Biological Forum — An International Journal, **3**(1): 67-73(2011) **ISSN : 0975-1130**

Physico-chemical Investigation of Honey samples of *Apis cerana incica* F. (Traditional Beekeeping) and *Apis mellifera* (Morden Apiculture) from Chamba District, Himachal Pradesh

Pawan K. Attri

Sr. Research Officer, Institute of Integrated Himalayan Studies, H.P. University, Shimla, (HP)

(Received 10 June, 2011 Accepted 25 June, 2011)

ABSTRACT : Physicochemical analysis of honey enables to form standards for genuine honey samples of any region based on various physicochemical characteristics. Moreover, the physicochemical data of any honey sample is essential for storage purpose and marketing. In the present investigation, physicochemical characteristics of honey were determined by collecting samples from different traditional hives; viz. wall hives, Log hives, miscellaneous hives and apiaries located in district Chamba. Honey sample were collected during the main flow seasons of the region i.e. May-June (summer) and Sep-Oct (autumn) in 2001-2005. The physicochemical properties of the various honey samples were studied with the International standard methods of analysis. In the present investigation various parameter i.e., Refractive index/moisture content, Specific gravity, Viscosity, Surface tension, Electrical conductivity, Colour, and Ash content were studied.

Keywords : Physiochemical investigation, honey, Chamba, Himachal Pradesh.

INTRODUCTION

Honey is a supersaturated solution of sugar, which together with other constituents in minor amounts, is made by bees from the nectar of flowers. Because of multiple importance of honey from food to medicine, it is of great interest to carry out complete analysis of honey and to formulate values and ranges of various honey constituents and characteristics. Honey is generally evaluated by a physico-chemical analysis of its constituents. Several of these constituents are of great importance to the honey industry as they influence the storage quality, granulation, texture, flavour and the nutritional and medicinal quality of the honey. The International Honey Commission (IHC) has therefore proposed certain constituents as quality criteria for honey. These include: moisture content, electrical conductivity, reducing sugars, amount of fructose and glucose, sucrose content, individual sugars, minerals, free acidity, diastase, HMF, invertase and praline. (Bogdanov, S. et al, 1999)

From physical viewpoint, honey can be visualized as an aqueous dispersion of varying sized particles. Though sugars are the major constituents of honey, yet various physical characteristics of honey, such as, refractive index, viscosity, density, and conductivity differ somewhat from an invert sugar solution of same moisture content because of presence of other minor constituents in honey as well as different ratios of different sugars in various samples.

Beekeeping endeavor in Himachal Pradesh is still taken up on a modest commercial scale by beekeepers in some remote areas. Chamba district has great potential of beekeeping; however, reliable information on the bee plants, types of honey and nectar flow and dearth periods in this district is as yet highly limited and inadequate. Therefore, In the present Investigation, samples of honey were collected from *Apis cerana indica* F. *colonies* located in different parts of district having different Altitudes, Latitudes and climatic conditions. Honey samples were collected from all Block of Chamba district *i.e.* Bharmour, Bhatyati, Chamba, Mehala, Salooni, Tissa and Pangi in the years from 2001 to 2005.

STUDY AREA

Nestling in the bosom of the Himalaya, Chamba district of Himachal Pradesh is unique in all aspects. Situated in the extreme north- west of the state of Himachal Pradesh, Chamba district is stretched between the upper Ravi (Vedic name-Purusni) valley and Chandra-Bhaga (Vedic name-Asikni) valley between North Latitude 32°10' and 33°13' and East Longitude 75°45' and 77°33' with an estimated area of 6,92,419 hectare. The district is surrounded on all sides by lofty hill ranges and the altitude in this entire mountainous territory ranges between 2,000 and 21,000 feet above sea level. The climate is warm, rainy season is well marked, the winter is mild and the snowfall is light (Table 1).

Table 1: Physiographic details of various areas of collection of honey samples of *Apis cerana indica* F. and *Apis mellifera* of District Chamba.

