

EFFECT OF SOME POLLEN SUBSTITUTES ON BROOD REARING ACTIVITY AND QUEEN PRODUCTION OF HONEYBEE COLONIES

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ABSTRACT

Wheat germ, dried brewer's yeast and defatted soybean flour were offered, in form of cake (paste), as pollen substitutes to honeybee colonies. The effect of such feeding on brood rearing activity and queen production were investigated during 2003/2004 and 2004/2005 seasons in the apiary of Faculty of Agriculture at Moshtohor. Summarized results are as follow:

1- The greatest total sealed brood area was measured during spring season, ranging between 1590.66 (control) – 2471.01 inch²/colony for wheat germ treatment in the first season; 1667.00 and 2538.33 inch²/colony in the second season. The least brood rearing activity, however was detected in winter during 2003/2004 and in autumn during 2004/2005.

2- The cake based on wheat germ induced the highest brood rearing activity in both seasons as the total sealed brood area reached 6874.00 and 7132.67 inch²/colony. Dried brewer's yeast cake came the second class (6210.00 and 5995.67 inch²/colony), followed by soybean cake (5291.00 and 5598.67 inch²/colony). On the other hand, control colonies reared 4475.33 and 4358.35 inch²/colony in 2003/2004 and 2004/2005, respectively.

Percent increase in sealed brood area realized due to pollen substitutes feeding attained 52.99, 38.76 and 18.23% in the first season; 63.67, 37.57 and 28.46% in the second season for the colonies fed on the cake of wheat germ, dried brewer's yeast and defatted soybean flour, respectively.

Feeding queen rearing colonies on the test pollen substitutes resulted in considerable increase in grafted queen cups acceptance, ranging between 29.49 – 86.44%. In addition, an increase in the emergence of virgin queen, ranging between 45.11- 105.10% was detected in pollen substitute fed colonies. Wheat germ cake proved most potent in enhancing both grafted cups acceptance and virgin queen emergence to be especially during clover season.

Keywords: Pollen substitutes, brood rearing activity, queen production, honeybee colonies.

INTRODUCTION

Pollen is the primary source of protein, fats, vitamins, and minerals in the diet of the honeybee, *Apis mellifera* L., and provides all the nutritive elements necessary for life when it is ingested along with nectar and water. However, in any study concerning the nutrition of honey bees, the interaction between larval and adult honeybees is a prime consideration because newly emerged adults must consume pollen during the 1st 10 days

after emergence. Without this initial pollen, the brood rearing ability of these bees is drastically impaired, Haydak (1949) since the glands responsible for producing the food fed by nurse bees to the larvae remain underdeveloped and nonfunctional.

Some biological activity of honeybee colonies are induced (enhanced) greatly by protein feeding, especially during the dearth periods when the colonies suffer the shortage of pollen needed to activate the glands responsible for larval foods secretion, Barker (1971).

Therefore, the present work is an attempt to evaluate the efficiency of three pollen substitutes (wheat germ, dried brewer's yeast and defatted soybean flour) in enhancing brood rearing activity and queen production of the fed colonies.

MATERIALS AND METHODS

The present investigations were carried out in the apiary Faculty of Agriculture, Moshtohor, Benha University during the two successive years 2003/2004 - 2004/2005.

1- Experimental colonies:-

Twelve honeybee colonies of first hybrid Carniolan bees, *Apis mellifera carnica* L. nearly equal in strength containing at least seven frames covered with bees and headed by open mated hybrid new sister queens. These colonies were divided into four groups, of three colonies each.

2- The diets:-

The tested diets are:-

1- Soybean flour + bee honey (2:1w/w), the chemical compositions of soybean flour determined by Hammad (2000) is as follows: humidity 6.58% , protein 50.88%, fat 5.41%, fiber 6.54% , ash 6.73%.

2- Wheat germ + bee honey (2:1w/w), the chemical compositions of wheat germ determined by Kent and Amos (1967) is as follows: humidity 9-13%, protein 22-32%.

3- Brewer's yeast + bee honey (2:1 w/w), the chemical compositions of dried Brewer's yeast determined by Atallah *et al.* (1979) is as follows: humidity 9.5%, crude protein 40.5%, ether extracts 1.5%, ash 6.25% in addition to vitamin B 1, B2 and nicotinic acid.

Diet mixtures were supplied (sweetened) with powdered sugar to become cakes. The cakes were then offered to the test colonies at the rate of 300g./colony every 13 days. The cakes were inbagged in perforated plastic saccules and placed over the top bars of brood nest, in addition to sugar syrup (1:1 w/v) feeding. Control colonies were offered sugar syrup only.

