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Nutritional feeding to honey bee colony during floral dearth responses higher production of quality hive products and medication

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Abstract
Honey bee colony of Indian bee keeping industry is suffering with the acute problems, such as scarcity of food source, infestation of bee enemies, diseases and temperature (45˚C) of day hours during floral dearth and these were experienced by bees at the same time. The 50 per cent population of bee colony was diminished by these stresses during the month of June to September each year. To overcome such conditions and also for proper growth of bee colony during floral dearth, availability of fresh drinking water in apiary, nutritional feeding with preserved fresh syrups such as mahua (*Bassia latifolia*) flowers' syrup, sugar beet (*Beta vulgaris*), neem (*Azadirachta indica*) fruit pulp syrups were not only beneficial for development but also serve as strong natural feeding option to surpass the dearth period. These syrups provide the nutritional ingredients to bees as required by them and increased the honey production and multiplication of bee colony. Honey bees are also derived their medication from plant products. Ecosystem of India consists of vast floristic ecological variations, at different temperature and locations at the same time (such as temperature of Leh - 35 to - 45 ˚C and at the same moment in Chennai +40˚C to + 48 ˚C). In this region sweet juicy corolla are available just prior to the commencement of floral dearth, which tempted us to prepare the preserved syrup of mahua (*B. latifolia*) flowers, made from extracted juice of fresh flowers for feeding of bee colony during floral dearth. The number of bee frames, brood and honey storage areas were increased by its feeding during floral dearth as compared to the sugar syrup feeding treatments.

Keywords: floral dearth, floristic, corolla, propolis, lysine, histidine, leucine and isoleucine

Introduction
Each and every living organism of nature requires carbohydrate, protein, vitamins and minerals for the survival. However, scarcity of such food source, infestation of bee enemies, diseases and high temperature of day hours during floral dearth are burning problems of honey bee colony and Indian bee keeping industry, due to these reasons, suffering at a great extent. Though, food source like cream coloured flowers have a fleshy and juicy corolla. The corolla is a rich source of sugar, vitamins and minerals. These corollas also contain appreciable amount of calcium. Fructose is present in a great amount than glucose and in the ripe stage of corolla the quantities are almost equal, in almost every parts of India, where the honey bee (*Apis mellifera*) colonies experience long period of food dearth. Essential amino acids namely lysine, histidine, leucine and isoleucine are also required by honeybees. These amino acids are present in mahua flowers and feeding of mahua flower syrup increased the number of larval essential amino acids twice in 2nd instar and thrice in 5th instar as compared to the sugar treatment (Singh and Upadhyay, 2010) [9].
On the other hands, bee keepers traditionally feed sugar syrup during such floral dearth periods but experiments showed that feeding colonies in dearth periods with syrup made from an extract of the sun dried flower's of mahua (*Bassia latifolia*) which provides both sugar and protein was a better alternative of sugar syrups (Singh and Upadhyay1999) [7]. Bee nutrition plays a key role in health and vigour of honey bee colonies and in their establishment as populations. Honey bees colonies are highly dependent upon the availability of floral resources from which they get the nutrients necessary to their development and survival (Abrol, 2012) [1]. However, foraging areas are currently affected by the intensification of agriculture and landscape alteration. Bees are therefore confronted to disparities in time and space of floral resource abundance, type and diversity, which might provide inadequate nutrition and

endanger colonies. Besides this, bee keeping industry is suffering with unavailability of nectar and pollen during lean period i.e. June to September. During such dearth periods up to half of the colonies may die or abscond from their hives due to the lack of food. Activities of bees are greatly influenced by food availability, during food scarcity, worker bees of weak colonies often eat young larvae. Under such circumstances, cream coloured mahua flowers have a fleshy and juicy corolla, being rich source of sugar, vitamins and minerals preferred as beneficial, natural, easily available and well known feeding option especially during the dearth period.

However, the information on the preserved of fresh mahua flower syrup and its impact on bee nutrition and particularly brood area development (cm2) of *Apis mellifera* colony is not available. The present investigation is, therefore, an attempt to perceive the response of fresh mahua flower syrup on honey and brood area development of *Apis mellifera* colony during floral dearth period.

Material and Methods

The present investigation was carried out at Main Research Farm and Apicultural and Insect Physiological Research Laboratory, Department of Entomology, NDUA&T, Kumarganj, Faizabad U.P. (India) during the year 2013-2014 with a view to assess the response of fresh mahua flower syrup on honey and brood area development of *Apis mellifera* colony during floral dearth period.

Experimental details

Treatment details: The four treatments with five replications were applied on bee colonies of *Apis mellifera* selected at randomly under identical conditions.

(i). Preserved syrup of fresh mahua (*Bassia latifolia* Roxb.) flowers.

(ii). Barhal (Artocarpus lakoocha) fruit juice syrup.

