

**EFFECT OF SUPPLEMENTAL FEEDING ON BROOD PRODUCTION AND POPULATION DEVELOPMENT OF HONEY BEE (*APIS MELLIFERA JEMENTICA*) COLONIES UNDER CENTRAL REGION CONDITIONS OF RIYADH, KINGDOM OF SAUDI ARABIA**

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**ABSTRACT:** *The effect of different feeding regimes on brood production and population development of honey bee colonies of first hybrid of *Apis mellifera jementica* (Indigenous bee) in Riyadh, Saudi Arabia had been studied. Seven feeding regimes were carried out during dearth period, extended from the end of September 2005 to January 2006. The feeding regimes were protein substitutes consisted of soybean flour, pollen grains and sugar powder plus sugar syrup (SPS); maize flour, pollen grains and sugar powder plus sugar syrup (MPS); pollen grains and sugar powder plus sugar syrup (PS); pollen grains and sugar powder cake only, without sugar syrup feeding (P); Niktabol plus sugar syrup (NS); dates (agwa) plus sugar syrup (DS); and sugar syrup 50% only (S), in addition colonies received no treatment served as control (C). Colonies were equalized in number of combs covered with bees and brood areas and had young fertilized queen bees of the same age. Feeding was conducted at 10 day intervals. The brood production and population development were recorded at 12 day intervals. It was shown that brood production and population development were significantly higher in the group fed on pollen grains cake plus sugar syrup (PS); pollen grains cake only (P) and soybean flour and pollen grains cake plus sugar syrup (SPS), where they had (1748.38, 1642.31 and 1290.73 brood area cm<sup>2</sup>/colony) and (5.16, 4.78 and 4.67 combs of adult bees/colony), respectively. In conclusion, feeding colonies with cake composed of (soybean flour, pollen grains and sugar powder) plus sugar syrup (SPS) promotes high brood development and colony populations without any significant differences between the two other groups (PS and P), and can be recommended. The other tested groups significantly did not increase brood area and honey bee population as compared with untreated colonies.*

**Keywords:** Honey bees, *Apis mellifera jementica*, feeding, protein supplements, brood rearing, population development.

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## **INTRODUCTION**

Many colonies were lost in central region of Saudi Arabia during dearth period due to the inactivity of queens which are ceased egg deposition.

Pollen is the main source of several important nutrients for honeybees. Consequently, an adequate pollen supply is essential to ensure the long-term survival of a colony and to maintain its productivity (Keller *et al.* 2005). Feeding honey bee colonies with different pollen supplement diets based on soybean flour, maize flour, pollen and dates have been studied on colonies strength such as brood production and population development by many investigators (Wallace, 1992; Chhuneja *et al.* 1993; Bobrzecki *et al.* 1994; Szymas, 1994; Silva and Silva, 1995; Couto *et al.* 1998; Hassan, 1998; Chandel and Arun, 2000; Nabors, 2000; Abbasian and Ebadi, 2002; Karacaoglu *et al.* 2003 and Dodologlu *et al.* 2004).

Abou-Zaid and Abd-Alfattah (1988) monitored brood rearing during dearth period in honey bee colonies fed with different pollen supplement diets, they found that colonies fed with soybean meal reared most brood. While, Musa *et al.* (1988) supplied local honey bee colonies with pollen substitute and sugar syrup, their diets were based on soybean flour, dates and sugar syrup, they found that colonies fed on soybean cake reared more brood and highest adult populations than colonies fed on other diets followed by colonies fed on dates. Wali and Chaudhry (1991) fed honey bee colonies with protein and sugar supplement during dearth period in Pakistan. They found that supplement feeding with a mixture of sugar, pollen and soybean flour increased brood development up to 81%. Schoreit and Hussein (1993) fed colonies of *A. mellifera* with sugar syrup mixed with a protein supplement (pollen, soybean flour, agwa date and chick pea), they concluded that colonies given 100 g supplement reared significantly more brood. They also found that soybean flour had the greatest effect on brood rearing and honey production followed by agwa dates. Abbas *et al.* (1995) fed honey bee colonies each had 4 combs of brood with pollen substitutes containing 55% soybean flour, they found that After 3 months the colony contained an average of 4.75 combs/colony, but colonies received no pollen had only 2.5 combs/colony. Hassan (1998) found that colonies fed on a diet with sugar solution resulted in moderate levels of brood area and combs of bees (701.00 cm<sup>2</sup> and 7.75 combs filled with adult bees/colony, respectively). However, the unfed colony showed weak results of these parameters: 380.00 cm<sup>2</sup> and 6.25, respectively. Castagnino *et al.* (2004) conducted an experiment for seven weeks, they reared *A. mellifera* colonies with or without a pollen substitute provided weekly, the pollen substitutes consisted of soybean flour, maize flour and wheat flour (1:1:1) corresponding to 24.8% protein. They found that colonies supplied with pollen substitutes had greater brood areas (cm<sup>2</sup>) than those without pollen substitutes. Dodologlu *et al.* (2004) examined the interacting effects of two feeding regimes (sucrose syrup or 'bee cake') on selected performance characters of honey bee (*Apis mellifera*) colonies in Turkey. They found that brood area was significantly increased in colonies that received supplementary feeding regardless of feeding method, feeding

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colonies with sugar syrup in autumn and with bee cake and syrup in early spring provided optimum colony buildup for the production season.

The aim of the present study is to investigate the effect of different pollen substitutes on brood production and population development of *Apis mellifera jementica* (Indigenous bee) during dearth period under Riyadh conditions and to find out the cheap materials available for feeding honey bee colonies.

