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Utilization of temperate fruits for off-season dietary management of honey bees

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ABSTRACT

Sugar is the main commodity to feed honey bees during off-season as nectar substitute. The primary objective of this study was to develop economical and efficient diet for honey bees from temperate fruits. For this, syrup containing temperate fruits was evaluated and bee colonies were provided by the four different fruit syrups, *viz.*, plum (*Prunus domestica*), apple (*Malus* sp.), apricot (*Prunus armeniaca*) and pear (*Prunus persica*) and compared with the control (sugar solution) to determine their impact on desirable attributes of bee colonies. Results from the per cent palatability of some syrups indicated that, they were completely accepted (100%) by bee colonies. Besides, a gradual increase in brood area, honey store, pollen store and foraging activity were observed after feeding in all the syrups combination, *viz.*, plum syrup followed by apricot, sugar (as control), and apple syrup. All the desirable parameters were found to be least in pear syrup. Cost and shelf-life were also calculated, in support of the adoption of these syrups. Results revealed that among the evaluated fruits plum followed by apricot syrup was the best dietary option for bees during off-season, which reduced the cost of feeding by more than 40 per cent.

Key words: *Apis mellifera*, fruit syrup, apple, plum, apricot, sugar supplement.

INTRODUCTION

Hill areas of Uttarakhand are paradise for bee keeping because of its richness in floral sources. Honey bees collect nectar as their principal carbohydrate source from the flowers. Ample available nectar in the field also acts as a stimulus to the colony (Somerville, 8). However, in off-season (dearth period) because of less floral rewards in vicinity supplement feeding is necessary for maintenance of bee population, which will be helpful to explore the available flora by the honey bees in favourable season. A shortage of carbohydrates may result in a reduction in brood rearing, honey storage (Pokhrel *et al*., 5) and may increase the robbing (Harris, 1) and absconding (Pokhrel *et al*., 5) and in some cases; it may lead to starvation, which is probably the single most important cause of death of colony. Feeding of bee colonies with sugar syrup at periodic intervals can help to overcome the problem of nectar shortage (Kencharaddi *et al*., 3). Feeding bees with dry sugar or sugar syrup increases the number of bees and frames covered by bees, brood area and colony weight (Sahinler *et al*., 6). But now-a-days beekeeping is an expensive activity because of increase in price of sugar. However, it has been reported that rice bran, buckwheat powder, sweet pumpkin, turnip; *Malus* fruits are used to feed bees during off-season in the higher hills of Nepal (Upadhyay, 13). Honey bees can utilize the complex carbohydrates (Harssnigg *et al.*, 2). Therefore, feeding bees with fruits or vegetables or cereals available during off-season, rich in carbohydrates, proteins, minerals and fats can be the best alternative to replace expensive cane sugar. Therefore, keeping the above idea in mind the present study was conducted at Haldwani (Distt. Nainital), Uttarakhand to develop a diet in the form of a syrup from local temperate fruits for dietary management of *Apis mellifera* L. in order to reduce the cost of feeding of the bees during off-season.

MATERIALS AND METHODS

The present study was conducted in rainy season (dearth period, *i.e.*, June to October) of 2007 and 2008. Bee colonies were provided by the four different fruits syrups purchased from local market, *viz.*, plum (*Prunus domestica*), apple (*Malus* sp.), apricot (*Prunus armeniaca*) and pear (*Prunus persica*). In control, sugar syrup artificial feeding supplement was provided. The experiment was conducted in Randomized Block Design and each treatment was replicated three times. The colonies selected for the study were of equal strength (6 frames of bees).

Sugar syrup was prepared by dissolving crystal sugar in fresh water (*i.e.* 1:1 v/v). The fruit syrups

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were prepared by adding 200 g flesh of ripened fruits to sufficient amount of fresh water. The mixture was blended properly with the help of wooden stirrer. To it, 100 g of crystal sugar and 20 g of honey were added and strained through a single layer of muslin cloth and volume was made up to one litre by adding water. Filled in glass bottles (already washed) and kept in refrigerator (~ 8^0C) until used. Different syrups (@ 30 ml / frame) were 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.

Activity of forager honey bees 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*., 11). Except that brood area (cm^2), honey stores (cm^2) and pollen stores (cm^2) were also 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). 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 suggested by Kencharaddi *et al.* (3).

$$\text{Feeding preference (\%)} = \frac{\text{Initial volume of syrup – volume of left over syrup} \times 100}{\text{Initial volume of syrup}}$$

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, 7).

