

Mass production of honey bee *Apis mellifera* queens under different food regime conditions

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ABSTRACT

The role of food regimes offered to honey bee colonies on the mass production of queen honey bee using grafting method was study during spring 2015 using honey bee colonies headed with open mated local carnica queens, *Apis mellifera carnica* at the apiary belonging to Faculty of Agriculture, Ain Shams University, Cairo, Egypt. The results showed that feeding the colonies on a balanced food containing the main necessary elements such as honey and pollen cake plus sugar syrup give higher quantity of emerged queens produced (83.3 % per colony), compared with a colony fed either on wet date plus sugar syrup which produced 73.3 % per colony or on one single source of carbohydrate food (sugar syrup only) which recorded 66.6 % per colony. After a period of two rearing brood cycle from the time of reintroduction of the same mated queens to the tested colonies, the number of combs and brood cells was monitored, where the colonies fed on pollen cake were obviously rebuilt, being more strength which recorded an increase of + 8.3 % for combs and + 19.5 % for brood cells. The other two diets failed to rebuild themselves, where colonies fed on wet date decreased by - 4.2 for combs covered with adult bees and - 4.8 % for brood cells. Also, colonies fed on sugar syrup only decreased by - 20 for combs covered with adult bees and - 15.2 % for brood cells.

Key words: Mass production, honey bee, *Apis mellifera*, queens, food regime conditions.

INTRODUCTION

Honey bee *Apis mellifera* queen considered one of the most important individual in honey bee colony. It keeps and transfer the genetically characters of the parents, which characterized of the races and strains⁽¹⁾. The importance of rearing queens is due to replacing unproductive queens (the old one), compensation of the lost ones and moreover establishment of new colonies to increase the number of colonies by high quality queens^(2,3). Queen production affected by different factors which play an important role for quality and quantity of produced queens, from which: the seasonal weather conditions ambient the hive⁽⁴⁾, colony status either strength^(5,6) or worker's age⁽⁷⁾, larval age at the time of grafting⁽⁸⁾ and bee race⁽⁹⁾. According to the important of food intake by nurse workers, so the beekeepers tend to offered pollen supplement⁽¹⁰⁾ or food substitute⁽¹¹⁾ to their bees during rearing process.

Therefore, the present study aimed to evaluate the role of the food regime that affect the mass production of honeybee queens.

Key word: honey bee - *Apis mellifera* – Queen rearing - Food regime

MATERIALS AND METHODS

The present work was carried out during spring, 2015 using honey bee colonies headed with open mated local carnica queens, nearly equal in their strength located at the apiary belonging to Faculty of Agriculture, Ain Shams University, Cairo, Egypt.

The grafting method was used in this study. The adult bees of the tested free flying colonies (twelve colonies) were shaken between two combs full of honey with a space between them for the grafting frame, moreover, the queens and brood combs were removed, where the queens kept in queen's bank and the brood combs incubated in another hive;. After nearly 2 hrs of preparing the bees in the nurse colony it became queenless and crowded in the space for the grafting frame. Each colony received one grafting frame, each one had two bars, and each bar had 15 queen cups, with total of 30 queen cups for each colony. About one day old worker larvae was grafted in each cell, then inserted in the space between the two combs of the queen less nurse colony. Ten days after grafting, The sealed queen cells, were carefully placed under wire screen cages on Langstruth comb. Then, they were left in the same queenless building colony until emergence.

After the end of each experiment, the same queen and relatively the same number of sealed brood combs were returned to the original colony. The number of the brood cells was monitored during a period of two rearing brood cycle from the time of reintroduction of the mated queens to the tested colonies. Sugar syrup (50%) was offered daily to each colony during the period of the experiment.

Three types of food were offered to the experimental colonies, where the colonies were divided into 3 groups; each consisting of 4 colonies (according to their population density). Colonies in the first group were each provided with two combs of honey plus Pollen cake which was prepared by mixing sucrose powder, pollen grains and warm water at the ratio of 3 : 3 : 1, respectively. The prepared cake was cut into pieces, each weighing about 100g. and offered to the colonies ad libitum, which were placed on top of the combs and covered with a piece of polyethylene to avoid dryness. The colonies in the second group were provided with two combs of honey plus Date paste where cut into pieces, each weighing about 100g. and offered to the colonies ad libitum, which were placed on top of the combs and covered with a piece of polyethylene to avoid dryness. The colonies in the third group were provided with two combs of honey plus sugar syrup (50%) only.

