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Section D: General Section

Research Article

Mineral characteristics of indigenous bee, *Apis dorsata* and *Apis cerana indica* honey from plains, hills and western ghats of Karnataka.

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ABSTRACT

Multifloral honey of giant honey bee, *A. dorsata* (wild) and indian hivebee, *A. cerana indica* (apiary) was collected from the plains, hills and western ghats of Karnataka and mineral characteristics were determined during April 2010 to March 2011. Honey of *A. dorsata* had more mineral content than that of *A.cerana.* Often mineral characteristics tested in honey, potassium was found maximum while chromium was minimal. Seasonally, mineral content of honey was relatively more in winter than summer. Mineral content of honey was higher in Western Ghats followed by plains and hills. The potassium, phosphorus, calcium, sodium and magnesium of honey were significant at 1% (P<0.01) levels in hills and Western Ghats and not significant in plains of Karnataka. Further iron, manganese, copper, chromium and zinc were not significant at 1% levels in plains, hills and western Ghats of Karnataka.

Key words: Mineral characteristics, honey, hills, plains, Western Ghats of Karnataka.

INTRODUCTION

Honeybees effectuate nectar to honey transformation. Honeybees are eusocial hymenopterans which are reliant on floral wealth like nectar and pollen. Honeybees and flowers are classical examples of mutualism and co-evolution. Nectar is dilute sugar-solution secreted by floral glands termed as nectaries. The amount of honey produced from the nectaries depends on the total quantity of nectar secreted and the sugar concentration of the nectar[1]. Nectar consists of ions, organic acids, terpenes, alkaloids, flavonoids, carotenoids, glycosides, vitamins, phenolics, volatile oils, and amino acids which are obviously found in

honey. Because of this unique, complex and distinctive 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 indispensable ingredients of panchamrutha, food offerings to God and religious ceremonies. Honey is as "nectar gathered, modified, stored and sealed by bees in well planned and architected hexagonal comb cells". Honey is truly remarkable product elaborated by bees to high-density and high-calorific food [2].

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 honey is limited [3, 4, 5, 6]. Interestingly, no information is available on the composition including the mineral characteristics of indigenous honeybee species from plains, hills and Western ghats of Karnataka. The primary objective of the present study is to provide comprehensive information on the mineral characteristics of honey of two indigenous honeybee species, *A. dorsata* and *A. cerana* from three geographical diverse zones *viz*., plains, hills and Western Ghats of Karnataka.

MATERIALS AND METHODS

Karnataka state extends from 11^{o} 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: Two districts centers each namely Tumkur and Chickaballapur from plains, 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. dorsata* was procured from tribals and honey hunters. The honey of *A. cerana* was extracted by honey extractor and that of *A.dorsata* 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

articles like dirt, beeswax and other impurities. Later it was stored in airtight container at room temperature under hygienic conditions.

Analysis of honey samples: 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. The detection of potassium, calcium, sodium, magnesium, iron, manganese, copper, chromium and zinc was done by Atomic Absorption Spectroscopy **Table 1**. The phosphorous was identified by colorimeter method [8].

Table- 1: Wavelength and fuel required for different mineral constituents

Sl. No	Element	Wave length (nm)	Fuel
1	Potassium	766.6	Air/ Acetylene.
2	Calcium	228.85	Air/ Acetylene.
3	Sodium	166.6	Air/ Acetylene.
4	Magnesium	285.20	Air/ Acetylene.
5	Iron	248.37	Air/ Acetylene.
6	Manganese	279.9	Air/ Acetylene.
7	Copper	324.80	Air/ Acetylene.
8	Chromium	357.90	Air/ Acetylene.
9	Zinc	213.90	Air/ Acetylene.

Lamp current: 3.5 m A.

