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DEVELOPMENT OF NECTAR SUPPLEMENT FOR DEARTH PERIOD MANAGEMENT OF HONEYBEES (*APIS MELLIFERA* LINNAEUS) COLONIES IN FOOTHILLS OF SHIVALIK RANGE OF HIMALAYAS

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ABSTRACT

Syrup containing fruits was evaluated as a diet supplement to develop an efficient and cheap nectar supplement. Bees were provided by the 4 syrup viz., T_1 Banana, T_2 Papaya, T_3 Grapes, and T_4 Guava and compared with T_5 Sugar to determine their impact on desirable attributes of colonies. Results indicated that, the % palatability of banana and papaya were 100% in both the years. A gradual increase in brood area (sqcm), honey store (sqcm), pollen store (sqcm) and foraging activity (forager/minute) were observed, which were maximum in banana (brood area 768.00, 774.00; honey stores 836.33, 856.00; pollen store 329.00, 335.33 with 18.33, 20.33 respectively) followed by papaya (brood area 733.00, 741.67; honey store 822.33, 845.00; pollen store 313.00, 318.67 with 16.66, 18.67 respectively), sugar (brood area 680.00, 683.00; honey store 799.00, 804.67; pollen store 298.67, 304.33 with 16.66, 17.33 respectively), and grapes (brood area 612.00, 615.67; honey store 734.67, 746.67; pollen store 282.67, 290.00 with 11.66, 11.67 no. of forager/minute respectively). All desirable parameters were found to be least in guava. So, among the evaluated fruits banana was the best nectar supplement followed by papaya which reduce the cost of feeding by more than 35% and 50% respectively.

INTRODUCTION

The success of beekeeping depends on the adequate availability of floral source. Honeybees need several nutrients, like carbohydrates, proteins, lipids, vitamins, and minerals for their proper growth and development. Out of these carbohydrate acts as a stimulus to honey bees to expand their colony and to spend active life. They receive carbohydrates from nectar Javaheri *et al*. (2000). But in dearth period mainly in rainy season because of less floral rewards supplement feeding is necessary for maintenance of bee population. In honey bee colonies shortage of carbohydrates may result in a reduction in brood rearing and in some cases; it may lead to starvation which is probably the single most important cause of death (Pokhrel *et al*., 2006 and Pande and karnatak, 2013). Sugar is the main commodity to feed honey bees during off season. Feeding bees with sugar syrup increase the number of bees and frames covered by bees, brood area, honey store, pollen area and colony weight Sahinler *et al*. (2003); Pande *et al*. (2011) and Pande and karnatak (2013). However, the price of sugar is increasing every year making bee keeping an expensive enterprise. Honeybees can utilize the complex carbohydrate Harssnigg *et al*. (2003). It has been reported that rice bran, buckwheat powder, soy bean in different form, germinated pulses powder, sweet pumpkin, turnip; malus fruits, temperate fruits are used to feed bees during off-season Upadhyay (2003) Pande *et al*. (2011); Pande and karnatak (2013) and Pande and Karnatak (2014). Therefore, feeding bees with fruits or vegetables or cereals rich in carbohydrates, proteins, minerals and fats can be the best alternative to replace expensive cane sugar (Pande and Karnatak, 2013). Therefore keeping the above idea in mind the present study was conducted to utilize fruits syrup as a diet supplement for dearth period feeding of honey bees in order to reduce the cost of feeding of the bees during off season by replacing expensive sugar syrup feeding.

MATERIALS AND METHODS

The present study was conducted in rainy season (dearth period *i.e.* June to October) of 2007 and 2008 at Haldwani (Distt. Nainital, Uttarakhand, India). Haldwani is situated as longitude 79.52°E, latitude of 29.22°N and altitude of 424 meters (1,391 feet) above mean sea level in the piedmont grade called *Bhabhar* region of Uttarakhand in Northern India.

Bee colonies were provided by the four different fruits syrup viz., T_1 Banana (*Musa paradisiaca*), T_2 Papaya (*Carica papaya*), T_3 Grapes (*Vitus vinifera*), and T_4 Guava (*Psidium guajava*). In T_6 control, sugar syrup artificial feeding supplement was provided. The experiment was conducted in Randomozed Block Design and each treatment was replicated three times. Sugar syrup was prepared by dissolving crystal sugar in fresh water (*i.e.* 1:1 v/v ratio).

