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VITAMIN CHARACTERISTICS OF MULTIFLORAL HONEY OF INDIGENOUS BEE *APIS FLOREA* AND *APIS CERANA INDICA* FROM PLAINS, HILLS AND WESTERN GHATS OF KARNATAKA

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ABSTRACT

Multifloral honey of giant honey bee, *A. florea* (wild) and Indian hivebee, *A. cerana indica* (apiary) was collected from the plains, hills and western ghats of Karnataka and vitamin characteristics were determined during April 2022 to March 2023. Six vitamins *viz*., thiamine (B_1), riboflavin (B_2), niacin (B_3), panthothenic acid (B_5), pyridoxine (B_6) and ascorbic acid (C) were analyzed in honey of wild and apiary honeybees. B_1 (0.07 µ gms) and B_6 (1.80 µ gms) of *A.florea* honey was minimum and maximum from hills and western ghats respectively. Similarly *A.cerana* honey had lowest of B_5 (0.08 µ gms) and highest of B_6 (1.62 µ gms) from hills and western ghats respectively. B_2 (0.12 µ gms - 0.20 µ gms), C (1.32 µ gms - 1.55 µ gms) and B_3 (0.43 µ gms – 0.55 µ gms) of honey demonstrated variations in wild and apiary honeybees. The vitamin C and B_6 of honey was significant at 1% ($p<0.01$) level in plains, hills and western ghats while B_1, B_2, B_3 and B_5 of honey was not significant at 1% ($p<0.01$) level in plains, hills and western ghats of Karnataka. All the six vitamins tested in *A.florea* and *A.cerana* displayed quantitative fluctuations in different geographical areas which are discussed in ensuing paper.

Key words: Apiary, honey, hills, plains, western ghats, thiamine (B_1), riboflavin (B_2), niacin (B_3), panthothenic acid (B_5), pyridoxine (B_6) and ascorbic acid (C), wild, Karnataka.

INTRODUCTION

Honeybees and flowers are classical examples of mutualism and co-evolution. Honeybees are eusocial hymenopterans which are reliant on floral wealth like nectar and pollen. Honey is delectable sweet product, which essentially consists of simple sugars, predominantly laevulose and dextrose [1]. The amount of honey produced from the floral nectaries depends on the total quantity of nectar secreted and the sugar concentration of the nectar [2]. Nectar consists of ions, organic acids, terpenes, alkaloids, flavonoids, carotenoids, xanthophylls, glycosides, vitamins, volatile oils, pinocembrin, galagin, polyphenols, tocopherols, lycopene and amino acids which are obviously found in honey. Because of this unique, complex and typical quality, honey finds place in antiseptic, laxative, antibiotic, pacifier, anti-oxidant and ingredient of variety of pharmaceutical, bakery, cosmetics, confectionary, and tobacco industry. Since times immemorial honey and milk are considered as symbol of prosperity and sanctity. Honey besides milk, curd, sugar and ghee are requisite constituents of panchamrutha, food offerings to God and religious ceremonies [3].

Hitherto the quality of temperate honey of *A.mellifera* including its composition and physico-chemical properties has been well-known. On the contrary, information on composition of tropical honeybee *A.cerana* honey is limited [4, 5, and 6]. Interestingly, no information is available on minor constituents of honey like vitamin B_1, B_2, B_3, B_5 and B_6 and C in wild and apiary honeybees which are essential as co-enzyme precursors and anti-oxidants Therefore, primary aim of the current study is to provide comprehensive information on the vital six vitamins in *A.florea* and *A.cerana* honey in plains, hills and western ghats of Karnataka.