(iii) Sugar syrup (only sugar dissolved in water, control)

(iv) Punjab Agriculture University (PAU) bee feed (pollen substitute)

Preparation of preserved mahua (*Bassia latifolia* Roxb.) flower syrup made from extracted juice of fresh flowers:

In this treatment 5kg fresh mahua flowers was taken. It was washed with fresh water and dipped in boiled water (2 L.) for 10 minutes. The mahua flowers were grinded with the help of electric mixer and squeezed manually for extraction of juice with the help of muslin cloth. Sugar syrup was made by adding water (2 L.) for dissolving the 9kg sugar. After slight boiling the sugar syrup was strained with musclin cloth. After preparation of homogenous sugar solution the citric acid was added @ 1% in sugar solution. This sugar syrup was ready to mix the mahua flowers extracted juice. The mahua flowers juice was added in the sugar syrup for preparation of fresh preserved mahua flowers syrup. After proper mixing the fresh mahua flowers preserved syrup was ready for bottling and packing. After bottling and packing mahua flowers syrup was kept in the freeze to feed the bee colony during floral dearth.

Observations recorded

Each of the four treatments with five replications had nearly same brood area and same brood frames for recording the observations of experimental studies. Bee colonies fed with sugar syrup were treated as control, which were identical in strength. There were five replications for each treatment and observations of the experimental studies were recorded with the following parameters:

1. Number of bee frames (covered with bees)
2. Brood area (cm2) during floral dearth.
3. Honey area (cm2) during floral dearth

Measurement of brood area

The brood area of honey bee colony of Apis melifera was measured prior to the feeding in square cm. After feeding of mahua flower preserved syrup, the brood area of each treatment was recorded after 15 days.

Honey storage area

The honey storage area was recorded prior to the feeding of mahua flower preserved syrup to the honey bee (*Apis mellifera*) colony in square cm. After feeding, each treatment of the honey storage area was also recorded after 15 days for experimental observations during floral dearth.

Result and Discussion

The 3.75 liter juice was extracted from 5 kg fresh mahua flowers. Total soluble sugar (TSS) of mahua flowers extracted juice was about 19%. It was estimated by refractometer. The prepared syrups were applied to feed the bee colonies during floral dearth for experimental observations. Nourishment of bee colonies influenced the brood area and honey storage area during floral dearth.

The mahua syrup consists of nutritional ingredients of juice of mahua flowers. This preserved mahua flowers syrup was edible, palatable and acceptable for feeding to bee (A. mellifera) colonies during floral dearth. In floral dearth fresh mahua flowers preserved syrup was fed and eaten by worker bees of the colony. This syrup was more consumed by bees as compared to the barhal fruit juice syrup and PAU bee feed. Feeding of mahua flowers syrup was beneficial effective stimulating and nourishing with nutritional constituents of juice of mahua flowers as bee feed during floral dearth to honey bee colonies. The intake of mahua flowers syrup amount was increased from initial date of feeding to last date and it was about twice of the first day feeding. During floral dearth the average honey storage area of mahua syrup treated bee colony was highest among all the treatments. In this treatment the average honey storage area was 752.5 square cm which was about 1.47 times; 1.18 times and 1.64 times more than the treatment of barhal fruit juice syrup, sugar syrup and PAU bee feed respectively. The honey storage area during floral dearth of treatments of mahua flowers syrup; barhal syrup; sugar syrup; and PAU bee feed treated bee colonies on 15th August, 2nd September, 15th September and 30th September were about 420,920,1030 and 640 square cm; 312,616,648 and 464 square cm; 390,770,810 and 580 square cm; 280.8,554.4,583.2 and 417.6 square cm respectively. Bee colonies survived more by feeding of mahua flowers syrup during floral dearth. During floral dearth the brood area was also varied in the order mahua > barhal > sugar syrup>PAU bee feed.

After 65 days feeding treatment the brood area was observed highest (1116 square cm) on last date (30th September) of feeding in the treatment of mahua flowers syrup fed bee colonies among all treatments. It was about 1.33 times more than the brood area observation of 15th August. In the mahua; barhal; sugar syrup and PAU bee feed treated bee colonies the brood area were about 1116; 754; 913; and 679 square cm. respectively. Brood area of mahua syrup fed bee colonies were about 1.4 times; 1.22 times and 1.6 times more than the barhal, sugar syrup and PAU bee feed treated bee colonies respectively. It was also observed visually that the worker

bees of mahua treated bee colonies were more active, more forager and gatherer of nectar and pollen, more brood producer, more number of comb (bee frames) and contained the greater honey storage areas during floral dearth as compared to the others as well as sugar syrup treated bee colonies respectively.