S. No.	*Areas*	*Latitude*	*Longitude*	*Altitude (in meters)*
1.	Bharmour	32°.26 N	76°31 E	1392-2358 M
2.	Bhattiyat	32°12 N	75°50 E	1107-1357M
3.	Chamba	32°11 N	75°49 E	1005-1225 M
4.	Salooni	32°45 N	76°05 E	1098-1349 M
5.	Tissa	32°50 N	76°10 E	1558-1835 M
6.	Mehala	32°28 N	76°11 E	1600-1825 M
7.	Pangi	33°05 N	76°24 E	2134-2591 M

MATERIAL AND METHOD

In the present investigation samples of honey were collected from different parts of district having different attitudes, latitudes and climatic conditions. Honey samples were collected from all Block of Chamba district *i.e.*, Chamba, Mehala, Bharmour, Bhatyati, Churah, Salooni and Pangi. Sample of honey were collected for year from 2001 - 2005, different mentioned located areas during major honey flow seasons of these area *i.e.* May-June and October-November. Thirty (30) honey samples, *i.e.*, 15 Apis cerana (kept in traditional log /wall hives), 15 *Apis mellifera* (kept in Langstroth hives) were collected. 15 *Apis cerana* samples were hand extracted and were bottled and brought to the laboratory for investigation. Along with these 15 *Apis mellifera* samples of machine-extracted honey from the private apiaries and Govt. Apiaries were collected. The samples were warmed for 20 minutes by keeping them in a water bath maintained at 50°C. These were then strained through a single thickness of cheesecloth of 4 meshes per millimeter length. In this way, the samples were made free from extraneous matters like bees wax piece, scum and surface dirt and were stored in airtight bottles at room temperature. The physicochemical properties of the various honey samples were studied with the International standard methods of analysis. In the present investigation various parameter *i.e.*, Refractive index/moisture content, Specific gravity, Viscosity, Surface tension, Electrical conductivity, Colour, and Ash content were studied.

RESULT

The analysis showed the following result for different physicochemical characteristics. Mean results and basic statistics obtained for moisture content, Specific gravity, Viscosity, Surface tension, Electrical conductivity, Colour, and Ash content are summarized in Table 2 for *A. cerana* (traditional hives) and for *A. mellifera* (Modern hives) in Table 3. Comparative statistic values of physicochemical characteristics of *Apis cerana* (Traditional hives) *Apis mellifera* (Modern hives) are highlight in Table 4.

Table 2: Physico-chemical characteristics of honey of district Chamba from *Apis cerana indica* F. (Traditional hives) Colonies.

Locality	*Moisture%*	*S. Gravity*	*Viscosity*	*S. Tension*	*E. Conductivity*	*Ash cont*	*Colour*
S1	28.8	1.3813	11.87	105.137	0.3128	0.22	white
S2	24.8	1.3991	12.05	108.932	0.029	0.26	Dirty white
S3	20	1.3875	12.0058	105.247	0.3129	0.35	light amber
S4	23.2	1.3803	11.98	103.241	0.0698	0.45	Amber
S5	22.4	1.3142	9.998	98.897	0.3055	0.456	light amber
S6	23	1.3102	10.578	110.8521	0.522	0.15	white
S7	20.2	1.4345	27.578	100.8574	0.0339	0.2	white
S8	21.2	1.4142	16.96	100.857	0.33	0.45	light amber
S9	19.8	1.4143	26.42	107.91	0.246	0.56	Amber
S10	19.8	1.3837	11.89	101.1377	0.029	0.46	light amber
S11	20	1.4075	13.58	98.89	0.3055	0.65	Amber
S12	22.8	1.3941	12.95	11.1736	0.0522	0.44	Amber
S13	22.2	1.3871	12.634	121.1373	0.033	0.66	light amber
S14	18	1.4315	30.57	105.04	0.113	0.35	light amber
S15	18.2	1.4008	15.231	106.1373	0.1392	1.34	Dark amber

Table 3: Physico-chemical characteristics of honey of district Chamba from *Apis mellifera* (Modern hives) colonies.

