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Studies on chemical properties of honey collected from different parts of Odisha

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Abstract
Investigations on "Physicochemical properties of apiary honey of Odisha" was carried out to study the chemical properties of honey of *Apis cerana indica* & *Apis mellifera*. The honey samples collected from 18 different locations of Odisha including hive honey of the All India Coordinated Research Project on Honeybees and Pollinators and All India Coordinated Research Project on Cashew during July 2019 to January 2020. Among the 18 samples analysed, 11samples were of *A. c. indica* and 7 samples were of *A. mellifera.* The chemical properties *viz*., reducing sugar (%), sucrose (%) and ash content (%)of the collected apiary honey samples varied from 62.81 to 74.96, 2.30 to 3.88 and 0.01 to 0.44 respectively. Amongst the parameters studied, the reducing sugar property satisfy the standards of ISI specification of Indian honey under A grade, special grade and standard grade.

Keywords: Honeybee, *Apis cerana indica, Apis mellifera,* Chemical properties, reducing sugar (%), sucrose (%), ash, apiary

Introduction
Honeybees are the eusocial hymenopterans which entirely dependent on nectar and pollen resources for their dietary requirement. They are unique which support the live on earth through their free pollination services in the nature. Neverthless they are important as producer of various hive products *viz*. Honey, wax, pollen, propolis, royal jelly and venom which remains as primary objective of beekeeper practicing beekeeping. Among the products honey is a natural gift to mankind having immense value to mankind. Honey bees collect and store surplus honey in the beehive. The honey produced by different species of honeybees from the nectars of flowers, nectar glands of plant parts and honey dew of sucking insects. These substances collected by honeybees are processed and transformed to ripen and matured honey by combining with specific substances of their own in the honeycomb (Codex A. Codex Standard for Honey, FAO) [5]. These honeys vary widely with respect to its physical and chemical properties. Though the precise composition of honey varies according to the plant species on which the bee forages, the main constituents are the same in all honeys. On the average, honey is composed of moisture (17.2%), fructose (38.19%), glucose (31.28%), sucrose (1.31%), disaccharides calculated as maltose (7.31%), higher sugars (1.5%), free acid as gluconic (0.43%), lactone as gluconolactone (0.14%), total acid as gluconic (0.57%), ash (0.16%) and nitrogen (0.041%) (Jeffrey and Echazarreta, 1996) [6].

Materials and Methods
Total reducing sugars and sucrose content
The total reducing sugars of honey samples collected from different locations from Odisha were recorded as per Layne-Enyon method. The prepared diluted honey solution was taken in a burette and titrated against 10 ml of mixed Fehlings solution A&B using methylene blue as an indicator. The solution then boiled for two minutes, added with three drops of methylene blue indicator and titration was completed within a minute. The end point was observed when decolourization of indicator occurred. The results were expressed as percentage of total reducing sugar.

$$\text{Total Reducing sugars \%} = \frac{\text{factor} \times \text{dilution} \times 100}{titre\ volume \times weight\ of\ sample(g)} = \frac{125}{titre\ volume}$$

Determination of Sucrose
A measured amount of honey solution (50 ml) was taken from each of the honey samples

collected in a volumetric flask to which concentrated HCL was added and kept for hydrolyzation overnight at room temperature. Next day, the solution was neutralized with saturated NaOH solution followed by a drop of phenolphthalein, finally the volume was made upto the mark with distilled water. This solution was treated against Fehlings solution A&B as done previously in case of reducing sugars. Titration value was used to calculate the per centof total sugars using the formula.

$$\text{Total sugars\%}=\frac{\text{factor}\times\text{dilution}\times 100\times 100}{50\times titre\ volume\times weight\ of\ sample(g)}=\frac{250}{titre\ volume}$$

Sucrose (%) = Total sugars(%)-total reducing sugar(%)

Ash content

Ash was indirectly determined by using the measured electrical conductivity and using the equation[15], X1 = (X2 - 0.143)/1.743,

where: X1 = ash value; X2 = electrical conductivity in mS at 20 ^{0}C

Results and Discussions

Reducing sugars of honey

The percentage of reducing sugars of *Apis cerana indica* honey samples ranged from 62.81 - 74.96 (Table 1.) which were found to be in the normal limit (Anonymous, 2012) [2]. The highest value (74.96 per cent) of reducing sugar of honey samples recorded from of Arjunpur, Bhadrak followed by Bhubaneswar (71.76 per cent) and Kishanagar, Cuttack (71.32 per cent). The sample obtained from Balliguda, Bhadrak having the least reducing sugar percentage i.e., 62.81 per cent. The findings of earlier work (Anupama *et al.*,2003) [3] that the reducing sugars ranged from 61.3 to 72.6 per cent supported the present study.

