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Quality evaluation of different types of Indian honey

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Chemical composition, flow behaviour indices and overall acceptability of the most popular types of honey produced in India were investigated. *Trifolium* honey showed the highest specific gravity, diastatic number, total acidity, free fatty acids content, consistency coefficient and overall acceptability. However, *Eucalyptus lanceolatus* honey showed the highest value for lactone and conductivity. Linear regression models for the formation of HMF as a function of time at different temperatures showed that *Trifolium* honey had fastest rate of HMF formation followed by *Eucalyptus lanceolatus* and *Brassica juncea* honey. Copyright © 1996 Elsevier Science Ltd

INTRODUCTION

Honey is the nectar and saccharine exudation of plants gathered, modified and stored in comb by honey bees (*Apis mellifica* and *Apis dorsata*). The composition and properties of honey varies with floral sources utilized by the bees as well as regional and climatic conditions (Trstenjak *et al.*, 1993; Salinas *et al.*, 1994; Perez-Arquillue *et al.*, 1994). The studies on physical and chemical properties of honey produced in different countries have been reported by many scientist (Siddiqui, 1970; Doner, 1977; Langridge, 1977; Thrasyvoulou, 1986; Bonvehi, 1988; Singh *et al.*, 1988; Steeg & Montag, 1988; Sancho *et al.*, 1992; Gupta *et al.*, 1992; Mateos-Nevado *et al.*, 1994; Rodriguez-Otero *et al.*, 1994). The present investigation was undertaken to study physicochemical properties of some of the most popular types of honey produced in India.

MATERIALS AND METHODS

The samples of honey were collected to represent three different sources viz. *Trifolium spp*, *Brassica juncea*, and *Eucalyptus lanceolatus* (litharge) from 1994–1995 season. The honey used in present study was ripe honey, harvested from hives, which were located in the areas, where *Trifolium*, *Brassica juncea* and *Eucalyptus lanceolatus* constitute the major flora, for the collection of nectar. Extraction of honey was carried out by filtering and squeezing the honey through muslin cloth and stored in air tight plastic jars for further analysis.

The specific gravity of honey was determined by dividing the weight of a glass beaker (50 ml) filled with honey to the weight of the same beaker, filled with water. Acidity, free acids, lactone, conductivity and diastases activity was determined by the AOAC (1990) methods. Colour was determined as its optical density without dilution (of honey) at 420 nm using spectrophotometer. To determine conductivity, 20 g of honey was dissolved in 100 ml distilled water and conductivity (ohms) was measured using conductometer. For the estimation of total colloids, 10 g of honey was mixed with 10 ml of distilled water and centrifuged at 15000 rpm for 15 min and per cent sedimented colloid residue was reported as total colloid contents. To study the effect of heating on HMF (hydroxymethylfurfural), 5 g of each honey sample was poured in a glass beaker and heated in a water bath at 65°C and 95°C for 5, 15 and 30 minutes, cooled and analyzed for HMF content by AOAC (1990) methods. Viscoelastic properties of different samples of honey were measured using Brookfield Viscometer (Brookfield Engineering Inc., model, DV-II). A 500 ml beaker with a diameter of 8.5 cm were filled up to a height of 8.5 cm, with honeys samples and brought to a temperature of 25°C, in TC-500 water bath (Brookfield Engineering Inc). Measurements were taken 2 min. after the spindle (No. 18 was immersed, so as to allow a thermal equilibrium in the sample and to eliminate the effect of immediate time dependency. A log-log plot of shear stress versus shear rate were drawn and consistency coefficient and flow behaviour indices of honey samples were calculated. Organoleptic evaluation of honey samples was done by a team of six scientists

Table 1. Physico-chemical properties of different types of honey

Type	Specific gravity (g/cm^3)	Diastatic number	Moisture (%)	Colour (O.D.)	Suspended colloids (mg/100g)
Trifolium	1.49^b	32.5^c	18.7^a	2.0^c	100^a
E lanceolatus	1.45^b	23.3^b	19.4^b	1.65^b	200^b
B juncea	1.35^a	8.5^a	21.8^a	0.82^a	400^c

Values with similar superscripts do not differ significantly ($p < 0.05$). Higher ranked letters are significantly different from lower ranked letters in the following order c > b > a.

