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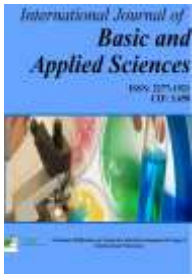

Full Length Research Paper

Impact of Different Artificial Diet Formulations on the *Apis mellifera* Diet in Dried Conditions

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ARTICLE DETAILS

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ABSTRACT

The purpose of the study was to figure out the impact of artificial diet by measuring consumption in situations where there were insufficient floral resources. Six diets were prepared: Diet 1: DSF-15%+BY-15%+ PG-15% +S-40%+G-15%; Diet 2: DSF-20%+BY-20%+SP-10%+S-35%+G-15%; Diet3:DSF-15%+BY-15%+PH-15%+S-35%+G-15%; Diet 4: DSF-15%+BY-15%+PH-10%+S-35%+G-15%+P-10%; Diet 5: SP-20%+H-80%; Diet 6: DSF-30%+BY-10%+SKM-10%+S-50%. The studies showed that *Apis mellifera* bees displayed differential consumption pattern throughout the summer and season by patty feeding experiments at Mandav in 2022.The order of the preferences for the various diets was 4 > 3 > 5 > 1 > 2 >6. Diet 4 was the most popular, followed by diets 3, 5, 1, 2, and 6. The number of frames that bees covered was significantly impacted by giving artificial meals. The strength of the bee colonies was maintained by the feeding of artificial food.

1. Introduction

In beekeeping, the season of floral scarcity poses a major challenge. As a result, bee colonies begin to decline and eventually die. A lack of pollen is terrible for bee colonies. It takes one pollen comb cell to raise one larva. (Dalio, J.S.,2008) Due to the lack of blossoms and the speedy depletion of stored honey and pollen, circumstances of starvation, rapid shrinking, and perishing of honey bee colonies have been reported during extended times of dearth (Mishra, 1995; Kumar et al. 2013).

In order to prevent this circumstance, colonies are either physically relocated to an area rich in bee flora or feeding pollen is provided. However, there are drawbacks to both pollen feeding and migration: moving bee colonies is labor-intensive and results in significant losses to honey bee mortality during transit (Mishra, 1995); additionally, packing and transporting the colonies to far-off locations requires a significant amount of time and labor; secondly, beekeepers typically neither gather nor feed natural pollen to bee colonies, nor do they have access to commercially available pollen. Furthermore, commercial pollen may be contaminated with a host of diseases (Herbert and Shimanuki, 1978; Kumar and Agrawal, 2014).

The need for artificial diets for honey bees has been the long-standing interest of the beekeeping industry and the most persistent apicultural research problem. Consequently, efforts should be made to formulate a highly palatable and nutritionally balanced pollen substitute to help the colonies over the dearth period so as to further strengthen commercial beekeeping in India. (Kumari I, Kumar R, 2019)

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2. Materials and methods

Feeding experiments were conducted during summer (April, May, June) and rainy (July, August, September) season of 2022 in the experimental colonies. Bees were kept in Langstroth wooden hives and equalized in term of brood and honey stores. The details of method adopted are mentioned below.

2.1 Colony equalization: For feeding experiment, Apis mellifera colonies were procured from registered beekeeper and maintained in Mandav, Madhya Pradesh, India, located at latitude 22.3340 N and longitude 75.4003 E. Six boxes having colonies of almost similar strength were selected, numbered and labelled. Fresh queens were maintained in all colonies and were given equal brood and honey stores measured by gridding method (Seelley and Mikheyev, 2003; Amir and Peveling, 2004). Similar equlaization of colonies was made during the year before the start of experiment.

2.2 Diet preparation: The protein and carbohydrate ingredients were selected keeping in mind the nutritional requirements of honey bees. These ingredients were mixed in specific ratio to prepare a complete formulation (Table 1).
This formulation was named bee sup during the current study. The diet was prepared by adding suitable quantity of water and left overnight so that all components may get properly mixed. Next day, patties (dough form) of diet were prepared and wrapped in butter paper to prevent moisture loss. This investigation was carried out at the Mandav, M.P.

Table-1 Composition of diet formulations used during study**-**

Diet 1	DSF-15%	BY-15%	PG-15%	S-40%	G-15%	---------
Diet 2	DSF-20%	BY-20%	SP-10%	S-35%	G-15%	---------
Diet 3	DSF-15%	BY-15%	PH-15%	S-40%	G-15%	---------
Diet 4	DSF-15%	BY-15%	PH-10%	S-35%	G-15%	P-10%
Diet 5	----------	---------	SP-20%,	--------	--------	H-80%
Diet 6	DSF-30%	BY-10%	SKM-10%	S-50%	--------	---------

DSF: Defatted Soy Flour, PG: Parched Gram, BY: Brewer's Yeast, SKM: Skimmed Milk Powder, PH: Protein Hydrolysate, SP: Spirulina, P: Pollen, S: Sugar, G: Glucose, H: Honey

2.3 Top bar feeding and consumption: Weighed amount (100 g) of diet patties was placed on top bars, inside the hives for feeding, with few small holes on both sides. The patties were replaced with fresh patties after every seven days interval and the left-out diet patties were weighed using electronic weighing balance.

