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DETERMINATION OF MINERALS IN GWALIOR-CHAMBAL REGION OF MADHYA PRADESH HONEY BY ATOMIC ABSORPTION SPECTROSCOPY

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Abstract

Honey is one of the major products from honey bees. It has been defined as the sweet, viscous liquid produced by honey bees from the nectar of flowers or from secretion of living plants which the bees collect, transform into honey and store in honey combs. Honey has been used by man in various ways since time immemorial. Due to the nutritive and medicinal value of honey for both man and animals, qualitative andquantitative analyses of the minerals is of great importance. Minerals and highconcentration of essential minerals can be toxic both to man and animals. Rapid increase inindustrialization in India has led to environmental pollution, hence increase of these metals in honey. In this study, honey samples collected four different areas/districts (Gwalior, Morena, Guna&Shivpuri) were selected for the sampling of honey samples (total sample 48). It was ensured that the samples must be contamination free and the colonies from which honey was collected should be disease free. Determine the levels of minerals (Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Mg, Zn, B and Ca). The samples were analyzed using flame atomic absorptionspectroscopy (FAAS). Resultsobtained from this study showed that Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Mg, Zn, B and Ca had mean values ranged from 1.09±0.06 to 3.69±0.59 ppm, 0.08±0.01 to 0.28±0.04 ppm, 0.04±0.02 to 0.05±0.004ppm 0.22±0.003 to 1.41±0.08 ppm, 0.35±0.02 to 0.78±0.06 ppm, 0.84±0.23 to 4.25±0.4 ppm, 1.92±0.05 to 5.74±0.39 ppm, 0.29±0.08 to 0.5±0.08 ppm, 0.06±0.002 to 0.39±0.07 ppm, 38.77±1.75 to 62.06±1.99 ppm, 1.06±0.08 to 1.69±0.14 ppm, 13.92±0.74 to 31.4±0.58 ppm and 58.54±5.97 to 120.12±8.19 ppm respectively of all areas.

***Key words**: Honey, minerals, determination, atomic absorption spectroscopy*

Introduction

Honey is one of the major products from honey bees. It has been defined as the sweet, viscous liquid produced by honey bees from the nectar of flowers or from secretion of living plants which the bees collect, transform into honey and store in honey combs. Honey has been used by man in various ways since time immemorial. It was the first and most reliable sweet substance used by human beings as a taste enhancer and source of energy. Honey contains about 80 different substances but 75 to 80 percent of honey is sugar. Besides high concentration of sugars, it contains other useful nutrients *i.e.* vitamins, proteins, minerals, enzymes and several phyto-nutrients. Honey is a "Super-food", as it contains very high amount (75-80%) of sugars, vitamins, minerals & enzymes.It can also be considered as "Functional Food", as

it contains a no. of functional food ingredients that can regularize body functions & supplement one / more nutrient deficiencies.Honey possesses numerous nutritional, healing and prophylactic properties. These are a direct consequence of its chemical composition. In order to have a beneficial effect, honey must be free of any contaminating agents. High concentration of metals in honey can be a source of illness to human beings, especially heavy metals. When the heavy metals are present in honey above the admitted levels by pollution standards, they are threats to human body through the possible negative effect of the contaminants. It has been reported that lead can cause damage of brain, kidney, nervous system and red blood cells. Other problems caused by heavy metals include metabolic anomalies, respiratory disorders, nausea and vomiting (Hase,*et al.,* 1973; Wotton, 1976, 1978). At low levels, essential metals are not toxic but in high concentration they can lead to illness. For example, extensive exposure to zinc chloride can cause respiratory disorders (Saeed, 1998).Studies on honey have been carried out with emphasis on organic, but little has been done on inorganic aspect (Ramos *et al.* 2008). Mineral content in honey is of interest not only for quality control, but also for determination of environmental contamination (Maurizio, 1975b). Pollution of water, soil and air has led to increase in levels of mineral content in honey. The nectar, from which the honey is made, contains metals absorbed by the roots from the polluted soil, and may also contain metals carried by the bees from polluted watersources.The quality of honey varies widely depending on the particular botanical origin, pedoclimatic conditions and extraction techniques (Ramos et *al*, 2008). Minerals are the main components that affect honey colour. Very light-coloured honeys often contain little mineral matter, while dark honeys may as well contain much- although not necessarily, since the colour also depends on other factors which are largely unknown. Elsewhere it has been established that the presence of metals may influence production of hydroxymethyl furfural (HMF). An increase in HMF leads to low level of simple sugars as it is formed at the expense of simple sugars. Studies have shown that prolonged storage of honey at 50°C leads to a decrease in volatile components while HMF increases (Wotton, 1976, 1978; Hase, 1973). Other factors affecting colour of honey are high levels of amino acids and presence of polyphenolic compounds.

The aim of the study was to determine essential minerals (Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Mg, Zn, B and Ca) in honey samples from various regions in Gwalior-Chambal region, Madhya Pradesh, India.