Locality	*Moisture%*	*S. Gravity*	*Viscosity*	*S. Tension*	*E. Conductivity*	*Ash cont*	*Colour*
M1	17.14	1.4335	69	101.137	0.31	0.08	white
M2	17.15	1.434	70	101.14	0.32	0.09	Dirty white
M3	17.13	1.432	68	101.12	0.3	0.07	light amber
M4	17.16	1.435	71	101.15	0.33	0.1	light amber
M5	17.12	1.431	67	101.11	0.29	0.06	light amber
M6	17.17	1.436	72	101.16	0.34	0.09	Dirty white
M7	17.11	1.43	66	101.1	0.28	0.05	Amber
M8	17.18	1.437	73	101.17	0.35	0.08	white
M9	17.1	1.429	65	101.09	0.27	0.04	Dirty white
M10	17.19	1.438	74	101.18	0.36	0.07	light amber
M11	17.09	1.428	64	101.08	0.26	0.03	white
M12	17.2	1.439	75	101.19	0.37	0.06	Amber
M13	17.08	1.427	63	101.07	0.25	0.02	light amber
M14	17.21	1.44	76	101.2	0.38	0.07	Amber
M15	17.07	1.426	62	101.06	0.24	0.01	white

Table 4: Comparative Statistic values of Physico-chemical characteristics of *Apis cerana* (Traditional) and *Apis mellifera* (Modern hives) honey samples from district Chamba.

S.No.	*R.I*		*Moisture %*		*S. Gravity*		*Viscosity*		*S. Tension*		*E. conductivity*		*Ash content*	
	T. hive	M. hive	T. hive	M. hive	T. hive	M. hive	T. hive	M. hive	T. hive	M. hive	T. hive	M. hive	T. hive	M. hive
1. Mean	1.481	1.494	22.51	17.14	1.389	1.433	15.75	69	99.03	101.13	0.189	0.31	0.467	0.061
2. S.D.	0.008	0.004	3.094	0.045	0.036	0.004	6.705	4.472	24.194	0.045	0.154	0.045	0.286	0.027
3. CV%	0.524	0.299	13.743	0.261	2.562	0.312	42.553	6.481	25.194	0.044	81.588	14.426	61.307	43.517
4. Min.	1.466	1.486	18.05	17.07	1.31	1.426	9.998	62	11.174	101.06	0.029	0.24	0.150	0.010
5. Max.	1.492	1.501	28.45	17.21	1.434	1.44	30.57	76	121.14	101.2	0.522	0.38	1.340	0.100
6. Range	0.026	0.014	10.4	0.14	0.124	0.014	20.572	14	109.96	0.14	0.493	0.14	1.190	0.090
7. t-value	5.4383**	5.4383**	6.5019**	6.5019**	4.5452NS	4.5452NS	24.725**	24.725**	0.314	0.314	2.8219**	2.8219**	5.2881**	5.2881**

N.S non-significant of 5% of significant, ** Significant at 1% level of significant

R.I. =Refractive index, S.D. = Standard deviation, CV% = Coefficient value, Min = Minimum, Max = Maximum.

Refractive index and moisture content

Moisture content in the present investigation was calculated from refractive index measurements using the following standard equation (Fulmer *et al.*, 1934; and Sacchi, 1955).

Refractive index in all the fifteen samples studied of traditional hives /*A. cerana* ranged from 1.426 to1.492 and moisture content calculated from these values ranged from 18.05 to 28.460. Average moisture content of 22.51 percent corresponded to the average refractive index 1.481 ± 0.008 S.D. The moisture content of modern hives/*A.mellifera* samples is 17.14 percent corresponded to the average refractive index 1.494 ± 0.004 S.D. The value for both the samples was 6.5019 for moisture content and is significant at 1% level of significance with the range of 0.014 only .

Specific gravity

Specific gravity in the present samples of honey of traditional hives /*A. cerana* ranged from 1.310 to 1.434 with difference of 0.124. Average value is 1.389 ± 0.036 S.D. (Table 4).Where as the modern hives /*A. mellifera* samples of honey value ranged from 1.426 to 1.440 with difference of 0.014. Average value is 1.433 ± 0.004 S.D. and the value 4.5452 is not significant at the 5% level of significance.