2.4 Measuring colony parameters: Egg laying, area of brood coverage and honey stores in the colonies were measured after every 21 days interval, with the help of wire grid frame consisting of squares of one inch^2 (Seeley and Mikheyev, 2003; Amir and Peveling, 2004).
The values were then converted into cm^2 by multiplying with a factor of 6.45. Bee strength in terms of total number of bees covered frames was also checked and recorded. Bee population was recorded by photographic print method (Jefree, 1951).

2.5 Statistical analysis: The experimental design used in the study was Completely Randomized Design (CRD). Data on feed consumption, sealed and unsealed brood area, bee population, bee covered frames, honey area was tabulated, transformed and statistically analysed by two-way ANOVA. Means were compared using critical differences (C.D.) at 0.05 per cent level of significance.

3. Results

A detailed investigation on six selected diet formulations was carried out during dearth period (summer and rainy season) at Mandav (M.P.). Different parameters of colonies were analyzed i.e., amount of sealed brood, egg laying, number of frames covered by bees, bee strength and honey stores, at the end of experiment. In all the experimental colonies, parameters were calculated to be better as compared to control colonies. Results obtained are presented in table 2,3

In experimental site during summer season, the colonies given diet 1, 2, 3, 4, 5 and 6 the percentage of egg laying was 49.7, 47.5, 57.1, 60.2, 55.2, 47.04. The unsealed brood area was calculated to be 18.6, 52.07, 60.3, 62.4, 57.4, 25.9. The sealed brood area was calculated to be 26.2, 40.0, 40.8, 44.4, 38.4, 29.9. The population of bee colonies was found to be 1.2, 0.68, 10.15, 4.7, 1.54, 1.86. The bee covered frames were 1.5, 3.1, 11.5, 8.2, 9.19, 1.61. Honey stores were found to be 39.6, 44.4, 42.9, 44.1, 38.6, 29.5. (Table 2)

Table 2: Table Showing value of various parameters of colonies with different diet in Mandav, (M.P.) region during summer season (April, May, June) 2022

Diet	Value of various parameters in percentage					
	Egg Laying	Unsealed Brood	Sealed Brood	Bee Population	Bee covered frames	Honey Stores
Diet1	49.7	18.6	26.2	1.2	1.5	39.6
Diet2	47.5	52.07	40.0	0.68	3.1	44.4
Diet3	57.1	60.3	40.8	10.15	11.5	42.9
Diet4	60.2	62.4	44.4	4.7	8.2	44.1
Diet5	55.2	57.4	38.4	1.54	9.19	38.6
Diet6	47.04	25.9	29.9	1.86	1.61	29.5

In experimental site during rainy season, the colonies given diet 1, 2, 3, 4, 5 and 6 the percentage of egg laying was 62.4, 59.6, 71.8, 75.6, 69.3, 59.0. The unsealed brood area was calculated to be 22.7, 65.4, 75.9, 78.4, 72.1, 32.4. The sealed brood area was calculated to be33.0, 50.2, 51.2, 55.8, 48.1, 37.6. The population of bee colonies was found to be 1.5, 0.8, 12.7, 5.87, 1.85, 2.32. The bee covered frames were 1.85, 3.8, 14.4, 10.27, 1.15, 2.0. Honey stores were found to be 49.7, 55.7, 53.6, 55.5, 48.5, 37.0. (Table 3)

Table 3: Table Showing value of various parameters of colonies with different diet in Mandav, (M.P.) region during rainy season (July, August, September) 2022

Diet	Value of various parameters in percentage					
	Egg Laying	Unsealed Brood	Sealed Brood	Bee Population	Bee covered frames	Honey Stores
Diet1	62.4	22.7	33.0	1.5	1.85	49.7
Diet2	59.6	65.4	50.2	0.8	3.8	55.7
Diet3	71.8	75.9	51.2	12.7	14.4	53.6
Diet4	75.6	78.4	55.8	5.87	10.7	55.5
Diet5	69.3	72.1	48.1	1.85	1.155	48.5
Diet6	59.0	32.4	37.6	2.32	2.0	37.0

The cost analysis was worked out on the basis of prices of various ingredients used to prepare artificial diet formulations. The final cost of different diets is shown in Table 4. The cheapest formulation was diet no. 1 with a cost of Rs. 80.4/kg followed by diet no. 3 (Rs.122 /Kg), diet no. 4 (Rs. 28/kg), diet no. 2 (Rs. 12.4/kg), diet no. 6 (Rs. 170/kg) and the costliest diet no. 5 (Rs. 310/Kg).

Table 4: Price list of various diets in Rupees

DIET	PRICE/KG
DIET 1	80.4
DIET 2	142.4
DIET 3	122.4
DIET 4	128
DIET 5	310
DIET 6	170

4. Discussion

The results of diet 4 were highest in apiaries and had the greatest effects on the parameters of the colonies, such as egg laying, unsealed brood area, sealed brood area, bee population, honey store, and bee coverage area; however, the cost was higher than that of diet 2. The results obtained in all other diets were lower and the input cost involved in preparing these diets was also high, so these cannot be recommended for commercial use. These results are consistent with those of who reported that occasionally, certain protein sources combined with other ingredients of diet formulations yield better results than pollen supplement formulations in terms of net consumption, positive influence on colony parameters, and input cost involved. Even

though further research is needed to make this combination economically viable, beekeepers are advised to utilize it during a time of shortage.

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