INTERNATIONAL JOURNAL OF APPLIED BIOLOGY AND PHARMACEUTICAL TECHNOLOGY

Volume: 2: Issue-3: July-Sept -2011 IJABPT *ISSN 0976-4550*

QUANTITATIVE PHYSICAL VARIATIONS IN RIPENING OF HONEY OF INDIGENOUS HIVE BEE *APIS CERANA INDICA*

M.V.BALASUBRAMANYAM

Department of Zoology,
Maharani's Science College for Women, Palace Road, Bangalore – 560 001.
balu_mv09@yahoo.com

ABSTRACT: Physical factors of refractive index, optical density, viscosity and surface tension demonstrated quantitative change throughout five stages of honey ripening process in indigenous hive honeybee *Apis cerana indica*. The five stages of nectar to honey transformations include floral nectar (fn), honey crop of foragers (hf), honey crop of house bees (hh), unsealed honey cells (uh) and sealed honey cells (sh). All the four physical factors gradually augmented through successive stages of honey ripening phenomena. The refractive index of floral nectaries and sealed honey cells was 1.23 and 1.49 respectively. Similarly, the optical density of house bees and unsealed honey cells was 0.39 and 0.54 respectively. Viscosity and surface tension of honey crop of foragers and sealed honey cells were 0.15 poise, 0.76 dynes/cms. and 76.65 poise, 102.01 dynes/cms. respectively. The analysis of variance (ANOVA) of viscosity and surface tension in honey formation was significant at P<0.01% levels and refractive index and optical density of honey in ripening process was not significant at P<0.01% levels
Key words: *Apis cerana indica*, honey ripening, physical factors.

INTRODUCTION

Honeybees and flowers are classical examples of mutualism and co-evolution. Honeybees are also true bioindicators of nature. Honeybees are eusocial hymenopterans which are entirely dependent on floral resources like nectar and pollen. Honey is truly remarkable product elaborated by honeybees to high-density and high-calorific food [1]. Since times immemorial honey and milk are considered as symbol of prosperity and sanctity. Honey besides milk, curd, sugar and ghee are essential ingredients of panchamrutha, food offerings to God and religious ceremonies. Honey is as "nectar gathered, modified, stored and sealed by honeybees in well planned and architected hexagonal comb cells". Honey has entice flavour, color, aroma and texture mainly due to the presence of volatile oils, flavonoids, aromatic acids, carotenoids and polyphenols. Because of this unique and complex nature, honey get place as an antiseptic, laxative, antibiotic, pacifier, anti-oxidant and ingredient of variety of pharmaceutical, bakery, cosmetics, confectionary, and tobacco industry. Nectar is dilute sugar-solution secreted by floral glands termed as nectaries. The quantity of honey that produced from the nectar of single flower depends on the total amount of nectar secreted and the sugar concentration of the nectar [2].

The quality of honey of European honeybee *A. mellifera* including its composition and physico-chemical properties are well documented. On the contrary, information on nectar to honey transformation of Asiatic hivebee *A. cerana indica* is limited [3]. Interestingly, no information is available on the physical factors influencing transformation of nectar to honey of indigenous honeybee species. The primary objective of the present study is to characterize the physical factors involved in the ripening of honey.

MATERIALS AND METHODS

The study area, Bangalore district is situated at 12º 58' to 13 º 65 North latitude to 77º 35' to 77º 40 East longitude with an elevation of 928m. It has an area of about 998 sq. km. The average rainfall is about 780 cms. with June to October as peak rainfall period. The temperature varied from 15º to C to 37.9 º C and humidity varied 42.5% to 84.5%. The flora of Bangalore district consists of diversified and includes ornamental, plantation, agricultural, horticultural and food crops. Further, the honeybee species are very well distributed in the study area, *A.cerana* exist both as wild and domesticated species, whereas *A. dorsata* and *A.florea* exists as only feral species. The nectar samples from floral nectaries, honey crop of foragers, honey crop of house bees, honey from unsealed honey cells and honey from sealed honey cells were collected from Shivakote, Bangalore North district, Karnataka.