Viscosity

Viscosity in the present sample of traditional hives/*A. cerana* honey ranged from 9.998 to 30.570 with range difference of 20.5772. Average value is 15.75 ± 6.703 S.D. poise at 30°C (Table 4). The moisture range is 18.050 to 28.450 percent. For viscosity determination, 30°C was formed the most suitable temperature. Below this temperature, honey samples become very viscous and were difficult to handle. Viscosity of the modern hives/*A. mellifera* sample of honey ranged from 62.00 to 76.00 with range difference of 14.00. Average value was 69 ± 4.472 S.D. t-value was 24.7252 and was significant at 1 % level of significance. With the increase in temperature, viscosity of honey samples decreased.

Surface tension

Surface tension in tradition hives/*A. cerana* samples ranged from 11.177 to 121.137 with mean value of 99.030± 24.951 S.D. (Table 4) In honey samples of modern hive/ A. mellifera surface tension was 101.130 ± 0.045 S.D. This value did not come under 1% level of significance. With the rise of temperature, surface tension was found to decrease.

Electrical Conductivity

Electrical conductivity in traditional hives/*A. cerana* samples ranged from 0.029 to 0.533 with average value of 0.189 ± 0.154 mho/cm. In honey samples of modern hives/ *A. mellifera* samples ranged from 0.240 to 0.380 with average value of 09.31 ± 0.045 mho/cm. t-values 2.8219 was significant at the 1% level of significance(Table 4).

Ash Content

Honey samples were analysed for their ash content. Ash content of A. cerana samples ranged from 0.150 to 1.34 and an average of 0.467 ± 0.286 S.D. Average value of modern hive/*A. mellifera* sample is 0.061 ± 0.027 S.D. ppm (Table 4).

Colour

Honey samples were of different colours ranging form white to yellowish brown through many intermediate shade of dirty white to dull yellow. Honey of summer season was darker in colour. The colour ranged from grayish yellow to yellowish brown. Colour in autumn honey ranged from white to orange yellow. Colour in multifloral honey varied from white to brownish yellow, unifloral honey were white or very light in colour (Table 2, 3).

Correlation matrix of various physicochemical characteristic of Traditional Hives/*A. cerana* of honey samples of district Chamba.

Refractive index showed significant positive correlation with moisture % (r = 0.9961; P < 0.01); S. gravity (r = 0.9552; P< 0.01); Viscosity (r = 0.8516; P < 0.01). Moisture Percentage, Showed significant negative correlation with gravity (–0.9357; P < 0.01); viscosity (–0.8823; P < 0.01).S. Gravity, showed positive significant correlation with viscosity (0.7412; P < 0.01)., While other parameter (viscosity, surface tension, Electrical conductivity, ash content) did not show any significant correlation with the each other (Table 5).

Tables 5: Correlation matrix of various physicochemical characteristics *Apis cerana indica* F. (Traditional hives) honey samples of district Chamba.

Refractive index	*Moisture %*	*S. Gravity*	*Viscosity*	*S. Tension*	*E. conductivity*	*Ash content*
Refractive index	0.9961**	0.9552**	0.8516**	–0.0171	–0.2237	0.1947
Moisture %		–0.9357**	–0.8823**	–0.0337	0.1902	0.161
S. Gravity			0.7412**	–0.0477	–0.376	0.2357
Viscosity				0.0904	-0.1111	0.019
S. Tension					0.2024	–0.0419
E. conductivity						–0.0639
Ash Content						

N.S non-significant of 5% of significant, ** Significant at 1% level of significant

Correlation among different physicochemical characteristics of modern hives/*A. mellifera* honey samples.

Refractive index showed significant positive correlation with the moisture % (r = 1.000; P < 0.001); specific gravity (r = 0.9996; P < 0.01); viscosity (r = 5.0999; P < 0.01); surface tension (r = 0.9992; P > 0.001). It showed significant correlation with ash content (r = 7580 P > 0.01). Specific gravity showed significant positive correlation with viscosity (r = 0.999; P < 0.01); E. Conductivity (r = .9994; P < 0.01). Surface tension, it showed significant correlation with the rest of characteristics (E. Conductivity, ash content). Electrical conductivity showed significant positive correction with the all characteristic (Table 6).

Table 6: Correlation matrix of various physicochemical characteristics *Apis mellifera* (Modern hives) honey samples of district Chamba.