RESULTS AND DISCUSSION

During both years all the treatments indicated that carbohydrate is an indispensable food to be given to honey bee colonies by showing their profound effect on brood development, store of honey and pollen and foraging activity of bees.

In 2007 utilization of syrups was significantly different from each other (Fig. 1A). Honey bees preferentially utilized plum (100%) and apricot (100%) followed by sugar soln. (99.6%), apple (87.3%) and pear (80.2%) for their requirement as indicated by left over amount, *viz.*, 0, 0, 41, 1,646 and 2,566 ml of syrups respectively. Similar trend was also observed in 2008 as plum (100.00%) and apricot (100%) followed by sugar soln. (99.5%), apple (90.7%) and pear (84.6%) (Fig. 1B). So the highest amount of syrup utilized by the colonies was plum and apricot syrups.

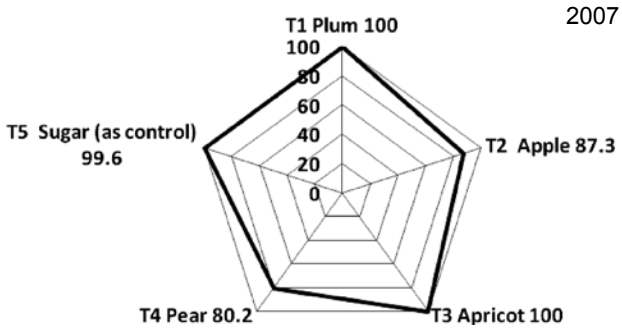

Fig. 1A

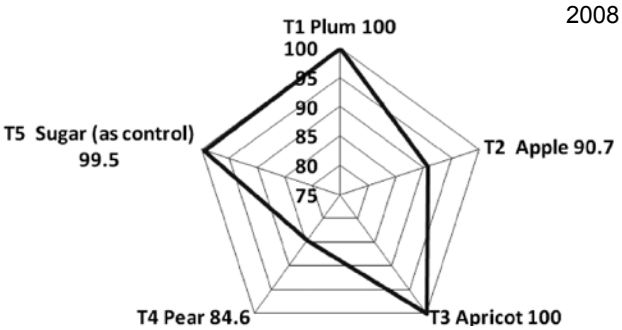

Fig. 1B

Fig. 1. Feeding preference of different syrups (dearth period, 2007 and 2008).

In 2007, at the end of the off-season maximum brood was recorded in colonies with syrup of plum (770 sq cm), followed by apricot (743 sq cm), while the minimum was in pear (614 sq cm) followed by apple (625 sq cm) and sugar soln. (680 sq cm). Similar trend was found during 2008 also. But only on 45 days after treatment (DAT) lowest brood area was recorded in apple (480 sq cm) followed by pear (483 sq cm). 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). Similarly, Neupane and Thapa (4), and Somerville, (8) reported that honey bee colonies when fed with banana and pumpkin syrup increased brood cells and ample available nectar acts as a stimulus to the colony and increasing interest in expansion of brood area within the colony.

During 2007, significant increase in honey store was observed in plum (814 sq cm), followed by apricot (802 sq cm), sugar soln. (799 sq cm) and apple (639 sq cm), while, a sharp reduction was observed in pear (565.667 sq cm) (Fig. 3A). Similar trend was also found during 2008 (Fig. 3B.)

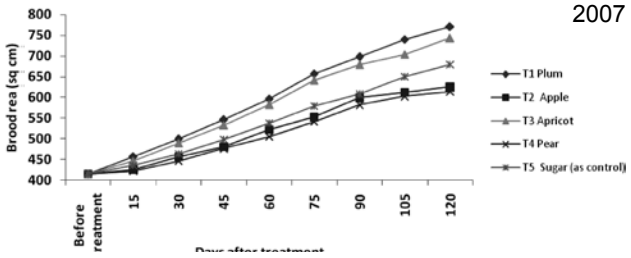

Fig. 2A

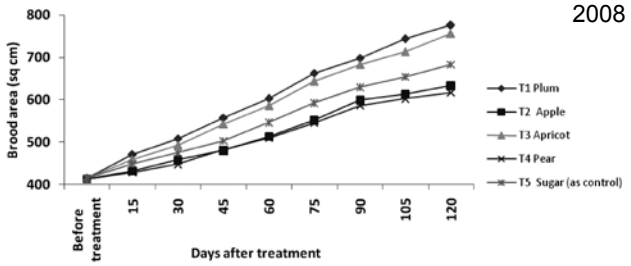

Fig. 2B

Fig. 2. Brood area in different syrups fed colonies (dearth period, 2007 and 2008).

