ± 1.2 a	75.93	38.05±0.38 a	111.8 ± 2.0 a	16.9 ± 1.7 a	84.88	55.92±0.27 a

Means followed by the same letter do not differ significantly at the 5% level of probability.

Table (6): Effect of feeding colonies with some proteinaceous diets on TSS%, THC and total protein concentration (mg/100ml) in 6-day old larvae haemolymph

Diets	T.H.C	T.S.S %	Protein concentration (mg/100ml)
Diet 2 (Mesquite)	3580 ± 55.69 c	14.83 ± 0.11 c	1974.51±10.55 c
Diet 3 (Date past)	3156 ± 42.35 d	14.07 ± 0.03 d	1862.35±21.56 d
Diet 4 (Feed Bee®)	3792 ± 48.00 b	15.19 ± 0.04 b	2034.12±14.31 b
Diet 5 (Corn gluten)	2936 ± 27.45 e	13.21 ± 0.05 e	1783.14±3.92 e
Control	4184 ± 46.65 a	15.8 1± 0.12 a	2080.00±5.30 a

Means followed by the same letter within the column do not differ significantly at the 5% level of probability.

الملخص العربي

أداء طوائف نحل العسل المتغذية علي بعض الوجبات البروتينية تحت ظروف العازل

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تمت الدراسة بقسم وقاية النبات بكلية علوم الأغذية والزراعة بجامعة الملك سعود. تم اختبار تأثير خمس خلطات غذائية بروتينية علي نشاط نحل العسل المربي في نويات تحت ظروف العازل . تم تقييم معدل استهلاك النحل لتلك الوجبات وكذلك قدرة النحل علي تربية الحضنة بتلك النويات بالاضافة الي تقييم جودة شغالات نحل العسل الناتجة. أظهرت النتائج أن أعلي معدل للإستهلاك تم تسجيلة بواسطة الوجبة رقم ٣ (معجون التمر) تلتها الوجبة رقم ٤ (الفيد بي) ثم الوجبة رقم ٢ (دقيق قرون البرسوبس) ثم الوجبة رقم ٥ (دقيق الجلوتين) و أخيرا الوجبة التقليدية رقم(١) دقيق فول الصويا. أظهرت النتائج أن مساحات الحضنة المرباة بواسطة نحل العسل بتلك النويات مرتبطة بشدة بمدى ملائمة البروتين في تلك الوجبات للنحل. علي وجه العموم كان خبز النحل (كنترول) أفضل مصدر للبروتين لنحل العسل وسجلت الطوائف التى تغذت عليه متوسط مساحة حضنة مغلقة ١٠٦٦.٧ عين / نوية بعد مرور ٤٢ يوم وكان لتلك القيمة فارق معنوى مع كل التغذيات البروتينية الأخري. أظهرت النويات المتغذية علي الفيد بي أعلي معدل لتربية الحضنة بين باقي التغذيات المختبرة بمعدل ١٧٤.٧ عين / نوية تلتها الوجبة رقم ٣ (دقيق قرون البرسوبس) بمتوسط ١١١ عين / نوية. أقل المساحات المتحصل عليها سجلت عند تغذية النحل علي الوجبة رقم ٥ (دقيق الجلوتين) بمتوسط ٣٩ عين / نوية.بينما لم تعط الوجبة رقم (١) و المعتمدة علي دقيق فول الصويا أي مساحات حضنة مغلقة. لتقييم جودة شغالات نحل العسل الناتجة تم تقدير الوزن الرطب والجاف والمحتوى البروتيني ليرقات الشغالات والحشرات الكاملة حديثة الخروج. جميع القياسات تحت ظروف العازل سجلت نتائج أقل منها في النويات المرباه تحت الظروف الطبيعية. من ناحية أخرى، أفضل النتائج المسجله تحت ظروف العازل ظهرت في النوات المتغذية على الفيد بي متبوعة بدقيق قرون البرسوبس. نسبة المواد الصلبة الذائبة الكلية (T.S.S.%) والعدد الكلي لخلايا الدم (T.H.C.) كانت قيمها مختلفة بين تلك التغذيات. أيضاً نسبة البروتين في هيموليمف يرقات الشغالات كانت مختلفة معنوياً بين التغذيات البروتينية المختلفة. و قد أظهرت النتائج مستوي القيمة الغذائية للوجبات البروتينية المقدمة عند أعتماد نحل العسل عليها بشكل كامل تحت الظروف المعزولة في تغذية الحضنة و تغذية الشعالات الكاملة.