



Research Paper

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

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Abstract

The honey bee is an invaluable partner in agriculture both for its production of honey and for its role in pollination. The honey bee colony comprises three castes: the queen (fertile female), workers (sterile females), and drones (fertile males). Each caste is different in its nutritional requirements. For the first three days after hatching, however, all the larvae are fed on a protein rich, milky secretion called royal jelly which comes from the salivary glands of worker bees of a certain age. 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 carbohydrates first increased then decreased in drone and worker larval food while in case of queen, it continued to decrease.

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

INTRODUCTION

The honey bee exhibits a combination of individual traits and social cooperation which is unparalleled in the animal kingdom. The multiple levels at which the honey bee expresses adaptations to its world provide one of the richest sources for study and knowledge among all organisms, made even more enriching by economic benefits the honey bee provides. Almost city like in the diversity of its function, the colony consists of several thousand bees that cooperate in nest building, food collection and brood rearing.

A hive's inhabitants are generally divided into three types of castes: the queen (fertile female), workers (sterile females), and drones (fertile males). Each caste has different nutritional requirements. On the basis of their findings and a review of other evidences from ants, wasps and bees, proposed that differences in the nutritional status of workers could be involved in the regulation of division of labour.[1]

Honey bees rely on pollen and honey for food. Nectar is the main source of energy for bees, while pollen provides proteins, lipids, vitamins and minerals for brood rearing and development.

Carbohydrates form a large part of the diet of the colony and are required by both the larva and adult for normal growth and development. Carbohydrates in the bee's diet are used mainly to generate energy for muscular activity, body heat, and vital functions of certain organs and glands, such as wax production. Nectar and honey are the chief sources of carbohydrates in the honey bee's natural diet. Adult bees can live on the carbohydrates glucose, fructose, sucrose, trehalose and maltose.

In social Hymenoptera division of labour between morphologically distinct queens and workers involves differences in nutrition during larval development [4] [16]. 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 striking 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 carbohydrates in brood food of different castes of *Apis mellifera* during spring season and to study the change in carbohydrate 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 °C till further use. The quantitative estimation of Total carbohydrates 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 67.68 mg and it contained 4.601 ± 0.495 mg/cell of carbohydrates. Larval food in worker larval cells just before capping (5-6th day) increased to 91.56 mg and it had 27.841 ± 2.352 mg/cell of carbohydrates. In worker larval cells after capping the larval food weight was 96.06 mg while carbohydrate content was 24.775 ± 3.849 mg/cell as shown in Table 1.

Weight of larval food in early (first 3 days) drone cells was 42.06 mg and the drone food contained 15.790 ± 1.526 mg/cell of carbohydrates. Larval food weight in drone cells just before capping (5-6th day) was 54.72 mg in which 26.756 ± 1.593 mg/cell was the quantity of carbohydrates. After capping (7th – 8th day) weight of drone larval food was 79.8 mg and it contained 29.123 ± 0.370 mg/cell of carbohydrates. There was initially an increase in concentration of carbohydrates along with increase in weight of drone larval food, but post capping the concentration of carbohydrates declined.

Queen larval food in early (first 3 days) queen cells was 48.2 mg and it contained 25.666 ± 0.832 mg/cell of carbohydrates. Weight of queen larval food was 103.81 mg just before capping stage (5-6th day) in which 31.070 ± 0.420 mg/cell of carbohydrates was found whereas weight of queen larval food after capping (7th – 8th day) was 180.82 mg in which 28.371 ± 0.863 mg/cell of carbohydrate was found. There was increase in amount of queen larval food but carbohydrate content continuously decreased.

Table 1: Carbohydrate concentration in brood food samples

Sr. No.	Comparison of carbohydrate content in brood food of different castes in <i>Apis mellifera</i> .								
	Worker			Drone			Queen		
	Samples collected from early larval cells	Samples collected from larval cells just before capping	Samples collected from larval cells after capping	Samples collected from early larval cells	Samples collected from larval cells just before capping	Samples collected from larval cells after capping	Samples collected from early larval cells	Samples collected from larval cells just before capping	Samples collected from larval cells after capping.
Amount of Brood food mg/cell	67.68	91.56	96.06	42.06	54.72	79.8	48.2	103.81	180.82
Amount of carbohydrate mg/cell	4.601 ±0.49 5	27.841 ±2.352	24.775 ±3.849	15.790 ±1.526	26.756 ±1.593	29.123 ±0.370	25.666 ±0.832	31.070 ±0.420	28.371 ±0.863
Percentage concentration of carbohydrate	6.796	30.406	25.791	37.541	48.896	36.494	53.248	29.929	15.690

It is generally agreed that sugars are the most important energy sources for honeybees [6] [8] [9]. On comparing the quantity of carbohydrates at different stages in drone, worker and queen it was found that total carbohydrates in drone brood food were high during all stages of development as compared to worker and queen brood food (Table 1). Quantity of brood food was, however highest in the queen cells. This is to be expected in view of the larger size of the queen cells and the size of the queen itself. More sugars are needed for drone brood rearing than for worker brood rearing by nurse bees [7].

Differences were there because for the first three days after hatching, all the larvae are fed on a protein-rich, milky secretion, called royal jelly, after that queen larvae alone continue to be fed on royal jelly for the rest of their lives. Queen-destined larvae receive abundant fresh royal jelly and grow at least 1500-1700 times the weight of the egg which ranges from 250-346 mg [5] [11] [14] [15].

Royal jelly is mainly secreted by the hypopharyngeal and mandibular gland of worker honey bees (*Apis mellifera*) between the sixth and twelfth days of their life [10] 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 [13].

Drone or worker larvae are given a mixture of dilute nectar and pollen. 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. Further, drones are reared in larger cells than those used for rearing worker brood [3] [2]. Hence there is difference in amount and type of diet which larvae received at different times of larva life.

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