The fruit syrup were prepared as per the method described by Neupane and Thapa (2005) with slight modification by adding two hundred gram flesh of ripen fruits to sufficient amount of

fresh water. The mixture was blended properly with the help of wooden stirrer. After that 100g of crystal sugar and 20g of honey was added and strained through a single layer of muslin cloth and volume was made up to one liter by adding water. Filled in glass bottles (already washed) and kept in refrigerator (~ 8ºC) until used.

Different syrup (@ 30 ml/frame) was provided to bees at an interval of 5 days by placing them inside the hive after filling the syrups in feeders with floating dry leaf twigs that the bees were not drawn in the syrup.

Amount of given syrups was recorded initially and after the 5 days interval of total experimental period. The amount of left out and supplied syrup in each colonies was worked out and utilized amount was calculated by using the formula.

$$\text{Feeding perferences(\%)} \quad \frac{\text{Initial volume of syrup} \quad \text{volume of left over syrup} \quad 100}{\text{Intial volume of syrup}}$$

Brood area (cm^2), honey stores (cm^2) and pollen stores (cm^2) were studied by measuring the total area covered by brood (sealed and unsealed); honey (capped) and pollen (uncapped) respectively by using wire grid device (5 cm x 5 cm). Activity of forager honeybees was estimated before the treatment and 15 days interval of experimental period by counting the number of workers going out from the entrance of the hive for one minute after every two hours of interval from 10.00 AM to 4.00 PM Srivastava *et al.* (2004). Shelf life of fruit syrup was assessed at room and refrigeration temperature. Finally, the cost of different syrups was calculated and compared with each other to find out the cheapest one.

Randomized Block Design (RBD) was used to compute the variance. After the determination of significance of difference between the treatments means at 0.05 % probability, critical difference was calculated in order to compare the treatment means Snedecor and Cochran (1968).

RESULTS AND DISCUSSION

All the treatments have shown profound effect on brood development, store of honey and pollen and foraging activity of bees during both 2007 and 2008 hold the opinion that carbohydrate is an indispensable food to be given to honeybee colonies.

Feeding preference

Utilization of syrups was significantly different to each other (Fig. 1a). Honey bees preferentially utilized T_1 Banana (100%) and T_2 Papaya (100%) followed by Sugar (99.6%), Grapes (81.3%) and Guava syrup (41.6%) as indicated by left over amount viz., 0 ml, 0 ml, 41 ml, 2423 ml and 7568 ml respectively in 2007. Similar trend was also observed in 2008 (Fig. 1b). So the highest amount of syrup utilized by the colonies was banana and papaya syrup. The result is supported by the findings of Pande and karnatak (2013) where honey bee consumed the 100 % amount of plum syrup and apricot syrup during feeding.

Effect of syrups feeding treatments on brood area

In 2007, maximum brood was recorded in colonies with syrup of T_1 Banana (768.000 sq cm), followed by T_2 Papaya (733.000 sq cm), while the minimum was in T_4 Guava (424.000 sq cm) followed by T_3 Grapes (612.000) and T_5 Sugar syrup (680.000 sq cm). Similar trend was found during 2008 also.

During both the years, brood area was almost similar at the beginning, but a significant increase was observed after feeding on all the combinations of syrups throughout the trial period (Fig. 2a & 2b). This is supported by the findings of Neupane and Thapa (2005) who reported that honeybee colonies when fed with banana and pumpkin syrup increased their brood cells. Similarly honey bee colony fed with temperate fruit plum syrup showed increase in brood area from 400 sq cm to 770 sq cm followed by apricot syrup (Pande and karnatak, 2013).

Effect of syrup feeding treatments on honey store

During the year 2007, significant increase in honey store was observed in T_1 Banana (836.333 sq cm), followed by T_2 Papaya (822.333 sq cm), T_5 Sugar (799.000 sq cm) and T_3 Grapes (734.667 sq cm) while, a sharp reduction was observed in T_4 Guava (432.000 sq cm) (Fig. 3a). Similar trend was also found during the year 2008 (Fig. 3b). The result is supported by the study of Pande and karnatak (2013) where colony showed the increment in honey store area up to 814 sq cm when plum fruit syrup was supplied to them.