Collection of nectar and honey

The floral nectar was collected in morning hours (07.30 hrs – 8.30 hrs) and late afternoon (3.00hrs to 4.30hrs) by using micropipette and immediately stored in vials of 0.5ml. The forager bees with swollen abdomen and without pollen pellets in corbiculae were captured near the hive entrance by using sweep net. Then they were anesthetized and abdomen was squeezed, the contents were drawn into micropipette [4]. To detect whether the foragers brought nectar or water, a filter paper test was conducted. Similar tests were conducted from the honey crop of the house bees inside the hive. The nectar deposited by house bees into empty cells of honeycomb remains for 4-5 days depending upon the inflow of nectar. The nectar from unsealed honey cells was collected after 1- 2 days of deposition. About 0.5ml.of unripened honey was collected from each unsealed honey cells. The ripened honey covered with thin layer of wax was used for analysis after removing thin layer of wax. The honey was extracted by using honey centrifugation.

Determination of refractive index of honey

Refractive index of nectar, nectar of foragers, house bees, unsealed honey and sealed honey was measured with the help of Abbe's refractometer [5].

Detection of optical density of honey

Optical density of nectar, nectar of foragers, house bees, unsealed honey and sealed honey was determined by colorimeter [5].

Measurement of viscosity of honey

Viscosity of nectar, nectar of foragers, house bees, unsealed honey and sealed honey was measured by Oswald's viscometer [5].

Calculation of surface tension of honey

The capillary drop weight is used to calculate the surface tension of nectar, nectar of foragers, house bees, unsealed honey cells and sealed honey cells [5].

Statistical analysis of data

Data of all four physical characteristics of different stages of honey ripening was 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

The transformation of floral nectar into sealed honey is progressive and definitive process. Honey ripening duration fluctuates with the species, colony size, climatic, floral and seasonal conditions. Honey ripening process duration is in between 126.5 ± 1.43 hrs to 138.5 ± 3.65 hrs.

The refractive index of fn was 1.23 and of hf had value of 1.3901, while the refractive index of nectar of hh had value of 1.4034. Further, the refractive index of uh and sh cells was 1.4567 and 1.4956 respectively (Fig. 1). The analysis of variance of refractive index of honey during different stages of ripening was not significant at 1% levels. Refractive index is the measure of ratio of velocity of light in free space to that of medium (honey). Similar results were reported by [6] in Venezuelan honeys where the refractive index was 1.49. Lesser refractive index indicates higher moisture content and higher refractive index means lower moisture content of nectar and honey. There is positive correlation of refractive index with specific gravity, viscosity and surface tension. Further, results suggest that all physical and chemical characteristics of honey differ with variations in refractive index [7].

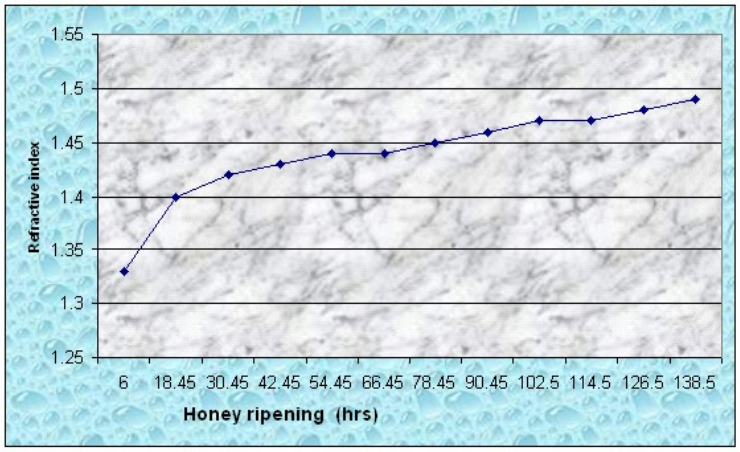
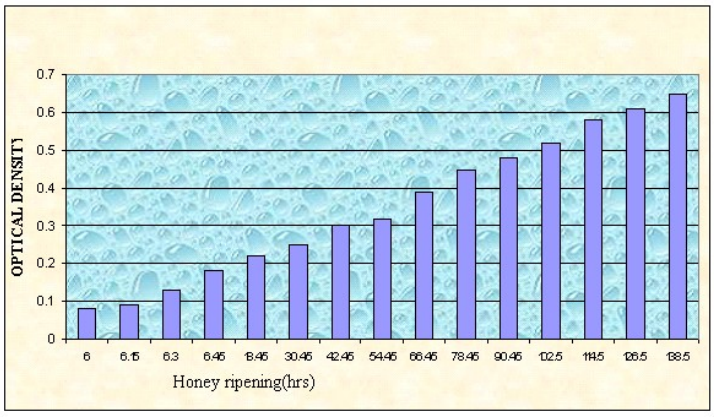