Statistical analysis of Data: Data of the mineral characteristics 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 minerals of honey of three honeybee species were clearly categorized as major minerals (potassium, phosphorous, calcium, sodium and magnesium) and minor minerals (iron, manganese, copper, chromium and zinc) based on quantity of individual elements. Potassium content of *A.dorsata* honey was highest 70.12 ppm while *A.cerana* honey was 68.50 ppm and magnesium content of *A. dorsata* and *A cerana* was 3.10 ppm and 2.94 ppm respectively from western ghats **(Fig. 1).** The analysis of variance of potassium and magnesium of honey of Western Ghats was significant at 1 % levels. Potassium content of *A.dorsata* honey was 68.10 ppm and 66.34 ppm in *A.cerana* honey in plains. Magnesium content of *A.dorsata* and *A.cerana* honey was 2.83 ppm and 1.43 ppm respectively **(Fig. 2).** The analysis of variance of potassium and magnesium of honey of plains was not significant at 1 % levels. Potassium content of *A.dorsata* and *A.cerana* honey was least of 66.12 ppm and 64.57 ppm respectively in hills. Similarly, magnesium content of *A. dorsata* was 2.51 ppm and *A cerana* was 1.20 ppm **(Fig. 3).** The analysis of variance of potassium and magnesium of honey of hills was significant at 1 % levels.

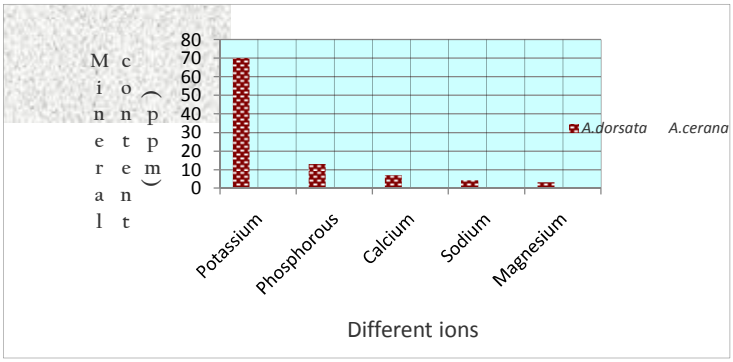

Fig. 1: Major mineral content of honey *of A.dorsata* and *A.cerana* from Western Ghats of Karnataka in the year 2010-11.

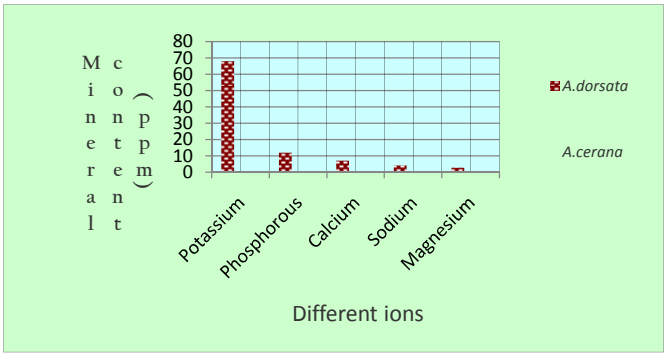

Fig. 2: Major mineral content of honey *of A.dorsata* and *A.cerana* from plains of Karnataka in the year 2010-11.

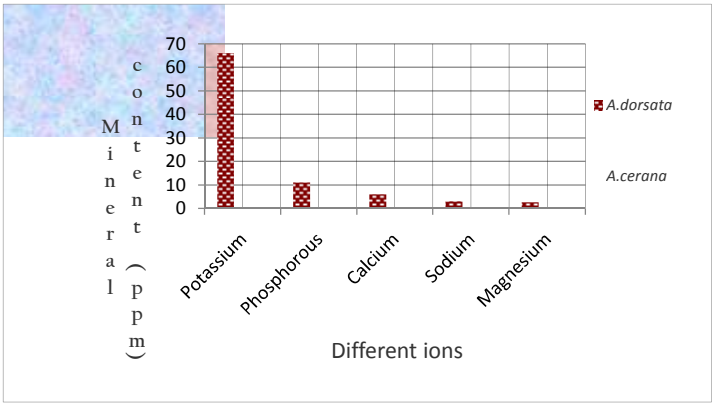

Fig. 3: Major mineral content of honey *of A.dorsata* and *A.cerana* from hills of Karnataka in the year 2010-11.