MATERIALS AND METHODS

Karnataka state extends from 11º 5 N to 19 º NL and from 74 º E 78 º EL. It lies in Deccan plateau with three major physical divisions' viz., coast, malnad and maidan. The total geographical area of the State is 1, 91,791 sq. kms, of which 54.70 % as net sown area, 16.14% forests, 10.66% not available for cultivation, 9.55% uncultivated land and 8.96% fallow land. The flora of Karnataka is rich and diversified, which includes agricultural, plantation, commercial, horticultural and forest flora. The temperature varied from 11 º C to 41 º C and the humidity ranges from 27.7% to 83.45%. The western ghats popularly well-known as Sahyadri hills are formed by the Malabar plains and succession of mountains running parallel to Indian west coast. Western ghats covers a large area from southern region (Agastyamalay range to Kalakkad Mundantorai Hill ranges) to Gujarat (Surat Dings) in the North. The entire hill range is divided into three regions namely southern western ghats (Kalakkad Mundantorai to Palghat), Central western ghats (Nilgiri- Wyanaad to Goa) and Northern western ghats (Northern Goa, Rathnagiri, Amboli to Dings in Gujarat). The rainfall is mainly due to South-west monsoon and the rainfall drastically reduces from south to north. The western ghats regarded as one of the twelve global hotspots of biodiversity and one of the two biodiversity hotspots in India with huge capacity of endemic species of flora and fauna. Unique floral and faunal assemblages characterize the biodiversity of the western ghats. Western ghats does support a significant diversity of endemic species, with nearly fifty

species and one endemic genus of bat along with lion tailed macaques, nilgiri martin and brown palm. In addition, Western ghats support innumerable genera of Arthropoda including wild and domesticated honeybee species due to variety of forest, plantation, horticultural and agricultural bee flora which yield pollen and nectar throughout the year which are pre-requisite for survival, propagation and honey production in these areas.

Honey collection

Four districts center each namely Hassan and Chickamagalur from hills and Madikeri and Uttara Kannada from Western Ghats were selected for the present study. From each district centres, twenty honey samples were collected and analyzed from mineral characteristics. Honey samples of domesticated hive bee, *A. cerana* were collected from the beekeepers and that of the rock bee, *A. florea* was procured from tribals and honey hunters. The honey of *A. cerana* was extracted by honey extractor and that of *A.florea* was obtained by squeezing and filteration. All honey samples were raw and unprocessed.

Preparation of honey samples

The honey samples were collected in sterilized polythene bottles from the place of honey extraction. The honey was filtered through single thickness fine cloth to remove suspended particles like dirt, beeswax and other impurities. Later it was stored in airtight container at room temperature under hygienic conditions.

Analysis of honey samples

Floral analysis of honey

All honey samples were prepared according to the method described by [7] for the identification of their floral source on the basis of pollen grains.

Determination of Vitamins in honey

Raw honey samples collected from *A.florea* and *A.cerana* were used for analysis of vitamins levels. B_1, B_2, B_3, B_5, B_6 and C vitamins in honey were determined by the method followed. All vitamins are measured in micrograms/ 100 gms. of honey [8].

Statistical analysis of Data

Data of the six vitamins of honey samples from plains, hills and western ghats were analyzed by F-test. The analysis of variance (ANOVA) along the F-test was calculated and significant levels were determined using F-table ($p<0.01$and $p<0.05$).

RESULTS AND DISCUSSION

Melissopalynological studies of honey samples from the study area revealed the occurrence of plantation, (*Cocus nucifera, Coffea arabica, Tectona grandis*), forest flora, (*Syzygium caryophyllatum, Borassus flabellifera, Sapindus emarginatus*) and commercial crops (*Musa paradisiaca, Ricinus communis Anacardium occindentale*) along with many other minor floral resources (Table 2, 3 and 4). Abundant floral resources coupled with suitable environmental factors are mainly responsible for copious honey production in these

regions. Further, bee flora was found throughout the year particularly in western ghats as when compared to plains and hills of Karnataka.

Table 2. Major bee flora of plains of Karnataka.

Sl. No	Family	Botanical name	Source
1	*Anacardiaceae*	*Mangifera indica*	N + P
2	*Compositae*	*Helianthus annus*	N + P
3	*Compositae*	*Tridax procumbens*	N + P
4	*Cruciferae*	*Brassica juncea*	N + P
5	*Cruciferae*	*Brassica nigra*	N + P
6	*Fabaceae*	*Tamarindus indica*	N + P
7	*Fabaceae*	*Pongamia pinnata*	N + P
8	*Fabaceae*	*Peltophorum pterocarpum*	N + P
9	*Meliaceae*	*Azadirachta indica*	N + P
10	*Umbelliferae*	*Coriandrum sativum*	N + P

N= Nectar. P= Pollen.

