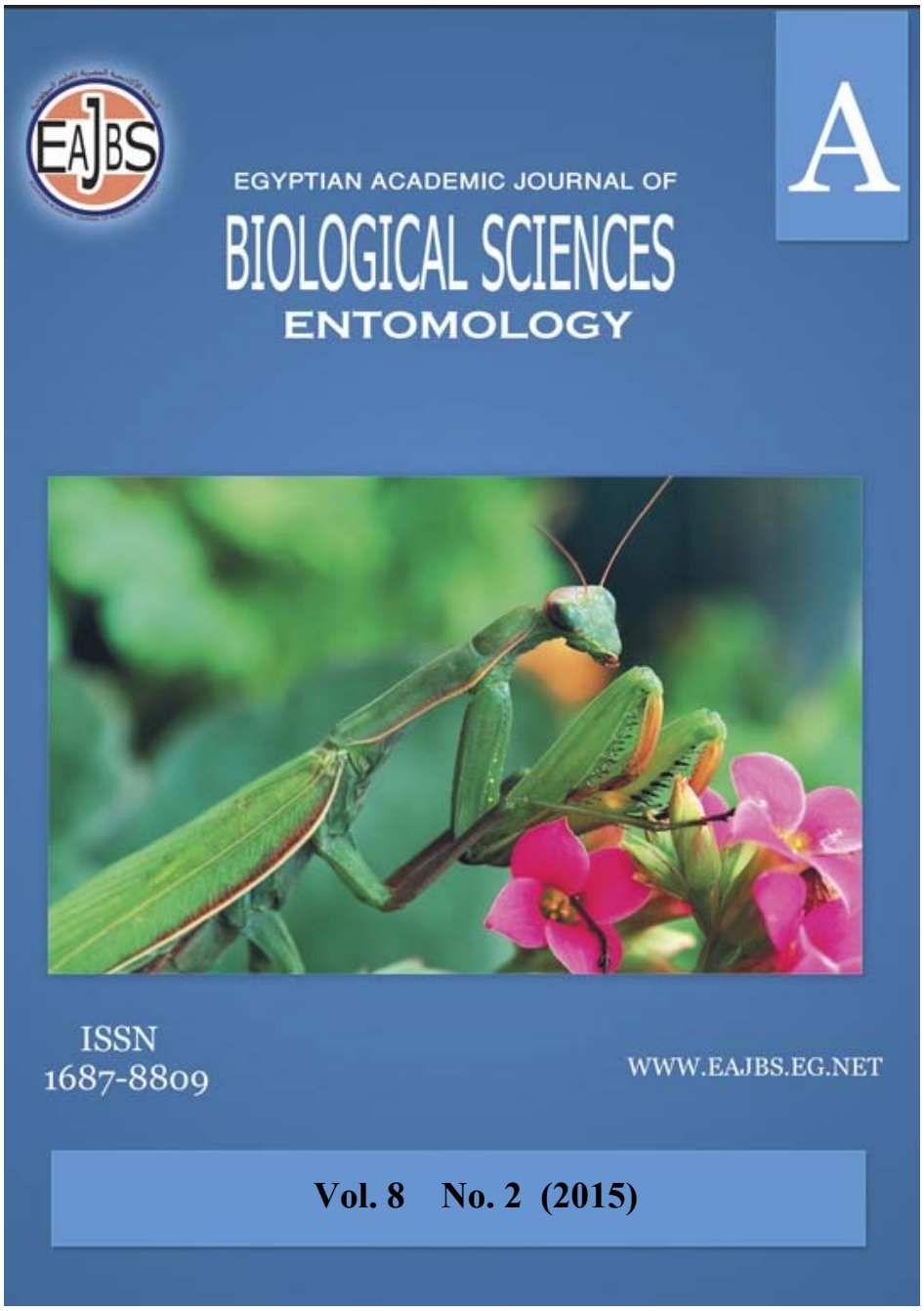

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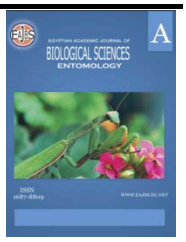

Strong Impact of Five Genetic and Non-genetic Factors Exerting Their Effects on Honey bee Queens to Increase Bee honey Production

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ABSTRACT

The study investigated the impact of using queens produced from a superior race, a young larval age, an improved diet, a large colony and young workers on weight of bee honey production.

