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EFFECTS OF FEEDING BY POLLEN SUBSTITUTES ON SUDANESE HONEYBEE COLONIES ACTIVITIES

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ABSTRACT

Purpose: The research aimed to study some feeding ingredients to determine the economic value and when feeding is needed.

Design/Methodology/Approach: The 20 Sudanese honeybee colonies were divided into five groups using different types of pollen substitutes compared with control and prepared as follow: Diet (A) soya bean flour, brewers' yeast and honey. Diet (B) dates palm, sugar and water. Diet (C) dates palm, brewer's yeast, sugar and water. Diet (D) brewer's yeast, sugar and water. Diet (E) without feeding.

Findings: The study showed that all honeybee colonies consumed the different diets in varying rates. Diet (A) super passed the other tested diets in all the colony activities due to high content of protein plus honey, the tested diets rated according to their value in promoting honeybee colony activities as diet (A), (C), (B), (D) and (E), respectively.

Originality/Value: Feeding with pollen substitute induction positive correlated with scarcity of natural food sources.

Keywords: honeybee; pollen substitute; pollen grains; dates palm; bee brood; Sudan.

INTRODUCTION

Honeybees, like any other animals, have their own unique nutritional requirements. These include proteins, carbohydrates, fats, vitamins and minerals. Honeybees feed naturally on pollen and nectar which were collect from flowers. Pollen is the principal source of protein in the honeybee diet and supplies the colony's total protein needs which are essential for body growth, tissue repair and normal body functions (Auclair and Jamieson, 1948). Total protein in the honeybee diet should range between 23 and 30%, the protein content of pollen ranges from 7 to 30% depending on the floral source and the amino acids constituting the protein are also very variable. Nectar is the main energy source and also provides bees with most of their water requirements. Honeybees convert nectar into honey which they store in combs. In many localities there is scarcity of pollen in nature. Such scarcity results in a reduction in brood rearing. Thus colonies of bees will be considerably weakened and consequently the honey crop is poor and pollination of crops by bees is less efficient. The need for supplementary feeding of honeybee colonies during periods of pollen dearth has long been recognised by beekeepers and scientists. Such interest needs to be packed up with a sound knowledge of the various aspects necessary for a developed bee industry. Important among these is the art of artificial feeding for the proper maintenance of honey bee colonies. Sudan occupies a land area of about million square miles with great diversity in climate and vegetation ranging from the almost rainless sandy deserts in the north to the tropical forests in the south with annual rainfall that exceeds 1500 mm showing great variability in its potentialities for beekeeping and in the occurrence of seasonal scarcity of natural forage for bees when artificial feeding becomes necessary. Thus this study was undertaken with the objective of finding answers to such questions as what to feed and when feeding is most needed.

LITERATURE REVIEW

Pollen

Rose et al. (2007), no effects on the weight and survival of honey bees feeding on Cry1Ab-expressing sweet corn pollen compared with colonies foraging in sweet corn plots and fed Bt pollen cakes. It was showed no adverse effects on bee weight, foraging activity and colony performance. Brood development was not affected by exposure to Bt pollen but significantly reduced by the positive insecticide control. The number of foragers returning with pollen loads, pollen load weight, and forager weight were the most consistent end points as indicators of foraging activity. Discussed are methods to ensure exposure to pollen, duration of exposure, positive controls, and appropriate end points to consider in planning laboratory and field studies to evaluate the non-target effects of transgenic pollen. Stroikov (1963), Bee bread (pollen stored in the comb) results from the action of yeasts in producing lactic acid, although bee bread has greater food value than fresh pollen. Pain (1963) positive correlation between amounts of pollen stored and of brood reared when colonies were well supplied with food stores; they reached maximum brood rearing before the major nectar flow. Pernal and Currie (2000) newly-emerged honey bees were fed sucrose syrup and one of the following single-pollen diets: *Malus domestica* Borkh., *Brassica campestris* L., *Phacelia tanacetifolia* L., *Melilotus officinalis* (L.) Pall., *Helianthus annuus* L., *Pinus banksiana* (Lamb.), artificial supplement (Bee-Pro®) or nothing. The development of hypo pharyngeal glands and ovaries varied with diet and, collectively, proved to be sensitive measures of protein utilisation and pollen quality. For workers fed one-year-old *Phacelia* pollen, protein was utilised in a differential fashion, promoting the development of ovaries over that of hypo pharyngeal glands. Development of glands and ovaries was strongly correlated with the amount of protein workers consumed from pollen diets, and to a lesser extent, the crude protein content of diets. Storing pollen for one year by freezing did not affect gland or ovary development.