Fig.1 Refractive index of honey in different hours of ripening

The optical density of sh cells were maximum with value of 0.68 and were minimum of 0.02 in the fn. The optical density of honey of uh cells and nectar of hh was 0.54 and 0.39 respectively (Fig. 2). The analysis of variance of optical density of honey during different stages of ripening was not significant at 1% levels. The optical densities of all honey samples are laevorotatory due to high amount of fructose. Fresh and pale honeys have less O.D compared to dark and stored honey samples. Generally, lighter honeys have more consumer demand than darker honey [8]. Colours of honey vary from pale yellow to nearly black. Colour variation of honey is entirely due to presence of pigments in the nectar, although, the colour may fluctuate depending on the storage conditions. The optical density increases due to heating, which hasten the formation of hydroxymethyl furfuraldehyde (HMF). HMF is breakdown product of fructose formed due to heating or storage.

Colour variation alters flavor and aroma of honey. Usually light floral honeys are mild in flavor than the darker honey [9]. The flavor and aroma judgments are personal, individual preferences may differ considerably.



.Fig.2. Optical density of honey in different hours of ripening

The viscosity of nectar in hf and nectar in hh had value of 0.15 poise and 0.21 poise respectively. The viscosity of honey of uh cells was 34.77 poise, while the honey of sh cells and fn was 76.94 poise and 0.08 poise (Fig. 3). The analysis of variance of viscosity of honey during different stages of ripening was significant at 5% levels. Viscosity is measure of the resistance of fluid to flow caused by internal friction, which results in different rates of flow in different parts of the liquid, denoted by η (eta). Viscosity of honey also depends on the nature of nectar. Viscosity of honey samples decrease with the increase in temperature. Summer honey samples had less viscosity than autumn honey [10]. Higher viscosity of honey causes severe problems during straining, processing and storage.

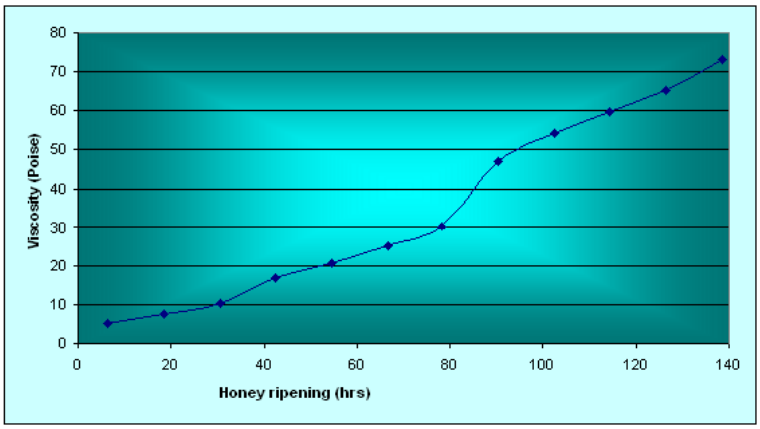


Fig.3 Viscosity of honey in different hours of ripening

The surface tension of fn was 0.39 dynes/ cms and nectar of hf and nectar in hh was 0.76 dynes/cms and 1.34 dynes/cms respectively. The surface tension of honey of uh cells was 25.95 dynes/cms. while the honey of sh cells was 102.01 dynes/cms. (Fig.4). The analysis of variance of surface tension of honey during different stages of ripening was significant at 5% levels. Surface tension is film-like tension on the surface of honey caused by the cohesion of fructose, glucose, sucrose and other suspended constituents, which has the effect of minimizing its surface area. Generally honey with higher water levels has higher surface tension than honey with lower water levels [11]. Surface tension of surface honeys had a mean value of 108.87 dynes/cms ± 1.8 S.E, while bottom honey samples had slightly lower surface tension having mean value of 107.97 dynes/cms ±1.63 S.E. [12].

