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Quality Attributes of Honey in Saudi Arabia

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ABSTRACT

The properties of locally produced and imported honeys on the Saudi market are compared to evaluate their native qualities and concurrence with specifications set by the Saudi Arabia Standard Organization (SASO).

Locally produced samples comply with almost all SASO requirements. Only two samples have higher sucrose contents than that set by the SASO. This may be attributable to lack of ripening.

Imported samples have lower soluble solids, reducing sugars, fructose to glucose ratio and diastatic activity, but higher moisture content, insoluble solids and hydroxy-methyl furfural (HMF) than the local samples, indicating better qualities of the latter. No differences are encountered in pH values or protein content between local and imported samples. The too high HMF content of some of the imported samples indicates their adulteration with invert sugar.

INTRODUCTION

Honey has always enjoyed a special esteem as food. It is rich in energy, minerals, vitamins, enzymes and hormones. It was Royal prerogative in ancient Egypt, and mentioned exclusively in ancient Egyptian religious texts (Darby *et al.*, 1977). It is cited in all holy books. Its virtues as a remedy for Man and as a food in Paradise are stressed in the Moslems' holy book 'The Koran'. Honey is therefore considered with great respect in Moslem countries, particularly in Saudi Arabia. However, it is only recently, after the great agricultural development in this Kingdom, that Saudi farmers have

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started to pay increasing attention to apiculture and honey production. This might partially explain the sharp drop in honey imports from 1975 tons in 1982 to 270 tons annually during the following years (*Statistical Year Book*, Central Department of Statistics, 1977–1984). Neither production figures nor any scientific study on honey in Saudi Arabia are available. However, we may estimate local honey production through the last few years at approximately one-third its imports. Strikingly enough, local honey enjoys a price almost thirty or more times that of most of the imported types. Factors responsible for this, remain to be investigated.

Excellent reviews on honey have been published by White (1978*a*,*b*) and Grane (1975). White (1975) has called for studies on honeys of different countries. This would have a strong impact on international trade and on setting down reasonable quality standards for natural honey. Such studies have been presented for honeys in Egypt (El-Sherbiny *et al.*, 1980), Libya (Mohamed *et al.*, 1982), Finland (Varis *et al.*, 1983), Italy (Butta *et al.*, 1983; Spettoli, 1983), Fiji (Pocini *et al.*, 1984), Russia (Ivanov & Chervenakova, 1984) and Korea (Chung *et al.*, 1984). This work is therefore aimed to investigate properties of local and imported honeys in Saudi Arabia and to evaluate their compliance with standards set by the Saudi Arabia Standards Organization (SASO, 1978).

MATERIALS AND METHODS

Sample collection

Locally produced honey is not to be found in supermarkets or groceries. Five samples are obtained directly from producers in the Eastern Province of KSA within one month of production. Eight samples of honey imported from Asia, Australia, Europe and the United States are collected from supermarkets. Production dates on the labels indicate they are 6–24 months old.

Sample preparation

Each sample is thoroughly mixed, strained through cheese cloth to remove foreign matter and kept refrigerated in glass containers for analysis.

Sample analysis

Moisture content is computed from refractive index measured by an Abbe' refractometer at 20°C, utilizing the respective Tables given in SASO (1978).

Total soluble solids are measured in an Abbe' refractometer at 20°C.

Water-insoluble solids (WIS) are determined gravimetrically (SASO, 1978).

The sugars fructose, glucose, sucrose and maltose are determined by an HPLC method using a reverse bonded phase chromatography technique (Quality Control Labs., 1981a) in a Hewlett Packard Model 1084 B Chromatograph equipped with a differential refractive index detector (Waters Associates Model 401).

Hydroxymethyl furfural (HMF) is determined photometrically (Quality Control Labs, 1981b).

The pH value is determined in a Kent Eil pH meter, Model 7060 on a 10-g sample dissolved in 75 ml carbon dioxide-free water (Farghaly, 1973).

Total acidity is determined as meq acid per kilogram of sample from summation of free titratable acidity and lactone (AOAC, 1980).

Diastase activity is measured by starch hydrolysis (AOAC, 1980).

Crude protein is determined by the Kjeldahl method (AOAC, 1980).

The ash content is determined according to SASO (1978).

