Journal of Global Biosciences
ISSN 2320-1355
Volume 5, Number 4, 2016, pp. 3935-3938
Website: www.mutagens.co.in
E-mail: submit@mutagens.co.in
researchsubmission@hotmail.com

Research Paper

COMPARISON OF TOTAL LIPIDS IN THE WORKER, DRONE AND QUEEN BROOD FOOD OF *Apis mellifera* DURING SPRING

Ruchika Mandla and Neelima R. Kumar

Department of Zoology,
Panjab University, Chandigarh- 160014.

Abstract

The honey bee exhibits a combination of individual traits and social cooperation which is unparalleled in the animal kingdom. At the individual level, honey bees have not one but three types of colony members: queen, drones and workers with their own specialisations and place in honey bee society. For each caste the nutritional requirements are different. For the first three days after hatching, however, all the larvae are fed on royal jelly which comes from the salivary glands of worker honey bees. The grubs in queen cells continue to be fed on royal jelly for the rest of their lives while a mixture of dilute nectar and bee bread is given to those in drone and worker cells. During the present studies it was observed that at different stages of development of queen, worker and drone larvae, the weight of the larval food increased but amount of lipid first increased then decreased in drone and queen larval food while in case of worker, it continued to increase.

Key words: total lipids, royal jelly, brood cells, larval food, queen, worker, drone.

INTRODUCTION

The honey bee colony has three types of colony members: queen, drones, workers each with their own specialization and place in honey bee society. Mechanisms behind caste determination allow tests of several models for the rise and development of social life [1][2]**.** Honey bees collect pollen from a wide range of flowering plants, which usually fulfils their dietary requirements for carbohydrates, proteins, lipids, minerals, and vitamins. Honey bees depend on the collection and storage of honey and pollen as primary and rich sources of proteins, amino acids, lipids, minerals and vitamins. Pollen is also an important dietary component for young bees and, of course, developing and growing larvae [3]. A nutritional deficit may shorten life span, reduce brood production, inhibit gland development, enhance emergence of diseases and reduce honey bee weight [4][5].

Pollen is an essential source of lipids for honey bees, used for energy and as a structural component of cell membranes. Most insects require essential polyunsaturated fatty acids (PUFA) in their diet, and linoleic and linolenic acids usually satisfy this nutritional need [6][7][8].

In social Hymenoptera division of labour between morphologically distinct queens and workers involves differences in nutrition during larval development [9] [10]. On the basis of findings and a review of other evidences from ants, wasps and bees, it has been proposed that differences in the nutritional status of workers could be involved in the regulation of division of labour [11].Female honey bees (*Apis mellifera)* are fated to become queens or workers during the first

few days of larval development. For the first three days after hatching, all the larvae are fed on a protein-rich, milky secretion, called royal jelly, which comes from the salivary glands of workers of a certain age. Female bees differentiate into workers or queens (caste differentiation) in response to diet very early in larval development The grubs in queen cells continue to be fed on royal jelly for the rest of their lives, but those in drone or worker cells are given a mixture of dilute nectar and pollen.

The astounding differences in the metabolic requirements of different castes suggest that there might be significant differences in the brood food fed to the developing larvae in the colony. Therefore, investigations were planned to analyse the total lipids in brood food of different castes of *Apis mellifera* during spring season and to study the change in lipids concentration in the brood food during larval development of the different castes of *Apis mellifera*.

MATERIAL AND METHOD

Brood food was collected from worker , queen and drone brood cells at three different stages of development *viz*.24-48 hrs , just before capping (5-6 day stage) and after capping (7-8 day stage) during the spring season. Larval food was scooped with a spatula and transferred to 1 N saline solution. This was stored at- 20 ^{0}C till further use.

The quantitative estimation of Total Lipids in the brood food samples of *A. mellifera* was carried out [12].

RESULTS AND DISCUSSION

The present study revealed that the weight of larval food in early (first 3 days) worker cells was 67.60mg and it contained 0.733±0.033 mg/cell of lipids. Larval food in worker larval cells just before capping (5-6 day) increased to 91.59 mg and it had 1.600±0.100 mg/cell of lipids. In worker larval cells after capping the larval food weight was 96.21 mg while lipid content was 1.700±0.173 mg/cell as shown in Table 1.