### **MATERIALS AND METHODS**

Experiments were carried out on honey bee colonies (*Apis mellifera jementica*) (Indigenous bees), during dearth period extended from September 2004 to January, 2005 at Queen Rearing and Honeybee Nuclei Production Center, belonging to Agricultural Extension Department, Ministry of Agriculture, located at Nmar valley, Riyadh, Kingdom of Saudi Arabia.

#### **Preparation of honey bee colonies:**

Forty honeybee colonies were chosen, each had an approximately equal number of frames covered with bees and brood areas and had young fertilized queen of relatively the same age. Each colony had one comb of brood, one comb honey and pollen as well as one empty comb. The combs were covered with adult workers. The experimental colonies were divided into eight groups, each group had five colonies which were received one of the following feeding regimes:

- 1- Protein supplement consisted of soybean flour, pollen grains and sugar powder plus sugar syrup (1:1) (SPS).
- 2- Protein supplement consisted of malze flour, pollen grains and sugar powder plus sugar syrup (1:1) (MPS).
- 3- Protein supplement consisted of pollen grains and sugar powder plus sugar syrup (1:1) (PS).
- 4- Protein supplement consisted of pollen grains and sugar powder only (P), without sugar syrup.
- 5- Protein supplement called Niktabol plus sugar syrup (1:1) (NS).
- 6- Dates (agwa) plus sugar syrup (1:1) (DS).
- 7- Sugar syrup (1:1) only (S).
- 8- Natural feeding as check control (C).

Feeding was conducted at 10-days interval (Mladenovic *et al.* 2002) with 300 grams of Soybean cake, malze cake, pollen cake, Niktabol or dates (agwa) and one liter of sugar syrup 50%. Control colonies fed naturally without any food addition.

#### **Preparation of different feeding regimes:**

- Soybean and pollen cake (SP): Consisted of soybean flour, pollen grains, sugar powder and water at ratio of 3: 3: 3: 1, respectively. To

prepare the cake, an amount of soybean seeds, pollen grains and pure cane sugar granules were ground separately at high speed blender, mixed together in glass container and the amount of water was added to make elastic paste. The paste was put in plastic sac and kept over night, then cut out and 300 grams were introduced to each experimental colony above the frames and covered with a piece of plastic.

- **Maize and pollen cake (MP):** Consisted of maize flour, pollen grains, sugar powder and water at ratio of 3: 3: 3: 1, respectively. To prepare the same procedure described for soybean pollen cake was followed.
- **Pollen cake (P):** Consisted of mixed pollen grains, pure cane sugar and water at ratio of 1: 1: 0.1, respectively. The procedure recorded for soybean and pollen cake was followed.
- **Niktabol (N):** This powder was imported from Germany and was purchased from beekeeping supplies store as honeybee protein supplement. 300 grams were cut out and introduced to each experimental colony, it was added inside the hive above the combs and covered with a piece of plastic sac. Niktabl is consisted of the following components: Moisture 9.81% , Crude protein 44.39% , Ether extract 2.55% , Crude fiber 3.36% , Ash 6.21% , T. Carbohydrate (calculated) 33.60% , ME 375.0 Kcal/kg and Salt As NaCl 0.14% .
- **Dates (agwa) (D):** This product was made in Al-Madina Al-Monawara (Al-Madine's agwa). It was cut out and dipped in sugar syrup, then 300 grams was introduced to each experimental colony above the frames and covered with a piece of plastic sac.
- **Sugar syrup (S):** The syrup was made of pure cane sugar which is composed of 1 part of pure sugarcane powder to 1 part of water. Each experimental colony was provided with 1 liter in an inner feeder. Some tree sticks were put inside the feeder for bees to stand on them during their feed.

### **Honeybee colonies strength:**

Brood area in cm<sup>2</sup> and number of combs covered with adult honey bees were studied. The brood areas were measured from both sides of each brood comb in all experimental colonies by using a ruler. The number of combs covered with adult bees from both sides was recorded visually for each colony. The brood production and population development were recorded at 12 day intervals (Karacaoglu *et al.* 2003).

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**Reproduction index (RI):** was calculated for each feeding regime at each date of inspection according to the formula suggested by Udayagiri and Mason (1997) with slight modifications.

$$R. I. = \frac{\text{area of treated} - \text{area of control}}{\text{area of treated} + \text{area of control}}$$

The index takes a positive or negative value indicating feeding regimes that were preferred by honey bee workers to estimate queen for oviposition (positive value) and those that are not preferred (negative value).

### **Experimental Design and Analysis:**

The experimental design was a completely randomized design (CRD). Results were analyzed using SAS (SAS Institute, 1985). The general linear modules procedure to test for differences ( $\alpha = 0.05$ ) and applied the least significant differences as a mean separation test were used.