Nectar

Nectar originates from the phloem sap of higher plants. It is essentially a solution of a number of sugars together with traces of nitrogen compounds, minerals, organic acids, vitamins, pigments and aromatic substances. The total sugar content varies considerably from 5 to 80% and there are great differences in the sugars present and in their proportions (Maurizio, 1979). Margarita et al. (2008) nectar-foraging behaviour of two euglossine species (*Euglossa cordata* and *Eulaema nigrita*) in urban areas and the predictive power of wing wear (flight capacities), using mark-recapture techniques at *Thevetia peruviana* trees. A total of 870 bees were marked. Recapture rates were 33% (±19.2) for *E. cordata* and 25% (±2.5) for *E. nigrita*. More than 75% of the individuals showed site-constancy at trees for at least 30 days. Wing wear accumulation rate was a poor predictor of age for *E. cordata*. Euglossine bees may have small foraging ranges in urban areas, indicating that home ranges greatly differ from their flight capacity and homing ability.

Scarcity of natural food sources

Johansson and Johansson (1977) effects of pollen deficiency on honeybee colony resulted in less brood, the drones are usually quickly eliminated from the hive, and queen production decreased and will be superseded and the protein content in the bodies of bees was fund to diminish during autumn feeding when bee bread was not available. Cavojsky (1987) most apiary sites in Slovakia there was a lack of pollen especially in early spring (March–April), and result in insufficient colony growth for utilising the early honey flow, as flowers supply bees with nectar and pollen, seasonal shortages of nectar are also encountered. Gavina et al. (2014) locations of domesticated eusocial bees, through the following mutually exclusive scenarios:

1. limited nectar and pollen sources within the vicinity of the apiary that cause competition among foragers and
2. fewer pollinators compared to the number of inflorescence that may lead to suboptimal pollination of crops.

Quantitative models (specifically using linear programming) for addressing the two given scenarios involving the following factors:

1. fuzzy preference of the beekeeper
2. number of available colonies
3. unknown-but-bounded strength of colonies
4. probabilistic carrying capacity of the plant clusters and
5. spatial orientation of the apiary.

MATERIALS AND METHODS

A total of 20 honeybee colonies in Langstroth hives were kept in Khartoum State Alkadaro locality during the period July/2005–August/2006. Each colony started with (4C/B). They were divided into five groups using different types of pollen substitutes compared with control.

Description of diets

Diet (A): Soya bean flour (0.50 kg) + Brewer's yeast (100 gm) + Honey (450 gm).

Method of preparation:

1. Soya bean was ground to fine powder using a mill (Culatti, type DFH).
2. The brewer's yeast was put into on oven at 80°C to kill the bacteria and was then ground by an electric blender (Moulinex, type 241) to give a fine powder.
3. The soya bean and brewer's yeast were weighed using a Mettier balance and added to the honey and mixed thoroughly.

Diet (B): Date palm (cv. Barakawi) 0.5 malwa (about 630 gm) + Water (0.5 L for soaking and 0.5 L at mixing) + Cane sugar (450 gm).

Method of preparation:

1. Dates were soaked in water for 2 hr.
2. The seeds (about 17.6% of the fruit weight) were removed.
3. The mixture was transferred into a blender (Moulinex, type 241) where an additional amount of water and cane sugar were added and the contents were mixed thoroughly.

Diet (C): Date palm (cv. Barakawi) 0.5 malwa (about 630 gm) + Water 1 L (0.5 L for soaking and 0.5 L at mixing) + Brewer's yeast (100 gm) + Cane sugar (450 gm).

Method of preparation: The same method of preparation of diet (B) in additional the brewer's yeast was treated as described before.