Table 1: Comparison of lipid content in brood food of different castes in *Apis mellifera.*

Sr. no	Worker			Drone			Queen		
	Early larval cells	Larval cells just before capping	Larval cells after capping	Early larval cells	Larval cells just before capping	Larval cells after capping	Early larval cells	Larval cells just before capping	Larval cells after capping .
Amount of Brood food mg/cell	67.60	91.59	96.21	42.50	54.17	79.18	48.20	103.56	180.95
Amount of Lipids mg/cell	0.733 ±0.033	1.600 ±0.100	1.700 ±0.173	0.333 ±0.058	0.5333 ±0.0289	0.4500 ±0.1323	0.3500 ±0.0500	0.8833 ±0.0577	0.5167 ±0.0333
Percentage concentration of Lipids	1.084	1.746	1.766	0.783	0.984	0.568	0.726	0.852	0.285

Weight of larval food in early (first 3 days) drone cells was 42.50 mg and the drone food contained 0.333±0.058 mg/cell of lipids. Larval food weight in drone cells just before capping (5-6 day) was 54.17 mg in which 0.5333±0.0289 mg/cell was the quantity of lipids. After capping (7 – 8 day) weight of drone larval food was 79.18 mg and it contained 0.4500±0.1323 mg/cell of lipids. There was initially an increase in concentration of lipids along with increase in weight of drone larval food, but post capping the concentration of lipids declined.

Queen larval food in early (first 3 days) queen cells was 48.20 mg and it contained 0.3500±0.0500 mg/cell of lipids. Weight of queen larval food was 103.56 mg just before capping stage (5-6 day) in which 0.8833±0.0577 mg/cell of lipids was found whereas weight of queen larval food after capping (7 – 8 day) was 180.95 mg in which 0.5167±0.0333 mg/cell of lipid was found. There was increase in amount of queen larval food but lipid content increased first and decreased after capping.

On comparing the quantity of lipids at different stages in drone, worker and queen it was found that total lipids in worker brood food were high during all stages of development as compared to drone and queen brood food (Table 1).

According to Hartfelder and Engels [9] there were physiological differences between workers and queens during development .Differences were there because for the first three days after hatching, all the larvae were fed on a protein-rich, milky secretion, called royal jelly, after that queen larvae alone were continued to be fed on royal jelly for the rest of their lives which explain why decreased lipid content was observed in later stages as observed in the post study.

Royal jelly is mainly secreted by the hypopharyngeal and a mandibular gland of worker honey bees (*Apis mellifera*) between the sixth and twelfth days of their life [13] and is an essential food for the development of the queen honey bee. Royal jelly is a complex substance containing a unique combination of proteins (12-15%), sugars (10-12%), lipids (3-7%), amino acids, vitamins, and minerals [14].

Drone or worker larvae are given a mixture of dilute nectar and pollen called bee bread. Bee bread is a fermented mixture of bee saliva, plant pollen, and nectar. Bee bread is about 20% proteins, 24-34% carbohydrates and 1.5 % of lipids.

The food of older drone larvae was reported to be of dirty-yellow-brown colour. Numerous pollen grains were present in it [15] .The change in colour is probably a consequence of change in composition as also observed in the present study. In the case of queen and worker larvae, it consisted of a mixture of water-clear and milky-white components [16]. There were relatively little variations in the composition of royal jelly fed to younger and older queen larvae [17]. However, changes in lipid content of young and older larvae were observed during present study. Melampy and Jones (1939) reported that royal jelly of 3 and 4 days old queen larvae contained 12.34 % protein, 5.46% fat and 12.49 % sugar [18]. Planta [19] and Elser [20] reported that the fat content in queen and drone brood food decreased along with increased in the age of larva. An initial increase followed by decrease in total lipids in the post capping stage was observed during present investigations. The studies clearly indicate that the quality and quantity of brood food fed to different castes varies and further, there is difference in the food fed to a particular caste during different stages.

ACKNOWLEDGEMENT

The authors would like to thank DST –INSPIRE and DST-FIST grant No. SR/FST/LSI-545/2012(C) for assistance at various stages of this research work.