All the experimental design in the present work is a completely randomized design; results were analyzed using SAS⁽¹²⁾.

RESULTS AND DISCUSSION

Colony productivity mostly is related to many factors, the most important of these factors is the queen. Queen quality is an important factor that influences not only the brood production but also productivity of the bee colony.

Food regime considered one of the most encouragements for queen rearing, so to indicate the effect of the food types that fed to adult worker bees on the number of produced queens, three types of food regimes were used.

In case of the colonies fed on pollen cake plus sugar syrup, the initial colony strength which compressed by combs covered with adult bees (ccab) and worker brood combs (wbc) averaged 6 ± 0.82 combs and 5035 ± 297.8 brood cells. Out of 30 queen cups / colony grafted an average of 29 cells (96.7%) were accepted and 25 cells (83.3%) were reached to the adult stage with an average weight of 170 ± 7.62 mg. After ten days from grafting where the queen cells were collected, the same queens and relatively the same number of sealed brood combs were returned to the original colonies. During a period of two rearing brood cycle from the time of reintroduction, the number of combs and brood cells was monitored and were obviously rebuilt, being more strength which recorded an average of 6.5 ± 0.58 combs (+ 8.3 %) and 6016 ± 462.3 brood cells (+ 19.5 %) (Table 1).

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Table (1): Queens's production during feeding pollen cake after grafting 30 queen cups

Replicates	Initial colony strength		No. of queen cells				Queens Weight (mg)	Colony status after rebuilding •			
	Ccab ¹	Wbc ²	Acc. ³	%	Emer. ⁴	%		Ccab ¹	%(+/-)	Wbc ²	%(+/-)
1	5	4660	29	96.7	27	90	167	6	+ 20	6210	+33.3
2	6	5030	30	100	26	86.7	180	6	0	5394	+7.2
3	6	5120	27	90	22	73.3	171	7	+16.7	6480	+26.6
4	7	5330	30	100	25	83.3	162	7	0	5980	+12.2
mean	6	5035	29	96.7	25	83.3	170	6.5	+8.3	6016	+19.5
SD	0.82	297.8	1.41	4.7	2.16	7.2	7.62	0.58		462.3	

¹ Ccab = combs covered with adult bees / ² Wbc= worker brood cells / ³ Acc= accepted / ⁴ Emer.= emerged

• After re- introduce the queen and after 2 brood cycles (+/-) = rates of increment (+) or decrement (-)

In case of the colonies fed on date paste plus sugar syrup, the data or results recorded that the initial ccab per colonies averaged 6 ± 0.5 combs and wbc averaged 5155 ± 404.3 brood cells, accepted 27 ± 2.6 (90 %) cells /colony out of them 22 ± 2.9 (73.3%) cells /colony emerged to queens with an average weight of 152 ± 12.78 mg.. After returned the queens and sealed brood combs to the colonies and after two brood cycles, the colonies failed to rebuild themselves as the initial values which recorded 5.75 ± 0.95 (- 4.2 %) ccab / colony and 4908 ± 322.4 (- 4.8 %) wbc / colony (Table 2).

Table (2): Queens production during feeding date paste after grafting 30 queen cups

Replicates	Initial colony strength		No. of queen cells				Queens Weight (mg)	Colony status after rebuilding •			
	Ccab ¹	Wbc ²	Acc. ³	%	Emer. ⁴	%		Ccab ¹	%(+/-)	Wbc ²	%(+/-)
1	6	5500	24	80	19	63.3	159	7	+16.7	4464	-18.8
2	7	5470	26	86.7	22	73.3	166	6	-14.3	5040	-7.9
3	6	4990	30	100	26	86.7	145	5	-16.7	5220	+4.6
4	5	4660	28	93.3	21	70	138	5	0	4908	+5.3
mean	6	5155	27	90	22	73.3	152	5.75	- 4.2	4908	-4.8
SD	0.81	404.3	2.6	8.6	2.9	9.8	12.78	0.95		322.4	

¹ Ccab = combs covered with adult bees / ² Wbc= worker brood cells / ³ Acc= accepted / ⁴ Emer.= emerged

• After re- introduce the queen and after 2 brood cycles (+/-) = rates of increment (+) or decrement (-)