Table 3. Major bee flora of hills of Karnataka.

Sl. No	Family	Botanical name	Source
1	*Aracaceae*	*Cocus nucifera*	N + P
2	*Anacardiaceae*	*Anacardium occidentale*	N+ P
3	*Fabaceae*	*Pterocarpus santalinus*	N + P
4	*Fabaceae*	*Tamarindus indica*	N + P
5	*Myrtaceae*	*Eucalyptus species*	N + P
6	*Polygonaceae*	*Antigonon leptopus*	N + P
7	*Rutaceae*	*Citrus species*	N + P
8	*Verbenaceae*	*Tectona grandis*	N + P

N= Nectar. P= Pollen.

Table 4. Major bee flora of Western ghats of Karnataka.

Sl. No	Family	Botanical name	Source
1	*Aracaceae*	*Borassus flabelliformis*	N + P
2	*Aracaceae*	*Cocus nucifera*	N + P
3	*Bignoniaceae*	*Tectoma stans*	N +P
4	*Compositae e*	*Ageratum conyzoides*	N + P
5	*Euphorbiaceae*	*Ricinus communis*	N + P
6	*Musaceae*	*Musa paradisiaca*	N
7	*Myrtaceae*	*Syzygium caryophyllatum*	N + P
8	*Rubiaceae*	*Coffea arabica*	N
9	*Sapindaceae*	*Sapindus emarginatus*	N + P
10	*Verbenaceae*	*Tectona grandis*	N + P
11	*Zygophyllacea*	*Tribulus terrestris*	N + P

N=Nectar. P=Pollen.

The vitamins of honey of two honeybee species were clearly categorized as major vitamins B_6 and C while minor vitamins B_1, B_2, B_3 and B_5 based on quantity of individual components. B_6 was highest of 1.80 µ gms and lowest of 1.40 µ gms in *A.florea* and *A.cerana* honey from western ghats and hills respectively (Fig 2 and 3). B_1 was minimum of 0.07 µ gms and minimum of 0.10 µ gms in *A.florea* and *A.cerana* honey from hills and western ghats (Fig 2 and 3). B_2 was lowest 0.12 µ gms in honey of *A.cerana* from plains and highest of 0.20 µ gms from Western Ghats (Fig 1 and 3). B_5 was highest of 0.25 µ gms and lowest of 0.11 µ gms in *A.florea* and

A.cerana honey from western ghats and plains respectively (Fig 1 and 3). B_3 was maximum of 0.55 µ gms and minimum of 0.43 µ gms in *A.cerana* honey from western ghats and hills respectively (Fig 2 and 3). C was highest of 1.55 µ gms and lowest of 1.28 µ gms in *A.florea* and *A.cerana* honey from western ghats and hills respectively (Fig 2 and 3). The C and B_6 of honey was significant at 1% ($p<0.01$) level in plains, hills and western ghats while B_1, B_2, B_3 and B_5 of honey was not significant at 1% ($p<0.01$) level in plains, hills and western ghats of Karnataka. In the present study maximum quantity of B_6 (1.80 µ gms) was observed, followed by C (1.55 µ gms) and least amount of B_1 (0.03µ gms). Qualitative variations of vitamins do not occur, but there is gradual significant quantitative augmentation of vitamins in each stage of honey ripening [9]. Although vitamins in honey are found in diminutive quantities, deficiency may cause some disorders, *viz*., B_1 (beriberi), B_2 (dermatitis), B_3 (pellagra), B_5 (nervous problems), B_6 (anemia) and C (scurvy). They are also essential for metabolic reactions and as coenzymes [10, 11, and 12]. All Vitamin of B are commonly referred as B complex, in general indispensable for healthy skin and nervous system and C for prevention of internal hemorrhage, bleeding gums, loosening of teeth and swollen tender joints. [13] reported that C is a powerful activator of the glucose oxidase system. [14] have found high C values ranging from 1.18-2.40 µ gms for three samples of honey of unknown source from mountains of Damavand area in Iran. He also reported an average vitamin C requirement of 3-6 µ g/day for animals used and concluded that honey actually contained 7.5 -15.0 µ g of C. They have suggested the possibility of encouraging the use of honey from this region as means of helping to relieve the marginal vitamin C deficiency often found in Iran leading to scurvy and bleeding problems.