Table 2. Chemical characteristics of different types of honey

Type	Free acid (meq/kg)	Lactone (meq/kg)	Total acidity (meq/kg)	pH	Conductivity (ohms)
Trifolium	26.5^c	15.0^a	41.5^b	4.1^a	0.82^b
E lanceolatus	9.5^a	21.5^b	31.0^a	4.76^c	1.04^c
B juncea	14.5^b	15.0^a	29.5^a	4.25^b	0.24^a

Values with similar superscripts do not differ significantly. ($p < 0.05$). Higher ranked letters are significantly different f rom lower ranked letters in the following order c > b > a.

for colour, consistency, taste, flavour and mouth feel using 9-point hedonic scale. Average of scores for attribute was calculated and reported as overall acceptability. The data were statistically analyzed using paired *t*-test (Steel & Torrie, 1960)

RESULTS AND DISCUSSION

Trifolium honey showed the highest specific gravity and diastatic number of 1.45 g/cm^3 and 23, respectively, followed by 1.45 g/cm^3 and 23 of *E. lanceolatus* and 1.35 g/cm^3 and 8 of *B. juncea* honey (Table 1). The variation in specific gravity may be attributed to variation in chemical composition. On the other hand, the variation in the activity of diastases may be related to source of honey as well as climate of region. Honey from citrus as well as those produced in warmer climates have been reported to have naturally low levels of diastase activity (LaGrange & Sanders, 1988). The honey samples having higher moisture content had lower specific gravity and vice versa. The moisture content of honey is an important factor contributing to its stability against fermentation and granulation during storage. The moisture content of different honey types differ significantly. *B. juncea* honey showed the highest value compared to other types. The moisture content of *B. Juncea* (21.75%) and *E. lanceolatus* (19.4%) honey was higher compared to values reported for normally ripened honey by White (1978). Abu-Tarboush *et al.* (1993) reported that the moisture content of honey in the range of 13.4–18.2%.

B. juncea honey showed the lightest colour measured as O.D at 420 nm and highest suspended colloids. Total acidity, free fatty acid content of *Trifolium* honey was significantly higher than *E. lanceolatus* and *B. juncea* honey. However, the *E. lanceolatus* honey showed the highest pH and lactone content. The total acidity value of *E. lanceolatus* and *B. Juncea* did not differ significantly (Table 2). *Trifolium* honey had highest free acid content of 26.5 meq/kg against lowest value of 9.5 meq/kg for *E. lanceolatus*. The acidity of honey is due to the presence of organic acids, particularly the gluconic acid, in equilibrium with their lactones or esters and inorganic ions such as phosphate and chloride (Echigo & Takenaka, 1974). The variation in acidity among different honey types may be attributed to variation in these constituents due to extraction season (Perez-Arquillue *et al.*, 1994). El-Sherbiny & Rizk (1979) reported that total acidity was higher in cotton honey than in clover honey which indicate the influence of floral types in total acidity. Data w.r.t conductivity value revealed a highest conductivity value of 1.04 ohms for *E. lanceolatus* followed by values of 0.82 and 0.24 ohms for *Trifolium* and *B. juncea* honey, respectively. The variation in conductance value in honey types might be due to variation in concentration of inorganic salts. Therefore, *E. lanceolatus* honey is more ionic in nature compared to other types. Crane (1975) reported that conductivity of honey depends on organic acids, proteins, complexed sugars and polyols, in addition to minerals. A number of workers have reported that the ash content of honey depends on the floral types used by bees (El-Sherbiny & Rizk, 1979; Abu-Tarboush *et al.*, 1993).

Linear regression models for the formation of HMF as a function of time at different ,temperature showed that with increasing heating time of 0-30 min, intensity of HMF formation in *Trifolium, E. lanceolatus* and *B. juncea* honey at 65°C increased from 1.7 to 24.3, 0.52 to 8.85 and 0.15 to 0.95 mg/100 g, respectively (Figs 1 and 2 and Table 3). The initial HMF content in all honey types corroborated well the colour value measured as O.D at 420 nm and is higher than the values reported by Doner (1977) and White (1978), which may be attributed to variation in climate of regions from where honey had been extracted. LaGrange & Sanders (1988) stated that honey produced in subtropical climates has high HMF, which exceed 40 ppm. Relative rates of HMF formation were calculated assuming the rate