The study has shown remarkable increases in honey production, attaining:

(1) 33.9% in citrus honey, 60.5% in clover honey as a result of using queens from the Italian race *Apis mellifera ligustica* as compared to queens from the Carniolan race *Apis mellifera carnica.*

(2) 58.1%, 61.5% and 64.7% in citrus honey and 61.8%, 177.0% and 232.2% in clover honey as a result of using queens reared from larval ages of 12 hours as compared to larval ages of 24, 36 and 48 hours, respectively.

(3) 69.2% and128.3% in citrus honey and 4.1% and126.1% in clover honey as a result of using queens from colonies fed on pollencake+5%thymolascompared to those fed on diets of pollen cake and sugar solution, respectively.

(4) 26.7% and 136.7% in citrus honey and 26.1% and 67.2% in clover honey as a result of using queens from colonies including 9 combs as compared to 6 and 3 combs, respectively.

(5) 50.0% in citrus honey and 90.8% in clover honey as a result of using queens reared by nurse workers as compared to field workers.

These results revealed wide opportunities for beekeepers to enhance their honey production whenever they rear queens from the Italian race *Apis mellifera ligustica* produced from larvae of 12 hours of age, fed on a diet involving pollen cake + 5% thymol reared in colonies containing 9combs and being relied on nurse workers

INTRODUCTION

According to recent studies (Mahbobi *et al.*, 2014; Ahmad *et al.* 2013; and Büchler *et al.* 2013) production of honey bee colony depends on a number of genetic and non-genetic factors. Thus, obtaining a significant improvement in weight of stored honey necessitates detailed investigation of as many as possible of genetic and non-genetic factors exerting effects on bee queen raising practices of beekeepers.

The present work involved five experiments aimed to evaluate the impact of race, larval age, diet, colony strength and the adult worker age on increasing the ultimate weight of stored honey.

MATERIALS AND METHODS

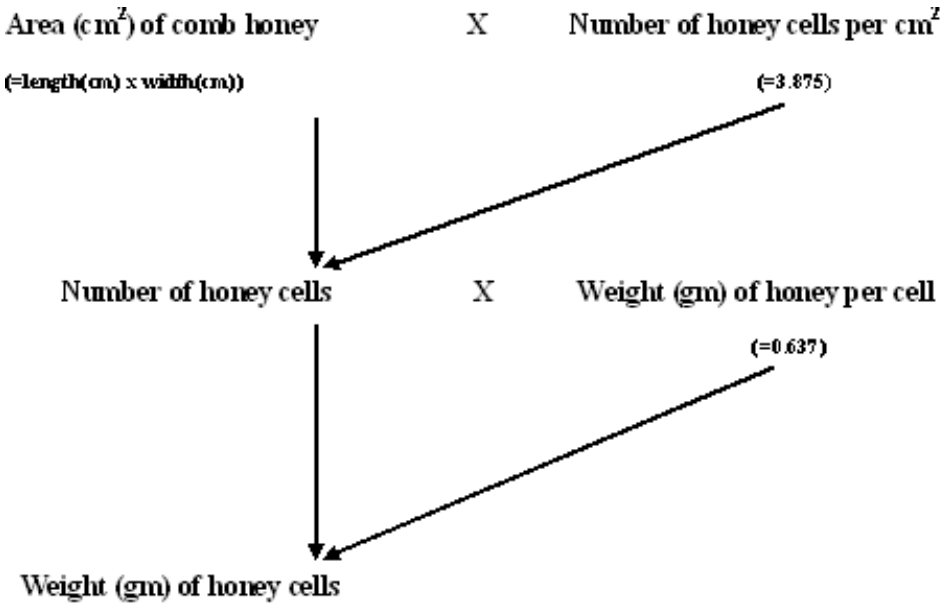
Location of the experiments

The five experiments included in the present study were conducted at the apiary belonging to the University of Ain Shams Faculty of Agriculture Experimental Station of Shalaquan at Qualubiya Governorate, where the bee colonies used were headed with open mated local carniolan queens, *Apis mellifera carnica*.