Materials and Methods

Sample collection

Four different areas/districts (Gwalior, Morena, Guna&Shivpuri) were selected for the sampling of honey samples. Twelve numbers of samples were collected from each area. Samples from Gwalior were purchased from local shopkeepers. Samples from other three districts were procured by visiting the apiaries/beekeepers situated over there (total locations is 48). It was ensured that the samples must be contamination free and the colonies from which honey was collected should be disease free.Honey samples collected from different locations were kept in separate containers. Samples were heated at 40^0C for almost 30 min. and then kept cooling for 24 hours. Samples were filtered in laboratory by using filter mess made of cotton cloth. Honey samples filtered in the laboratory were finally stored in 500 ml wide mouth properly leveled bottles at room temperature ranging from 25 to 35 ^{O}C, till further use.

Sample preparation:

Acid digestion: Samples were prepared according to 920,180 method of the A.O.A.C (1990). Five ml of 75% HNO3 were added to each 2 g sample of honey within a porcelain crucible. Then, the acid was evaporated on an electrically heated

mantle at 100-120 ºC. Then it was gauged to 10 ml with distilled water (*dilution 1:5).*

Analysis:

Heavy metals were analyzed by using atomic absorption spectrophotometer (Model –S4 AA, 9423 400 30041). The instrument was calibrated and standardized with different working standards. After making sure that the instrument was properly calibrated and results of standards were in confidence limit, concentration of metals in each sample was measured individually.

BLANK USED: 0.5% HNO3.

Results

Trace elements were analyzed in forty eight honey samples by using AAS. The number of positive responses, defined as concentrations higher than the different detection limit for each trace element in all honey samples analyzed is shown in table 1.

From the results obtained, the concentration of metals varied from one sample to another depending on the botanical origin, climatic conditions, ex traction and storage techniques. The basic statistical data obtained for the content of Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Mg, Zn, B and Ca with mean values ranging from 1.09±0.06 to 3.69±0.59 ppm, 0.08±0.01 to 0.28±0.04 ppm, 0.04±0.02 to 0.05±0.004 ppm 0.22±0.003 to 1.41±0.08 ppm, 0.35±0.02 to 0.78±0.06 ppm, 0.84±0.23 to 4.25±0.4 ppm, 1.92±0.05 to 5.74±0.39 ppm, 0.29±0.08 to 0.5±0.08 ppm, 0.06±0.002 to 0.39±0.07 ppm, 38.77±1.75 to 62.06±1.99 ppm, 1.06±0.08 to 1.69±0.14 ppm, 13.92±0.74 to 31.4±0.58 ppm and 58.54±5.97 to 120.12±8.19 ppm respectively.

Table 1 indicates the trace elements found in Gwalior market samples. It was observed that all 13 trace elements are present in these samples in minor concentrations. Maximum average value was observed in case of Calcium. All 12 samples collected from Gwalior market have Calcium content in the mean of 81.49±11.06 ppm. Next average highest concentration was observed for Mg i.e. 53.18±4.94 followed by Boron (31.4±0.58). Value obtained for all other metals were non-significant and found to be 3.69±0.59 ppm for Al, 0.26±0.04 ppm for Cd, 0.04±0.003 ppm for Co, 1.41±0.08 for Cr, 0.58±0.05 for Cu, 2.79±0.43 for Fe, 2.65±0.52 for Mn, 0.29±0.08 for Ni, 0.31±0.07 for Pb and 1.69±0.14 ppm for Zn.

Results obtained for Guna samples shows that Calcium was found in maximum concentration in Guna samples, average value being 58.54±5.97 ppm. Concentration of Mg was next to Ca and analyzed to be 62.06±1.99 ppm followed by B (13.92±0.74), Mn (3.34±0.34), Zn (1.22±0.11), Al (1.21±0.09), Fe (0.84±0.23), Cu (0.78±0.06), Ni (0.50±0.08), Cd (0.28±0.04), Cr (0.26±0.03), Pb (0.25±0.05) and Co (0.05±0.004).

Similar results were obtained in the samples collected from Morena&Shvpuri region. At both the locations, value of Calcium was found maximum i.e. 120.12±8.19 ppm & 81.34±1.21 ppm in Morena&Shivpuri district respectively whereas concentration of Cobalt was found to be minimum value being 0.04±0.004 ppm& 0.04±0.002 ppm.

Table 1: Concentration of Minerals (ppm) analysis in honey samples collected from Gwalior-Chambal Region in Madhya Pradesh