3- Estimation of brood rearing activity:-

Areas of sealed worker brood in the test colonies were measured at 12 day intervals during the two successive years using a typical Hoffman frame divided into square inches. This frame was laid against any comb to count the inches of sealed brood.

4- Estimation of queen rearing activity:-

Doolittle (1880) method used in queen rearing and production that adopted by Laidlow (1979) was followed: A frame with 4 bar containing 60 queen cups(15 queen

cups/bar) were grafted with worker larvae of 24 hours after hatching. The grafted bars were introduced into queenless colonies until the queen cells were sealed. Percent acceptance of queen cubs after 24 hr. of introduction into breeding colony and the number of emerged virgin queens were assessed.

Data obtained were statistically analyzed according to Little and Hills (1975) methods.

RESULTS AND DISCUSSION

The efficiency of wheat germ, dried brewer's yeast and defatted soybean flour cakes, as pollen substitutes, on brood rearing activity and queen production was studied. Data obtained are presented in Tables (1 & 2).

1- Brood rearing activity:

Sealed brood area in inch² was measured at 12-day intervals all over the successive seasons of 2003/2004 and 2004/2005. Obtained data are summed and tabulated in Table (1) for autumn, winter, spring and summer in both years of study.

Obtained results clear that the total sealed brood area measured during autumn season attained 1197.66, 1192.00, 1051.32 and 911.01 inch²/colony in 2003/2004; 1072.67, 922.68, 818.00 and 634.33 inch²/colony in 2004/2005 for the colonies offered the cakes of wheat germ, dried brewer's yeast and defatted soybean flour and control, respectively. Analysis of data revealed that all test diets induced significantly brood rearing activity as compared to that of the control. However, wheat germ cake proved to be the superior meanwhile soybean flour cake was the inferior.

During winter season, the total sealed brood area reared in the test colonies recorded 1253.67, 1025.00, 904 and 483.33 inch²/colony in 2003/2004; 1314.34, 1071.00, 1029.66 and 453.32 inch²/colony in 2004/2005 season for the colonies fed on wheat germ, dried brewer's yeast and defatted soybean flour cakes and sugar syrup (control), respectively. Analysis of variance clear that wheat germ cake induced the highest brood rearing activity, being insignificantly differed as compared to that of the other two cakes. Generally, the test pollen substitutes were significantly higher than the control in this activity.

The total sealed brood area measured during spring season was the highest among the four seasons of the year, as it reached 2471.01, 2099.01, 1806.34 and 1590.66 and inch²/colony in 2003/2004; 2538.33, 2130.34, 1912.34 and 1667.00 inch²/colony in 2004/2005 season for the colonies fed on wheat germ, dried brewer's yeast and defatted soybean flour cakes and sugar syrup (control), respectively. Analysis of data indicated that the best diet in inducing brood rearing activity was dried brewer's yeast in the first season and wheat germ in the second one. The differences between means were mostly significant, especially in the second season.

During summer season, the total sealed brood area reared by the test colonies recorded 1924.66, 1894.01, 1529.32 and 1490.33 inch²/colony in the first season; 2207.33, 1871.68, 1838.66 and 1603.67 inch²/colony in the second one for honeybee colonies fed on wheat germ, dried brewer's yeast and defatted soybean flour cakes and sugar syrup (control) colonies, respectively. Statistical analysis revealed that wheat germ

Table (1): Effect of pollen substitutes feeding on brood rearing activity, brood (inch²/colony) during 2003/2004 and 2004/2005.