Iron content of *A.dorsata* honey was highest 0.70 ppm while *A.cerana* honey was 0.68 ppm while chromium content of *A. dorsata* and *A cerana* was also more of 0.029 ppm and 0.025 ppm respectively from western ghats **(Fig. 4).**

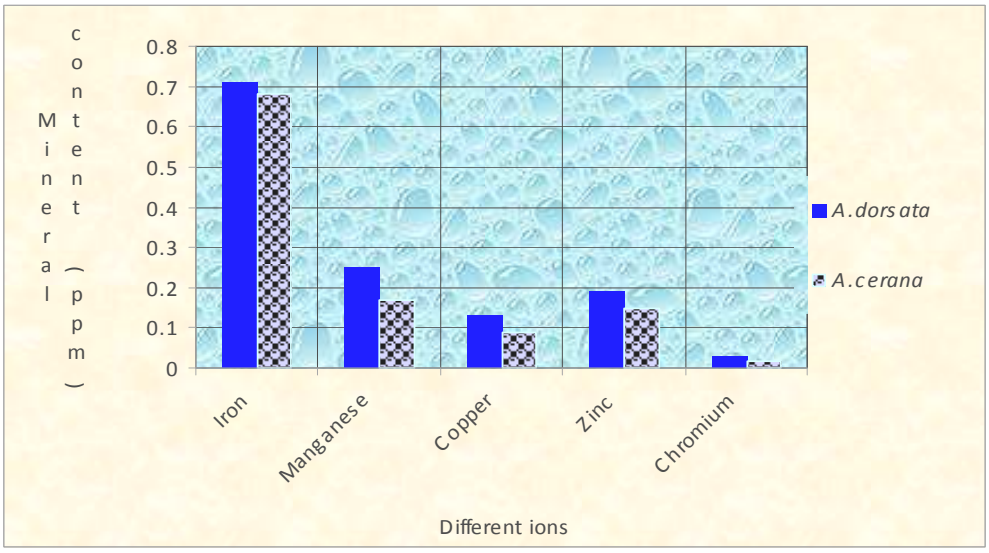

Fig. 4: Minor mineral content of honey *of A.dorsata* and *A.cerana* from Western ghats of Karnataka in the year 2010-11.

The analysis of variance of iron and chromium of honey was not significant at 1 % levels. Iron content of *A.dorsata* honey was 0.68 ppm while *A.cerana* honey was 0.65 ppm similarly, chromium content of *A. dorsata* and *A cerana* was 0.025 ppm and 0.014 ppm respectively from plains **(Fig. 5).** The analysis of variance of iron and chromium of honey was not significant at 1 % levels. Iron content of *A.dorsata* honey and *A.cerana* honey was least of 0.64 ppm and 0.61 ppm respectively and chromium content of *A. dorsata* and *A cerana* was 0.020 ppm and 0.012 ppm respectively from hills of Karnataka **(Fig.6)**.

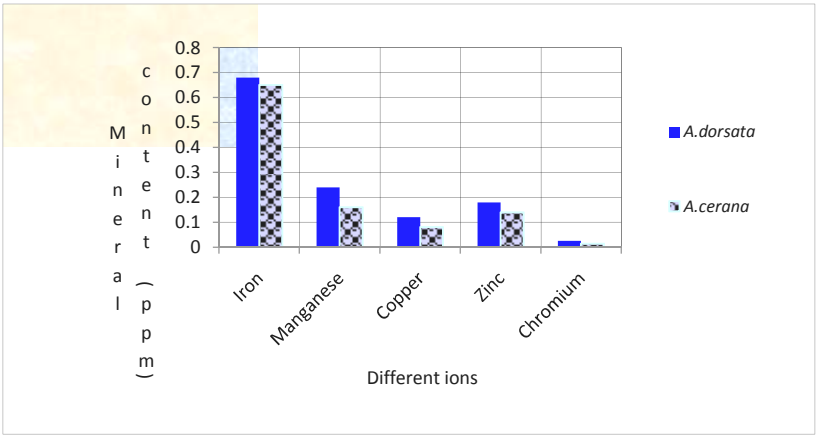

Fig. 5: Minor mineral content of honey *of A.dorsata* and *A.cerana* from plains of Karnataka in the year 2010-11.