The minerals sodium, potassium, calcium, magnesium, iron, copper and zinc are determined by atomic absorption spectrophotometry (El-Shaarawy, 1973) in a Perkin Elmer AAS Model 603 using an air/acetylene flame. Lanthanum oxide is used to suppress phosphorus interference (El-Shaarawy, 1971).

Statistical analysis of data for local versus imported honeys is effected as described by Snedecor & Cochran (1974).

RESULTS AND DISCUSSION

Sensory examination

Examination of samples shows that all are free from any visible mould growth, insect fragments, sand particles, undesirable flavours or any fermentation, and hence agree with the general requirements of the SASO (1978).

Approximate analysis

Moisture content of honey is important for its keeping quality. According to the SASO (1978), honey must contain no more than 23% moisture for heather and clover or 21% for other honeys, respectively. None of the samples examined shows such a high moisture content (Table 1). Moreover, locally produced samples enjoy a moisture content significantly lower than that of the imported ones, being 13·8–15·6 and 15·4–18·8, respectively. These

TABLE 1
Approximate Analysis of Honey on Saudi Market

Sample no.	*Moisture* (%)	*Total soluble solids* (%)	*Water-insoluble solids* (%)	*Protein*	*pH*	*Total acidity* (*meq/100 g*)	*Ash* (%)
			Local honey				
1	13·8	83·5	0·06	0·25	3·7	13	0·22
2	13·8	83·5	0·07	0·21	3·8	21	0·09
3	15·5	82·5	0·08	0·25	4·2	22	0·36
4	14·3	83·1	0·07	0·24	3·6	24	0·12
5	15·6	82·2	0·06	0·28	3·8	17	0·19
Range (Average)	13·8–15·6 (14·6)	82·2–83·5 (83·01)	0·06–0·08 (0·07)	0·21–0·28 (0·25)	3·6–4·2 (3·8)	13–24 (19)	0·09–0·36 (0·20)
			Imported honey				
1	15·4	82·0	0·09	0·22	4·3	26	0·67
2	18·8	79·0	0·10	0·24	3·7	28	0·14
3	17·3	80·3	0·10	0·24	4·2	30	0·54
4	18·3	79·8	0·07	0·24	3·7	25	0·12
5	18·6	79·1	0·08	0·27	3·6	19	0·08
6	17·8	79·8	0·09	0·22	3·7	22	0·13
7	16·0	81·5	0·09	0·23	3·8	25	0·13
8	16·3	80·9	0·07	0·21	3·6	25	0·11
Range (Average)	15·4–18·8 (17·3)	79–82 (80·7)	0·07–0·10 (0·09)	0·22–0·27 (0·23)	3·6–4·3 (3·8)	19–30 (25)	0·08–0·67 (0·24)
SASO	≤21	—	0·5	—	—	40	1·0
	23	—	0·1	—	—	40	0·6
T. calculated	4·1**	4·3**	2·94*	0·04	0·1	2·7*	0·40

T. Table at P 0·05 = 2.20; at P 0·01 = 3·11. * Statistically significant at $P = 0·05$. ** Statistically highly significant at $P = 0·01$.

values lie within the range of 13·4–22·9 reported by White in his survey of 490 samples (White, 1975).

As expected from the low moisture content, the total soluble solids (TSS) of all our samples are high, with those of the local samples significantly higher than those of the imported types (Table 1). Nevertheless, the water-insoluble solids (WIS) of the local honeys are significantly lower than those of the imported. However, all values for WIS fall within the Saudi requirements of 0·1% (SASO, 1978). These results may indicate an overall better quality of local honeys than of imported ones.

Protein content of local versus imported honeys does not show any significant difference. All values lie within the range mentioned by White (1975) for American honey (0·0–0·8%) and by other researchers (Farghaly, 1973; El-Sherbiny & Rizk, 1979) for Egyptian honeys (0·04–0·48).

Acidity affects honey flavour and shelf life (White, 1978*a*). No significant differences are revealed between pH of Saudi and imported honeys, both ranging from 3·6 to 4·2, and falling within the range of 3·42 to 6·1 cited by White (1975). Honey pH is affected, not merely by various acids, but also largely by its mineral content (White, 1975). No limits for pH values are suggested in Saudi Standards for honey, but acidity shall not exceed 40 meq/kg honey and shall not be artificially modified (SASO, 1978). Methods to detect modification of natural acidity are not given (SASO, 1978) but set limits for ash content may guard against artificial modification. Acidities in all samples lie within the limit set by the SASO, with those of the local samples significantly lower than those of the imported.