The reducing sugars of *Apis mellifera* honey samples ranged from65.95to 73.21per centin sample of Maliput, Koraput and of AICRP on cashew, Bhubaneswar respectively. The samples with 70.40 per centreducing sugar recorded from Janiguda, Koraput followed by 69.75 per centin Gudikhamara, Koraput and 69.41 per centfrom Damanjodi, Koraput (Table 1). The above findings supported the view of previous researchers (Nayik *et al.*, 1999) [12] and (Khandelwal *et al*., 2020) [7] who stated that the mean reducing sugar values of acacia honey, pine honeydew and multifloral honey 66.24%, 60.6%, 72.81% respectively as well as the samples collected from Wardha, Nagpur, Yavatmal and Gadchiroli districts were measured 69.63±1.74, 73.94±1.84, 72.14±1.80 and 72.66±1.81 per cent respectively.

As per the ISI specifications the honey samples obtained from Kishanagar, Bhubaneswar, Odosingha, Bhagatpur, Arjunpur, Janiguda and AICRP on cashew, Bhubaneswar are of special grade honey. Whereas, the honey samples of Balanga, Dhamnagar, Mahulpalli, Khandagiri, Damanjodi, Koraput, Maliput, Koraput, Chindri, Gudikhamara and Nandpur, are of A Grade honey.

Sucrose content of honey

The sucrose content of *Apis cerana indica* honey samples ranged from 2.39to3.88per cent. The highest sucrose per cent in honey sample of Kishanagar, Cuttack (3.88per cent) followed by Balanga, Puri (3.65per cent), Bhagatpur, Bhadrak (3.58 per cent) and Mahulpalli, Sundergarh (3.49per cent). Whereas, the least (2.39per cent) was recoded from honey sample of Odosingha, Narasinghpur. The sucrose content of *Apis mellifera* honey samples ranged from 2.30 per cent in Maliput, Koraputto 3.86per cent in AICRP on cashew, Bhubaneswar. The highest sucrose per cent values was followed by 3.22per cent in Damanjodi, Koraput, 3.07per cent in Chindri, Koraput honey samples. The least sucrose content was recorded from Maliput, Koraput sample with 2.30 per cent (Table 2). The variations in the sucrose levels may be indicative of the effect that different geographical origin have on the compositional differences of honey (Nayik *et al.*,2015) [11]. The relative variation between glucose and fructose, with a high percentage of sucrose sugar may be due to the inability of enzymes secreted by bees to contain and break down this huge amount of sucrose sugar (Vanhanen *et al.*,2011) (Cantarelli *et al.*,2008) [13, 4].

Ash content of honey

The ash content of *Apis cerana indica* honey samples collected from different geographical locations ranged from 0.01to 0.44per cent (Table-3). The highest ash content (0.44%) was recorded from sample of Parlakhemundi, Gajapati followed by 0.16per cent in Kishanagar, Cuttack and 0.1per cent in Balliguda, Bhadrak sample. Among the eighteen samples tested the Dhamnagar, Bhadrak sample recorded the minimum (0.01 per cent) ash content. Highest ash content of *Apis cerana indica* honey recorded in Gudi Khamara, Koraput (0.20 per cent) samples whereas, least was recorded in Chindri, Koraput sample (0.03 per cent). The ash percentage found in honey expresses its richness in mineral content and constitutes a quality parameter (Moniruzzaman, *et al.*,2013) [10] for botanical and geographical origin of honey (Vanhanen *et al.*, 2011) [13] The variability in the mineral content of honeys could be due to harvesting processes, beekeeping techniques and the material collected by the bees while foraging on the flora. The work of the present author was in agreement with earlier results which indicated thatash content of honey from Northern India was in a range of 0.08–0.49 per cent (Kumar *et al.*, 2018) [8] and 0.1-1.0 per cent of honey samples of Ethiopia (Adgaba, *et al.*, 2017) (Marchini *et al.*,2007) [1, 9].

Table 1: Reducing sugars of apiary honey samples collected from different locations of Odisha

Sample No.	Location	Bee Species	Major source	Reducing sugars (%)	Honey grade as per ISI specifications
1	Balanga, Puri	*Apis cerana indica*	Mango	67.16	A grade
2	Dhamnagar, Bhadrak	*Apis cerana indica*	Multifloral	65.06	A grade
3	Kishanagar, Cuttack	*Apis cerana indica*	Multifloral	71.32	Special
4	Bhubaneswar	*Apis cerana indica*	Mango	71.76	Special
5	Mahulpalli, Sundergarh	*Apis cerana indica*	Jamun	68.46	A grade
6	Odosingha, Narasinghpur	*Apis cerana indica*	Multifloral	70.73	Special
7	Parlakhemundi, Gajapati	*Apis cerana indica*	Multifloral	68.17	A grade
8	Bhagatpur, Bhadrak	*Apis cerana indica*	Multifloral	70.01	Special
9	Arjunpur, Bhadrak	*Apis cerana indica*	Multifloral	74.96	Special
10	Balliguda, Bhadrak	*Apis cerana indica*	Mango	62.81	Standard