Effect of syrups feeding treatments on pollen store

In case of pollen stores trend was similar as in brood area. At the end of the experiment pollen stores in the syrup fed

Table 1: Cost of syrups and per cent reduction in cost

Treatment	Required amount of raw material (gram) for 1 liter of syrups		Cost of raw material (Rs./Kilogram)	Cost of raw material used in 1 liter of nectar substitute	Total cost	Per cent reduction
	Material Required	Quantity in (gram)				
Banana	pulp	200	Rs. 20	Rs.4.0	Rs.8.7	35.56
	sugar	100	Rs.27	Rs.2.7		
	honey	20	Rs.100	Rs.2.0		
Papaya	pulp	200	Rs.10	Rs.2.0	Rs.6.7	50.37
	sugar	100	Rs.27	Rs.2.7		
	honey	20	Rs.100	Rs.2.0		
Grapes	pulp	200	Rs.30	Rs.6.0	Rs.10.7	20.74
	sugar	100	Rs.27	Rs.2.7		
	honey	20	Rs.100	Rs.2.0		
Guava	pulp	200	Rs.15	Rs.3.0	Rs.7.7	42.96
	sugar	100	Rs.27	Rs.2.7		
	honey	20	Rs.100	Rs.2.0		
Sugar (control)	Sugar	500	Rs.27	Rs.13.5	Rs.13.5	0

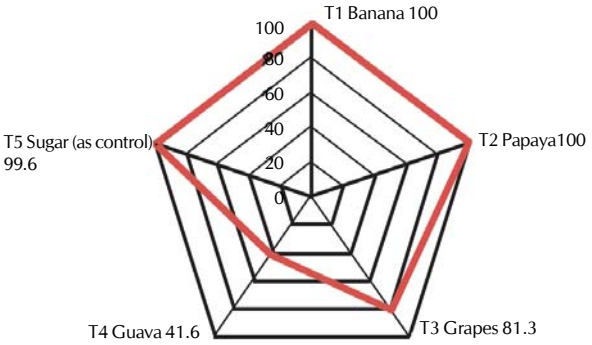

Figure 1a: Feeding preference of different syrups during dearth period (2007)

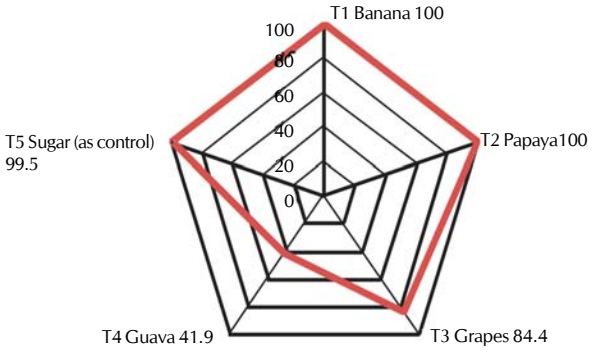

Figure 1b: Feeding preference of different syrups during dearth period (2008)

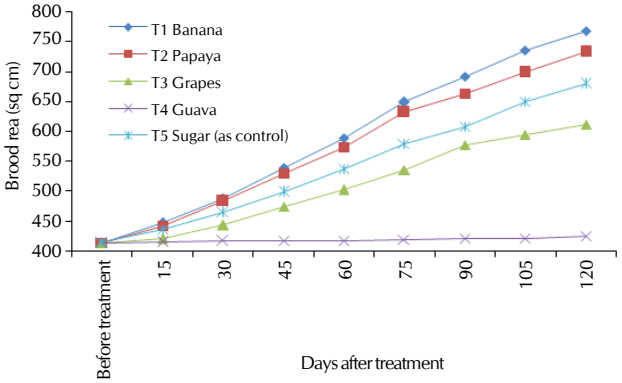

Figure 2a: Brood area in different syrups fed colonies during dearth period (2007)

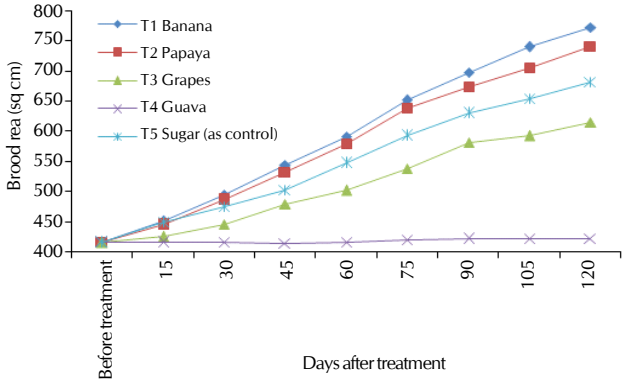

Figure 2b: Brood area in different syrups fed colonies during dearth period (2008)