## **RESULTS**

### **1- Brood area in cm<sup>2</sup>:**

Data given in Tables (1 and 2) showed the square centimeters of brood in the experimental colonies fed on different diet regimes. Table (1) and Fig. (1) show brood area in colonies fed on protein cake consisted of soybean flour, pollen grains, sugar powder and water (SPS) plus sugar syrup; (maize flour, pollen grains, sugar powder and water) plus sugar syrup (MPS); (pollen grains, sugar powder and water) plus sugar syrup (PS); pollen grains, sugar powder and water only (P), without sugar syrup and colonies fed naturally without any food addition (Control, C). The square centimeters of brood at the beginning of the experiment on September 30, 2005 were 1137.60, 765.60, 1361.80, 1215.60 and 1110.20 cm<sup>2</sup>/colony for colonies fed on (SPS), (MPS), (PS), (P) and (C), respectively. 12 days after treatment, after one cycle of brood production on October 12, 2005, no apparent differences were observed between treatments and control colonies, but colonies fed on (PS and P) had significantly more brood area (1465.60 and 1464.40 cm<sup>2</sup>/colony) without significant differences between them and colonies fed on SPS (1205 cm<sup>2</sup>/colony). Colonies fed on MPS had significantly less brood area (824.80cm<sup>2</sup>/colony) without significant difference between them and control group (C) (1108.40 cm<sup>2</sup>/ colony). On October, 24 the same trend was obtained. After three cycles of brood production on November, 05, significant differences between the feeding groups were observed. Colonies fed on (SPS, PS and P) had significantly more brood area (1384.20, 1812.00 and 1755.20 cm<sup>2</sup>/ colony, respectively) without any differences between them. The same trend was obtained until the end of the experiment. On January 04, 2006,

Table (1): Brood areas (cm<sup>2</sup>/colony) after feeding the honey bee colonies on different supplementary diets mixed with pollen grains and sugar syrup (Means  $\pm$  S.E).

Inspection date	Feeding Regime					F. value	L.S.D.
	SPS**	MPS**	PS**	P**	C**		
Sep. 30	1137.60 $\pm$ 84.10 ab (+0.012)	765.60 $\pm$ 148.45 b (-0.184)	1361.80 $\pm$ 502.45 a (+0.102)	1215.60 $\pm$ 175.36ab (+0.045)	1110.20 $\pm$ 244.71ab	1.62	509.45
Oct. 12	1205.00 $\pm$ 195.59ab (+0.042)	824.80 $\pm$ 198.66 b (-0.147)	1465.60 $\pm$ 106.84 a (+0.139)	1464.40 $\pm$ 84.96 a (+0.139)	1108.40 $\pm$ 201.10ab	2.20	534.85
Oct. 24	1292.40 $\pm$ 223.62ab (+0.084)	880.20 $\pm$ 199.60 b (-0.107)	1553.80 $\pm$ 107.0 a (+0.175)	1599.20 $\pm$ 218.96 a (+0.189)	1091.80 $\pm$ 192.36ab	2.45	575.24
Nov. 05	1384.20 $\pm$ 238.71ab (+0.188)	927.00 $\pm$ 248.46 b (-0.010)	1812.00 $\pm$ 203.54 a (+0.314)	1755.20 $\pm$ 190.20 a (+0.299)	946.20 $\pm$ 133.75 b	4.18	611.67
Nov. 17	1420.40 $\pm$ 245.91ab (+0.208)	1020.40 $\pm$ 269.94 b (+0.045)	1917.60 $\pm$ 258.11 a (+0.346)	1873.60 $\pm$ 188.18 a (+0.336)	931.80 $\pm$ 113.32 b	4.27	658.44
Nov. 29	1471.40 $\pm$ 260.91ab (+0.234)	1113.00 $\pm$ 278.18 b (+0.098)	2024.60 $\pm$ 279.90 a (+0.378)	1989.60 $\pm$ 342.08a (+0.370)	914.00 $\pm$ 113.76 b	3.55	786.06
Dec. 11	1541.60 $\pm$ 264.41abc (+0.428)	1293.20 $\pm$ 326.06bc (+0.192)	2170.80 $\pm$ 307.21 a (+0.424)	1981.20 $\pm$ 359.10ab (+0.386)	877.20 $\pm$ 37.35 c	3.38	836.85
Dec. 23	1360.80 $\pm$ 275.05ab (+0.449)	1111.60 $\pm$ 366.62bc (+0.365)	1991.40 $\pm$ 284.61 a (+0.587)	1739.20 $\pm$ 293.81ab (+0.541)	517.40 $\pm$ 87.55 c	4.25	820.08
Jan. 04	803.20 $\pm$ 76.08ab (+0.442)	483.60 $\pm$ 76.90 b (+0.218)	1437.80 $\pm$ 348.50 a (+0.644)	1162.80 $\pm$ 347.72 a (+0.578)	310.80 $\pm$ 51.58 b	4.22	669.63
Mean $\pm$ S.E	1290.73 $\pm$ 218.26ab (+0.190)	935.49 $\pm$ 234.76 b (+0.031)	1748.38 $\pm$ 217.20 a (+0.331)	1642.31 $\pm$ 255.60 a (+0.303)	867.53 $\pm$ 130.61 b	4.19	575.43

- \*\*) SPS, soybean and pollen grains plus sugar syrup; MPS, Maize flour and pollen grains plus sugar syrup; PS, Pollen grains plus sugar syrup; P, Pollen grains cake and C, Control (Natural feeding colonies).

- Values between brackets represent reproduction indices (RI).