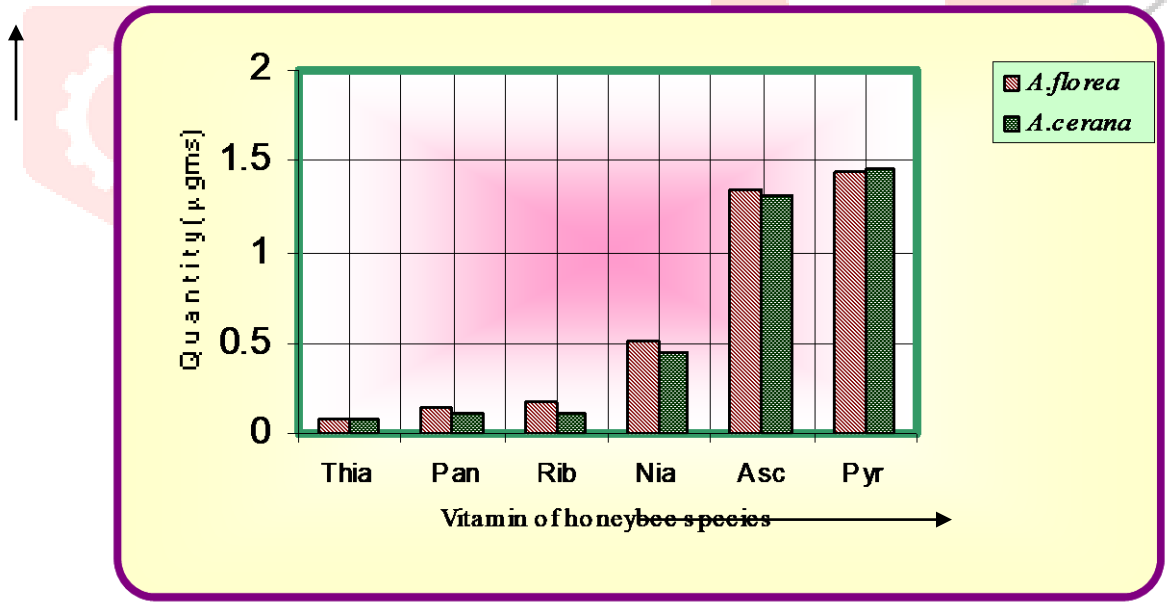

Fig.1.Vitamins of *A.florea* and *A.cerana* honey * from plains of Karnataka in 2011-12.

Vitamins are measured in micrograms/ 100 gms. of honey.

