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## Comparative performance of honeybee colonies fed with artificial diets in Gwalior & Panchkula region

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### Abstract

Honey bee colonies have to struggle for their existence during dearth periods. Colonies must be fed with artificially formulated diets to maintain bee population. In the present study, efforts were made to develop highly palatable, nutritionally balanced and economically viable pollen supplement or substitute for *Apis mellifera*. Diet 3 composed of soy flour-1part, brewer's yeast-1part, soy protein hydrolysate-1part, sugar-1part, glucose-1part proved to be best for honeybees in terms of biochemical composition, net consumption, positive influence on colony parameters and input cost involved.

**Keywords:** *Apis mellifera*, Dearth Period, Beekeeping, Gwalior, Panchkula, Artificial Diet

### 1. Introduction

Honey bees feed upon pollen and nectar of flowers. Pollen is the major source of protein, vitamins and minerals and nectar fulfils their carbohydrate requirement. During certain periods of the year (summer and rainy seasons in India), weather conditions are not suitable for bees and availability of food (nectar and pollen) resources is very low. The problems of deleterious influence of adverse weather conditions and non-availability of bee flora all round the year, in a particular locality, have been realized by earlier workers [6, 8, 9, 11] and the concept of migration of bee colonies been developed to solve this problem. But again, migration itself is not an easy task, it involves lot of expenses, labour and yet it is not risk-free. It has been estimated that even following the concept of migratory beekeeping, approximately 40% colonies die out annually during dearth period. In a preliminary study it has been noticed that short distance migration to vegetable farms and orchards and periodical supply of sugar and pollen substitute feeding may reduce the bee colony losses and input costs (Agrawal *et al.*, unpublished observations). Further, such short distance migration may be frequent as they do not involve higher amount of money. However, more research is required to confirm and establish this concept. An alternative strategy of migration is artificial feeding (nectar and pollen substitutes) to the bee colonies so that egg laying, brood rearing and some foraging activities continue, enough bee population is maintained and the advantage of forthcoming rich bee flora can be taken. A number of attempts on pollen supplement or substitute formulations have been made by various workers [1, 2, 3, 4, 5, 6, 8, 9, 10, 11]. In India, most of the beekeepers either do not provide any external food to bee colonies or just use sugar syrup. However, it is often emphasized by bee scientists [1, 8] that provision of pollen supplement or substitute will be helpful in saving weaker colonies and maintaining enough bee population to derive benefits of future non-dearth period. But the practice of protein source feeding is not followed due to several reasons like un-awareness, non-availability of commercial readymade formulation (s), lack of explicit recommendations, confused recommendations, high cost of recommended ingredients etc [8]. In the present study, an effort was made to develop a suitable, protein rich, commercially viable artificial diet for honeybees. Also a comparison was made among various parameters to recommend one formulation as "Best" out of six tested diets in two different locations.

### 2. Material and Method

The detailed study on the influence of artificial diet formulations was conducted during summer dearth periods, i.e. from the month of April to September, 2010 and 2012 in the two

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apiaries i.e. Gwalior & Panchkula (Table 1). Provision of feeding the diet formulations to honeybees was made in the form of patties for a feeding period of 14 days. Weighed amount

of patties were fed to *Apis mellifera* colonies by top bar method of feeding <sup>[4]</sup> (Photograph 1).

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

Diet Code	DSF	PG	BY	SKM	PH	SP	P	S	G	H
Diet 1	16.7%	16.7%	16.7%	-----	-----	-----	-----	33.3%	16.7%	-----
Diet 2	20.7%	-----	20.7%	-----	-----	8.3%	-----	33.3%	16.7%	-----
Diet 3	16.7%	-----	16.7%	-----	16.7%	-----	-----	33.3%	16.7%	-----
Diet 4	16.7%	-----	16.7%	-----	8.3%	-----	8.3%	33.3%	16.7%	-----
Diet 5	-----	-----	-----	-----	-----	16.7%	-----	-----	-----	83.3%
Diet 6	30%	-----	10%	10%	-----	-----	-----	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



**Photograph 1:** Top Bar Method of feeding diet patties to Honeybees

Observations on the amount of diet consumed in a period of fourteen were recorded and compared in both apiaries. In order to estimate the effect of diet formulations, the overall performance of colonies was judged by observing and comparing all the parameters *viz.* sealed and unsealed brood, egg laying, honey stores, and bee activity with control colonies. For studying the economics of feeding the pollen substitutes and supplements, the prices of the feedstuffs used in the various formulations were collected from the market and cost per kg of each of the pollen substitute and supplement was calculated. This cost also included the grinding charges @ Rs. 5 per kg.

### 3. Results

A detailed investigation on six selected diet formulations was carried out during dearth period at Panchkula (Haryana) & Gwalior (M.P.). Overall performance of colonies was measured by comparing all the analyzed parameters 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.