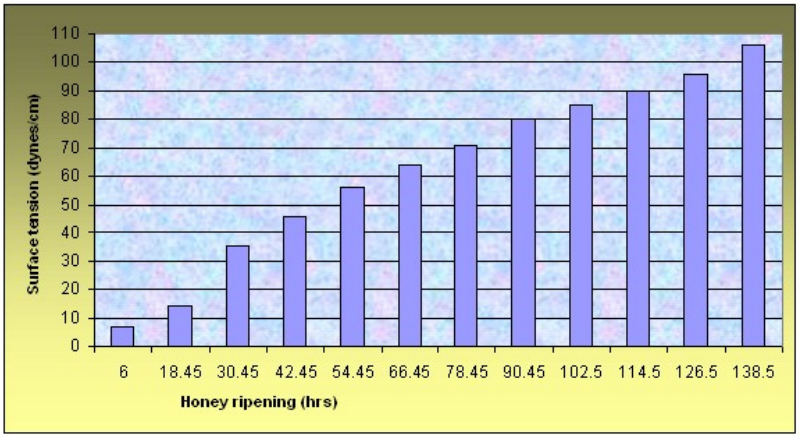


Fig.4. Surface tension of honey in different hours of ripening

CONCLUSION

Nectar is thin, dilute sugary solution, technically termed as unripened honey. The unripened honey is different from ripened honey in aroma, flavor, color, texture, surface tension, density including other physical and chemical characteristics. The refractive index, optical density, viscosity and surface tension confirmed quantitative change in each successive stages of honey ripening process. The conversion of nectar to honey is innate behavior and pre-requisite to hoard honey for future generations. Obviously, honey though a plant origin but definitely is as much a primary product of honeybees. Well ripened honey has an important role in preparation of Ayurvedic and related other naturopathic therapies. Further, ripened honey is natural food that has vital essential nutrients in proper proportions and easily absorbed through the blood stream.

ACKNOWLEDGEMENT

Author acknowledges Dr. C. Chandrasekhara Reddy, Former Chairman, Department of Zoology and presently working as Emeritus Professor, Department of Zoology and Applied Genetics for his critical comments, encouragement and valuable suggestions in preparing the manuscript, wife, Mrs.M.Bharathi, Assistant Professor, Department of Computer Science, S.J.C.I.T., Chickballapur for her support in computation of data and moral support and University Grants Commission, South Western Regional Office, Bangalore for funding the Minor Research Project.

REFERENCES

1. Crane, E , (1990). From *Honey: A Comphrensive survery*, Heineman, London, p 175-190.
2. Seema Singh Thakur and Sudha Kanaujia. (2003). Influence of day hours, temperature and relative humidity on nectar-sugar secretion pattern and honeybee visit in neem, *Azadirachta indica* (*Meliaceae*). *Indian Bee J*. **65**(3-4): 100- 104.
3. Balasubramanyam, M.V and Chandrasekhara Reddy, C.(2003). Physical characteristics of multifloral wild and apiary honey from plains, hills and Western Ghats of Karnataka. *Indian Bee J*. **65** (3&4): 113-117.
4. Rinderer, T.E., Sylvester, H. A., and Bolten, A.B.1983. Honey sac contents, A technique for collection and measurement in foraging bees (*Hymenoptera: Apidae*), *J. Eco. Entom.***76**: 204-206
5. Balasubramanyam, M.V.(2006). Factors influencing the ripening of honey.*Ph.D Thesis*, Bangalore University, Bangalore p 43-48.
6. Vit, P., Martorelli, I.G., de and Lopez, P.S.(1994) Classification of commercial Venezuelan honeys`. *Archivos – Latinoamericanos de Nutrition* **1** : 47 – 56.
7. Balasubramanyam, M.V and Chandrasekhara Reddy, C. (2011). Mineral variations of honey of indigenous honeybee species from Western Ghats of Karnataka. *Journal of Pharmaceutical Research and Clinical Practice*, 1(2): 36-42.
8. Wakhle, D.M. (1997). Beekeeping Technology - Production, Characteristics and Uses of honey and other products. *In Perspectives in Indian Apiculture* (Ed. R.C. Mishra, *Agro-Botanica*, Bikaner) p 134-139.
9. Balasubramanyam, M.V and Chandrasekhara Reddy, C (2005). Mineral content of raw, processed and stored honey of indigenous honeybee species, paper presented in International Beekeeping Congress. Beekeeping for sustainable livelihoods and rural development, Bangalore p71.
10. Sharma, A., (1998) Physico-chemical analysis of some honeys from North-west Himalayas, *Ph.D., Thesis,* Himachal Pradesh University, Shimla, India, pp 84-99.
11. Joshi, S.R., Pechhacker, H., William, A., and Vonder ohe, W. (2000). Physico-chemical characteristics of *A. dorsata, A. cerana* and*mellifera* honey of Chitwan district, Central Nepal, *Apidologie* 31:367-375.
12. Shripad N. Agashe and Rangaswamy, B.E.2001. Chemical characterization of *Apis cerana F* and *Apis dorsata F*. honey from Dakshina Kannada, Karnataka (India), *Indian Bee J*. 63(3&4): 15-20.