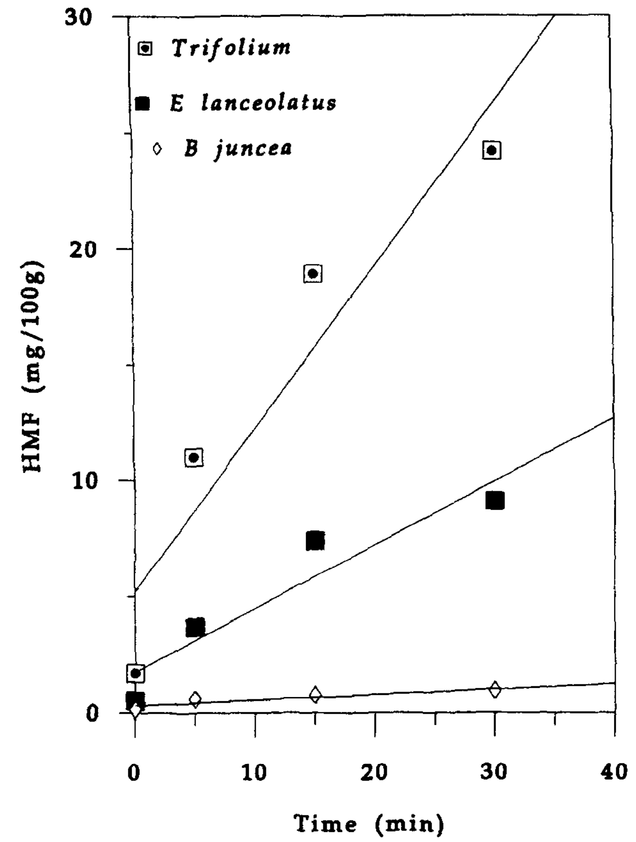

Fig. 1. Linear regression analysis for the formation of HMF in different honey types at 65°C.

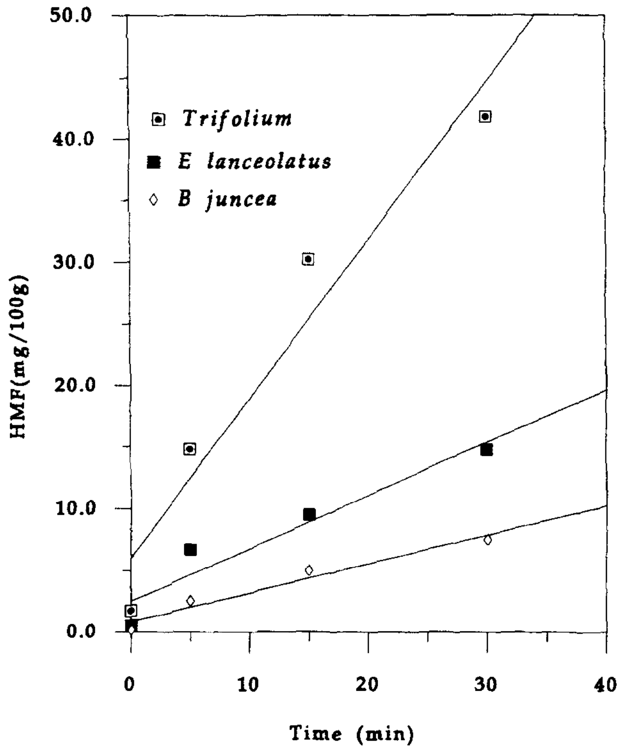

Fig. 2. Linear regression analysis for the formation of HMF in different honey types at 65°C.

constant for *B. juncea* honey to be 1 at different temperatures. The rate of HMF formation at 65°C over a period of 30 min for *Trifolium* and *E. lanceolatus* honey was 30 and 12 times faster as compared to *B. juncea*. However, the rate decreased to 6 and 2 times at 95°C, for *Trifolium* and *E. lanceolatus* honey, respectively. This variation may be attributed to variation in sugar composition of honey types. Doner (1977) reported honey from different sources vary in their fructose:glucose ratio. HMF formation results from the acid catalysed dehydration of hexose sugars with fructose being particularly susceptible to this reaction. Fructose has been reported to be unstable at pH 4.6 and is 5 times more reactive than glucose in its most stable acid environment (2-6). Conformation stability of sugar molecules is self explanationery for the faster rate of HMF formation from fructose than glucose because fructose enolizes faster than glucose (Isbell *et al.*, 1969; Lee & Nagy, 1990; Kuster, 1990). Highest rate of HMF formation in *Trifolium* honey may also be attributed to its lowest pH value. Hase *et al.* (1973) also reported that honey of low pH value produced more HMF on heating.