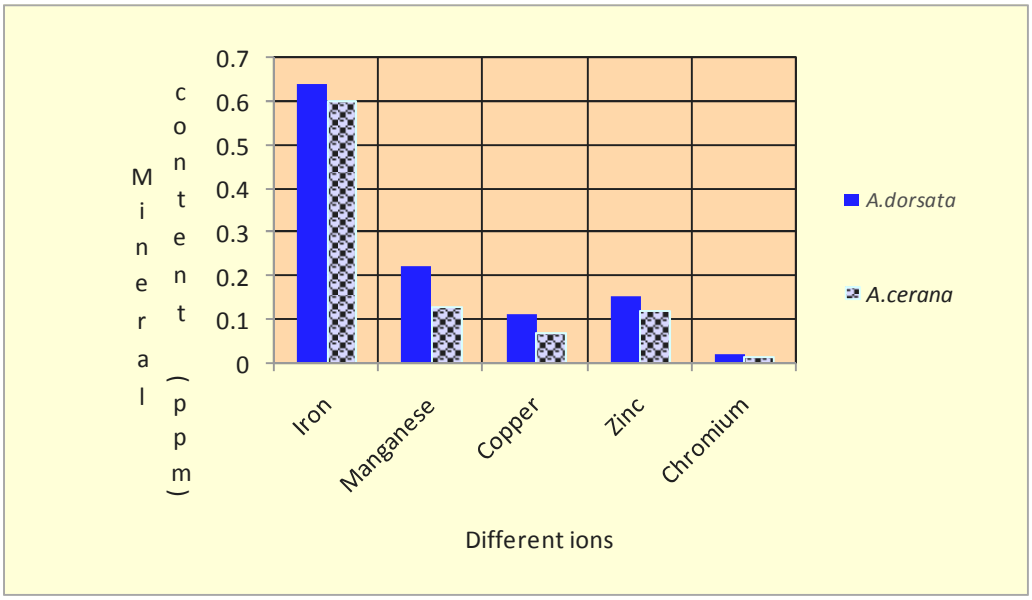

Fig.6: Minor mineral content of honey *of A.dorsata* and *A.cerana* from hills of Karnataka in the year 2010-11.

The analysis of variance of iron and chromium of honey was not significant at 1 % levels. [9] analyzed honey samples and reported average content of phosphorous, potassium, calcium, magnesium, iron and zinc in range of 8-10ppm, 65-75ppm, 6-7ppm, 2-4 ppm, 0.25-0.52 ppm and 0.012 – 0.029ppm respectively in North-Western Himalayas. [10] reported positive correlation of most of the minerals such as potassium, iron, manganese and magnesium content of honey with electrical conductivity. Honey contains less sodium than potassium and hence it is suggested to use Na/K ratio to detect honey adulteration. Various parameters such as color, aroma, flavour, texture, medicinal properties of honey are largely dependent on mineral content which eventually are derived from floral resources [11].

A. dorsata honey of Western ghats showed maximum ash content (0.89%) followed by plains (0.78%) and hills (0.61%) of Karnataka while *A. cerana* honey of Western ghats showed least ash content (0.70%) followed by plains (0.65%) and hills (0.53%) of Karnataka **(Fig. 7).**

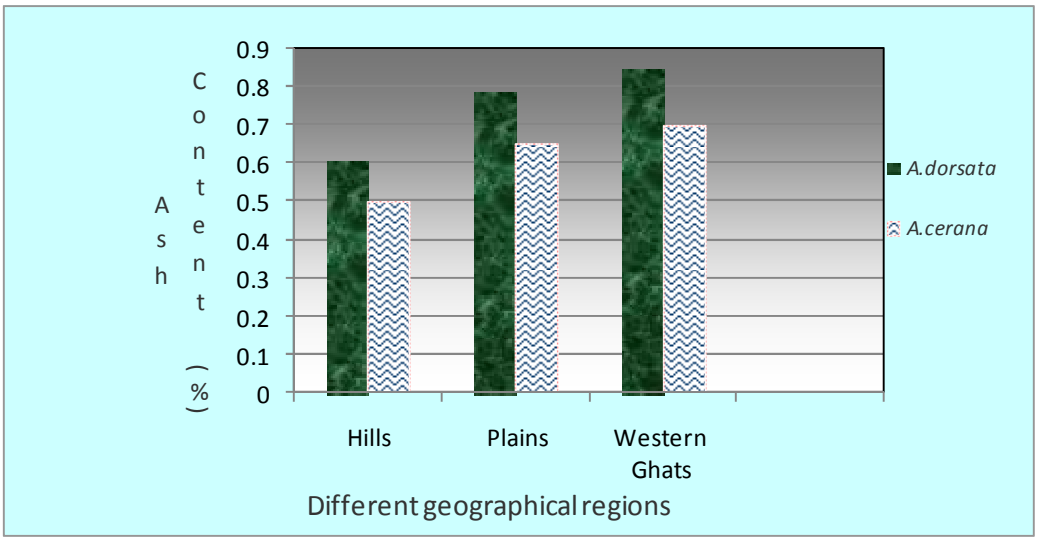

Fig. 7: Ash **content of honey in hills, plains and Western Ghats during year 2010-11.**

The mean ash content of honey was 0.70% and potassium was most abundant of all the elements [12]. Ash content of different honey samples from different honeybee species varied due to different floral sources,

climatic conditions and edaphic factors [13]. Darker and stored honeys have comparatively higher ash content than lighter and fresh honey samples.