Saudi honeys show a range of ash contents narrower than that of the imported, the difference being statistically insignificant (Table 1). Two maxima for ash content, 1% and 0·6%, are set in the Saudi Standards (SASO, 1978) depending on plant source used by bees. Since this source is not known for our samples, we have to consider the higher limit. Only one of the imported samples falls just above the 0·6% limit, though still below the 1% accepted. All other samples, particularly the local, have ash contents lower than 0·6%. Such low ash (Foda, 1961) contents have also been previously reported, i.e. 0·19% for Egyptian honeys (Foda, 1961) and 0·12% for American honeys (White *et al.*, 1962). Values lower than 0·1% (White *et al.*, 1962) or as high as 1·5% have also been mentioned (Anon, 1972). As previously stated (White, 1975), honeys rich in ash content generally have high pH values (Table 1).

Chemical aspects

Mineral content is one of the factors affecting colour of honey (Schuette, 1932–1939). Among all minerals determined, potassium shows by far the

TABLE 2
Mineral Content of Honey Samples (mg/kg)

Sample no.	*Potassium*	*Sodium*	*Calcium*	*Magnesium*	*Iron*	*Zinc*	*Copper*
			Local honey				
1	229	87	116	78	6	2	1
2	170	31	90	29	8	9	1
3	977	107	75	56	8	1	1
4	308	66	154	23	10	10	2
5	187	37	82	70	8	1	3
Range (Average)	170–977 (374)	31–107 (66)	75–154 (103)	23–78 (51)	6–10 (8)	1–10 (5)	1–3 (2)
			Imported honey				
1	2476	615	77	49	15	9	4
2	147	79	25	18	17	3	1
3	1980	594	74	16	13	6	2
4	426	77	53	21	6	10	1
5	176	50	44	16	9	3	0
6	182	82	33	12	27	6	1
7	400	60	38	32	7	2	0
8	182	49	28	23	8	14	1
Range (Average)	147–2476 (746)	49–615 (201)	25–76 (47)	12–49 (23)	6–27 (13)	2–14 (7)	0–4 (1)
T. calculated	0·85	1·18	3·94**	2·76	1·50	0·82	0·39

T. Table at P 0·05 = 2.20; at P 0·01 = 3·11. * Statistically significant at $P = 0·05$. ** Statistically highly significant at $P = 0·01$.

highest content, followed by either calcium (for local samples) or sodium (for imported samples) (Table 2). Magnesium, iron, zinc and copper then follow.

While the contents of potassium and sodium in local samples are, on average, almost half or less than in imported honeys, calcium and magnesium contents are nearly double those of the imported. However, the difference is statistically significant only in the cases of calcium and magnesium. Variation in concentration of sodium and potassium in each group of samples is quite wide. Sugars naturally form most of the honey solids, hence determining its characteristics. Two local and two imported samples are found to contain higher contents of sucrose than allowed by the SASO (Table 3). The reducing sugar content of the same two imported samples is lower than the 65% minimum level accepted by the SASO for blossom honey. Moreover, it is only a little higher than the 60% minimum set for blossom honey/honey-dew mixture. The labels on the packages do not clearly indicate the type of honey. Therefore, these two samples can hardly be considered acceptable.

The same four samples, containing unacceptably high sucrose content, have concomitantly higher levels of maltose, but lower concentrations of glucose, fructose and total reducing sugars than do the rest of the samples (Table 3). The amount of monosaccharides has been suggested to be a function of honey ripening time (White *et al.*, 1961). Lack of ripening might therefore be responsible for the elevated disaccharide content of the two odd local samples. On the other hand, oligosaccharides were reported to increase during storage of honey at the expense of monosaccharides (White *et al.*, 1961; Kalimi & Sohonie, 1964). Assuming no adulteration, this might explain the high disaccharide levels of the two imported samples. It might be noteworthy that, except for samples with too high sucrose content, the ratio of sucrose to total reducing sugars is almost constant at around 0·04. Further consideration is needed to prove the validity of this in the composition of natural honey. All samples are found to contain more fructose than glucose (Table 3). Average fructose/glucose ratio of local samples is significantly higher than that of the imported. This may indicate a less variable nectar source for the Saudi hive. Unifloral honey often contains substantially more fructose than glucose (White *et al.*, 1962). The fructose/glucose ratio may have an impact on honey flavour, since fructose is far more sweet than glucose (Mead-Chen, 1977). It also indicates that local honey would be less prone to granulation than most of the imported types. Honeys with high fructose/glucose ratios would remain liquid for long periods (White *et al.*, 1962).