Log-log plots of shear stress-shear rate were drawn to calculate regression constants a and b for linear relationship between honey samples from different floral regions (Fig. 3). The slope (b) represents the flow behaviour index (n) and the anti-logarithm of the intercept (a) gives the consistency coefficient or the viscousness of the honey (Table 4). The consistency coefficient of various samples varied in the range of 1.72 to 5.71 Pa sec^n and it was the highest for *Trifolium* honey and lowest for *B. juncea* (Table 5). The ease in handling a honey type can be assessed from the consistency coefficient. The variation in the consistency coefficient of different honeys may be due to variation in water content. Heldman & Singh (1981) reported a consistency

Table 3. Regression analysis and relative rates for HMF formation from different honey types

Type	Temp	Regression equation	R2	Relative rate
Trifolium	65°C	Y = 5.21 + 0.699X	0.89	30
E lanceolatus	65°C	Y = 1.76 + 0.273X	0.88	12
B. juncea	65°C	Y = 0.32 + 0.023X	0.81	1
Trifolium	95°C	Y = 6.02 + 1.287X	0.94	6
E lanceolatus	95°C	Y = 2.49 + 0.432X	0.92	2
B. juncea	95°C	Y = 0.84 + 0.235X	0.96	1

Y, HMF content; X, Time.

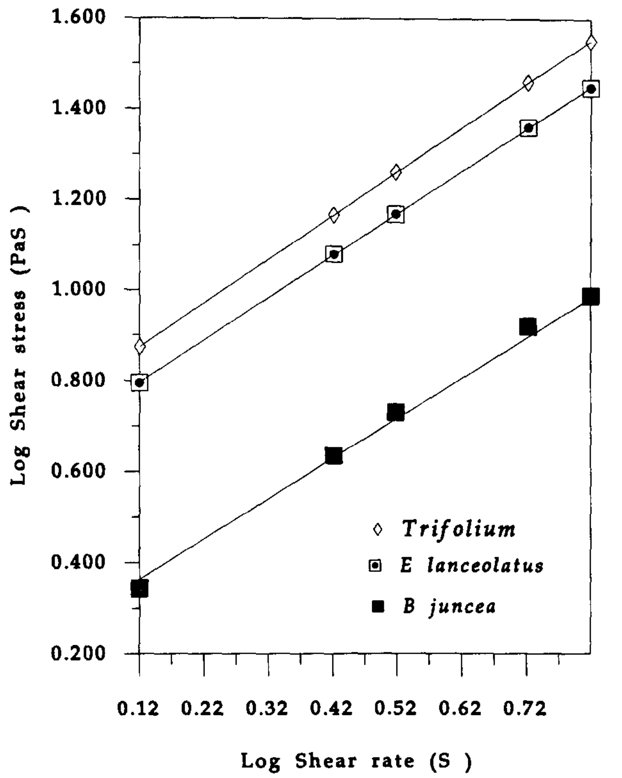

Fig. 3. Shear stress–shear rate plots for different honey types.

Table 4. Regression constants for the relationship log τ = a + b log γ for different types of honey

Type	a	b	R2
Trifolium	0.757	0.9692	0.99
E lanceolatus	0.683	0.9342	0.99
B Juncea	0.237	0.9330	0.99

Table 5. Consistency coefficient and flow behaviour indices for different honey types

Type	Consistency coefficient Pa s^n (m)	Flow behaviour index (n)
Trifolium	5.72[a]	0.96
E lanceolatus	4.82[b]	0.93
B juncea	1.72[c]	0.93

Values with similar superscripts do not differ significantly. ($p < 0.05$). Higher ranked letters are significantly different from lower ranked letters in the following order c > b > a.

coefficient of 5 Pa sec^n for honey. The flow behaviour index of 1 indicates newtonian fluid. Therefore, any deviation from 1 would indicate non-newtonian fluid behaviour. The flow behaviour indices of honey types are in agreement with those reported by Heldman & Singh (1981). Data for organoleptic evaluation showed a significant variation in honey samples from different floral sources. *Trifolium* honey showed highest overall acceptability scores of 7.7 followed by 6.6 for *E. lanceolatus* and 5.0 for *B. juncea* honey.

It could be concluded that the chemical composition, flow behaviour and overall acceptability depends on the floral types used by bees. Heating of honey, an essential step during honey processing to prevent granulation and fermentation, must be controlled considering the floral source from which honey had been extracted.

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REFERENCES

Abu-Tarboush, H. M., Al-Kahtani, H. A. & El-Sarrage, M. S. (1993). Floral types identification and quality evaluation of some honey types. *Food Chem.*, **46**, 13–17.

AOAC, 1990. *Official Methods of Analysis* (15th edn), ed. K. Helrich. Association of official Analytical Chemists, Inc., Arlington, VA, USA.