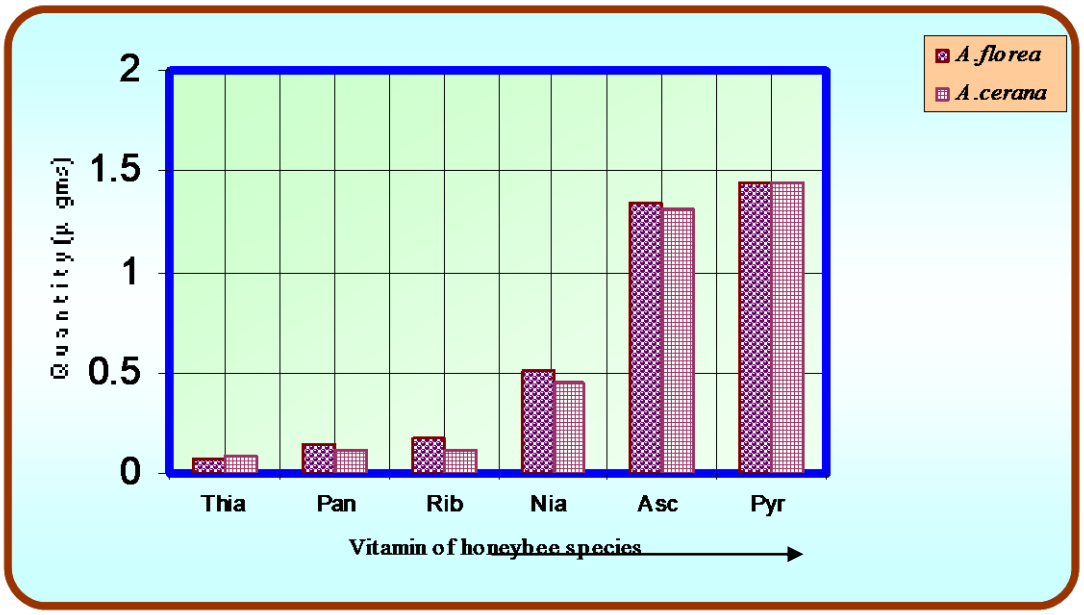

Fig.2.Vitamins of *A.florea* and *A.cerana* honey* from hills of Karnataka in 2011-12.

* Vitamins are measured in micrograms/ 100 gms. of honey.

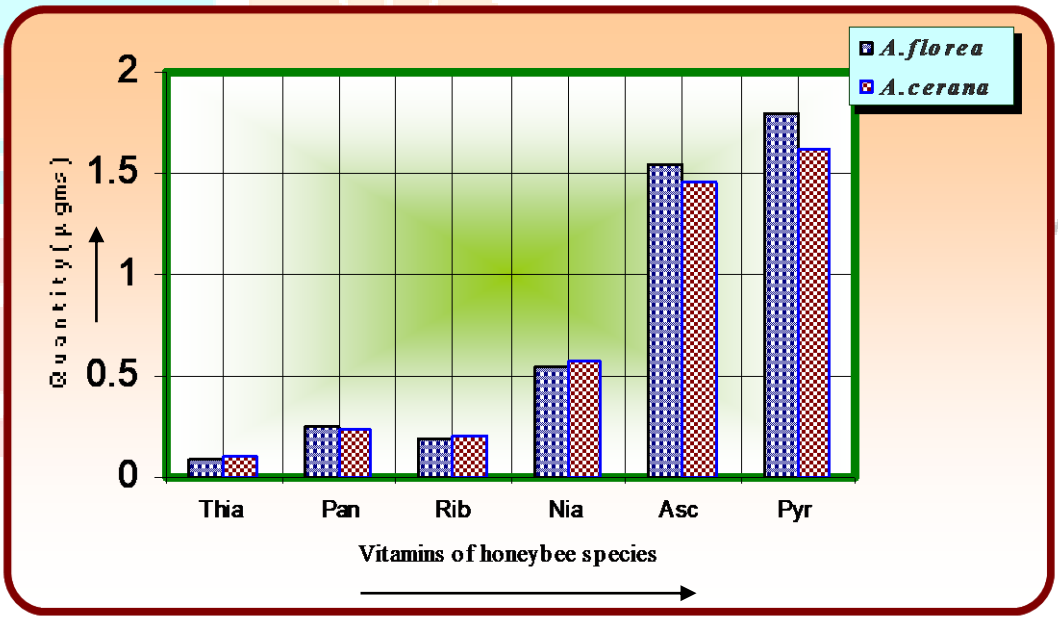

Fig.3.Vitamins of *A.florea* and *A.cerana* honey * from Western Ghats of Karnataka in 2011-12.

* Vitamins are measured in micrograms/ 100 gms. of honey.

[15] reported that the commercial filtration of honey reduced vitamins content by amounts from 8% - 45%. This was basically attributed to more the complete removal of pollen from honey. Vitamins B_1, B_2, B_3, B_5, B_6 and C of honey are water-soluble and hence liable to be destroyed due to extreme heat [16].

CONCLUSIONS

The multitude properties of honey are exclusively reliant on chemical composition of floral nectaries. Like to any other component, vitamins of honey are also derived from floral nectar. The vitamins analyzed in honey of both wild and apiary honeybees was B_1, B_2, B_3, B_5, B_6 and C. B_6 in honey was highest (1.80 µ gms) and B_1

(0.07 µ gms) of *A.florea* honey was minimum and maximum from hills and western ghats respectively throughout five stages of ripening of honey. The transformation of nectar to honey involves quantitative physical, chemical behavioral (fanning activity and thermoregulatory) and biochemical changes. During the path of formation of honey, vitamins are also steadily augmenting to optimal levels found in comb honey.

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