Honey bee colonies offered only sugar syrup started with an average of 6.25 ± 0.94 ccab and 5205 ± 532.3 wbc / colony. The number of accepted queen cups averaged 26 ± 1.4 cups / colony, which represents 86.6 ± 4.7 % of the introduced cups. The total numbers of queens emerged from the accepted queen cells averaged 20 ± 2.58 queens / colony. After returned the queens and sealed brood combs to the colonies, the colonies failed to rebuild

themselves after two brood cycles as the initial values, which recorded 5 ± 0.82 (- 20 %) ccab / colony and 4416 ± 434.5 (- 15.2 %) wbc / colony (Table 3).

Table (3): Queens production during feeding Sugar Syrup only after grafting 30 queen cups

Replicates	Initial colony strength		No. of queen cells				Queens Weight (mg)	Colony status after rebuilding •			
	Ccab ¹	Wbc ²	Acc.	%	Emer. ⁴	%		Ccab ¹	%(+/-)	Wbc ²	%(+/-)
1	6	4560	25	83.3	17	56.7	126	4	-	4220	-7.5
2	5	5850	26	86.7	19	63.3	150	5	0	5010	-14.3
3	7	5300	25	83.3	23	76.6	135	5	-	4436	-16.3
4	7	5110	28	93.3	21	70	145	6	-	3998	-21.8
mean	6.25	5205	26	86.6	20	66.65	139	5	-20	4416	-15.2
SD	0.94	532.3	1.4	4.7	2.58	8.57	10.68	0.82		434.5	

¹ Ccab = combs covered with adult bees / ² Wbc= worker brood cells / ³ Acc= accepted /

⁴ Emer.= emerged

• After re- introduce the queen and after 2 brood cycles (+/-) = rates of increment (+) or decrement (-)

The analysis of variance for the data showed that, rearing queens had significant differences in the accepted queen cells between colonies fed on pollen cake plus sugar syrup and those fed on wet date paste plus sugar syrup and fed on sugar syrup only ($F= 2.62$ & $LSD = 1.43$). The same situation and manner appear for either the emerged queen cells ($F= 3.80$ & $LSD = 2.465$) or queens weight ($F= 8.672$ & $LSD = 16.283$) was found. The analysis of variance for the situation of the colonies that used for rearing queens appear no significant differences among all the treatments in the initial colony strength either for ccb ($F= 0.111$) or for wbc ($F= 0.174$). Regarding two brood cycles after collecting the queen cells and returning the same queens and relatively the same number of sealed brood combs to the original colonies, the analysis of variance showed significant differences among all treatments in case of ccab ($F= 2.454$ & $LSD = 0.656$) and highly significant differences in case of wbc ($F= 13.78$ & $LSD = 453.507$). Where, the colonies fed on pollen cake plus sugar syrup was obviously rebuilt, being more strength than the same colonies at the beginning of the experiment. In this case, the increasing recorded + 8.3 % for ccab and + 19.5 %for wbc. On the other hand, the colonies fed on date paste plus sugar syrup failed to rebuilt as being decrease in case of ccab - 4.2 % and wbc - 4.8 %. The colonies fed on sucrose syrup only had significantly less encouragement for rebuilding which recoded decrease reached to- 20 % for ccab and - 15.2 % for wbc (Table 4 & Fig.1).

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Table (4): Performance of honey bee colonies for queen production after grafting 30 queen cells and fed on different regimes (mean \pm SD of 4 replicates).

Replicates	Initial colony strength		No. of queen cells				Queens Weight (mg)	Colony status after rebuilding •			
	Ccab ¹	Wbc ²	Acc. ³	%	Emer. ⁴	%		Ccab ¹	%(+/-)	Wbc ²	%(+/-)
Pollen. cake + Sugar Syrup	6	5035	29 ^a	96.7 ^a	25 ^a	83.3	170 ^a	6.5 ^a	+ 8.3	6016 ^a	+ 19.5
Wet date + Sugar Syrup	6	5155	27 ^b	90 ^b	22 ^b	73.3	152 ^b	5.75 ^b	- 4.2	4908 ^b	- 4.8
Sugar Syrup only	6.25	5205	26 ^b	86.6 ^b	20 ^b	66.6	139 ^b	5 ^c	- 20	4416 ^c	- 15.2
F values	0.111	0.174	2.62*		3.8*		8.672*	2.454*		13.78**	
P values	0.896	0.843	0.126		0.064		0.008	0.166		0.006	
LSD	-	-	1.43		2.465		16.283	0.656		463.507	