Bee keepers traditionally feed sugar syrup during such times. Experiments showed that feeding colonies in dearth periods with a syrup made from extract of sun dried flowers of mahua (*Bassia latifolia*) which provides both sugar and protein, was a better alternative, resulting in increased in honey and propolis production increased brood production and multiplication of colonies, increased larval weight, protein and fructose content, compared to the feeding of sucrose syrup (Singh and Upadhyay1999 [7]; Singh and Upadhyay, 2008) [8]. It was also reported by Singh and Singh (1996) [6] that Apis dorsata can be kept at semi protected sites throughout the year by management of availability of food source and favourable temperature. In the mahua syrup treated bee colonies the brood area, and honey storage area during floral dearth were about 1, 33 times and 1.18 times more than sugar syrup fed bee colonies respectively. The brood area on the 1st feeding and last date feeding treatments of mahua flowers syrup were about 833.2 and 1116 square cm, which was 1,33 times more than the 1st day feeding treatment during floral dearth respectively. Enhancement of brood area during floral dearth was itself evidence of stimulation for egg laying of queen, consequently increased the brood area. The experimental findings revealed that nutrition feeding was mandatory during floral dearth for proper growth and development of bee colony.

The quality of food collected by honeybees has an important relationship to the overall hive development, on special attention must be given to the role that food plays on the development of the hypo pharyngeal glands (HG) (Wcislo and Cane 1996) [10]. Hypo pharyngeal glands of workers of *Apis mellifera* L. have been morphologically and physiologically studied due to their importance on the production of royal jelly (Cruz- Landim 2009; [2] Seehuus *et al*. 2007, [5] Gatehouse *et al*. 2004) [4].

Table - 1: Impact of feeding mahua (*B. latifolia*) flowers preserved syrup made from extracted juice of fresh flowers, barhal (*A. lakoocha*) fruit juice syrup, sugar syrup and PAU bee feed (pollen substitute) on brood area development (cm^2) of *Apis mellifera* colony during floral dearth period.

Treatments																							
	Mahua flower syrup (ml.) brood area (cm^2)						Barhal syrup (ml.) brood area (cm^2)						Sugar syrup (ml.) brood area (cm^2)						PAU Bee feed (gm.) brood area (cm^2)					
Date	R1	R2	R3	R4	R5	Mean	R1	R2	R3	R4	R5	Mean	R1	R2	R3	R4	R5	Mean	R1	R2	R3	R4	R5	Mean
15/08/13 standard week no. 33	748	1062	1056	940	360	833.2	620	629.8	704	393.6	309.6	544	525	1116	830	492	387	680	378	803.52	633.6	354.24	278.64	489.6
02/09/13 standard week no. 36	419	682	1308	1248	704	872.2	511.2	358.4	500	421.6	367.2	431.68	889	448	375	527	459	539.6	540.08	322.56	370	379.44	330.48	388.51
15/09/13 standard week no. 37	2396	1729	3067	2562	2100	2370.8	964	1443.2	1086.4	1007.2	1355.2	1171.8	1694	1804	1358	1259	1205	1464	1219.68	1298.88	977.6	906.48	867.6	1054.08
30/09/13 standard week no. 40	940	682	1248	1062	1648	1116	1012	998.4	1038.2	421.6	309.6	754.56	890	1248	1664	527	387	913.2	640.8	898.56	1198.08	379.44	278.64	679.10
SEM						152.90						93.01						130.34						87.49
CD at 5 %						471.16						286.61						401.62						269.60

Table 2: Impact of feeding mahua (*B. latifolia*) flowers preserved syrup made from extracted juice of fresh flowers, barhal (*A. lakoocha*) fruit juice syrup, sugar syrup and PAU bee feed (pollen substitute) on honey area development (cm^2) of *Apis mellifera* colony during floral dearth period

Treatments																								
	Mahua flower syrup (ml.) honey area (cm^2)						Barhal syrup (ml.).) honey area (cm^2)						Sugar syrup (ml.).) honey area (cm^2)						PAU Bee feed (gm.). honey area (cm^2)					
DATE	R1	R2	R3	R4	R5	Mean	R1	R2	R3	R4	R5	Mean	R1	R2	R3	R4	R5	Mean	R1	R2	R3	R4	R5	Mean
15/08/13 standard week no. 33	500	450	350	350	400	420	440	360	240	240	280	312	550	450	300	300	350	390	396	324	216	216	252	280.8
02/09/13 standard week no. 36	900	950	1000	900	850	920	560	680	640	600	600	616	700	850	800	700	800	770	504	612	576	504	576	554.4
15/09/13 standard week no. 37	1050	1050	1050	1000	1000	1030	680	640	560	800	560	648	850	800	700	1000	700	810	612	576	604	620	504	583.2
30/09/13 standard week no. 40	700	850	400	550	700	640	440	640	360	560	320	464	550	800	450	700	400	580	396	576	324	504	288	417.6
Sem						41.432						38.47						51.031						33.91
CD at 5 %						127.666						118.54						157.242						104.92

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