Journal of Applied and Natural Science 6 (2): 812 - 815 (2014)

JANS

Exploration of various flours as pollen substitutes for *Apis mellifera* L. during Dearth period at Tarai region of Uttarakhand, India

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Received: March 05, 2014; Revised received: November 02, 2014; Accepted: December 14, 2014

Abstract: Studies on evaluation of various flours as pollen substitutes and availability of pollen resources for *Apis mellifera* honey bees were conducted at Govind Ballabh Pant University of Agriculture & Technology, Pantnagar, India during 2010. Four flours were taken *viz.* Soybean, Maize, Wheat and Gram as pollen substitutes for *A. mellifera.* All the flours were mixed with honey and water to make a total of 4 treatments (4 flours + honey + water). Treatment T_1 (Soybean flour + honey + water) were found to be best in reference to visitation of bees with a mean number of 32.59 honey bee foragers /5min/day and weight loss in flours was 19.12 g due to foraging by bees followed by the treatment T_3 (Maize flour + honey + water) and T_2 (Wheat flour + honey + water) were found 29.30 and 23.05, respectively. Gram flour + honey + water (T_4) combination were found to be least preferred pollen substitute for *A. mellifera* (19.76 honey bee foragers/5min/day) with a weight loss 6.66 g. The overall study has great significance for bee keepers. The use of pollen substitute is important for growth and development of the bee colonies not only in dearth periods but also at other times (during foraging, pollination process and to overcome pesticide exposures.). From the present findings it can be concluded that although bees have accepted and grew on all the diets.

Keywords: *A. mellifera*, Gram, Honey, Maize, Pollen, Soybean, Wheat

INTRODUCTION

Apicultural industries are being developed in hilly areas of Uttarakhand due to its rich biodiversity, ethnicity and floral sources. The success of beekeeping depends on the adequate availability of floral source. Bee receives carbohydrates from nectar and proteins from pollen (Javaheri *et al.* 2000). But in rainy season (dearth period) because of less floral rewards, supplement feeding is necessary for maintenance of bee population. Soy flour is acceptable as a protein feed for bees. It contains 47 to 50% crude protein and the amino acid profile is acceptable for bee metabolism. The amino acid isoleucine is well represented, and gives extra supplementation to the bees feeding on it (Stace and White, 1994). Soy flour has been utilized extensively for a number of decades with various degrees of success in honeybee (*Apis mellifera* L.) supplementary feeds (Pokhrel *et al.,* 2006, Prakash *et al.,* 2007, Dodologlu and Emsen, 2007, Siede *et al.,* 2003, Manning, 2006). But some soy flours seem to contain antifeedant compounds that reduce the palatability to honeybees. When soy flour is heated during the manufacturing process, proteolytic enzyme inhibitors are destroyed and leads to improper digestion of the protein. Therefore, the study was undertaken to develop an efficient pollen substitute from local resources for dearth period management of honeybee to reduce the cost of feeding of the bees during off season.

The Italian honeybee (*Apis mellifera*) is the most widely distributed all over the country. Brood rearing starts into late summer or autumn in adequacy of pollen store and irrespective of nectar flow. Pollen is mainly used to feed developing larvae and young bees. During breeding season the requirement of pollen is high. De Groot (1953) identified a number of amino acids that are essential for normal growth and development of bees. They can, however, compensate to some extent for pollen lower than desirable levels of amino acids by consuming more pollen. In areas where floral resources are insufficient, a beekeeper needs to provide pollen supplement substitute for sustaining his honeybees during dearth period. Thus, knowledge of a suitable pollen substitute/supplement is essential. Beekeepers can use protein supplemental foods to improve the nutrition of their bees when natural pollen is scarce (Standifer *et al.,* 1977).

The honeybee colonies supplemented with the pollen substitute like soybean flour, maize flour, wheat flour had greater brood areas than those were not supplied with pollen substitute (Costagmino *et al.,* 2004). A good pollen substitute for bees is one that can readily be consumed and have the quality and quantity of proteins, lipids, vitamins and minerals required for

ISSN : 0974-9411 (Print), 2231-5209 (Online)

growth and development of individual. Viewing above facts that importance and requirements of pollen is very high for honeybees regarding their brood development as well as production of honey and other apicultural products, the present study was therefore planned to acquire more information on some more preferred pollen substitute given to honey bee in Dearth period.