Diets Seasons		Sealed brood area inch ² /colony					L.S.D.	
		Wheat Germ	Dried Brewer's yeast	Soybean flour	Control	Total	0.05	0.01
2003/2004								
Autumn	Total	1197.66	1192.00	1051.32	911.01	4351.99	28.8	41.4
	Mean	171.10	170.29	150.19	130.14	621.72		
	%*	31.47	30.84	15.37	-----	-----		
Winter	Total	1253.67	1025.00	904.00	483.33	3666.00	24.06	32.95
	Mean	179.10	146.43	129.14	69.05	523.72		
	%*	159.38	112.07	87.04	-----	-----		
Spring	Total	2471.01	2099.01	1806.34	1590.66	7967.02	48.17	65.98
	Mean	353.00	299.86	258.05	227.24	1138.15		
	%*	55.34	31.96	13.56	-----	-----		
Summer	Total	1924.66	1894.01	1529.32	1490.33	6838.32	32.17	43.6
	Mean	274.95	270.57	218.48	212.90	976.90		
	%*	29.14	27.09	2.62				
Grand season	Total	6847.00	6210.00	5291.00	4475.33	22823.33	-----	----
	Mean	244.53	221.78	188.96	159.83	-----		--
	%*	52.99	38.76	18.23	-----	-----	-----	----
2004/2005								
Autumn	Total	1072.67	922.68	818.00	634.33	3447.68	26.47	36.4
	Mean	153.24	131.81	116.86	90.62	492.53		
	%*	69.01	45.46	28.95	-----	-----		
Winter	Total	1314.34	1071.00	1029.66	453.32	3868.32	62.4	85.5
	Mean	187.76	153.00	147.10	64.76	552.62		
	%*	189.94	136.26	127.14	-----	-----		
Spring	Total	2538.33	2130.34	1912.34	1667.00	8248.01	51.43	70.45
	Mean	362.62	304.33	273.19	238.14	1178.28		
	%*	52.27	27.79	14.72	-----	-----		
Summer	Total	2207.33	1871.68	1838.66	1603.67	7521.34	32.17	43.6
	Mean	275.92	233.96	229.83	200.46	940.17		
	%*	37.64	16.71	14.65	-----	-----		
Grand season	Total	7132.67	5995.67	5598.67	4358.33	23085.35	-----	----
	Mean	254.73	214.13	199.96	155.65	-----	-----	----
	%*	63.66	37.57	28.46	-----	-----	-	---

*% = % Increased

and dried brewer's yeast in the first season and wheat germ in the second season induced the highest significant brood rearing activity, while soybean flour cake and sugar syrup fed colonies (control) reared the least significant brood area. Data obtained are in partial accordance with those of Free and Williams (1976), Herbert and Shimanuki (1982), Abu-zaid and Abd-Alfattah (1989), Baidya *et al.* (1993), and El-Shaarawi (2001).

2- Queen rearing activity:

a) Percent acceptance of grafted queen cups:

Data presented in Table (2) clear that feeding queen rearing colonies on the cakes of wheat germ, dried brewer's yeast and soybean flour during citrus season increased the rate of grafted queen cups acceptance by 45.51, 32.05 and 33.97% in 2003/2004 season; 42.95, 29.49 and 35.56% in 2004/2005 season, respectively. The corresponding figures during clover season were 86.44, 56.78 and 64.41% in the first season; 85.22, 75.62 and 66.96% in the second season. The rates of queen cups acceptance during cotton season were intermediate, as they recorded 64.89, 45.04 and 47.33% in 2003/2004 season; 76.61, 48.39 and 55.65% in 2004/2005 season, respectively.

b) Percent emergence of virgin queens:

Obtained results clear that the rate of increase in the queen emergence was the highest in the colonies fed on wheat germ cake. For instance, the rate of increase in % emergence attained 63.78, 52.76 and 55.91% in 2003/2004; 57.14, 45.11 and 50.38% in 2004/2005 during citrus season, the rate of increase during clover season were 89.58, 81.25 and 83.33% in 2003/2004; 105.10, 61.62 and 88.89% in 2004/2005 season, and were during cotton season; 91.84, 74.49 and 73.47% in the first season; 98.10, 65.71 and 61.90% in the second season for the colonies fed on the cakes wheat germ, dried brewer's yeast and soybean flour over the percentage of queen emergence recorded for control colonies, respectively.

Queen cups acceptance and queen production depend upon many factors i.e climatic factors, especially ambient air temperature, relative humidity and daytime length. The most favorable climatic conditions are prevailing during May (clover season). This factors studying by Atmowidjojo *et al.*(1997), Osborne and Oldroyd (1999) and Woyke *et al.*(2004). Followed by July and August (cotton season) meanwhile the climatic factors suffer (manifest) great change during March and April (citrus season) David *et al.*(2000). In addition, food availability and quality has its great role, as the abundance of pollen or pollen substitute enhances the development of larval food glands and enable them to secrete sufficient royal jelly needed for raising queen larvae of well built bodies. Svoboda *et al.* (1986).

Other factors of low or great importance such as the existence of natural enemies (wasps, frogs, mite, reptiles and birds like bee eater; (*Meropes spp.*) and diseases infection may have a decisive role in this respect. Similar results were also reported by Revell (1960), Zaytoon *et al.* (1988), El-Shemy (1997), Shimanuki *et al.*(1992), and Malone *et al.*(2001),.

A well known fact that most honeybee diseases, which play adverse role on colony activities, are epidemically spread during cold season autumn and winter). On the other hand, wasps and bee eater *Meropes spp.* are abundantly occurred during summerseason. These phenomena in addition to tropic and weather factors could provide logic explanation to the low rate of queen rearing activity of honeybee colonies during citrus and cotton seasons, and the higher activity during clover season (May).