The targeted dependent variable used for all the five experiments

This variable is the weight of stored bee honey in colonies with queens considered at the end of the blooming season for two sources: citrus trees and clover plants.

The weight of the stored bee honey was calculated from the estimated area of comb honey, as follows.



The independent variable and its levels for each of the five experiments 3- Experiment (1):

The following two honey bee races were considered:

(i) the Carniolan bee, *Apis mellifera carnica* and
(ii) the Italian bee, *Apis mellifera ligustica.*

Each race contained 3 queens while each queen was put on a colony containing 5 combs of relatively equivalent strength.

Experiment (2):

The following four larval age groups were used to obtain queens by the grafting method:

(i) the12 hr old group,
(ii) the 24 hr old group,
(iii) the 36 hr old group and
(iv) the 48 hr old group.

Each larval age group contained three queens, while each queen was put on one hive with 5 combs covered with bees.

Experiment (3):

The following three diet groups were considered to obtain queens:

(i) the pollen cake plus 5% thymol group: (the pollen cake is a mix of poll engrains, sugar powder and warm water at a ratio of 3:3:1, respectively.),
(ii) the pollen cake group and
(iii) the sugar solution group.

Each diet group contained three queens, while each queen was put on a hive with 5 combs covered with bees.

Experiment (4):

The following three honey bee colony strength groups were considered to obtain queens:

(i) the nine comb group,
(ii) the six comb group and
(iii) the three comb group.

Each group contained three queens, while each queen was put on a hive.

Experiment (5):

The following two adult worker age groups were considered to rear the queens:

(i) the nurse worker group and
(ii) the field worker group.

Each group contained three queens, while each queen was put on a hive.

RESULTS AND DISCUSSION

Impact of increasing the race quality

Table (1) shows that the passage from the Carniolan race to the Italian increased ($p<0.05$) the quantity of honey by 33.9% in the case of citrus honey and by 60.5% in the case of clover honey. This could be explained by the superior number of ovarioles and brood cells known to characterize the Italian race. Zaitoun *et al.* (2009) recorded, for the entire April season, 5300 and 4500 brood cells for *Apis mellifera ligustica* and *Apis mellifera syriaca*, respectively. Al-Ghazawi and Zaitoun (2008), comparing queen honeybees of the Italian race *Apis mellifera ligustica* with the Surian race *Apis mellifera syriaca* in terms of queen rearing season, queens weight, acceptance, preoviposition period, volume of the spermatheca with the quantity and quality of sperms, showed the Italian race to be superior to the Syrian race. In their earlier work, Hauser & Lensky (1994) reported the high quality of the Italian bee race, *Apis mellifera ligustica* in terms of nectar collection and, hence, honey yields.

Table 1: Weight (gm) of stored honey in citrus and clover seasons from colonies with queens produced from two races (Means ± S.E.).