11	Khandagiri, Bhubaneswar	*Apis cerana indica*	Multifloral	65.69	A grade
12	Damanjodi, Koraput	*Apis mellifera*	Eucalyptus	69.41	A grade
13	Maliput, Koraput	*Apis mellifera*	Coriander	65.95	A grade
14	Chindri, Koraput	*Apis mellifera*	Niger	67.89	A grade
15	Gudikhamara, Koraput	*Apis mellifera*	Karanj	69.75	A grade
16	Janiguda, Koraput	*Apis mellifera*	Wild Tulsi	70.40	Special
17	AICRP on cashew, Bhubaneswar	*Apis mellifera*	Cashew	73.21	Special
18	Nandpur, Koraput	*Apis mellifera*	Wild Tulsi	66.28	A grade

Table 2: Sucrose content of apiary honey samples collected from different locations of Odisha

Sample No.	Location	Bee Species	Major source:	Sucrose (%)
1	Balanga, Puri	*Apis cerana indica*	Mango	3.65
2	Dhamnagar, Bhadrak	*Apis cerana indica*	Multifloral	2.68
3	Kishanagar, Cuttack	*Apis cerana indica*	Multifloral	3.88
4	Bhubaneswar	*Apis cerana indica*	Mango	3.47
5	Mahulpalli, Sundergarh	*Apis cerana indica*	Jamun	3.49
6	Odosingha, Narasinghpur	*Apis cerana indica*	Multifloral	2.39
7	Parlakhemundi, Gajapati	*Apis cerana indica*	Multifloral	2.56
8	Bhagatpur, Bhadrak	*Apis cerana indica*	Multifloral	3.58
9	Arjunpur, Bhadrak	*Apis cerana indica*	Multifloral	2.58
10	Balliguda, Bhadrak	*Apis cerana indica*	Mango	3.45
11	Khandagiri, BBSR	*Apis cerana indica*	Multifloral	3.29
12	Damanjodi, Koraput	*Apis mellifera*	Eucalyptus	3.22
13	Maliput, Koraput	*Apis mellifera*	Coriander	2.30
14	Chindri, Koraput	*Apis mellifera*	Niger	3.07
15	Gudi khamara, Koraput	*Apis mellifera*	Karanj	2.61
16	Janiguda Koraput	*Apis mellifera*	Wild Tulsi	2.98
17	AICRP on cashew, BBSR	*Apis mellifera*	Cashew	3.86
18	Nandpur, Koraput	*Apis mellifera*	Wild Tulsi	2.98

Table 3: Ash content of apiary honey samples collected from different locations of Odisha

Sample No.	Location	Bee Species	Major source	Ash (%)
1	Balanga, Puri	*Apis cerana indica*	Mango	0.08
2	Dhamnagar, Bhadrak	*Apis cerana indica*	Multifloral	0.01
3	Kishanagar, Cuttack	*Apis cerana indica*	Multifloral	0.16
4	Bhubaneswar	*Apis cerana indica*	Mango	0.05
5	Mahulpalli, Sundergarh	*Apis cerana indica*	Jamun	0.03
6	Odosingha Narasinghpur	*Apis cerana indica*	Multifloral	0.02
7	Parlakhemundi	*Apis cerana indica*	Multifloral	0.44
8	Bhagatpur, Bhadrak	*Apis cerana indica*	Multifloral	0.07
9	Arjunpur, Bhadrak	*Apis cerana indica*	Multifloral	0.09
10	Balliguda, Bhadrak	*Apis cerana indica*	Mango	0.10
11	Khandagiri, BBSR	*Apis cerana indica*	Multifloral	0.07
12	Damanjodi, Koraput	*Apis mellifera*	Eucalyptus	0.04
13	Maliput, Koraput	*Apis mellifera*	Coriander	0.17
14	Chindri, Koraput	*Apis mellifera*	Niger	0.03
15	Gudi Khamara, Koraput	*Apis mellifera*	Karanj	0.20
16	Janiguda, Koraput	*Apis mellifera*	Wild Tulsi	0.13
17	AICRP on cashew, Bhubaneswar	*Apis mellifera*	Cashew	0.14
18	Nandpur, Koraput	*Apis mellifera*	Wild Tulsi	0.13

Conclusion

The reducing sugars of *Apis cerana indica* and *Apis mellifera* honey samples ranged from 62.81 to 74.96per cent and 65.95 to 73.21 per cent respectively. Out of the eighteen honey samples collected from different geographical locations seven samples are examined as special grade honey and nine samples are A grade honey as per the ISI specifications. The sucrose content of *Apis cerana indica* and *Apis mellifera* honey samples ranged from 2.39 to3.88per cent and 2.30 to 3.86 per cent respectively. The ash content of *Apis cerana indica* honey samples ranged from 0.01 to 0.44 whereas, that of *Apis melifera* ranged from 0.03 to 0.2 per cent.

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