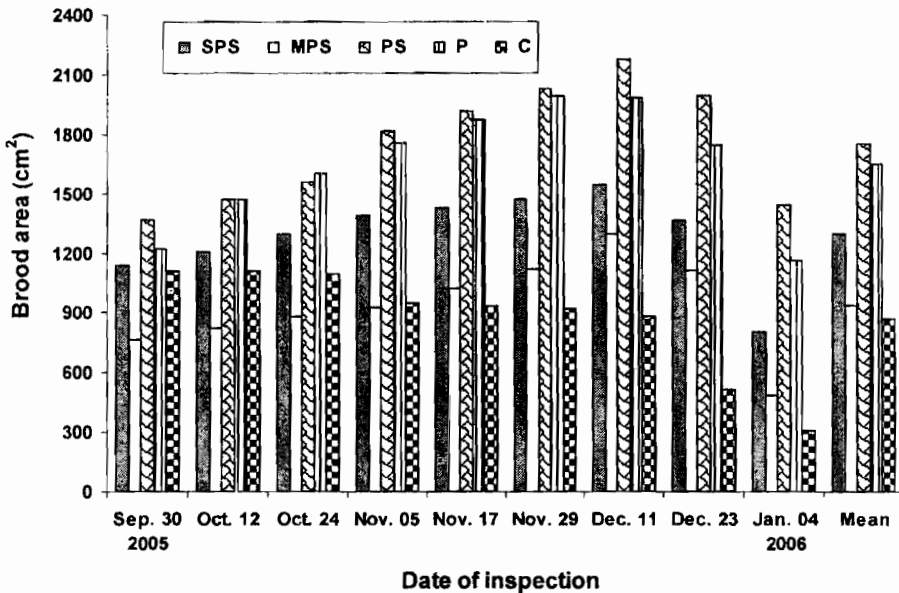
Table (2): Brood areas ( $m^2$ /colony) after feeding the honey bee colonies on Niktabol and dates, each mixed with sugar syrup and sugar syrup only (Means  $\pm$  S.E).

Inspection dates	Feeding Regimes				F. value	L.S.D.
	NS**	DS**	S**	C**		
Sept. 30	886.40 $\pm$ 115.21 a (-0.112)	759.40 $\pm$ 226.97 a (-0.188)	903.00 $\pm$ 240.78 a (-0.103)	1110.20 $\pm$ 244.71a	0.46	641.76
Oct. 12	866.40 $\pm$ 185.37 a (-0.123)	987.20 $\pm$ 179.25 a (-0.058)	836.20 $\pm$ 261.67 a (-0.140)	1108.40 $\pm$ 201.10a	0.35	628.90
Oct. 24	861.20 $\pm$ 192.12 a (-0.118)	784.80 $\pm$ 181.25 a (-0.164)	681.00 $\pm$ 203.96 a (-0.232)	1091.80 $\pm$ 192.36a	0.82	578.40
Nov. 05	855.40 $\pm$ 217.27 a (-0.050)	844.40 $\pm$ 188.94 a (-0.057)	850.40 $\pm$ 326.83 a (-0.053)	946.20 $\pm$ 133.75 a	0.04	684.22
Nov. 17	828.00 $\pm$ 249.55 a (-0.059)	954.40 $\pm$ 246.59 a (+0.012)	928.40 $\pm$ 313.64 a (-0.002)	931.80 $\pm$ 113.32 a	0.05	726.85
Nov. 29	937.00 $\pm$ 261.61 a (+0.012)	946.40 $\pm$ 243.08 a (+0.017)	1062.00 $\pm$ 338.09 a (+0.075)	914.00 $\pm$ 113.76 a	0.07	757.94
Dec. 11	1064.80 $\pm$ 365.51a +0.097	1025.20 $\pm$ 281.89a (+0.078)	1157.40 $\pm$ 357.04a (+0.134)	877.20 $\pm$ 37.35 a	0.16	878.08
Dec. 23	593.40 $\pm$ 187.09 a (+0.068)	800.40 $\pm$ 212.74 a (+0.215)	943.40 $\pm$ 359.88 a (+0.292)	517.40 $\pm$ 87.55 a	0.69	700.21
Jan. 04	353.40 $\pm$ 142.55 a (+0.064)	481.20 $\pm$ 136.32 a (+0.215)	451.00 $\pm$ 109.29 a (+0.184)	310.80 $\pm$ 51.58 a	0.48	347.36
Mean $\pm$ S.E	805.11 $\pm$ 69.75 a (-0.044)	842.60 $\pm$ 210.78 a (-0.021)	868.09 $\pm$ 279.02 a (-0.006)	867.53 $\pm$ 130.61 a	0.02	609.03

- \*\*/ NS, Niktabol plus sugar syrup; DS, Dates plus sugar syrup; S, Sugar syrup 50% only; and C, Control (Natural feeding colonies).

- Values between brackets represent reproduction indices (RI).

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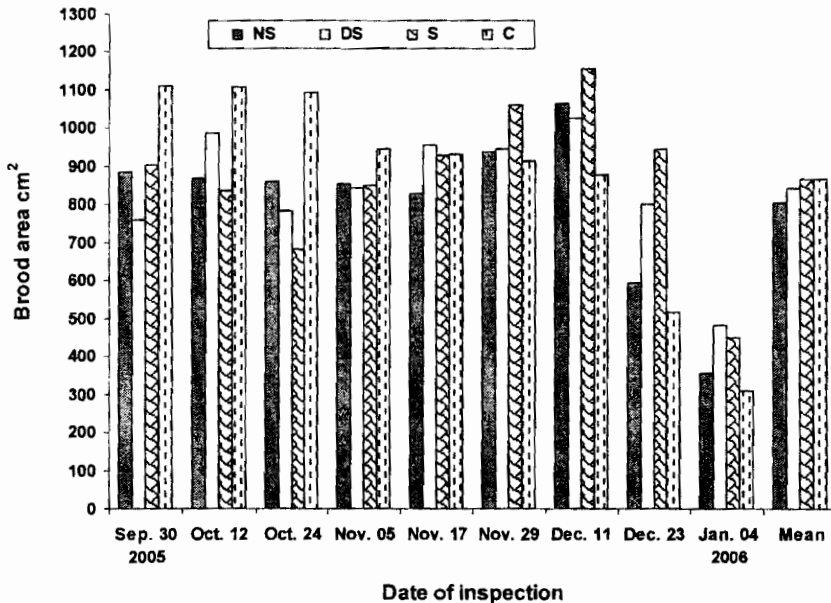
**Fig. (1): Brood area (cm<sup>2</sup>) after feeding the honey bee colonies on different supplementary diets mixed with pollen grains and sugar syrup**

