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RESEARCH ARTICLE

Analysis of heavy metal and pollen contents of honey collected from the areas near the thermal power plant in Bhupalpally district, Telangana state, India.

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Abstract In the present study, four honey samples, two are of *Apis florea* and other two are of *Apis dorsata* were analyzed to detect heavy metal contents (Co, Cu, Cd, Cr, Ni, Zn, Pb) and botanical sources near to the thermoelectric power plant which is 5-15 km away from the hive in Bhupalpally District, Telangana state, India. All the four samples are unifloral in nature dominated by the *Eucalyptus, Gardenia, Aspidopterys* and *Capsicum* pollen. The accumulation of heavy metals was compared with recommended limits for food. Cd and Pb are higher than permissible limits and other metals are found within the limits. The level of heavy metal content in honey is an important indicator for environmental pollution.

Keywords: Bhupalpally District, Heavy metals, Thermo electric, Unifloral

Introducation

Apis florea and *Apis dorsata* are two natural honey bees commonly present in Bhupalpally District, Telangana State. They collect nectar and pollen from the bee pasturage plants for their carbohydrate and protein source. This natural sweet substance is also rich in minerals, proteins, amino acids, enzymes, vitamins and heavy metals (Kujawski and Namieśnik 2008, Wang and Li 2011). The popularity of honey has increased in recent years due to health claims, and it is considered to be a desirable ingredient in a range of different foodstuffs (Alvarez-Suarez *et al.* 2010). Honey composition is variable owing to the differences in plant species, environmental conditions and climate, (De Rodrıguez *et al.* 2004, Küçük *et al.* 2007). Generally, *Apis florea* honey is considered mainly from one source (mono-floral) if the pollen frequency of that plant is more than 45% (Louveaux *et al*. 1978) and distinguished from poly- floral honey by its characteristic smell and taste. Uni-floral honey can also vary in moisture content, colour and conductivity, depending on the bee pasturage plant source and the honeys are named as Soapnut honey, Mustard honey, Jamoon honey, Tamarind honey, etc.

The combustion of coal in thermal power plants leads to the various environmental problems and effect the human health directly or indirectly. One main problem with this is leach of heavy metals from the ash and smoke further that will be added to the air. Constructed honey combs by the *Apis* bees near to the thermal power plants also gets contaminated by the deposition of heavy metals through the ash and smoke released from these thermal plants (Hennessy *et al.* 2010, Pohl *et al.* 2011, Yurukova *et al.* 2008, Costa silva *et al.* 2011, Tuzen and Soylak 2007). Bee pasturage plants and their flower nectar, pollen will be contaminated by the deposition of heavy metals released from the thermal plants. In addition some studies shown that trace element levels of honey depend on the botanical source of honey (Feller-Demalsy *et al.* 1989, Gonzalez-Miret *et al.* 2005).

The main objective of this study is to produce data related to the heavy metal content from bee hives located near to the thermal power plant in Bhupalpally District, Telangana state, India. This study was mainly focused on Co, Cu,

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Cd, Cr, Ni, Zn, Pb element analysis from the four honey samples.

Material and method

Sampling of Honey

Four honey samples (two of *Apis florea* and two of *Apis dorsata)* were collected from different places of Bhupalpally District near to thermal power plant in the year 2020. The floral source and mono-floral pollen percentages are presented in Table 1. Pollen count and identification of mono-floral honey was done by the established method (Moar 1985).

Metal analysis

The samples were subjected to acid digestion. 1 g of honey sample, mixed with 15 ml of distilled water, homogenized, and placed in a conical flask. Three (3) ml of concentrated nitric acid and 6 ml of Concentrated HCl were added to the flask. Then, the sample mixture was placed on the water bath and heated for dryness. The flask was removed from the water bath and cooled to room temperature. To the cooled sample, 50 ml of de-ionized water was added to dissolve the dried mass and the contents were filtered. Then the concentration of heavy metals were determined by Atomic Absorption Spectrophotometer (Guler and Arzu 2006) (AAS- model no AA-6300). AA-630-Model ROM Version 1.03 Shimazdu (Japan).