In the apiary maintained at Panchkula, the percent increase in sealed brood area in colonies given diet 1, 2, 3, 4, 5 and 6 was calculated to be 41.6, 54.2, 66.0, 64.3 and 22.8 and 31.6 percent more as compared to control colonies, respectively. Also, egg laying area was also calculated to be higher in the

colonies fed formulated diets. The percentage of egg laying was 51.4, 66.2, 76.0, 74.6, 28.8 and 44.9 more in the colonies fed diet 1, 2, 3, 4, 5 and 6 respectively when compared with control colonies. The population of bee colonies was found to be 11.3, 10.9, 15.8, 15.5, 1.3 and 10.3 percent more in the colonies fed with formulated diets as compared to control colonies. Quantity of honey stores were found to be higher in the colonies fed with formulated diets which means the worker bees collected more nectar ultimately resulting in higher honey yield. Honey stores were found to be 50.3, 56.5, 59.7, 54.9, 25.0 and 48.9 percent more in the colonies fed with diet 1, 2, 3, 4, 5 and 6 respectively as compared to control colonies (Table 2).

In Gwalior apiary, the percent increase in sealed brood area in the colonies given diet 1, 2, 3, 4, 5 and 6 was calculated to be 32.0, 48.4, 49.8, 54.3 and 3.08 and 36.6 percent more as compared to control colonies, respectively. Egg laying area was also calculated to be higher in the colonies fed with formulated diets. The percentage of egg laying was 60.7, 57.5, 69.8, 73.5, 8.5 and 43.0 higher in the colonies fed diet 1, 2, 3, 4, 5 and 6 respectively when compared with control colonies. The population of bee colonies was found to be 1.5, 0.9, 12.4, 5.8, 1.9 and 2.3 percent more in the colonies fed with formulated diets as compared to control colonies. Honey stores were found to be 48.3, 54.2, 52.4, 53.9, 17.0 and 36.1 percent more in the colonies fed diet 1, 2, 3, 4, 5 and 6 respectively as compared to control colonies (Table 3).

**Table 2:** Showing % enhancement of various parameters over control colonies in Panchkula region

Diet Code	% enhancement over control colonies						Overall Enhancement
	Egg Laying	Unsealed Brood	Sealed Brood	Bee Population	Bee covered frames	Honey Stores	
Diet 1	51.4	37.9	41.6	11.3	9.4	50.3	33.6
Diet 2	66.2	17.5	54.2	10.9	11.1	56.5	36.0
Diet 3	76.0	65.0	66.0	15.8	17.2	59.7	59.9
Diet 4	74.6	53.9	64.3	15.5	12.7	54.9	55.9
Diet 5	28.8	-0.21	22.8	1.3	4.1	25.0	13.6
Diet 6	44.9	31.2	31.6	10.3	5.8	48.9	28.7

**Table 3:** Showing % enhancement of various parameters over control colonies in Gwalior region

Diet Code	% enhancement over control colonies						Overall Enhancement
	Egg Laying	Unsealed Brood	Sealed Brood	Bee Population	Bee covered frames	Honey Stores	
Diet 1	60.7	22.2	32.0	1.5	1.9	48.3	27.7
Diet 2	57.5	63.5	48.4	0.9	3.8	54.2	38.0
Diet 3	69.8	73.6	49.8	12.4	13.7	52.4	45.7
Diet 4	73.5	76.2	54.3	5.8	13.7	53.9	45.2
Diet 5	8.5	-0.30	3.1	1.9	-0.2	17.0	5.0
Diet 6	43.0	31.2	36.6	2.3	1.9	36.1	25.1

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 diet formulations is shown in Table 4. The cheapest formulation was diet no. 1 with a cost of Rs. 41.70/kg followed by diet no. 3 (Rs.60.90 /Kg), diet no. 4 (Rs. 81.50/kg), diet no. 2 (Rs. 90.30/kg), diet no. 6 (Rs. 128.60/kg) and the costliest diet no. 5 (Rs. 175.20/Kg).

**Table 4:** Price list of various diet formulations

Sr. No.	Feed stuff	Price (Rs/kg)
1	Diet 1	41.70
2	Diet 2	90.30
3	Diet 3	60.90
4	Diet 4	81.50
5	Diet 5	175.20
6	Diet 6	128.60

#### 4. Discussion

Diet 3 (pollen substitute) was found to be consumed in maximum quantity in both the apiaries and showed maximum effects on colony parameters viz. egg laying, unsealed brood area, sealed brood area, bee population, honey store & bee coverage area. Diet. 4 (pollen supplement) was found to be the next favourable both with regard to consumption and its ability to enhance egg laying, unsealed brood area, sealed brood area, bee population, honey store and bee coverage area; being at par with the same parameters under diet 3. However, the cost was higher as compared to diet 3. Results obtained in all other diets were lower and input cost involved in preparation of these diets was also high hence these cannot be recommended for commercial use. These results are in accordance with that of [2, 6, 9, 10] who reported that in some instances, some protein sources in combination with other ingredients of diet formulations show better results than pollen supplement formulations.

It can be thus concluded that Diet 3 is the best formulation for feeding bee colonies during dearth period. It provided best results with regard to its favorable biochemical composition,

net consumption, positive influence on colony parameters and input cost involved. Though, some more investigations are required to make this formulation commercially promising, it can be recommended to be used by beekeepers during dearth period.

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