Diet (D): Cane sugar (2 kg) + Brewer's yeast (100 gm) + Water 1 L (in winter) – 2 L (in summer).

Method of preparation:

1. The brewer's yeast was treated as described before.
2. The brewer's yeast was added to the water which was boiled in a flask and sugar was added after the flask was removed from the heat source and attired using a glass rod to get syrup which was then left to cool at room temperature.
3. The concentration of the syrup differed according to season. For winter feeding, one part of sugar was added to one part of water. For summer feeding the amount of water was doubled (Hassanein, 1953).

Each colony was offered the amount described above every 12 days. Stronger colonies were given more food. Chemical analysis of these materials (Barakawi and Brewer's yeast) was carried out in Chemical laboratory at University of Khartoum Faculty of Agriculture.

Data collection

The colonies were regularly inspected at 12 day intervals where the amounts of brood reared (workers and drones), colony strength, pollen stored and surplus honey produced were estimated and recorded. The following parameters were considered and the methods of estimation and calculation are described below:

1. *Brood rearing*: the technique of Jeffree (1958) was adapted to measure brood area separately and results were expressed in (sq.in).
2. *Colony strength (population)*: strength of colonies was estimated in terms of combs covered with bees (C/B) from both sides.

3. *Pollen grain collection*: the amounts of pollen grains stored in the cells were estimated according to Jeffree (1958) and results were expressed in (sq.in).
4. *Honey yield (production)*: the surplus honey was estimated in b/colony.

The data was analysed using the analysis of variance.

RESULTS

Chemical analysis

The results of the chemical analysis of food were showed that, soya bean seeds contain 39–42% protein, 25% carbohydrate, 18–22% oil and 4.8% minerals Anon (1982). Barakawi dates contain 2.01% crude protein, 46.50% carbohydrate, 3.00% ash, 0.16% fat, 3.16% crude fibre, 13.00% moisture, 1.064% vitamin and minerals (Mg = 88.00 mg/100 g, P = 96.10 mg/100 g, K = 32.50 mg/100 g, Ca = 88.00 mg/100 g). Yeast contain 40.00% protein, 25.00% carbohydrate, 7.00% ash, 2.50% fat, 5.00% moisture, trace of vitamin and trace of oil extract.

Biological study

All experimental colonies have shown a seasonal pattern in their activities, the highest diets consumption was during summer months and the beginning of autumn while the lowest diets consumption was during nectar flow period winter months. Comparison revealed differences in the results as shown in the following:

Population density: the overall means of population densities were 9.55 ± 00.94, 8.41 ± 00.76, 6.91 ± 00.49, 6.65 ± 00.48 and 5.57 ± 00.37(C/B), for treatments (A), (C), (B), (D) and (E), respectively, (Figure 1).

Worker brood: the overall means of worker brood produced were 1056.48 ± 125.70, 912.65 ± 87.82, 696.12 ± 77.14, 642.90 ± 69.30 and 478.00 ± 53.37(sq.in.) for treatments (A), (C), (B), (D) and (E), respectively, (Figure 2).

Drone brood: the overall means of drone brood produced were 215.92 ± 75.39, 162.27 ± 60.66, 83.55 ± 08.21, 62.69 ± 15.46 and 52.48 ± 11.62 (sq.in) for treatments (A), (C), (E), (D) and (B), respectively, (Figure 3).