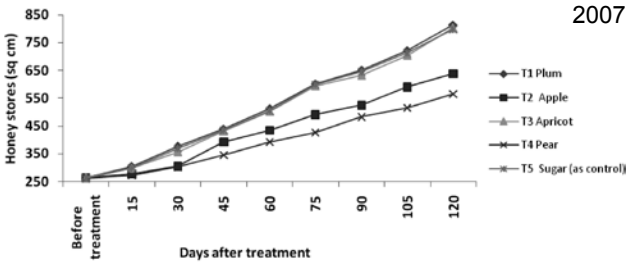

Fig. 3A

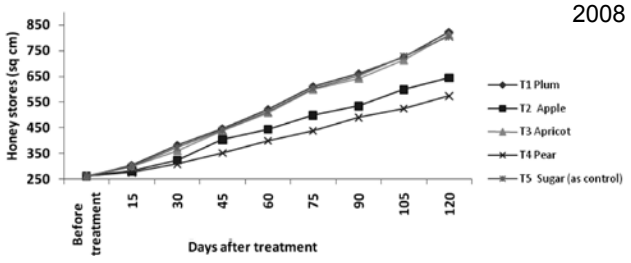

Fig. 3B

Fig. 3. Honey stores in different syrups fed colonies (dearth period, 2007 and 2008).

During 2007 and 2008, the data pertaining to the effect of syrup on pollen stores is presented in Fig. 4. In 2007, on 15, 30, 45 and 60 DAT similar trend was observed as in brood area but on 75 DAT, pear and apple showed similar pollen stores of 256.667 sq cm.

At the end of the experiment pollen stores in the syrup fed colonies increased significantly and was maximum in plum (311.667 sq cm), followed by apricot (305 sq cm), sugar soln. (298.667 sq cm) and apple (260.667 sq cm) syrup. Throughout the experimental period, pollen stores of all the experiment remained significantly higher than pear (256.667 sq cm) syrup (Fig. 4A). Similar trend was also found during the year 2008 (Fig. 4B). But on 15 DAT lowest pollen stores was observed in apple 250.667 sq cm followed by pear 251.667 sq cm. Similarly, Somerville (8) reported that ample available nectar acts as a stimulus to the colony and encouraging colony for pollen collection.

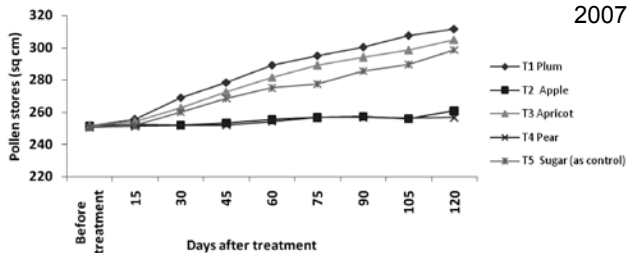

Fig. 4A

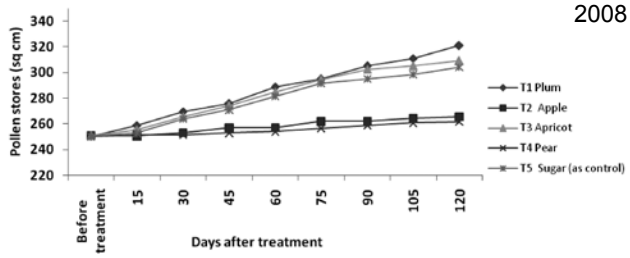

Fig. 4B

Fig. 4. Pollen stores in different syrups fed colonies (dearth period, 2007 and 2008).

In 2007, maximum no. of foragers (18.333 forager/min.) were observed in plum followed by apricot (16 forager / min.), sugar soln. (16.667 forager / min.) and apple (12.333 forager / min.) syrup. Lowest forager /min. was recorded in pear syrup (11.667 forager / min.) (Fig. 5A.). Almost similar pattern was also observed during the year 2008 (Fig. 5B). Increase in activity of foragers may be due to increment of broods in the hive as reported by Vergheese and Prasad (14). After feeding the colonies with syrup the increment was observed in foraging activity it was similar to the report of www. al.gov.bc.ca. (15); and findings of Thapa and Pokhrel (12), and Somerville (9) reported that supplement feeding encourages foraging.