MATERIALS AND METHODS

The experiment was conducted in Apiary in the Department of Entomology, College of Agriculture, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, India during the year 2010. Various grains were collected and grinded separately to get them converted in the form of flour. Flour of different grains were passed through a sieve in order to make them as small as pollen grains. Ratio in each combination was 2:1:1 i.e. Test material: Honey: Water respectively. All the flours were mixed with honey and water to make total of four treatments (four flours + honey + water) with three replication. Equal amount (250 g) of each combination were taken and put on polythene sheets and placed on the trays of 2'x 2' size at height of 1.0 feet as one treatment and put in trays and placed near the hives. Counted that the no. of bees at 10.00 AM, 11.00 AM, 12.00 PM, 1.00 PM, 2.00 PM, 3.00 PM, 4.00 PM and 5.00 PM at the interval of one hours feeding on pollen substitute.

Treatment details:

T_1 = Soybean flour (250 g) + Honey (25 ml) + Water (25 ml)
T_2 = Wheat flour (250 g) + Honey (25 ml) + Water (25 ml)
T_3 = Maize flour (250 g) + Honey (25 ml) + Water (25 ml)
T_4 = Gram flour (250 g) + Honey (25 ml) + Water (25 ml)

Quantity of given treatments were recorded initially and difference was calculated to find the feeded quantity of flours by bees as pollen substitute. Number of forager bees visiting various flours were counted at an interval of one hour for duration of five minutes.

RESULTS AND DISCUSSION

A glance of data depicted in Table 1 (Fig. 1) indicated the visitation of honey bees when all (Soybean flour, Maize flour, Wheat flour and Gram flour) the flours were mixed with honey + water and offered to honey bees.

The highest number of honey bee visited on Soybean flour with 58.74 bees/5min/day followed by wheat (31.56 bees/5min/day), gram (26.52 bees/5min/day) and maize (23.48 bees/5min/day) at 2.00 PM in comparison to other interval (Hours).

The minimum number of honey bees visitation were recorded on all flour (Soybean flour, Maize flour, Wheat flour and Gram flour) at 10.00 AM with 14.12 bees/5min/day (Soybean flour) followed by 10.22 bees/5min/day (wheat flour), 6.46 bees/5min/day (maize flour) and 4.24 bees/5min/day (Gram flour).

On the basis of above results, the order of preferences of visitation of bees was in the order of - Soybean (T_1) > Maize (T_3) > Wheat (T_2) > Gram (T_4)

The maximum intake of various flours by bees observed on the basis of weight loss was in Soybean flour (19.12 g) followed by maize (18.01 g), wheat (16.78 g) and Gram (6.66 g) shown in Table 2 (Fig 2). These finding were also supported by Kencharaddi *et al.* (2003) and Thapa and Pokhrel (2005) who have reported that the high rate of flight activities was due to soybean as a pollen substitute and encouraged foraging. The diet composed of soybean flour supplemented with vitamin B complex and methionine was found to be best diet for strengthening the colony (Saleem *et al.,* 2003). The present results are in

Table 1. Visitation of honey bee foragers on various flours mixed with honey and water at different day hours.