Refractive index	*Moisture %*	*S. Gravity*	*Viscosity*	*S. Tension*	*E. conductivity*	*Ash content*
Refractive index	1.0000**	0.9996**	0.9996**	0.9992**	.9981**	0.758**
Moisture %		0.9996**	0.9996**	0.9992**	0.9981**	0.7579**
S. Gravity			0.9995**	0.9999**	0.9992**	0.7628**
Viscosity				0.9991**	0.9994**	0.7746**
S. Tension					0.9980**	0.7638**
E. conductivity						0.7958**
Ash Content						

N.S non-significant of 5% of significant, ** Significant at 1% level of significant

DISCUSSION

Physicochemical analysis of honey is based on various physicochemical characteristics and it enables to form standards for genuine honey samples of any region. Moreover, the physicochemical data of any honey sample is essential for storage purpose and marketing. In the present investigations, the honey samples from various regions of district Chamba have been analysed and the data has been discussed from fundamental as well as preservation point of view as follows: Moisture content of honey is a very important physical characteristic, as it affects various other properties like density, specific gravity, refractive index, viscosity and optical properties (Pryce-Jones, 1950). Moisture content also plays an important role in preservation of honey. If the moisture content exceeds 22 percent, honey is likely to ferment (Marvin, 1933). So, for preservation, honey of higher moisture content require the lowering of moisture content, either by partial drying or by mixing the samples with lower moisture content. For quick determination of moisture in honey, refractive index method is used. Refractive index in the present samples of traditional hive/*A. cerana* varied from 1.466 to 1.492 (1.481 ± 0.008 S.D.) and the corresponding moisture content ranged from 18.05 to 28.45 (22.51 ± 3.094 S.D.) percent (Table 4). The average moisture content of these samples was in maximum limit of 22 percent, beyond which honey samples are liable to ferment (Marvin, 1933). Average moisture content for honey extracted from Apis cerana indica as reported by different authors was 19.98 percent in samples of North India (Phadke, 1967) and according to Mallick (1958), it varied from 16.60 to 26.40 percent. These values were some as those observed in the present analysis and such higher values have also been reported by other investigators in foreign honey. For example, moisture content varied from 20-24 percent in Taiwan honey (Lin *et al.*, 1977) and similar moisture content was reported in Japanese honey by Iwaida *et al.*, (1969). These authors reported that in Japanese honey, moisture content of 23 percent for domestic and 21 percent for imported honey was considered adequate. Comparatively lower values of moisture content have been reported in honey samples from many other countries. For example, the average percentage for American honey samples was 16.72 (White *et al.*, 1954) and in Spanish honey it ranged from 14.5 to 21.6 percent reported by Perz and Rodgriguz, 1970. Moisture in honey is subjected to wide range of variations depending upon the weather conditions which influence the degree of ripeness of honey more humid conditions, both before and after removed of honey from the hive are likely to increase to moisture content and vice-versa (Townsend, 1970). The average moisture content (Table 3) of *A. mellifera* honey samples is (17.14 ± 0.045 S.D.) and t-value 6.5019 with A. cerana honey samples. Phadke (1967) also found that in different climatic zones, average moisture content of honey did not vary significantly. Since the relative to humidities in summer and autumn seasons were the same in this region, honey of both the seasons did not show significant variations in refractive index and moisture content. Parti and Pandy (1967) reported average moisture content of summer and rainy season honey as 17.0 and 25.9 percent respectively. Refractive index of *A. mellifera* samples showed a significant positive correlation with specific gravity, viscosity and surface tension (Table 6). This implied that all these characteristics vary in a similar as was refractive index. Where as correlation matrix of *A. cerana* samples showed positive correlation with specific gravity and viscosity but correlation between traditional and modern hives showed negative results. Specific gravity of honey is an important characteristic for its quality evaluation. In the present analysis, specific gravity at 30°C ranges from 1.310 to 1.434 with a mean value of 1.389 ± 0.056 S.D. (Table 4) for traditional/*A. cerana* samples specific gravity ranged from 1.426 to 1.440 with an average 1.433 ± 0.004 S.D. for *A. mellifera*. Perti and Pandy (1967) showed that specific gravity for Indian honey ranged from 1.3492 to 1.4401 with a mean value of 1.4043. They also reported that density value of 1.38 to 1.33 gm/ml for Apis dorsata corresponds to a moisture content of 19 to 20 percent. In the present samples of *A. cerana* moisture contents of 18 to 28 percent showed density 1.389 gm/ml. Phadke (1967) showed average specific gravity equal to 1.397 for Indian multifloral honey of northern region. He, however, has not specified the temperature of measurement and specific gravity value which decreases at higher temperature. A wide range of variations