colonies fed on PS and (P) had significantly more brood area (1748.38 and 1642.31 cm<sup>2</sup>/ colony) without significant difference between them and colonies fed on (SPS) (1290.73 cm<sup>2</sup>/ colony). Colonies fed on (MPS) had 935.49 cm<sup>2</sup>/ colony, without significant difference between them and control colonies (C), where they had 867.53 cm<sup>2</sup>/ colony. The same trend could be applied for general mean obtained in Table (1), where 1290.73, 935.49, 1748.38, 1642.31 and 867.53 cm<sup>2</sup>/colony were recorded for colonies fed on (SPS, MPS, PS, P and C, respectively) (F= 4.19, L.S.D = 575.43)

Brood area in colonies fed on Niktabol plus sugar syrup (NS), dates (agwa) plus sugar syrup (DS), sugar syrup only (S) and control colonies are presented in Table (2) and Fig. (2). At the beginning of the treatment on September 30, 2005, colonies were equal in brood areas, where they were 886.40, 759.40, 903 and 1110.2 cm<sup>2</sup>/ colony for colonies fed on NS, DS, S and C, respectively without significant differences between them. The same trend was obtained in the rest period of the experiment until the end of the experiment on January 04, 2006, at eighth cycle of brood production. The general mean obtained in Table (2) showed that there were no significant differences between colonies of all feeding regimes and control colonies, where they had 805.11, 842.60, 868.09 and 867.53 cm<sup>2</sup>/colony for colonies fed on (NS, DS, S and C, respectively; F= 0.02, L.S.D= 609.03)



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**Fig. (2): Brood areas (cm<sup>2</sup>) after feeding the honey bee colonies on niktabol and dates, each mixed with sugar syrup and sugar syrup only**

**2- Combs covered with adult honeybee workers:**

The data presented in Tables (3 and 4) show the number of frames covered with adult honey bees. Table (3) shows the number of combs covered with honeybees in colonies fed on protein cake consisted of: soybean flour, pollen grains, sugar powder and water (SPS) plus sugar syrup; maize flour, pollen grains, sugar powder and water (MPS) plus sugar syrup; pollen grains, sugar powder and water (PS) plus sugar syrup; pollen grains, sugar powder and water only (P), and control colonies (C). At the beginning of the treatment on September 30, 2005, the number of combs covered with adult bees from both sides was 3.40, 2.80, 3.60, 4.00 and 3.60/colony for colonies fed on SPS, MPS, PS, P and C, respectively without significant differences between them. The same trend was obtained after 12 days at the first cycle of bee production on Oct. 12, 2005. Differences were found between treatments at second cycle on Oct. 24, 2005. At this time, colonies fed on PS had significantly more combs covered with bees (4.80 combs/colony), with no significant difference between them and those fed on SPS (4.40 combs/colony) or P (4.20 combs/colony). Colonies fed on MPS or control colonies had significantly less number of combs covered with adult

**Table (3):** Number of combs covered from both sides with adult bees after feeding the honey bee colonies on different supplementary diets mixed with pollen grains and sugar syrup (Means  $\pm$  S.E).

Inspection dates	Feeding Regimes					F. value	L.S.D.
	SPS**	MPS**	PS**	P**	C**		
Sep. 30	3.40 $\pm$ 0.40 a (-0.029)	2.80 $\pm$ 0.37 a (-0.126)	3.60 $\pm$ 0.40 a (0)	4.00 $\pm$ 0.71 a (-0.053)	3.60 $\pm$ 0.24 a	0.94	1.332
Oct. 12	3.60 $\pm$ 0.51 a (+0.059)	3.00 $\pm$ 0.32 a (-0.032)	4.20 $\pm$ 0.20 a (+0.135)	4.00 $\pm$ 0.71 a (+0.111)	3.20 $\pm$ 0.20 a	1.38	1.279
Oct. 24	4.40 $\pm$ 0.40 ab (+0.158)	3.20 $\pm$ 0.49 b (0)	4.80 $\pm$ 0.20 a (+0.20)	4.20 $\pm$ 0.66 ab (+0.135)	3.20 $\pm$ 0.20 b	2.87	1.265
Nov. 05	5.40 $\pm$ 0.68 ab (+0.286)	3.80 $\pm$ 0.58 bc (+0.118)	5.60 $\pm$ 0.24 a (+0.302)	5.20 $\pm$ 0.80 ab (+0.268)	3.00 $\pm$ 0.00 c	4.33	1.616
Nov. 17	5.00 $\pm$ 0.55 ab (+0.250)	3.60 $\pm$ 0.68 bc (+0.091)	5.60 $\pm$ 0.24 a (+0.302)	5.20 $\pm$ 0.80 a (+0.268)	3.00 $\pm$ 0.00 c	4.29	1.594
Nov. 29	5.20 $\pm$ 0.37 a (+0.268)	3.60 $\pm$ 0.68 b (+0.091)	5.60 $\pm$ 0.24 a (+0.302)	5.20 $\pm$ 0.80 a (+0.268)	3.00 $\pm$ 0.00 b	5.05	1.504
Dec. 11	5.20 $\pm$ 0.37 ab (+0.321)	3.80 $\pm$ 0.66 bc (+0.188)	6.00 $\pm$ 0.45 a (+0.395)	5.80 $\pm$ 0.66 a (+0.373)	2.60 $\pm$ 0.24 c	8.17	1.493
Dec. 23	5.00 $\pm$ 0.55 ab (+0.220)	4.40 $\pm$ 0.68 bc (+0.158)	6.00 $\pm$ 0.32 a (+0.304)	5.00 $\pm$ 0.63 ab (+0.220)	3.20 $\pm$ 0.37 c	3.76	1.561
Jan. 04	4.80 $\pm$ 0.37 a (+0.297)	4.60 $\pm$ 0.40 a (+0.267)	5.00 $\pm$ 0.45 a (+0.316)	4.40 $\pm$ 0.67 a (+0.257)	2.60 $\pm$ 0.24 b	4.57	1.332
Mean $\pm$ S.E	4.67 $\pm$ 0.47 ab (+0.210)	3.64 $\pm$ 0.54 bc (+0.087)	5.16 $\pm$ 0.30 a (+0.259)	4.78 $\pm$ 0.72 ab (+0.220)	3.04 $\pm$ 0.17 c	3.92	1.310