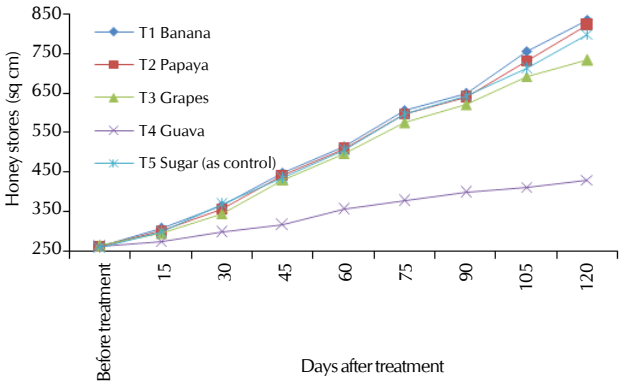

Figure 3a: Honey stores in different syrups fed colonies during dearth period (2007)

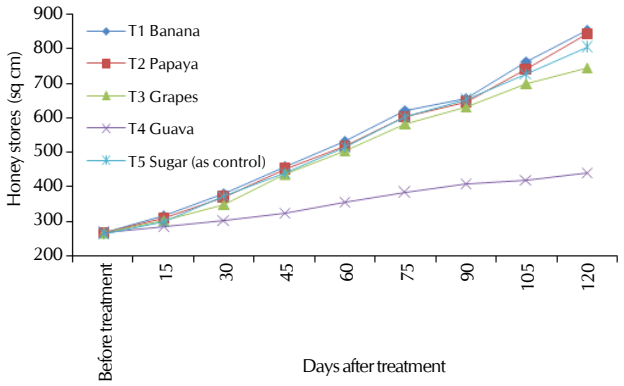

Figure 3b: Honey stores in different syrups fed colonies during dearth period (2008)

colonies increased significantly and was maximum in T_1 Banana (329.000 sq cm), followed by T_2 Papaya (313.000 sq cm), T_5 Sugar (298.667 sq cm) and T_3 Grapes (282.667 sq cm). Throughout the experimental period, pollen stores of all the experiment remained significantly higher than T_4 Guava (255.000 sq cm) in 2007 (Fig. 4a). Similar trend was also found during the year 2008 (Fig. 4b). Pande and karnatak (2013) reported that at the end of season colony provided with plum syrup, apricot syrup and apple syrup showed significant increase in pollen store

Effect of syrup feeding treatments on foraging activity:

After 15 days of treatment, maximum no. of forager 7.333 forager/min was observed in T_2 Papaya followed by 6.667 forager/min, in T_1 Banana and T_3 Grapes syrup. Lowest forager/min was recorded in T_4 Guava 5.333 forager/min followed by

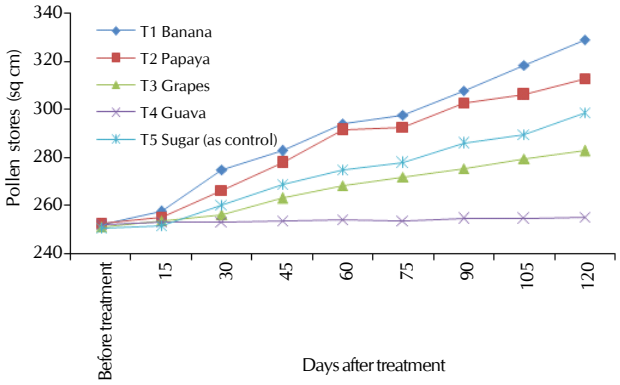

Figure 4a: Pollen stores in different syrups fed colonies during dearth period (2007)

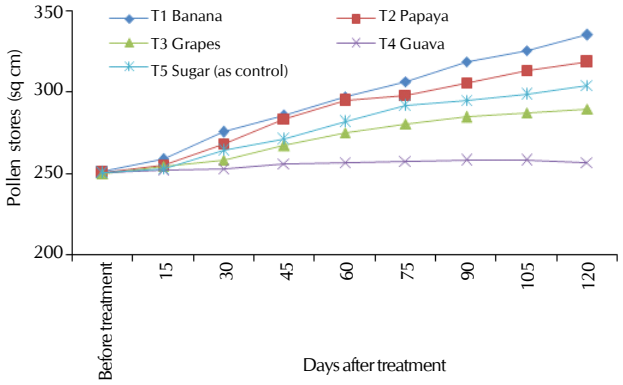

Figure 4b: Pollen stores in different syrups fed colonies during dearth period (2008)