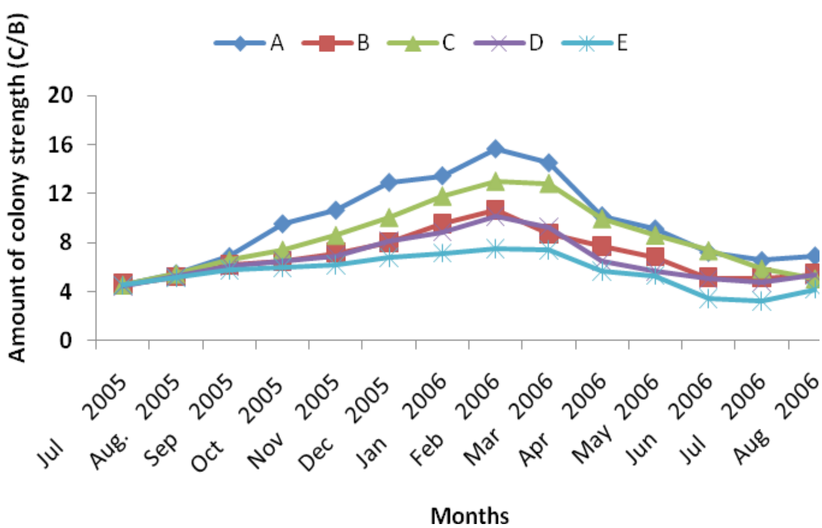

Figure 1 Monthly amount of population densities of honeybee colonies fed the tested diets

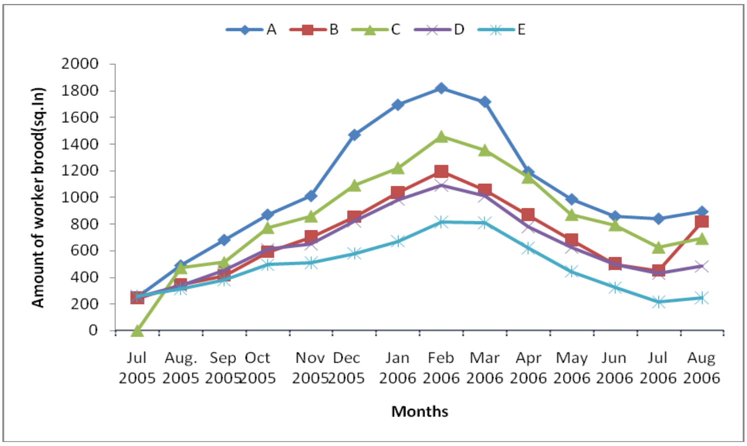

Figure 2 **Monthly amount of worker brood production of honeybee colonies fed the tested diets**

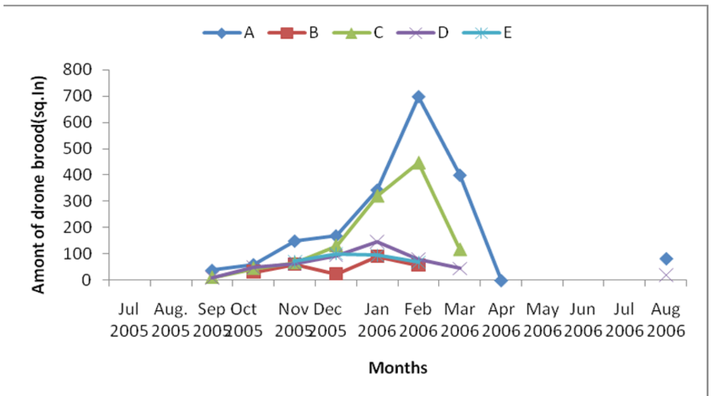

Figure 3 **Monthly amount of drone brood produced by honeybee colonies fed the tested diets**

Pollen grains: The overall means of pollen grains collection were 404.89 ± 75.89, 309.47 ± 53.93, 188.08 ± 30.10, 106.42 ± 16.19 and 153.25 ± 23.10 (sq.in) for treatments (A), (C), (B), (E) and (D), respectively, (Figure 4).

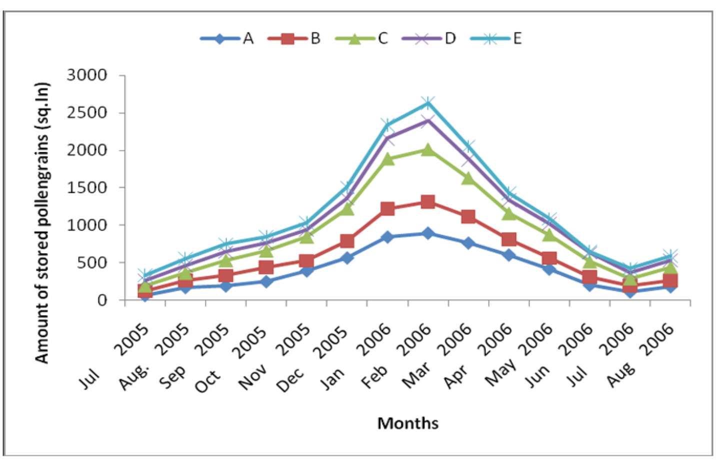

Figure 4 **Monthly amount of pollen grains stored by honeybee colonies fed the tested diets**