in specific gravity has been reported by many investigations. For example, specific gravity ranged from1.39 to 1.44 gm/ml in Italian Honey (Fini 1966, 1967); 1.310 to 1.410 gm/ml in Japanese honey (Watanable and Goto, 1956) and average value of specific gravity for Scottish and English honey was 1.4153 (Deans, 1953). On account of Variations in moisture contents honey samples may show variation in specific gravity. Present investigation revealed a significant positive correlation of viscosity. ($r = 0.851$ $p > 0.01$) of *A. cerana* with *A. mellifera* honey samples and also showed significant position correction with surface tension, E. Conductivity and ash content. This specific gravity of honey increased with increase in refractive index (or decrease in moisture content) and vice-versa (Table 5). Similar conclusion was drawn by Perti and Pandy (1967). They reported that specific gravity of a honey sample would depend, to a large extent, upon its moisture content. Viscosity of honey is important in its handling during extraction and is influenced by moisture content, density and temperature. Viscosity of present samples of *A. cerana* varied from 9.998 to 30.57 poise with a mean value of 15.75 ± 6.75 poise at 30°C (Table 4). Viscosity of *A. mellifera* samples varied from 62 to 76 poise with a mean value of 69 ± 4.472 poise at 30°C. Munro (1943) determined viscosity of honey at different moisture contents and temperature. He found a wide range of variations. The present values also fit into that range. Average viscosity of summer honey (29.319 ± 3.5950 S.E.) was non-significantly lower than that of autumn (30.5116 ± 5.3365 S.E.) honey. Thus, due to non-significant changes in moisture contents of honey of the two seasons, viscosity also does not change significantly. Lothrop (1939), concluded that viscosity variation in honey samples are due to non-sugar materials, particularly dextrins and colloidal materials. Munro (1943), however, noted that viscosity of honey changes most rapidly as the temperature rises to room temperature and after 30°C there is relatively little change. Temperature and moisture are two important features in honey extraction. At lower temperature and moisture, it is very difficult to handle honey on account of increased viscosity. According to Crane (1979), temperature at 30°C and above significantly facilitates honey handling. Surface tension of honey affects its processing. Low value of surface tension may lead to excessive foaming and scum formation. Paine *et al.* (1934) noted that when the surface tension of 25 percent solution of seven floral honey and one honeydew honey was changed from 41.0 to 60.2 dyne/cm, foaming and retention of air bubbles decreased. In the present analysis, surface tension at 30°C for *A. cerana* samples of honey ranged from 11.174 to 121.14 with a mean value of 99.03 ± 24.19 S.D. and 101.13 ± 0.045 S.D. for the samples of *A. mellifera*. Surface tension is a complex phenomenon and is influenced by mineral constituents and all other active minor honey constituents which may be surface active. Substances which distribute themselves uniformly throughout the solution raise the surface tension. Whereas, surface accumulating substances lower its value (Gibbs - Thomson rule) so, surface tension of both samples showed non-significant correlation with other characteristics of honey samples. Electrical conductivity is due to the presence of irons in honey it is also due to the presence of various mineral constituents and organic acids. In the present analysis specific electrical conductivity at 30°C ranged from 0.029 to 0.522 × 10-4/cm with average value of 0.189±0.154 S.D. for *A. cerana* and 0.310±0.45 S.D. and for samples of *A. mellifera* (Table 4). Different ranges for electrical conductivity were shown by Aganin (1971). He showed that for Russian honey, it ranged from ± 020 to 1.34×10^{-4} mho/cm. For 20 percent solution of German honey, Vorwohl (1964) showed that electrical conductivity ranged from 0.85 to 8.47 × –4 mho/cm. for the honey, he reported that this value ranged around 10^{-6} to 10^{-7} mho/cm. For Argentinean honey it varied from 1.73 to 13.80×10^{-4} mho/cm (Bianchi, 1978). Depending upon the mineral content, electrical conductivity of honey may show wide range of value. It was also suggested by Aganin (1971) that mineral content and acidity influence electrical conductivity of honey. According to Crane (1979), electrical conductivity of two different honey samples differs from each other on account of varying amounts of mineral salts, organic acids, proteins and various complex materials. For similar reasons, electrical conductivity of samples of honey of *A. cerana* and *A. mellifera* showed different electrical conductivity which increased with increase of temperature because of weakening of intermolecular forces. Honey samples studied in the present investigation showed colour varying from white to yellowish brown through varying intermediate shades of dirty white to dull yellow. Summer honey was darker in colour than autumn honey. Colour in summer honey ranged from grayish yellow to yellowish brown and from white to orange yellow in autumn honey. Colour in multifloral honey varied from white to brownish yellow, unifloral honey was white or very light in colour. In the present analysis, colour or honey was found to be related to ash content. Dark honey contained higher ash percentage as compared to light coloured. Mineral contents of honey influence the various characteristic such as colour, taste, flavor, medicinal value, keeping quality and a few physical characteristics (Crane, 1979). In the present analysis, ash content of *A. cerana* honey samples ranged from 0.50 to 1.34 and an average of 0.467 ± 0.286 S.D. and average t-value of *A. mellifera sample* is 0.061±0.027S.D. Similar range (0.03 to 0.75 percent) of ash content was also found by Mallick (1958) in Indian honey. However, Wide to narrow range (0.03 to 1.2 percent) for Indian honey was shown by Das and Bose (1946). Pladke (1967) reported average ash content of 0.196 percent for Indian honey of Northern region whereas, in the present analysis average ash content was 0.40 present (Table 4). In American honey, ash content ranged from 0.02 to 1.03 percent (White *et al.*, 1962). In Yugoslavian honey ash content varied from 0.15