- \*\* SPS, soybean and pollen grains plus sugar syrup; MPS, Maize flour and pollen grains plus sugar syrup; PS, Pollen grains plus sugar syrup; P, Pollen grains cake and C, Control (Natural feeding colonies).

- Values between brackets represent reproduction indices (RI).

**Table (4): Number of combs covered from both sides with adult bees after feeding the honey bee colonies on Niktabol and dates, each mixed with sugar syrup and sugar syrup only (Means  $\pm$  S.E).**

Inspection dates	Feeding Regimes				F. value	L.S.D.
	NS**	DS**	S**	C**		
Sep. 30	3.00 $\pm$ 0.32 a (-0.091)	2.80 $\pm$ 0.37 a (-0.125)	2.60 $\pm$ 0.51 a (-0.165)	3.60 $\pm$ 0.24 a	1.33	1.122
Oct. 12	3.80 $\pm$ 0.37 a (+0.86)	3.00 $\pm$ 0.32 a (-0.132)	3.20 $\pm$ 0.58 a (0)	3.20 $\pm$ 0.20 a	0.77	1.180
Oct. 24	3.20 $\pm$ 0.49 a (0)	3.60 $\pm$ 0.40 a (+0.059)	3.60 $\pm$ 0.75 a (+0.059)	3.20 $\pm$ 0.20 a	0.21	1.499
Nov. 05	4.00 $\pm$ 0.55 a (+0.143)	3.80 $\pm$ 0.49 a (+0.118)	3.00 $\pm$ 0.77 a (0)	3.00 $\pm$ 0.00 a	0.97	1.601
Nov. 17	3.60 $\pm$ 0.40 a (+0.091)	3.80 $\pm$ 0.49 a (+0.118)	3.40 $\pm$ 0.75 a (+0.063)	3.00 $\pm$ 0.00 a	0.49	1.469
Nov. 29	3.40 $\pm$ 0.51 a (+0.063)	3.80 $\pm$ 0.49 a (+0.118)	3.60 $\pm$ 0.68 a (+0.091)	3.00 $\pm$ 0.00 a	0.49	1.469
Dec. 11	3.40 $\pm$ 0.51 a (+0.067)	3.60 $\pm$ 1.00 a (+0.152)	3.60 $\pm$ 0.68 a (+0.152)	2.60 $\pm$ 0.24 a	0.80	1.601
Dec. 23	3.40 $\pm$ 0.51 a (+0.03)	3.80 $\pm$ 0.37 a (+0.086)	3.60 $\pm$ 0.68 a (+0.159)	3.20 $\pm$ 0.37 a	0.27	1.499
Jan. 04	3.40 $\pm$ 0.51 a (+0.067)	3.00 $\pm$ 0.32 a (+0.071)	3.60 $\pm$ 0.51 a (+0.159)	2.60 $\pm$ 0.24 a	1.16	1.236
Mean $\pm$ S.E	3.47 $\pm$ 0.46 a (+0.066)	3.47 $\pm$ 0.43 a (+0.064)	3.36 $\pm$ 0.66 a (+0.05)	3.04 $\pm$ 0.17 a	0.22	1.282

- \*\*) NS, Niktabol plus sugar syrup; DS, Dates plus sugar syrup; S, Sugar syrup 50% only; and C, Control (Natural feeding colonies).

- Values between brackets represent reproduction indices (RI).

bees, where they both had 3.20 combs/colony. The same trend was obtained until the seventh cycle of bee production on Dec. 23, 2005. At the end of the experiment on January 04, 2006 no significant differences were noticed in number of combs covered with adult bees in colonies fed on different regimes, but significant difference was found between these groups and control colonies (C). The general mean obtained in Table (3) showed that colonies fed on PS had significantly more combs of adult bees (5.16 combs/colony) without significant differences between them and colonies fed on SPS and P, where they had 4.67 and 4.78 combs/ colony. On the other hand, colonies fed on MPS had less number of combs covered with adult bees (3.64 combs/colony) without significant difference between them and control colonies (3.04 combs/colony, Fig. 3), ( $F = 3.92$ , L.S.D= 1.310).