¹ Ccab = combs covered with adult bees / ² Wbc= worker brood cells / ³ Acc= accepted / ⁴ Emer.= emerged

• After re- introduce the queen and after 2 brood cycles (+/-) = rates of increment (+) or decrement (-)

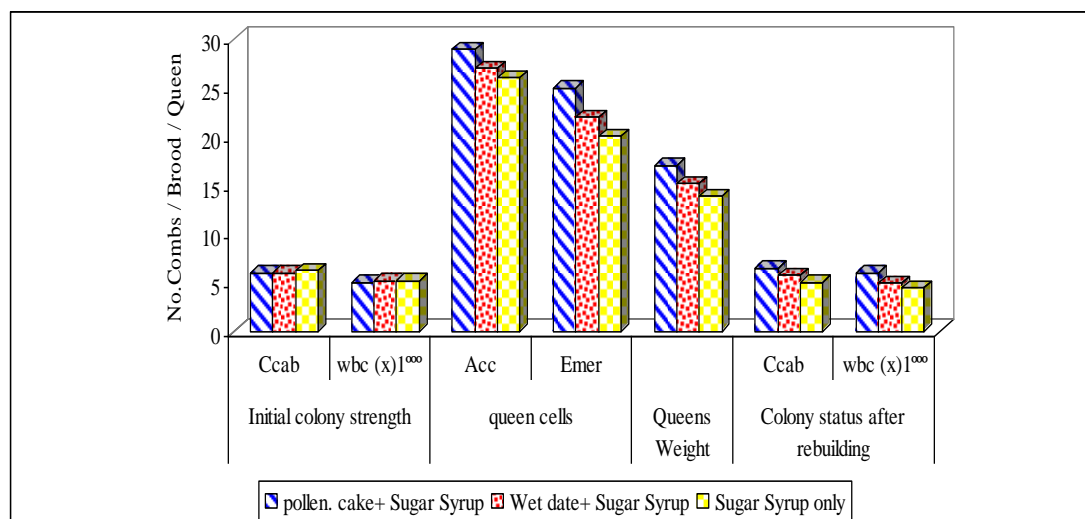


Fig. (1): Colonies status during queens production after different types of feeding.

From the fore mentioned data, it could be concluded that the highest the number and percentage of accepted queen cells, the highest was the numbers of queens production. Good rebuilding of the experimental colonies was obtained in colonies fed on pollen cake plus sugar syrup. The moderate values were given date paste plus sugar syrup followed by those fed on sucrose syrup only which recorded the lowest values. Feeding the honey bee colonies on balanced food consisted on the main sources of nutrients (as in pollen) gave the higher percentage of accepted queen cups, the maximum numbers of produced queens and the colonies were successfully rebuilt, as compared with the colonies supplied with sugar syrup only. The present results were in agreement with Elbassiouny and Mady⁽³⁾ (2007) whom

found that strong colonies gave the highest amount of accepted queen cells, also, El-Din⁽¹²⁾ who found that the Natural incubation gave the best results of emerged queens. In this respect Eweis⁽¹⁴⁾ found that the feeding bee colony with balanced food gave the best results of the accepted queen cells.