Regions / Minerals	Gwalior region	Guna region	Morena region	Shivpuri region
Al (ppm)	3.69±0.59	1.21±0.09	1.09±0.06	1.09±0.009
Cd (ppm)	0.26±0.04	0.28±0.04	0.08±0.01	0.08±0.02
Co (ppm)	0.04±0.003	0.05±0.004	0.04±0.004	0.04±0.002
Cr (ppm)	1.41±0.08	0.26±0.03	0.58±0.02	0.22±0.003
Cu (ppm)	0.58±0.05	0.78±0.06	0.35±0.02	0.42±0.015
Fe (ppm)	2.79±0.43	0.84±0.23	4.25±0.4	1.09±0.09
Mn (ppm)	2.65±0.52	3.34±0.34	5.74±0.39	1.92±0.05
Ni (ppm)	0.29±0.08	0.5±0.08	0.36±0.02	0.40±0.014
Pb (ppm)	0.31±0.07	0.25±0.05	0.39±0.07	0.06±0.002
Mg (ppm)	53.18±4.94	62.06±1.99	38.77±1.75	54.87±0.38
Zn (ppm)	1.69±0.14	1.22±0.11	1.36±0.26	1.06±0.08
B (ppm)	31.40±0.58	13.92±0.74	24.45±4.6	17.16±0.39
Ca (ppm)	81.49±11.06	58.54±5.97	120.12±8.19	81.34±1.21

Values expressed as Mean ± S. E.

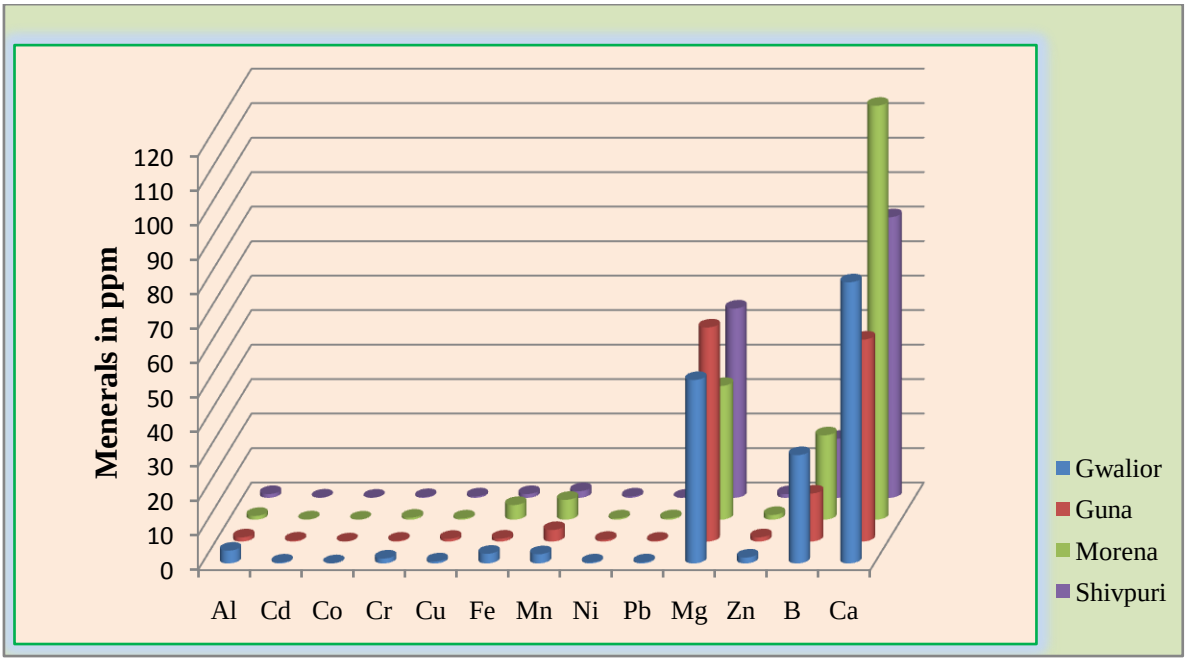

Figure 1: Concentration of minerals (ppm) in honey samples from Gwalior-Chambal region of Madhya Pradesh

Discussion

Many trace elements in different types of bee honeys have been analyzed (Rodriguez-Otero *et al.*, 1992; Chung & Tsai, 1992; Stein &Umland, 1986; Vinas*et al.*, 1997; Carol*iet al.*, 1999; Taddia*et al.*, 2004; Gonzalez-Mire*tet al.*, 2005; Ioannidou*et al.*, 2005; Munoz &Palmero, 2006; Bibi*et al.*, 2008 &Kacaniova*et al.*, 2009). Mbiri*et al.* (2011) results showed that K, Na, Ca and Mg had mean values ranged from 781.52±0.09 to 172.83±0.02 ppm, 269.1 to 98.04±0.03 ppm, 70.17±3.9 ppm to

19.33±4.07 ppm and 41.88 ±0.92 to 12.64 ±0.43 ppm respectively.

In the present studies, thirteen trace elements were analyzed in forty eight honey samples collected from four different locations in M.P. Results indicate the trace elements found in Gwalior market samples. It was observed that all 13 trace elements are present in these samples in minor concentrations. Calcium was found in all the samples in highest amount.

The concentrations metals in the present study are low and not likely to cause any acute effects. There is a need to regulate and monitor the level of heavy metals in commercial honey samples so as to maintain the standards of export quality honey.

Conclusion

In the present studies, thirteen trace elements were analyzed in all forty eight honey samples. It was observed that all 13 trace elements are present in these samples in minor concentrations. Calcium was found in all the samples in highest amount as compared to other elements.

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