Bonvehi, J. S. (1988). Physicochemical properties, composition and pollinic spectrum of *Lavandulla latifolia* Med. honey from spain. *Sci. Aliments.*, **8**, 295–307.

Crane, E. (1975). *Honey: A Comprehensive Survey*. International Bee Research Association, Heinemann, London, UK.

Doner, L. W. (1977). The sugars of honey: a review. *J. Sci. Food Agric.*, **28**, 443–456.

Echigo, T. & Takenaka, T. (1974). Production of organic acids in honey by honeybees. *J. Agric. Chem. Soc. Japan*, **48**, 225–230.

El-Sherbiny, G. A. & Rizk, S. S. (1979). Chemical composition of both clover and cotton honey produced in A. *R.E. Egypt. J. Food Sci.*, **7**, 69–75.

Gupta, J. K., Kaushik, R. & Joshi, V. K. (1992). Influence of different treatments, storage temperature and period on some physico-chemical characteristics and sensory qualities of Indian honey. *J. Food Sci. Tech.*, **29**, 84–87.

Hase, S., Suzuki, O., Odate, M. & Suzuki, S. (1973). Changes in quality of honey on heating and storage. I. Changes in hydroxymethylfurfural (HMF) content of honey. *J. Food Sci. Tech.*, **20**, 248–256.

Heldman, D. R. & Singh, R. P. (1981). *Food Process Engineering*. 2nd ed, AVI Publishing company, Inc., Westport, CT, pp 399–400.

Isbell, H. S., Frush, H. L., Wade, C. W. R. & Hunter, C. E. (1969). The use of HMF and diastase as criteria of quality of Greek honey. *J. Apic. Res.*, **25**, 185–195.

Kuster, B. F. M. (1990). 5-Hydroxymethylfurfural (HMF). *A review focussing on its manufacture. Starch/Starke*, **42**, 314–321.

LaGrange, V. & Sanders, S. W. (1988). Honey in cereal-based new food products. *Cereal Foods World*, **33**, 833–838.

Langridge, D. F. (1977). A study of some quality factors of Australian honey. *Food Tech. Aust.*, **29**, 109–112.

Lee, H. S. & Nagy, S. (1990). Relative reactivities of sugars in the formation of 5-hydroxymethyl furfural. *J. Food Process Preser.*, **14**, 171–178.

Mateos-Nevado, M. D., Saenz De La Maza, J. A. & Mateos-Nevado, B. (1994). Honey from Seville province II. Chemical and physicochemical characterization of honey from La Campina regin. *An. Bromatol.*, **44**, 101–104.

Perez-Arquillue, C., Conchello, P., Arino, A., Juan, T. & Herresa, A. (1994). Quality, evaluation of Spanish rosemary (*Rosomarinus officinalis*) honey. *Food Chem.*, **51**, 207–210.

Rodriguez-Otero, J. L., Paseiro, P., Simal, J. & Cepeda, A. (1994). Mineral content of the honeys produced in Galicia (North-west spain). *Food Chem.*, **9**, 169–171.

Salinas, F., Montero De Espinosa, V., Osorio, E. & Lozano, M. (1994). Determination of mineral elements in honey from different floral origins by flow injection analysis coupled to atomic spectroscopy. *Revista Espanola de Ciencia y Tecnolgia de Alimentos.*, **34**, 441–449.

Sancho, M. T., Muniategui, S., Huidobro, J. F. & Simal, J.. *(1992). Aging of honey. J. Agric Food Chem.*, **40**, 134–138.

Siddiqui, I. R. (1970). The sugars of honey. *Adv. Carbohydr. Chem. Biochem.*, **25**, 285–309.

Singh, N., Singh, S., Bawa, A. S. & Sekhon, K. S.. *(1988). Honey-its food uses. Indian Food Packer*, **42**, 15–25.

Steeg, E. & Montag, A. (1988). Quantitative determination of aromatic carboxylic acids in honey. *Z Lebensm-Unters. Forsch.*, **187**, 115–120.

Steel, R. G. D. & Torrie, J. H. (1960). *Principles and Procedures of Statistics*, McGraw-Hill, New York.

Thrasyvoulou, A. T. (1986). Use of HMF and diastase as criteria of quality of Greek honey. *J. Apic Res.*, **25**, 186–195.

Trstenjak, P. Z., Mandic, M., Grgic, J., Grgic, Z. & Besic, J. (1993). Selenium levels in some species of honey in Eastern Croatia. *Deuts. Lebensm. Runds.*, **89**, 46–48.

White, J. W., Jr. (1978). *Honey. Adv. Food Res.*, **24**, 287–375.