Population development in colonies fed on Niktabol plus sugar syrup (NS), dates (agwa) plus sugar syrup (DS), sugar syrup only (S) and control colonies are presented in Table (4) and Fig. (4). As shown in this table, all the experimental colonies were the same strength, without significant differences between them at the beginning of treatment. The same trend was obtained until the end of the experiment on January 04, 2006. General mean showed that there were no significant differences between all the feeding regimes and control colonies, where the mean number of combs covered with adult bees was 3.47, 3.47, 3.36 and 3.04 combs/colony for colonies fed on NS, DS, S and C, respectively ( $F = 0.22$ , L.S.D= 1.282).

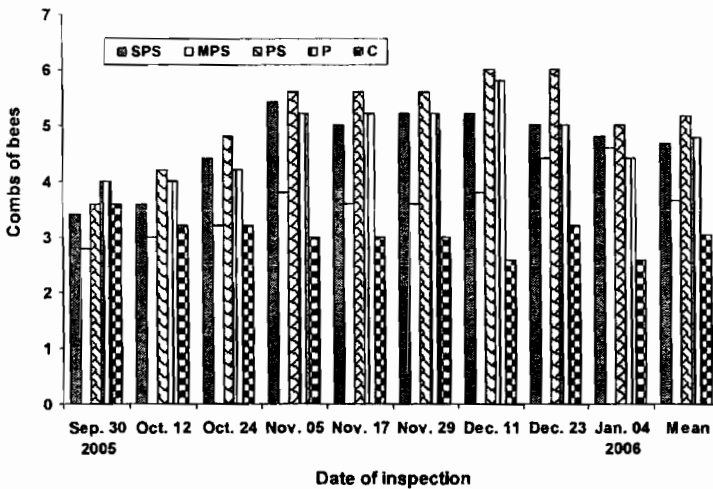


Fig. (3): Number of combs covered from both sides with adult bees after feeding honey bee colonies on different supplementary diets mixed with pollen grains and sugar syrup

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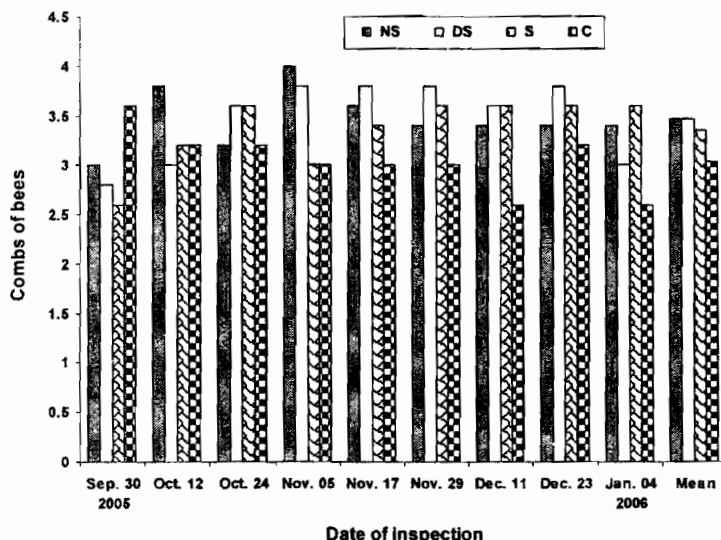


Fig. (4): Number of combs covered from both sides with adult bees after feeding honey bee colonies on niktabel and dates, each mixed with sugar syrup and syrup only

**DISCUSSION**

The present findings were found in agreement with Al-Ghamdi (2000) who reported that pollen supplementary feeding increased the population density and brood rearing areas during summer in Riyadh, K.S.A. The findings were also in agreement with those of El-Sarrag (1988) who found that brood rearing activity of *A. mellifera sudanensis* increased during autumn and winter rather than in summer. The present results agree with Abou-Zaid and Abd-Alfattah (1988) found that colonies fed on soybean meal reared most brood. Musa *et al.* (1988) found that colonies fed on soybean cake reared more brood and gave the highest adult populations than colonies fed on other diets. Wali and Chaudhry (1991) found that supplement feeding with a mixture of sugar, pollen and soybean flour increased brood development up to 81%. Schoreit and Hussein (1993) concluded that soybean flour had the greatest effect on brood rearing and honey production followed by agwa dates. The obtained results were also in agreement with Szymas (1994) who found that feeding colonies with pollen substitutes in spring promoted early development and in autumn bees fed on pollen substitutes had larger hypopharyngeal glands and fat bodies. Szymas and Przybyl (1995) found that colonies fed on soybean had brood area double that of colonies not fed with pollen or sugar. Hassan (1998) found that colonies fed on a diet with sugar

solution resulted in moderate levels of brood area and combs of adult bees (701.00 and 7.75, respectively). Castagnino *et al.* (2004) found that colonies supplied with the pollen substitute had greater brood areas than those which were not supplied with the pollen substitute. The present results were in agreement with Mladenovic *et al.* (2002) who found that feeding with sucrose syrup (1:1 sucrose : water) did not increase the brood area and bee population.

From the fore-mentioned results, it could be concluded that supplementary pollen cake is very important for feeding honey bees in central region of Saudi Arabia as it encouraged the honey bee colonies *Apis mellifera jementica* (Indigenous bee) to perform better in rearing brood which resulted in high colonies population densities and pass winter season successfully.

Soybean cake made from soybean flour, pollen grains, sugar powder and water is recommended as protein supplement for feeding honey bee colonies during dearth period under Riyadh conditions. This cake is consisted of cheap materials and commercial beekeepers whom have thousands of colonies can easy made it and they can save the amounts of pollen if they made pollen cake that consisted of pollen grains, sugar powder and water. Finally, there were no significant differences between colonies fed on soybean cake and pollen cake in brood production and population development. Feeding honey bee colonies during this period with sugar syrup (1:1) is also recommended.

