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Impact of floral variations on physico-chemical properties of bee pollen

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Abstract
Honeybee collected pollen has a great value not only for bee nutrition, but also for humans, as it provides a rich source of easily digestible proteins. Due to the presence of high concentrations of proteins, amino acids and vitamins bee pollen has an indispensable value for human diets. But bee pollen samples indicate large variations in their chemical composition with change in their floral origins and great nutritional value. Thus in the present study three samples of stored bee pollen of mustard, golden rod and bajra flora were subjected for the physico-chemical analysis. Different physico-chemical parameters *viz*: moisture, total solids, pH, nitrogen, crude protein, vitamin-c and amino acids were studied. The highest variations were found among proteins and vitamin-c, ranged from 15.01 – 22.97% for proteins and 11.67-14.57% for vitamin-c. While slight variations were reported for moisture, total solids, pH, nitrogen and amino acid content, ranged from 7.05-10.27%, 89.73-92.95%, 4.24-5.14, 2.41-3.68% and 1.42-2.09%, respectively. Bee pollen of mustard flora contained the higher amount of moisture, protein, nitrogen and amino acids. While vitamin-c and total solid content was found higher in bee pollen sample of golden rod flora and bajra flora, respectively.

Keywords: Bee pollen, physico-chemical properties, floral variations, Kjeldhal's method, titration

1. Introduction
Bee pollen is the mixture of pollen, nectar and saliva of honey bee. When bees visit flowers, their body touches the stamens and get covered with pollen dust, bees collect this pollen dust and moisten the collected pollen with mouth secretion contains amylase and catalase enzyme which help the pollen to cling together and to the basket hairs [5]. Worker bees collect this pollen load in their pollen basket (corbicula) and store inside the hive. A pollen load contains up to 10% nectar, which is necessary for packing it in pellet form in corbicula.

Pollen is the major source of the important nutrients like proteins, fats, minerals, and vitamins for the worker bees [2]. Honeybee collected pollen has a great value not only for bee nutrition, but also for humans, as it provides a rich source of easily digestible proteins [18]. In addition to proteins, pollen also contains carbohydrates, unsaturated and saturated fatty acids and minerals [12] along with phenolic compounds. Due to the presence of high concentrations of these nutrients and essential amino acids, bee pollen has an indispensable value for human diets [1] and promoted as a healthy and functional food with a wide range of nutritional and therapeutic properties [20]. It is used in formulating supplementary food products and folk medicine because of its wide range of nutritional and therapeutic properties [7]. In folk medicines bee pollen is used to alleviate colds, allergies, ulcers, anaemia, skin problems, asthma, infertility, addiction of alcoholism and stomach problems [11]**.** These valuable nutritional and therapeutic qualities really make bee pollen a "super food" [4]. Although, the nutritional composition of bee-pollen is known to vary according to the flora from which the pollen was collected [11], the geographic origin [10], the season [12], and the storage method [16]**.** Respective bee flora is the major variable causing variations in the chemical composition of bee pollen, which may be influenced by the location and season [17].

Thus the present study was aimed to evaluate the chemical composition of bee-pollen from different botanical origins so that quality of the bee pollen of respective flora could be recognized. These kind of investigations are great opportunities for the development of beekeeping and consequently the production of bee products, including bee pollen and also allow the producers to bring confidence from consumers, leading to a premium price of this bee product.

2. Materials and Methods

The present experiment was carried out at apiary and laboratory available in G. B. Pant University of Agriculture and Technology, Pantnagar-263145, District: Udham Singh Nagar (Uttarakhand) India, during the period 2017-2018. The samples of bee pollen of different floral origins were collected from the colony of *Apis mellifera* L. by means of pollen trap. After collection the samples were kept at -20^{0}C for the physico-chemical analysis. Total three treatments were taken for the analysis *viz.* Mustard bee pollen, Golden rod bee pollen and Bajra bee pollen with five replications of each sample. For the statistical analysis of data obtained, statistical design CRD (Completely Randomized Design) and software STPR3 were used.

Physico-chemical analysis of bee pollen

Moisture: Moisture content was estimated by conventional oven drying method at 105^{0}C temperature, as given by [21].

Total solids: Total solid content of each sample of bee pollen was estimated by using the following formula:

Total solids (%) = 100- Moisture content

pH: pH of each bee pollen sample was measured by using Digital pH meter after mixing 10g of bee pollen in75 ml of distilled water, as given by [21].

Nitrogen (%) and Crude protein content in pollen: The nitrogen content was determined by Kjeldahl method, as outlined by the [2].

$$Nitrogen \quad (\%) = \frac{Titre \quad value \times 0.00014 \times Vol.made}{Aliquot \quad taken \ (ml) \times Weight \quad of \quad sample \quad (g)} \times 100$$

Crude protein (%) = % Nitrogen x 6.25

Vitamin-C: The vitamin-c in each sample of bee pollen was determined via titration method [2].

Amino acids: The total content of free amino acids in each sample was estimated by using spectrophotometric method which is based on the reaction of amino acids with a ninhydrin solution [5].