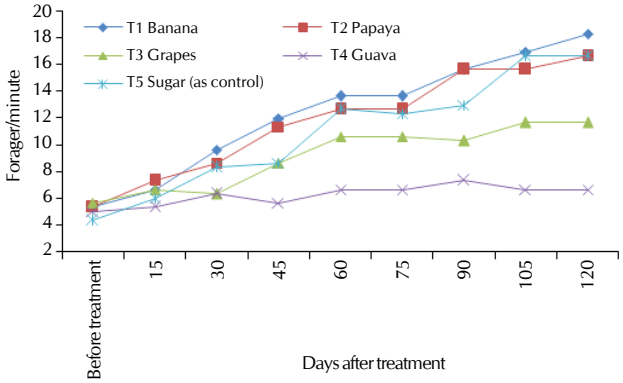

Figure 5a: Forager/minute in different syrup fed colonies during dearth period (2007)

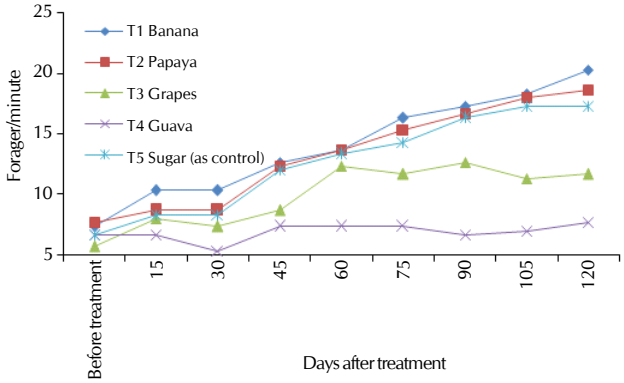

Figure 5b: Forager/minute in different syrup fed colonies during dearth period (2008)

T_5 Sugar 6.000 forager/min. Finally, foraging activity in the syrups fed colonies increased significantly and was maximum in T_1 Banana (18.333 forager/min.) followed by T_2 Papaya and T_5 Sugar (16.667 forager/min.), T_3 Grapes (11.667 forager/min.) and least in T_4 Guava syrup (6.667 forager/min.) (Fig.5a). Almost similar pattern was also observed during the year 2008 (Fig. 5b). On 120 days after treatment number of forager/minute significantly higher in all the experiment as in comparison of T_4 Guava syrup (7.667 forager/min.) and it was highest in T_1 Banana (20.333 forager/min.) followed by T_5 Sugar (18.667 forager/min.), T_2 Papaya (17.333 forager/min.) and T_3 Grapes (11.667).

After feeding the colonies with syrup the increment was observed in foraging activity it was similar to the findings of www.al.gov.bc.ca. (2008); Thapa and Pokhrel (2005); Somerville (2005a) and Pande and karnatak (2013) reported that supplement feeding encourages foraging. Increase in activity of forager may be due to increment of broods in the hive as reported by Vergheese and Prasad (1980).

Cost of syrups and per cent reduction in cost

Feeding cost of 1 liter syrups for bee colonies (Table. 1) varied greatly between sugar, banana, papaya, grapes and guava syrup feedings. The highest cost of feeding was recorded for T_5 Sugar (Rs 13.5) followed by T_3 Grapes (Rs 10.7), T_1 Banana (Rs 8.7), T_4 Guava (Rs 7.7) and T_2 Papaya (Rs 6.7) syrup, respectively. It has been found from the experiment that the cost of sugar feeding during off-season can be reduced by 50.37% by feeding bees with T_2 papaya syrup 42.96 % by T_4 guava syrup, 35.56% by T_1 banana syrup and 20.74 % by T_3 grapes syrup. So fruit and cereal easily available during dearth period and cheaper in price can be taken as alternatives to feed bees during that period. It is also reported by Neupane and Thapa (2005); Pande, (2009) and Pande and karnatak (2013).

Shelf life of syrups

In room and refrigeration temperature

During both the years, it was observed that syrups kept at room temperature were not preferred or accepted by the honey bees after 3 days of preparation.

It might be due to fermentation of these syrups by natural microbial flora. Somerville (2005b) and Pande and karnatak (2013) reported similar result on shelf life of syrups as in present study. By keeping the syrups in refrigerator (8ºC to 10ºC) the shelf life and bee acceptance was extend up to 5 days after preparation. Honey bees accepted these syrups up to 5 days after preparation. It may be due to lower metabolic activity of microbes at lower temperature. The finding is supported by Pande and karnatak (2013).

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