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تأثير التغذية بالبدائل على إنتاج الحضنة ونمو طوائف نحل العسل اليمني  
(السلالة المحلية) تحت ظروف المنطقة الوسطى (الرياض)  
بالمملكة العربية السعودية

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الملخص العربي

أجريت هذه التجربة في محطة تربية الملكات وإنتاج الطرود التابعة لإدارة الإرشاد الزراعي - وزارة الزراعة الواقعة بوادي نمار جنوب مدينة الرياض بالمملكة العربية السعودية خلال فترة قلة الرحيق وحبوب اللقاح (من نهاية سبتمبر ٢٠٠٥ حتى يناير ٢٠٠٦) بهدف تقييم بعض بدائل التغذية البروتينية لطوائف نحل العسل وكذلك تأثير التغذية بالمحلول السكري على قوة الطائفة من سلالة النحل البلدي المحلي. وقد استخدم في هذه التجربة أربعون طائفة نحل قسمت إلى ثماني مجاميع، احتوت كل مجموعة على خمسة طوائف وغذيت علي العجائن التالية بالإضافة إلي محلول سكري (١:١):

- ١ - المجموعة الأولى: عجينة دقيق فول صويا، حبوب اللقاح، سكر بودرة، ماء بنسبة ٣:٣:٣:١، علي التوالي.
- ٢ - المجموعة الثانية: عجينة دقيق الذرة، حبوب اللقاح، سكر بودرة، ماء بنسبة ٣:٣:٣:١، علي التوالي.
- ٣ - المجموعة الثالثة: عجينة حبوب اللقاح، سكر بودرة، ماء بنسبة ١:١:١:٠,١، علي التوالي.
- ٤ - المجموعة الرابعة: عجينة حبوب اللقاح، سكر بودرة، ماء بنسبة ١:١:١:٠,١، علي التوالي بدون إضافة محلول سكري.
- ٥ - المجموعة الخامسة: تم تغذيتها بالنيكتابول.
- ٦ - المجموعة السادسة: عجوة المدينة (بعد إزالة النواة).
- ٧ - المجموعة السابعة: تم تغذيتها بمحلول سكري (١:١) فقط دون تغذية بروتينية.

٨- المجموعة الثامنة: تركت بدون تغذية إضافية اعتماداً على ما تجمعه من رحيق وحبوب لقاح (مقارنة).

قدم لكل طائفة تجريبية ٣٠٠ جم بروتين ولتر محلول سكري واحد كل ١٠ أيام، وتم قياس مساحة الحضنة وعدد الأقراص المغطاة بالنحل البالغ من الجانبين كل ١٢ يوماً. وقد أظهرت نتائج هذا البحث ما يلي:

١- كان إنتاج الحضنة والنحل مرتفعاً في طوائف النحل التي تغذت على عجائن حبوب اللقاح وبدون أي فرق معنوي بينها وبين طوائف النحل التي تغذت على عجينة دقيق فول الصويا، حيث احتوت الطائفة في نهاية التجربة على متوسط (١٢٩٠,٧٣، ١٧٤٨,٣٨ و ١٦٤٢,٣١ سم<sup>٢</sup> حضنة/طائفة و ٤,٦٧، ٥,١٦ و ٤,٧٨ قرص نحل/طائفة) لكل من طوائف النحل التي تغذت على عجينة دقيق فول الصويا، حبوب اللقاح بالإضافة إلى محلول السكري و عجينة حبوب اللقاح بدون تغذية سكرية على التوالي.

٢- لم يرتفع إنتاج الحضنة والنحل في الطوائف التي غذيت على عجينة دقيق الذرة وقاربت النتائج تلك التي تحصل عليها من طوائف لم يقدم لها أي تغذية إضافية، حيث احتوت الطائفة على (٩٣٥,٤٩ و ٨٦٧,٥٣ سم<sup>٢</sup> حضنة/طائفة و ٣,٦٤ و ٣,٠٤ قرص نحل/طائفة) لكل من الطوائف التي تغذت على عجينة الذرة وتلك التي تركت بدون تغذية إضافية (المقارنة) على التوالي وبدون فرق معنوي بينهما.

٣- لم تؤثر تغذية طوائف النحل بالنيكتابول والعجوة تأثيراً إيجابياً على إنتاج الحضنة والنحل، حيث أنتجت الطائفة (٨٠٥,١١ و ٨٤٢,٦٠ سم<sup>٢</sup> حضنة/طائفة و ٣,٤٧ و ٣,٤٧ قرص نحل/طائفة، على التوالي) بالمقارنة بطوائف النحل التي تركت بدون تغذية إضافية (٨٦٧,٥٣ سم<sup>٢</sup> حضنة/طائفة و ٣,٠٤ قرص نحل/طائفة) بدون فرق معنوي بين المجاميع الثلاثة.

وتجدر الإشارة إلى أن تغذية الطوائف بالمحلول السكري تعتبر عاملاً هاماً أيضاً خلال تلك الفترة على الرغم من أن تلك التغذية ليس لها تأثيراً معنوياً على إنتاج الحضنة ونموها تبعاً لما أثبتته هذا البحث. ويقترح في فترة قلة الرحيق وحبوب اللقاح توصية بتغذية طوائف نحل العسل تحت ظروف المنطقة الوسطى بالمملكة بعجينة دقيق فول الصويا للحفاظ على هذه الطوائف لرخص ثمنها وكفاءتها الغذائية.