Result and discussion

All the honey samples studied have yielded enough pollen contents. The concentration of pollen and 7 elements measured in honey samples are presented in Table 1 and Table 2. As can be seen from the Table 1 all four samples are mono-floral in origin with dominance of *Eucalyptus globulus* (Myrtaceae), *Gardenia resinifera* (Rubiaceae), *Aspidopterys indica* (Malphigiaceae) and Capsicum frutescens (Solanaceae). Honey bees foraged through forest, social forestry and agricultural tracts for the collection of nectar and pollen. Secondary and tertiary pollen percentages are very meager. Gaddiganipally sample consists of 72% of Gardenia resinifera (Rubiaceae) pollen, 17% of grass pollen whereas 10.5 % of *Schleichera oleosa (Sapindaceae)* pollen. Azamnagar sample consists of 77% of *Capsicum frutescens* (Solanaceae) pollen, 18% of grass pollen, 2.5 % of *Sesamum indicum* (Pedaliaceae) pollen and 1% of *Hibiscus rosa-sinensis* (Malvaceae) pollen. In Chelpur sample 62% of *Aspidopterys indica*

Name of the sample	Area name	Distance from thermal plant	Dominant pollen type	Pollen percentage	Type of Bee
Sample-1	Gaddiganipalli	5 km	*Eucalyptus globulus*	82%	*Apisflorea*
Sample-2	Gaddiganipalli	5 km	*Gardenia resinifera*	72%	*Apisdorsata*
Sample-3	Chelpur	4 km	*Aspidopterys indica*	63%	*Apisflorea*
Sample-4	Azamnagar	10 km	*Capsicum frutiscens*	77%	*Apisdorsata*

Table:1 Pollen analytical data off our honey samples

	Co	Cu	Cd	Cr	Ni	Zn	Pb
Sample-1	0.01 ±0.01	<0.01 ±0.00	4.48 ±0.17	<0.01 ±0.00	7.24 ±0.61	4.85 ±0.14	34.16 ±0.52
Sample-2	2.85 ±0.04	<0.01 ±0.01	4.1 ±0.13	<0.01 ±0.00	17.14 ±0.9	3.13 ±0.04	27.99 ±0.61
Sample-3	4.53 ±0.16	<0.01 ±0.01	4.33 ±0.14	<0.01 ±0.00	1.87 ±0.12	3.56 ±0.21	21.82 ±0.38
Sample-4	5.09 ±0.09	<0.01 ±0.00	4.97 ±0.02	<0.01 ±0.02	9.1 ±0.33	4.93 ±0.48	17.77 ±0.29