Race	Citrus honey	Clover honey
Italian	1649.9±32.43	5124.4±25.45
Carniolan	1232.4±16.35	3192.8±19.52
Significance of differences	P<0.05	P<0.05

Impact of decreasing the larval age at grafting:

Table (2) shows that the weight of stored honey increased with the step-wise decrease in the age of larvae from 48 to 36 hours then from 36 to 24 hours and from 24 to 12 hours by 2.0, 2.2 and 58.1%, respectively, in citrus honey and by 19.7, 71.4 and 61.8%, respectively, in clover honey. This could be explained by the fact that more royal jelly was fed by the younger larvae than by the older larvae, so that the queens reared from the younger larvae were heavier in weight, with larger number of ovarioles, higher quantity of produced brood and increased bee population (workers), resulting in greater amounts of collected nectar and stored honey. Mahbobi *et al.* (2014)

found that the most efficient colonies were headed by queens reared from 1 day-old larvae which were superior to queens reared from 3 day-old larvae by 18% in brood production, 40% in bee population and 54% in honey production. It is well known that newly emerged queens from the younger larvae are heavier than those emerging from older ones. Gengerr *et al.* (2000) found that the queens reared from1-day-old larvae were significantly (P<0.01) heavier than those from 2-day-old larvae.

Table 2: Weight (gm) of stored honey in citrus and clover seasons from colonies with queens produced from worker larvae grafted at four ages (Means ± S.E)*.

Larval age at grafting (hrs)	Citrus honey	Clover honey
12	2445.6^{a}±31.4	4901.1^{a}±13.0
24	1546.9^{b}±68.0	3028.1^{b}±31.2
36	1514.1^{b}±34.2	1766.2^{c}±14.2
48	1484.9^{b}±37.8	1475.2^{d}±70.6

*:means with the same superscript in the same column were not significantly different (p<0.05)

Impact of empowering diets

Table (3) shows that the step-wise passage from colonies with queens produced from colonies fed sugar solution to pollen cake then to pollen cake + 5% thymol resulted in increase (p<0.05) in quantity of honey by, respectively, 34.9% and 69.2% in citrus honey and by, respectively, 17.2% and 4.1%, in clover honey.

Table 3: Weight (gm) of stored honey in citrus and clover seasons from colonies with queens produced from colonies fed three diets (Means ± S.E)*.

Diet	Citrus honey	Clover honey
pollencake+0.5%thymol	3678.3^{a}±15.24	6406.8^{a}±55.77
Pollen cake	2173.9^{b}±101.79	6153.0^{b}±13.78
sugar solution	1611.1^{c}±15.39	2833.5^{c}±22.69

*:means with the same superscript in the same column were not significantly different (p<0.05)

Previous literature indicated that intensified protein sources would improve characteristics of the emerged queens. Mahbobi *et al.* (2014) found that the supplemental feeding of rearing colonies increased brood production by 11%, bee population by 16% and honey production by 15%. Tharwat *et al.* (2002) reported that feeding on orange juice, carrot juice and propolis combined with sugar syrup resulted in higher body weight, longer and broader fore wings and heavier ovaries of emerged queens as compared to those fed sugar alone. Sena *et al.* (2012) indicated that feeding supplemental pollen to honey bee colonies improved their performance. Estegamat and Gholami (2010) highlighted the increased rate of acceptance of new queens as a result of supplementation of syrup, nectar or pollen. Gengerr *et al.* (2000) found that supplemental feeding of rearing colonies significantly improved the acceptance rate of grafted larvae and the length and volume of queen cells.

Impact of using higher colony strength

Table (4), shows that raising the colony strength from 3 to 6 combs and then from 6 to 9 combs resulted in weight increase of honey of, respectively, 86.5% and 26% in citrus honey and of, respectively, 32.6% and 26.0% in clover honey. This could be explained by the fact that as the number of workers raises the quantity of royal jelly secreted from glands in their heads to feed the larval queens increases. Thus, the queens produced from colonies with large number of bees are heavier than those

produced from colonies with fewer workers. Durmus and Guler (1999) and Rana *et al.* (1996) highlighted the positive role played by the colony strength in royal jelly production. Büchler *et al.* (2013) emphasized the dependence of success and quality of queen production on strong, well fed and healthy nurse colonies.