Treatments	Mean no. of honey bee foragers /5min/day at different day hours								Mean
	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	
T_{1S}	14.12 (3.82)*	25.76 (5.12)	25.42 (5.09)	55.42 (7.48)	58.74 (7.70)	25.88 (5.14)	25.14 (5.06)	30.24 (5.54)	32.59 (5.62)
T_{2W}	10.22 (3.27)	15.00 (3.93)	20.78 (4.61)	21.20 (4.65)	31.56 (5.66)	22.54 (4.80)	21.36 (4.67)	15.42 (3.99)	23.05 (4.72)
T_{3M}	6.46 (2.63)	16.14 (4.08)	24.56 (5.10)	15.32 (3.98)	23.48 (4.90)	19.58 (4.48)	41.54 (6.48)	37.32 (6.15)	29.30 (5.24)
T_{4G}	4.24 (2.17)	11.54 (3.47)	34.84 (5.94)	44.68 (6.72)	26.52 (5.20)	45.76 (6.80)	37.84 (6.19)	28.96 (5.43)	19.76 (4.45)
Mean	8.76 (2.97)	17.11 (4.15)	26.4 (5.19)	34.16 (5.71)	35.08 (5.87)	28.44 (5.31)	31.47 (5.60)	27.99 (5.28)	26.17 (5.01)
SEM±	0.65 (0.12)	0.87 (0.11)	0.44 (0.04)	1.01 (0.08)	0.50 (0.04)	0.65 (0.06)	0.67 (0.06)	0.65 (0.06)	-
CD at 5 %	2.23** (0.40)**	2.99** (0.38)**	1.52** (0.13)**	3.50** (0.28)**	1.73** (0.15)**	2.23** (0.22)**	2.30** (0.21)**	2.23** (0.22)**	-
CV	12.76 (6.80)	8.77 (4.56)	2.86 (1.29)	5.14 (2.48)	2.47 (1.26)	3.93 (2.07)	3.67 (1.89)	3.99 (2.05)	-

*Data given in parentheses are square root transformed values

Table 2. Weight loss of various flours mixed with honey due to foraging by honey bee foragers at different day interval.

Treatments	Weight loss of various flours + honey (gm) + water at different days							
	I	II	III	IV	V	VI	VII	Mean
T_{1S}	12.48 (3.60)*	9.41 (3.15)	18.42 (4.35)	25.34 (5.08)	22.46 (4.79)	20.88 (4.62)	24.87 (5.04)	19.12 (4.38)
T_{2W}	4.10 (2.14)	12.78 (3.64)	16.86 (4.7)	25.89 (5.14)	22.83 (4.83)	20.41 (4.57)	14.56 (3.87)	16.78 (4.13)
T_{3M}	4.52 (2.23)	8.74 (3.04)	5.12 (2.36)	14.56 (3.88)	13.72 (3.77)	56.42 (7.54)	22.96 (4.84)	18.01 (3.95)
T_{4G}	1.86 (1.51)	2.23 (1.63)	4.78 (2.29)	4.27 (2.18)	12.16 (3.56)	11.86 (3.51)	9.48 (3.16)	6.66 (2.55)
Mean	5.74 (2.37)	8.29 (2.7)	11.30 (3.43)	17.52 (4.07)	17.79 (4.24)	27.39 (5.06)	17.97 (4.23)	15.14 (3.75)
SEM±	0.65 (0.15)	0.50 (0.10)	0.60 (0.11)	0.67 (0.10)	0.76 (0.08)	0.50 (0.06)	0.67 (0.09)	-
CD at 5 %	2.23** (0.53)**	1.73** (0.36)**	2.08** (0.38)**	2.30** (0.34)**	2.64** (0.29)**	1.73** (0.19)**	2.30** (0.31)**	-
CV	19.48 (11.25)	10.45 (6.24)	9.21 (5.81)	6.59 (4.17)	7.44 (3.46)	3.16 (1.92)	6.43 (3.67)	-

*Data given in parentheses are square root transformed values.