to 0.63 percent (Murko *et al.*, 1976). In Taiwan honey from 0.1 to 03 percent (Lin *et al.*, 1977) and from 0.07 to 0.60 percent in Iranian honey, the average ash content was 0.328 percent (Anderson and Perold, 1964) and for Italian honey, it was 0.38 percent (Cirilli *et al.*, 1973). Ash content of honey may differ due to differences in floral origin honey. Other aspect of beekeeping is honey quality and quantity because organic honey has the image of a safe, traditional, locally made product. Indeed, honey is one of the very last food items, which remains almost totally natural and untreated. Moreover, honey as any other commodity, is prone to adulterations and frauds. These frauds can encompass the use of unlawful production methods and misleading labeling or claims like wrong or incomplete declaration of geographical or botanical origin. Inspite of a tremendous scope and good prospects of beekeeping in the Himachal Himalaya, our beekeeping does not match the level at which it is being practiced in other areas. So, there is a need to fill the various gaps for further development of apiculture in the Himachal Himalaya.

Table 7: Correlation matrix of various physicochemical characteristics of *Apis cerana* and *Apis mallifera* honey samples of district Chamba.

Apis cerana (Traditional) Honey samples	*Apis mellifera* (Modern) Honey samples						
	Refractive index	***Moisture %***	***S. Gravity***	***Viscosity***	***S. Tension***	***E. conductivity***	***Ash content***
	–0.0644	0.0731	–0.0429	0.0030	–0.3879	–0.0971	–0.4592
	–0.0644	0.0731	–0.0428	0.0030	–0.3880	–0.0971	–0.4591
	–0.0694	0.0780	–0.0446	–0.0018	–0.3857	–0.0900	–0.4679
	–0.0.0745	0.0826	–0.0525	–0.0062	–0.3809	–0.0968	–0.4753
	–0.0709	0.0794	–0.0448	–0.0032	–0.3851	–0.0874	–0.4706
	–0.0867	0.0939	–0.0641	–0.0166	–0.3717	–0.0825	–0.4963
	–0.2496	0.2362	–0.2264	–0.1499	–0.0760	0.0753	–0.7624*

N.S non-significant of 5% of significant, ** Significant at 1% level of significant

REFRENCES

Aganin, A. V. (1971). Electrical conductivity of several unifloral honeys. *Tr. Sarat. Zootekh. Vet. Inst.* **21**: 137-144.