3. Result and Discussion

3.1 Moisture

The data related to the moisture content in different samples of bee pollen was presented in Table-1. The range of moisture content was observed between 7.05% - 10.27%. Significantly higher value was reported in the bee pollen sample of mustard flora 10.27% followed by 8.32% moisture content in bee pollen sample of golden rod flora. The significantly lowest value was obtained in the sample of Bajra flora 7.05% with a mean value 8.55%. The findings of present study was at par with the findings of [15], who recorded the moisture content in pollen samples of *Brassica spp.* 11.0 % while in contrary with the findings of [19] who reported an average of 12.83% moisture content in *Brassica spp.*

3.2 Total Solids

The data related to the total solids in bee pollen of different floral origin was presented in Table-1. The range of total solids in different bee pollen samples was reported between 92.95% - 89.73 %. Significantly higher value 92.95% was reported in the bee pollen sample of bajra flora, followed by 91.68% in bee pollen of golden rod flora. The significantly lowest value 89.73% was obtained in the sample of mustard flora with an average moisture content of 91.45%. The findings of present study was found in accordance with the findings of [3], while in contrary with the findings of [9].

3.3. pH

The data related to the pH of bee pollen of different floral origin was presented in Table-1. The pH has great importance during the storage of bee pollen, as they influence its texture, stability and shelf life. The range of pH was lied between 4.24 -5.14. Significantly higher pH 5.14 was reported in the sample of Bajra flora followed by 4.51 in bee pollen sample of mustard flora. The significantly lowest pH 4.24 was obtained in the sample of golden rod pollen with 4.64 mean value. The results are in accordance with the findings of [9].

3.4 Nitrogen and crude protein

The data related to the nitrogen and crude protein content of bee pollen of different floral origin was presented in Table-1. The range of nitrogen (%) was lied between 2.41% - 3.68%. Significantly higher value 3.68% was reported in the pollen sample of mustard flora followed by 2.63% in bee pollen of golden rod flora. The significantly lowest content of nitrogen *viz.* 2.41% was obtained in the bee pollen sample of bajra flora with 2.91%average content in different samples of bee pollen.

The range of crude protein content was noticed between 15.01% - 22.97% with significantly higher value in the bee pollen of mustard flora and lowest in bee pollen of bajra flora, which was reported in accordance to the findings of [15]. The mean value was obtained 18.14%, which was found in accordance to the findings of [1].

3.5 Amino Acids

The data related to the Amino acids content of bee pollen of different floral origin was presented in Table-1. The range of amino acids in bee pollen samples was lied between 1.42% - 2.09%, with significantly higher value in the bee pollen sample of mustard flora and lowest in bee pollen sample of bajra flora. The mean value was obtained 1.69%, which was reported in accordance to the findings of [14].

3.6 Vitamin-C

The data related to the vitamin-c content of bee pollen of different floral origin was presented in Table-1. The values of Vitamin-C in different samples of bee pollen varied between 11.67% - 14.57% with significantly higher value in the bee pollen sample of Bajra flora, followed by mustard flora and lowest value in the bee pollen sample of golden rod flora. The mean value 12.98 % was observed. The results of the present investigation was found comparable with the findings of [15], who recorded an average of 12.96% vitamin-c in the bee pollen of *Brassica spp.*

Table 1: Moisture, total solids, pH, Nitrogen, crude protein, vitamin-c, amino acid content in bee pollen of different floral origins

Treatments	Moisture (%)**	Total solids (%)**	pH*	N (%)**	Crude proteins (%)**	Vitamin C (%)**	Amino acids (%)**
T1 (Mustard)	10.27 (18.69)	89.73 (71.31)	4.51 (2.24)	3.68 (11.05)	22.97 (28.64)	12.71 (20.89)	2.09 (8.33)
T2 (Goldenrod)	8.32 (16.76)	91.68 (73.24)	4.24 (2.18)	2.63 (9.34)	16.45 (23.93)	11.67 (19.98)	1.57 (7.21)
T3 (Bajra)	7.05 (15.39)	92.95 (74.61)	5.14 (2.37)	2.41 (8.94)	15.01 (22.79)	14.57 (22.44)	1.42 (6.83)
Mean	8.55	91.45	4.64	2.91	18.14	12.98	1.69
SEM	0.18	0.18	0.75	0.51	0.15	0.89	0.54
CD at 5%	0.54	0.54	0.23	0.16	0.46	0.27	0.17
F value	Significant	Significant	Significant	Significant	Significant	Significant	Significant

** Angular Transformation

* Square Root Transformation

4. Conclusion

In the present study, it could be said that bee flora have the significant impact on the nutritive quality of bee pollen. It was documented that the bee pollen samples of mustard flora revealed the better quality due to the presence of higher amount of crude protein, nitrogen and amino acids than the samples of bajra and golden rod flora. While vitamin-c content was found higher in bee pollen sample of golden rod flora than the other samples.Thus, it can be advised to collect pollen loads of mustard during the blooming periods and use it as pollen supplement for feeding bee colonies during the dearth period. Also it can be used as a healthy human food supplement in diet.

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