Table 2: Heavy metals (µg/g) analytical data off our honey samples

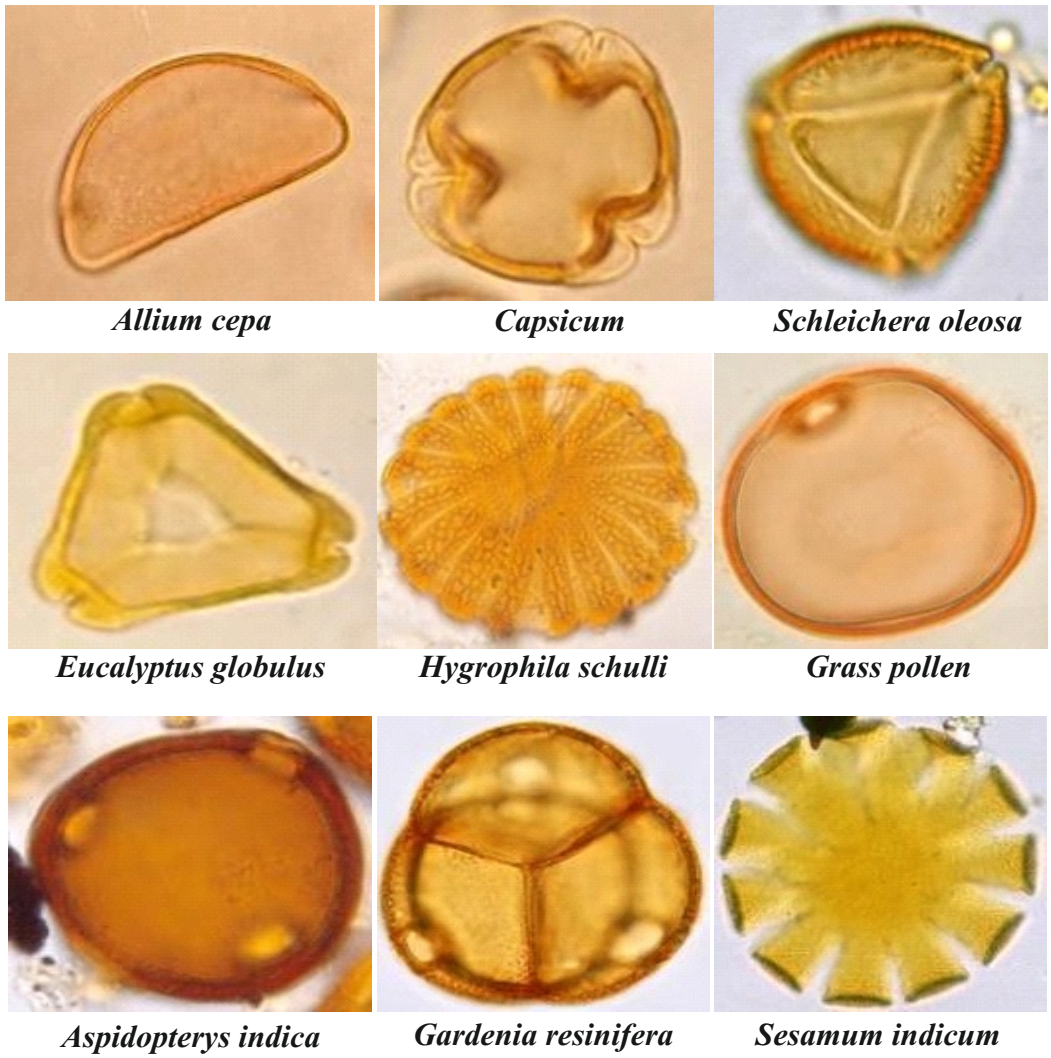

Figure 1: Photomicrographs of important pollen grains recovered from the honey samples

(Malphigiaceae) pollen, 24.9% of *Allium cepa* (Solanaceae) pollen, 12% of Grass pollen (Poaceaae) and 0.33 % of *Hibiscus* pollen was represented. In Gaddiganipalli sample *Eucalyptus* glubulus (Myrtaceae) pollen was dominated with 83% and remaining pollen was 7.5 % with Hygrophila schulli (Acanthaceae), Gass pollen with 7.5 % and *Sida acuta* (Malvaceae) with 1.2 % was present (Fig-1).

In the present study all four samples were analyzed and found higher levels of Pb and Cd compared to the permissible limits suggested by Prevention of Food Adulteration act 1954 and Codex Alimentarius commission standards (2001). Cadmium (Cd) levels in four samples were ranging from 4.12 $\mu g/g^{-1}$ to 4.97 $\mu g/g^{-1}$ which are higher than permissible limits (PFA-1.5, Codex Alimentarius Commission standards 0.05 $\mu g/g^{-1}$). Cadmium contents occur in honey that comes from bee hives that are close to highways. The higher concentration of Cadmium can be due to burning of coal at thermal power stations, or incineration of municipal waste and use of pesticides in agriculture fields (Sibel silici *et al.* 2013, Esubalew Adugna *et al.* 2020).

Higher levels of Lead (Pb) was detected in all four honey samples ranging from 17.7 $\mu g/g^{-1}$ to 34.16 $\mu g/g^{-1}$ compared to the permissible limits (PFA 2.54 and CACS -0.3 $\mu g/g^{-1}$). It can be due to emission of Lead released from vehicles, Lead contaminated dust which is directly released in to the air as suspended particles from motor vehicles

and industrial sources and extensive use of fertilizers for crops (Tuba Pehlivan and Aziz Gul 2015, Prabawati *et al.* 2016).

Other metals like Co ranging from 0.01 to 5.09 compared to the permissible limits (FAO/WHO, 2001 50mg/kg), Cr ranging from <0.01 compared to the permissible limits (Prevention of Food Adulteration Act, 1954, 20 and 0.05 according to Indian standards), Ni levels were ranged between 1.87 to 17.14 compared to permissible limits (PFA 50 ppm), Zn levels were ranged from 3.13 To 4.93 compared to permissible limits (PFA 5 ppm and 5 µg/g according to Codex Alimenturies Commissions 2001) and Cu ranged <0.01 compared to the permissible limits (PFA, 30 And CACS 5 µg/g) these were found to be below the permissible limits.

Conclusion

The present study provides information of the pollen composition and heavy metal contamination of honey samples from the Bhupalapally district of Telangana State. A total of 11 pollen types from four honeys produced by *Apis dorsata* and *Apis florea* were identified, including 10 entomophilous pollen types and 1 anemophilous pollen type i.e., Grass pollen.

Presence of honey combs in the surrounding area of a point source or of diffuse pollution sources, the use of pesticides, fertilizers containing heavy metals etc. causes the contamination of honey. The accumulation of heavy metals in the honey samples is mainly due to coal mining, and the thermo-power industries. The results are useful in improving the quality of honey samples and assessing the pollution levels in the environment.

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