REFERENCES

- 1- Elbassiouny, A.M. (2008). Genetic aspect of multiple queen status in honey bee *Apis mellifera*. J. Agric. Sci. Mansouta Univ., 33(1):539 – 548
- 2- Elbassiouny, A.M. (2003). Importance of hybridization between the Egyptian and the Carniolan honey bees to improve its morphological characters. Arab.Univ.J.Agric.Sci., Ain Shams Univ., Cairo, 11(1), 401-409.
- 3- Elbassiouny, A.M. and Mady, I.A. (2007). Activities of honey bee colonies in El-Omeid, natural protectorate area, Egypt. Bull. Fac. Agric., Cairo Univ., 58: 159 - 163.
- 4- Kumova, U.; Korkmaz, A.; Berkin, O.; Inceer, M. (2005). An investigation about the effects of various factors on royal jelly production in different honeybee (*Apis mellifera* L.) genotypes. Mellifera. Development Foundation of Turkey, Ankara, Turkey: 5 (9): 24-32, 56-64.
- 5- Rana, V.K.; Goyal- N.P and Gupta, J.K. (1996). The effect of bee strength on cell acceptance and royal jelly production in *Apis mellifera* colonies. Pest management at Economic Zoology, 4 (1-2):123-124.
- 6- Cengiz, M; Emsen, B. and Dodologlu, A. (2009). Some characteristics of queenbees (*Apis mellifera* L.) rearing in queenright and queenless colonies. J. Anim.Vet. Adv., 8(6): 1083-1085.
- 7- Moritz, R.F.A; Lattorff, H. M. G.; Neumann, P.; Kraus, F. B.; Radloff, S. E. and Hepburn, H.R. (2005). Rare royal families in honeybees, *Apis mellifera*. Naturwissenschaften, 92 (10): 488-491.
- 8- Gilley, D. C; D. R. Tarpy and B. B. Land (2003): Effect of queen quality on interactions between workers and dueling queens in honeybee (*Apis mellifera* L.) colonies. Behav. Ecol. Sociobiol. 55 (2): 190-196.
- 9- Al-Ghzawi, A.A. and Zaitoun, S. (2008). Origin and rearing season of honeybee queens affect some of their physiological and reproductive characteristics. Entomol. Res., 38 (2): 139-148.
- 10- Karem, M.M.(1999). New treatments for increasing and improving the production of the honey colonies M.Sc. Thesis Faculty of Agriculture Fayoum , Cairo University, pp.85-93.
- 11- Moraes, F.C. and de Nogueira, R.H. (2000). Alternative sources of protein utilization for royal jelly production in *Apis mellifera* . Ecosystema, 25(2) : 184-187.
- 12- El-Din, H.A.(1999). Biological and ecological studies on rearing honeybee queens (*Apis mellifera* L.) for commercial queens production. Honeybee Science, 20 (3):127-130.
- 13- SAS Institute (2001).SAS/STAT User's Guide. Statistics Ver.8.2. SAS Institute Inc. Cary.Nc.
- 14- Eweis , M.A.(1974). Some factor affecting royal jelly production and effect on the method of strong on its quality. Ph.D. Thesis, Faculty of Agric, Cairo University. pp.227

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تربية ملكات نحل العسل تحت ظروف تغذية بعلائق مختلفة

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المستخلص

تم في هذه الدراسة تقييم دور العلائق الغذائية على تربية الملكات بأعداد كبيرة (على نطاق تجارى) بأستخدام طريقة التطعيم أثناء موسم الربيع 2015, بأستخدام طوائف نحل ذات ملكات كرينولى محلى ملقحة طبيعياً, وذلك بمنحل كلية الزراعة جامعة عين شمس. وقد أظهرت النتائج المتحصل عليها أن تغذية الطوائف على غذاء متزن يحتوى على العناصر الأساسية مثل العسل وحبوب اللقاح أعطت أفضل النتائج من حيث صفة خروج الملكات العذراى (83.3 % للطائفة الواحدة). ذلك مقارنة بالطوائف التى غذيت شغالاتها اما على البلح الرطب والمحلول السكرى والتى انتجت 73.3 % للطائفة الواحدة او التى غذيت شغالاتها على محلول سكرى فقط والتى انتجت 66.6 % للطائفة الواحدة. ايضا أظهرت النتائج أن بعد اعادة ملكات طوائف التجربة الى خلاياها وبعد مرور دورتين من الحضنة استطاعت الطوائف التى غذيت على عجينة حبوب اللقاح ان تعيد توازن نفسها وبقوة اكبر حيث سجلت كلا من اعداد الاقراص المغطاة بالنحل زيادة مقدارها + 8.3 % وكذلك الحضنة + 19.5 %. أما التغذية الأخرى لم تستطع اعادة بناء نفسها حيث سجلت الطوائف التى غذيت على البلح الرطب نقصا مقداره - 4.2 % فى اعداد الاقراص المغطاة بالنحل وكذلك - 4.8 % فى اعداد الحضنة وايضا الطوائف التى غذيت على المحلول السكرى فقط نقصا مقداره - 20 % فى اعداد الاقراص المغطاة بالنحل وكذلك - 15.2 % فى اعداد الحضنة.