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تأثير بعض بدائل حبوب اللقاح على نشاط تربية الحضنة وإنتاج الملكات في طوائف نحل العسل

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أجريت هذه الدراسة بمنحل الكلية خلال عامي ٢٠٠٣/٢٠٠٤م و ٢٠٠٤/٢٠٠٥م وذلك بغرض دراسة تأثير بعض بدائل حبوب اللقاح مثل (جنين القمح - الخميرة الجافة - دقيق فول الصويا منزوع الدسم) والمستخدم في تغذية طوائف نحل العسل صناعيا كبداية لحبوب اللقاح الطبيعية على نشاط طوائف نحل العسل في تربية الحضنة وإنتاج الملكات. وأوضحت النتائج المتحصل عليها في هذه الدراسة أن الطوائف التي تغذت على بدائل حبوب اللقاح وخاصة جنين القمح تفوقت في تربية الحضنة خلال فصل الربيع مقارنة بالمعاملات الأخرى في كل من موسمي الدراسة، حيث كانت متوسط مساحة الحضنة المسجلة بالطائفة مقدره بالبوصة المربعة ٢٤٧١,٠١ بوصة مربعة/طائفة خلال الموسم الأول، بينما كانت في الموسم الثاني ٢٥٣٨,٣٣ بوصة مربعة/طائفة. كما كان أقل نشاط في تربية الحضنة خلال فصل الشتاء في الموسم الأول وفي فصل الخريف في الموسم الثاني من الدراسة. ومن النتائج اتضح أيضا أن الطوائف التي تغذت على عجينة جنين القمح كانت في المرتبة الأولى حيث سجلت ٦٨٤٧,٠٠ و ٧١٣٢,٦٧ بوصة مربعة/طائفة، والطوائف التي تغذت على عجينة الخميرة الجافة جاءت في المرتبة الثانية وسجلت ٦٢١٠,٠٠ و ٥٩٩٥,٦٧ بوصة مربعة/طائفة، والطوائف التي تغذت على عجينة دقيق فول الصويا جاءت في المرتبة الثالثة وسجلت ٥٢٩١,٠٠ و ٥٥٨٩,٦٧ بوصة مربعة/طائفة، بينما طوائف الكنترول سجلت ٤٤٧٥,٣٣ و ٤٣٥٨,٣٣ بوصة مربعة/طائفة خلال موسمي الدراسة على التوالي. كما لوحظت نسبة زيادة في مساحات الحضنة كانت ٥٢,٩٩، ٣٨,٧٦ و ١٨,٢٣ % في الموسم الأول، وكانت ٦٣,٦٦، ٣٧,٥٧ و ٢٨,٤٦ % في الموسم الثاني في الطوائف التي تغذت على عجينة جنين القمح، عجينة الخميرة الجافة، عجينة دقيق فول الصويا مقارنة بطوائف الكنترول على التوالي.

كما اتضح من النتائج أيضا أن طوائف نحل العسل التي تغذت على بدائل حبوب اللقاح قد أظهرت تقوفا ملحوظا في تربية الملكات، حيث زادت نسبة قبول البيوت الملكية المطعومة، وتراوحت هذه النسبة بين ٣٢,٠٥ - ٨٦,٤٤ % في الموسم الأول وبين ٢٩,٤٩ - ٨٥,٢٢ % في الموسم الثاني في هذه الدراسة مقارنة بطوائف الكنترول، كما أن نسبة خروج الملكات العذارى قد زادت في الطوائف المغذاة عن طوائف المقارنة بنسبة تراوحت بين ٥٢,٧٦ - ٩١,٨٤ % خلال الموسم الأول وبين ٤٥,١١ - ١٠٥,١ % خلال الموسم الثاني من هذه الدراسة. وكانت الطوائف التي تغذت على عجينة جنين القمح هي الأفضل في كل من: قبول البيوت الملكية المطعومة، وخروج الملكات العذارى وخاصة في موسم البرسيم.

ويتحليل النتائج إحصائيا كانت الفروق بين المعاملات معنوية وكانت الفروق بين المعاملات والكنترول معنوية جدا. من هذه الدراسة ننصح باستخدام هذه المواد كبداية لحبوب اللقاح وخاصة بديل جنين القمح لزيادة نشاط طوائف نحل العسل والحفاظ عليها خلال الفترات إلي يندر فيها وجود حبوب اللقاح الطبيعية بالحقول.