Anderson, R.H. and Perold, I.S. (1964). Chemical and physical properties of South African honey. *S. Afr. J. Agric. Sci.* Z: 365-374.

Bianchi, E.M. (1978). Electrical conductivity of honeys from Argentine. *Gaceta del Colmenar.* **40**: 268-271.

Bogdanov S. *et al.*, (1999) Honey quality and international regulatory standards: review by the *International Honey Commission, Bee World*, **80**: 61-69.

Cirilli, G, Papagheorghev, A. and Savigni, G, (1973). Chemical and nutritional characteristics of honey. *Industrie Alimentari*. **12**: 74-76.

Crane, E. (1979). From honey-A comprehensive survey (ed. Crane, E.). London: Heinemann.

Deans, A.S.C. (1953). Specific gravity of honey. Scot. Beekpr. 29: 60.

Fini, M.A. (1966). Physicochemical properties of honey, *Apic. Ital*. **33**: 231.

Fini, M.A. (1967). Physicochemical properties of honey, *Apic. Ital* .**34**: 37-51.

Fulmer, E.T., Bosch,W., Park, O.W and Buchanan, J.M. (1934). The analysis of the water content of honey by use of refactometer *Am. bee. J.* **74**: 208.

Iwaida, M., Shirotori, T. and Kawashiro, I. (1969). On the determination of water content in honey. J. *Food Hyg. Soc. Jpn.* **10**: 47-49.

Lin, Y.C., Shew, S.Y. and Kong, H.H. (1977). Physicochemical characteristics of certain Taiwan honeys, *Formosan Sci.* **31**: 34-39.

Lothrop, R.E. (1939). The composition of honey and its utilization relation of composition and viscosity. *Am. Bee J.* **79**: 130-133.

Mallick, A.K. (1958). Analysis of Indian honey *J. Inst. chem. India.* **30**: 171-173.

Marvin, G.E. (1933). Methods for determining the weight per gallon of honey. *Am. Bee J.* **73**: 426-428.

Munro, J.A. (1943). The viscosity and thixotropy of honey. *J. Econ. Ent.* **36**: 769-777.

Murko, D., Pasic, T. and Ramic, S. (1976). Composition of 14 types of honey. *Hem. Ind.* **30**: 113-115.

Paine, H.S., Gertler, S.I. And Lothrop, R. E. (1934). Colloidal constituents of honey. Influence on properties and commercial value. *Indian Eng. Chem. Ind.* **26**: 73-81.

Perez, B.S. and Rodriguez, A.T. (1970). Chemical composition and pollen spectrum of Spanish honeys. *An. Bromatot.* **22**: 377-406.

Perti, O.N. and Pandey, P. (1967). Study of physicochemical constants of Apis dorsata Honey. *Indian Bee J.* **29**: 1-3.

Phadke, R.P. (1967). Studies on Indian honeys. *Indian Bee J.* **29**: 14-26.

Pryce- Jones, J. (1950). The composition and properties of honey. *Bee World.* **3**: 2-6.

Sacchi, R. (1955).Umbrian honeys and the determination of moisture by refractometry. *Ann. Sper. Agrar.***10**: 1029-1042.

Townsend, G.F. (1970). Preparation of honey for market. Publ. Ont. Dept. Agric. No. 544.

Vorwohl, G. (1964). Measurement of electrical conductivity of honey, its use in identifying honey types and in detecting adulteratiob with honey from sugar fed bees. *Z. Bienenforsch.* **7**: 37-47.

Wantanade, T. and Goto, M. (1956). Studies on useful components in natural sources. IX. Studies on Japanese honeys. Jpn. *J. Pharmacogn.* **10**: 145-148.

White, J.W. Jr. and Maher, J. (1954). Sugar analysis of honey by a selective adsorption method. *J. Assoc. Agric. Chem. Wash.* **37**: 466-478.

White, J.W. Jr., Subers, M.H. and Schepartz, A.I. (1962). The identification of inhibine. *Am. Bee. J.* **102**: 430-431.