Table 4: Weight (gm) of stored honey in citrus and clover seasons from colonies with queens produced from colonies of three strengths (Means ± S.E.)*

Colony strength of	Citrus honey	Clover honey
9 combs	2882.3^{a}±21.46	3700.3^{a}±45.64
6 combs	2271.0^{b}±22.25	2935.5^{b}±32.30
3 combs	1217.6^{c}±9.68	2212.9^{c}±20.10

*:means with the same superscript in the same column were not significantly different ($p<0.05$)

Impact of decreasing the adult worker age

Table (5), shows that the weight of honey increased ($p<0.05$) while passing from colonies with queens reared through field workers to colonies with queens reared through nurse workers by 50% in citrus honey and 90.8% in clover honey. It is well known that the glands of royal jelly in 6-12 day old workers are more active in secretion as compared with the older workers, so that the queens reared by nurse workers are heavier in weight and greater in number of ovarioles as compared with queens produced from colonies with field workers.

Table 5: Weight (gm) of stored honey in citrus and clover season from colonies with queens reared by workers of two ages (Means ± S.E.)

Worker age category	Citrus honey	Clover honey
Nurse worker	1077.3±37.04	2833.9 ±22.19
field worker	718.1 ±24.18	1484.9 ±23.68
Significance of differences	P<0.01	P<0.01

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ARABIC SUMMERY

المردود القوى لخمس عوامل وراثية وغير وراثية وتأثيرها على ملكات نحل العسل لزيادة انتاج عسل النحل

سوسن محمد عبد المجيد
قسم وقاية النبات كلية الزراعة جامعة عين شمس القاهرة مصر

تهدف الدراسة الى تأثيراستخدام ملكات ناتجة من سلالة جيدة ويرقات عمر صغير وأفضل نظام غذائي وطائفة قوية وشغالات حاضنة على وزن عسل النحل الناتج .
وقد أظهرت الدراسة زيادة ملحوظة في إنتاج العسل، حيث:

(1) بلغت 33.9 ٪ في عسل الموالح، 60.5 ٪ في عسل البرسيم نتيجة لاستخدام ملكات من السلالة الإيطالي بالمقارنة مع الملكات من السلالة الكرنيولى.

(2) بلغت 58.1 ،٪ 61.5 ٪ و 64.7 ٪ في عسل الموالح و 61.8 ٪ و 177.0 ٪ و 232.2 ٪ في عسل البرسيم نتيجة لاستخدام الملكات المرباة من الأعمار اليرقية من 12 ساعة بالمقارنة مع الأعمارالبرقية من 24 و 36 و 48 ساعات، على التوالي.

(3) بلغت 69.2 ٪ و 128.3 ٪ في عسل الموالح و 4.1 ٪ و 126.1 ٪ في عسل البرسيم نتيجة لاستخدام الملكات من الطوائف المغذاة على عجينة حبوب اللقاح 5 + ٪ الثيمول بالمقارنة مع تلك التي تتغذى على عجينة حبوب اللقاح ومحلول السكر،على التوالي.

(4) بلغت 26.7 ٪ و 136.7 ٪ في عسل الموالح و 26.1 ٪ و 67.2 ٪ في عسل البرسيم نتيجة استخدام ملكات ناتجة من طوائف تحتوي على 9 أقراص بالمقارنة مع 6 و 3 أقراص، على التوالي.

(5) بلغت 50.0 ٪ في عسل الموالح و 90.8 ٪ في عسل البرسيم نتيجة لاستخدام الملكات تم تربيتها من قبل شغالات حاضنة بالمقارنة مع شغالات الحقل.

هذه النتائج كشفت عن فرص واسعة لمربي النحل لتعزيز إنتاج العسل عندما تربى الملكات من السلالة الإيطالي *Apis mellifera ligustica* والمنتجة من يرقات عمر 12 ساعة، تغذت على نظام غذائي من عجينة حبوب اللقاح 5 + ٪ الثي مولوتمتر بيتها في طوائف تحتوي على 9 أقراص ويتم الاعتماد على الشغالات الحاضنة فى تربية الملكات.