Mineral content of *A.dorsata* honey was 0.85% and 0.55% in summer and winter seasons from western ghats, while mineral content of A.cerana honey was 0.73% and 0.51% in similar seasons in hills of Karnataka **(Fig. 8)** Similar findings were found by [14] in honey of *A.cerana* in North-western Himalayas. Mineral content of honey from all two honeybee species varied seasonally due to diversity of floral resources and nectar composition. Honeys are rich in ash content and highly variable with species of honeybee. Honey may be also dark which are related to the plant source of honey, which include a high content of tyrosine, tryptophan and the presence of polyphenolic compounds [15, 16].

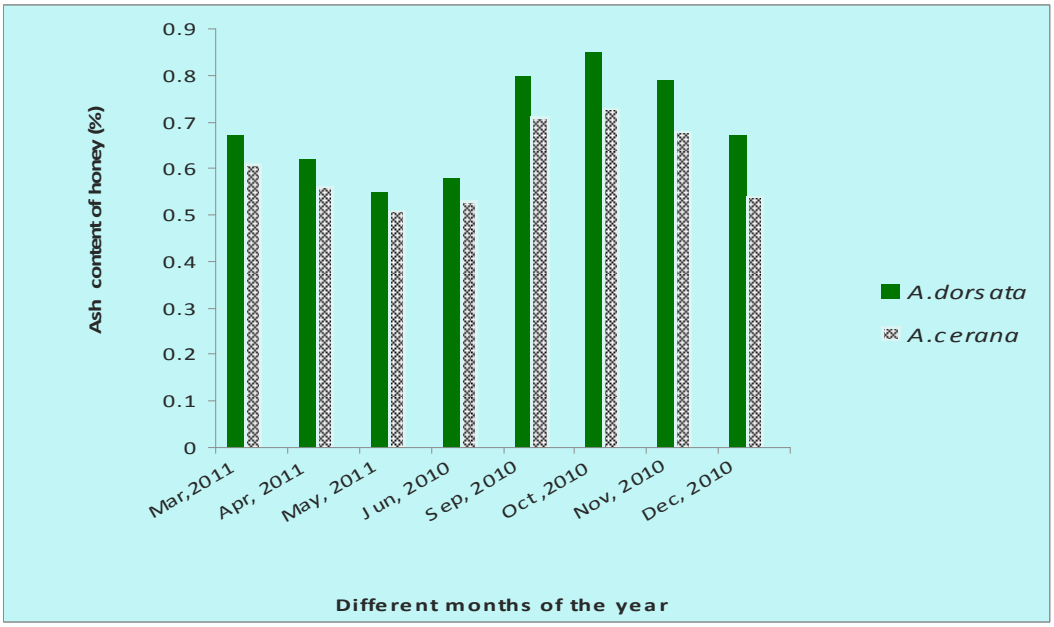

Fig. 8: **Ash content of honey of *A.dorsata* and *A.cerana* in summer and winter honey flow season during the year 2010-11.**

Honey that is available in the market for human consumption must be well ripened and must be free from extraneous materials such as excessive pollen, dust, insect parts, wax and other impurities. It must, of course, be free of-off flavors or color of any origin. Honey must be as original as it exists in the cells of comb before it is extracted. To market honey in its original conditions of high quality and delectable flavour and aroma is possibly the greatest challenges of the beekeepers, honey packers and traders.

CONCLUSION

Fundamentally, honey is a supersaturated solution of monosaccharides (laevulose and dextrose) and small quantities of sucrose. In addition, honey has variety of other components like minerals, acids, pigments, vitamins and amino acids. Of all the minerals tested in honey samples from two indigenous honeybee species, potassium and chromium was maximum and minimum respectively. Honey from western ghats had higher mineral content compared to plains and hills of Karnataka. Mineral content of *A.dorsata* honey was more compared to *A.cerana*. Therefore it becomes essential to analyze minerals besides physical and chemical characteristics for preparation of Ayurvedic and related other naturopathic therapies.

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