REFERENCES

[1] Gadagkar, R. (1997).The evolution of caste polymorphism in social insects: genetic release followed by diversifying evolution. *J Genet*, **76,** pp-**167**-179.

[2] Evans, J., Wheeler, D. (1999). Differential gene expression between developing queens and workers in the honeybee, *Apis mellifera.Proc Natl Acad Sci USA*,**96,**pp- 5575-5580.

[3] Southwick, E.E. (1990).Pollen. *Am Bee J*, **130**, pp-664-66.

[4] Alaux, C.,Ducloz, F., Crauser, D., Le Conte, Y. (2010). Diet effects on honey bee immunocompetence. *Biology Letters***, 6**,pp- 562-565.

[5] Schmidt, J.O., Thoenes, S.C., Levin, M.D. (1987). Survival of honey bees, *Apis mellifera* (Hymenoptera, Apidae), fed various pollen sources. *Ann. Entomol.Soc.Am,* **80,** pp-176-183.
[6] Canavoso, L.E., Jouni, Z.E., Karnas, K.J., Pennington, J.E., Wells, M.A. (2001). Fat metabolism in insects. *Annual Review of Nutrition*, **21**, pp- 23-46.
[7] Khani, A., Moharramipour, S., Barzegar, M., Naderi-Manesh, H. (2007). Comparison of fatty acid composition in total lipid of diapause and non-diapause larvae of *Cydia pomonella* (Lepidoptera : Tortricidae). *Insect Sciece*. **14**, pp-125-131.
[8] Wang, Y.M., Lin, D.S., Bolewicz, L., Connor, W.E.(2006). The predominance of polyunsaturated fatty acids in the butterfly *Morpho peleides* before and after metamorphosis. *Journal of Lipid Research* **,47**,pp- 530-536.
[9] Hartfelder, K., Engels.W. (1998).Social insect polymorphism: hormonal regulation of plasticity in development and reproduction in the honey bee.*Curr Top Dev Biol*,**40**,pp-45-77.
[10] Wheeler, D. E. (1986) Developmental and physiological determinants of caste in social Hymenoptera: evolutionary implications. *American Naturalist*, **128**, pp-13–43.
[11] Blanchard, G. B., Orledge, G. M., Reynolds, S. E.and Franks, N. R. (2000) Division of labour and seasonality in the ant *Leptothorax albipennis*: worker corpulence and its influence on behaviour. *Animal Behaviour*, **59**, pp-723–738.
[12] Fringes, C.S., Dunn, R.T.(1970). A colorimetric method for determination of total serum lipids based on the sulpho phosphor- vanillin reaction. *Am.J.Clin.Pathol*, **53,** pp-89-91.
[13] Patel, N.G., Haydak, M.H, Gochnauer, T.A. (1960). Electrophoretic components of the proteins in honeybee larval food. *Nature*, **186**, pp**-**633-634.
[14] Takenaka, T. (1982). Chemical composition of royal jelly. *Honeybee Sci*, **3,**pp- 69-74.
[15] Haydak., M. H. (1957).The food of drone larvae. *Ann. Entomol. Soc. Am*., **50**, pp- 73-75.
[16] Jung-Hoffmann., I. (1966). Die Determination von Konigin und Arbeiterin der Honingbiene. Z. *Bienenforsch.,* **8**, pp- 296-322.
[17] Shuel, R. W., Dixon, S. E. (1959). Studies in the mode of action of royal jelly in honey bee development. II. Respiration of newly emerged larvae on various substrates. *Can. J. Zool*., **37**, pp-803-13.
[18] Melampy, R.M., Jones, D.B.(1939). Chemical composition and vitamin contents of Royal Jelly. *Proc.Soc.exp.Biol.,*N.Y., **41**, pp-382- 388
[19]. Planta, A. V. (1888). Uber den Futtersaft der Bienen Hoppe-Seyl*. Z.Physiol. Chemie* **12,** pp-327-354, 13,552-561.
[20] Elser,E.(1929). Die chemische Zusammensetzung der Nahungstoffe der Biene.*Markische Bienen Ztg*,**19,**pp-210-215,232-235, 248-252.