The level of hydroxymethyl furfural (HMF) in fresh honey is normally very low, but increases significantly by storage, heat-treatment or addition of invert sugar (Doner, 1977). Up to 100 mg HMF/kg honey were reported

TABLE 3
Sugars and Diastase Activity of Honey

Sample no.	*Fructose* (%)	*Glucose* (%)	*Fructose glucose ratio* (%)	*Maltose* (%)	*Total reducing sugars* (%)	*Sucrose* (%)	*Diastase activity* (*No.*)	*Hydroxy-methyl furfural* (*mg/kg*)
				Local honey				
1	36·8	28·2	1·30	5·7	70·7	11·7	15·0	11
2	39·3	31·7	1·24	5·4	76·4	4·7	17·0	9
3	42·1	33·0	1·26	3·2	78·3	2·8	13·6	14
4	42·2	33·2	1·27	3·6	79·0	3·2	30·0	22
5	35·2	28·1	1·25	5·9	69·2	11·2	13·0	10
Range (Average)	35·2–42·2 (39·1)	28·1–33·2 (30·8)	1·24–1·30 (1·27)	3·2–5·9 (4·6)	69·2–79 (74·7)	2·8–11·7 (6·7)	13–30 (17·7)	9–22 (13)
				Imported honey				
1	29·6	25·6	1·16	6·3	61·5	13·1	8·6	120
2	35·4	30·8	1·15	3·9	70·1	2·3	9·4	149
3	29·9	23·9	1·25	7·9	61·7	12·7	20·0	20
4	38·8	32·7	1·19	3·9	75·4	3·1	13·0	164
5	35·4	33·5	1·05	5·3	74·2	2·8	12·0	149
6	39·2	32·9	1·19	3·5	75·6	3·2	5·5	125
7	41·0	33·0	1·24	3·0	77·0	3·5	6·7	160
8	41·0	32·4	1·26	3·2	76·6	3·1	13·0	60
Range (Average)	29·6–41·0 (36·3)	23·9–35·6 (30·6)	1·06–1·26 (1·19)	3·0–7·9 (4·6)	61·5–77 (71·5)	2·3–13·1 (5·5)	5·5–20 (11·0)	20–160 (119)
SASO					≥60 ≥65	≤ 6 ≤10	≥3 ≥8	≤13 ≤40
T. calculated	1·27	0·19	2·54*	0·07	1·47	0·48	2·1	2·94*

T. Table at P 0·05 = 2·2; at P 0·01 = 3·11. * Statistically significant at $P = 0·05$.

for many samples, and a level of 150 mg was considered an indication of adulteration with invert sugar (Doner, 1977). The SASO allows a level of only 40 or 15 mg/kg according to a minimum diastatic activity of 8 or 3, respectively (SASO, 1978). All our local samples, but only two of the imported ones, thus meet the Saudi standards for HMF. The rest of the imported samples show significantly high HMF levels. The diastase activity, on the other hand, meets the requirements of the SASO, except for two of the imported samples, suggesting the other samples were not subjected to heat treatment severe enough to inactivate the enzymes. The high HMF levels encountered with those imported samples may therefore be attributed to storage for long periods at high temperatures, and/or to adulteration. Without air-conditioning, storage temperatures during summer may reach somewhere close to 45°C. Further study is needed to assess the effect of such storage conditions on HMF, diastatic activity and other quality attributes of genuine honey.

In conclusion, many of the imported samples do not meet one or more specifications of the SASO. Some may even be adulterated.

Except for only two samples with sucrose contents higher than that accepted by the SASO, Saudi honeys meet all other SASO requirements. Ripening is expected to amend this drawback.

Having lower contents of moisture, WIS, ash and HMF, with higher levels of TSS, reducing sugars, fructose to glucose ratio and diastatic activity, Saudi honeys enjoy better characteristics than imported types. However, this does not account for the very high difference in prices.

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