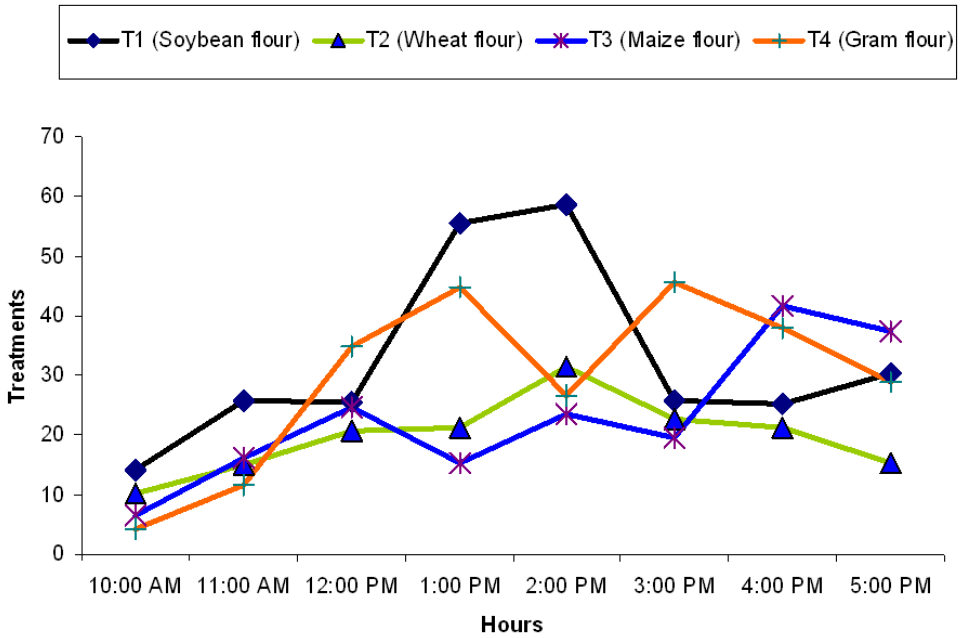

Fig. 1. *Visitation of honey bee foragers mean no. of honey bee foragers /5min/day at different day hours on various flours mixed with honey and water.*

accordance with Prakash *et al.* (2007) who reported that pollen store increased with the feeding of soy flour steadily from the beginning to the end of the experiment and remained significantly higher than the control. Srivastava *et al.* (2004) reported that after feeding of pollen supplement, pollen hoarding capacity was better than the control. The work is also supported by, Erickson and Herbert (1980) and Sabir *et al.* (2000) who reported that soybean products were good substitute as pollen supplement and had positive effect. The overall study has a great significance for bee keepers. The use of pollen substitute is important for growth and development of the bee colonies not only in dearth periods but also at other times (during foraging, pollination process and to overcome pesticide exposures). From the above findings it can be concluded that although bees have accepted and grew on all the diets, the soybean flour was superior for bees, followed by maize flour with above combination.

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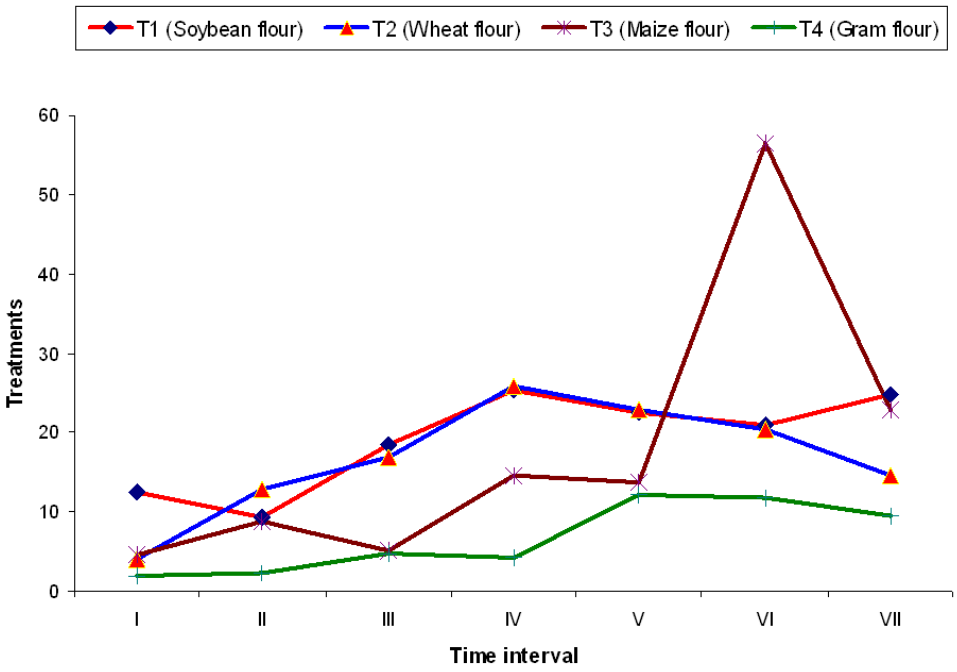

Fig. 2. *Weight loss of various flours mixed with honey (g) and water due to foraging by honey bee foragers at different day interval.*

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