Feeding cost of one litre syrup (prepared by temperate fruits) for bee colonies (Table 1) varied greatly between sugar, plum, apple, apricot and

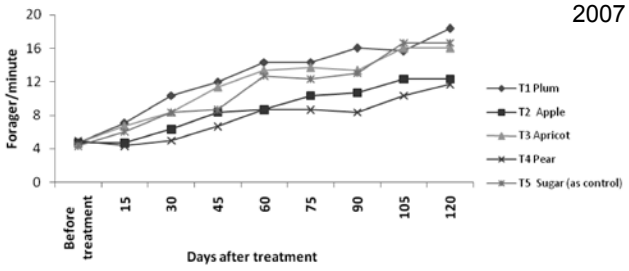

Fig. 5A

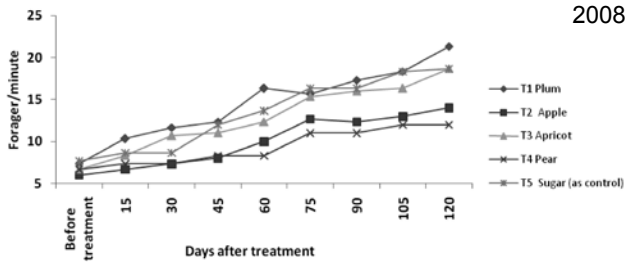

Fig. 5B

Fig. 5. Forager/ minute in different syrup fed colonies (dearth period, 2007 and 2008).

pear syrup feedings. The highest cost of feeding was recorded for sugar soln (Rs. 13.5) followed by apple (Rs. 10.7), plum and apricot (Rs. 7.7) and pear (Rs. 6.7) syrup, respectively. It has been found from the experiment that the cost of sugar feeding during off-season can be reduced 49.63% by feeding bees with pear syrup 42.96% by plum and apricot syrups and 20.74% by apple syrup. Hence, fruit and cereal easily available during dearth period at cheaper in price can be taken as alternatives to feed bees during that period. It is also reported by Neupane and Thapa (4).

During both 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 (10) reported similar result on shelf-life of syrups as in present study. By keeping the syrups in refrigerator (8° to 10°C) the shelf-life and bee acceptance was extended 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.

Non-availability of flora in vicinity during off-season is one of the major constrains in maintaining honey bee colonies. Hence, fruits and cereals easily available during dearth period are cheaper in price can be taken as alternatives to feed bees during that period. From the present findings it can be concluded that, although bees have accepted and grown on various syrups; however, plum syrup was found to be superior for bees followed by apricot. In addition, feeding bees with plum and apricot syrup reduces the cost of feeding by more than 40 per cent. However, pear syrup reduced the cost of feeding up to 49 per cent but the syrup showed no appreciable increase in all the parameters as in comparison with control. Therefore, plum and apricot syrups have been found superior over other syrups and can be suggested for feeding bee colonies during off-season to reduce the cost of feeding, maintaining colony strength and maximizing honey production during nectar flow season.

Table 1. Cost of syrups (prepared by temperate fruits) and per cent reduction in cost.

Treatment	Required amount of raw material (g) for 1 lit. of syrups		Cost of raw material (Rs./kg)	Cost of raw material used in 1 litre of nectar substitute (Rs.)	Total cost (Rs.)	Reduction (%)
	Material required	Quantity (g)				
Plum	pulp	200	15	3.0	Rs. 7.7	42.96
	sugar	100	27	2.7		
	honey	20	100	2.0		
Apple	pulp	200	30	6.0	Rs. 10.7	20.74
	sugar	100	27	2.7		
	honey	20	100	2.0		
Apricot	pulp	200	15	3.0	Rs. 7.7	42.96
	sugar	100	27	2.7		
	honey	20	100	2.0		
Pear	pulp	200	10	2.22	Rs. 6.7	49.63
	sugar	100	27	2.7		
	honey	20	100	2.0		
Sugar (control)	Sugar	500	Rs. 27	Rs. 13.5	Rs. 13.5	0

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