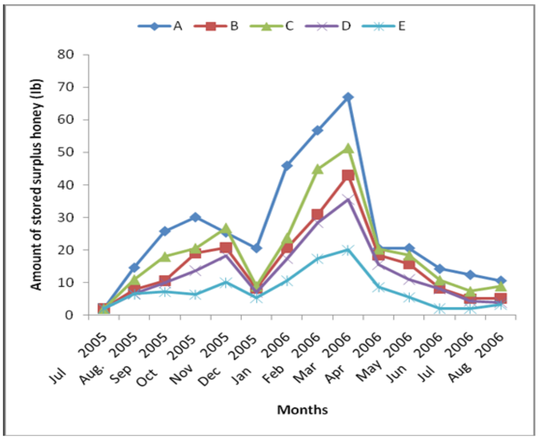

Figure 5 **Monthly amount of honey produced by honeybee colonies fed the tested diets**

Honey production: the overall means of honey production were 26.18 ± 04.91, 19.52 ± 03.76, 15.37 ± 03.02, 12.93 ± 02.56 and 07.62 ± 01.46 (b/colony) for treatments (A), (C), (B), (D) and (E), respectively (Figure 5).

DISCUSSION AND CONCLUION

The nutritional requirements of honeybees are naturally supplied by pollen and nectar. Since pollen is often not available in adequate quantities in the field, beekeepers frequently supplement fresh pollen supplies by feeding bees with pollen substitutes or supplements or commercial trapped pollen to promote colony growth. Although pollen and pollen supplement diets were found more attractive to bees and gave better results than pollen substitute diets. Many investigators (Jordan, 1957; Pain, 1963; Stroikov, 1963) have shown that food mixtures gave better results in honey bee feeding than any one substance alone. Thus, pollen substitute food mixtures were tried in the present study. Four pollen substitute diets were tested against control. Although the colonies were allowed to collect pollen freely all the year round, visual observations have shown that colonies used the diets at varying rates according to season. The consumption of the diets was highest during the hot dry summer months (April–July) where pollen collection was least as shown in Figure 3. While minimal during the period of nectar flow (November–February). This is in agreement with earlier reports that honeybees neglect substitutes as soon as natural pollen is available Hohmann (1969). The effectiveness of the diets was evaluated by measuring their effects on such criteria as brood rearing (worker and drone brood), population growth, pollen collection and honey yield. The results showed that colonies offered the pollen substitute diets responded to feeding. The test diets showed a great variance in influencing brood rearing of the test colonies. Colonies fed diet (A) surpassed all other treatments in the amount of brood reared scoring a mean of 1056.48 + 125.70 (sq.in.) was significantly different from of control colonies (E) 478.00 + 53.37 (sq.in.). The superiority of the pollen substitute diet (A) and followed by diet (C) over the other tested diets of (B) and (D) in promoting brood rearing and other criteria under study due to high content of protein from soya bean seeds (39–42% protein) and yeast (40.00% protein), all colonies were allowed to forage freely all the year round suggest that although pollen was available, quantities were not sufficient to satisfy colony requirements and indicates the need to supplement natural pollen supplies with protein, carbohydrate feeds in the area of study. Jachimowicz and Ruttner (1974) considered that feeding bees with sugar syrup alone was satisfactory only if some natural forage was available. Rosca et al. (1972) reported that colonies given protein diets produced 9.7–19.3% more brood than the control. Haydak (1963) stated that without pollen or a good pollen substitute or supplement, the brood rearing activity was curtailed and finally ceased completely. The results of the present investigation show that colonies which were better than the control in brood rearing were also better in other activities under study. It was concluded that when supplementary feeding might be required during periods of dearth or poor season without natural pollen and nectar, bad weather which prevents foraging during a nectar flow and insufficient summer stores in years when the bees cannot obtain nectar to provide enough honey stores for themselves.

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BIOGRAPHICAL NOTES

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