ELSEVIER

Food Chemistry 67 (1999) 21–25

Food Chemistry

www.elsevier.com/locate/foodchem

Physicochemical characteristics and pollen spectrum of some Saudi honeys

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Received 18 June 1998; accepted 2 March 1999

Abstract

Ten unifloral Saudi honeys were studied and botainically typified: Sidir Aseer (*Ziziphus Spina-christi* (L)), Sidir Albaha (*Ziziphus Spina-christi* L), Talh Tehamh (*Acacia* spp.), Samra Taif (*Acacia Etbaica*), Magra Aseer (*Hypericum perforatum*), Doarm Taif (*Levandula Dentata*), Shorm Taif (*Ocimum repandra*), Talh Medina (*Acacia* spp.), Farm Riyadh (*Heliantemum chamaecistus*), and Farm Qaseem (*Cheno Podium* spp.). Honeys were considered to be unifloral when the dominant pollen was over 40% of total pollen. All samples were examined for moisture, refractive index, specific gravity, viscosity, total solids, water-insoluble solids, ash content, pH, total acidity, hydroxy methyl furfural, diastase, invertase activity, optical rotation, minerals and sugars. These samples were found to meet all major national and international honey specifications.

1. Introduction

Consumption of honey in Saudi Arabia has increased considerably in recent years. The total consumption during 1994 was (1645.5 tons), while the local production was only (76.532 tons) (Anon, 1995). The composition of a particular honey sample greatly depends on the composition of nectar(s) whence it originates.

A number of investigations have been related to physical properties and chemical composition of honey (Abu-Tarboush, Al-Kahtani, & Elsarray, 1993; Arquillue, Pilar, Augstin, Teresa, & Antonio, 1994; Arquillue, Pilar, Arino, Juan, & Herrere, 1995; Mateo, Bosch, & Pastor 1987; Mesallam. and El-Shaarawy, 1987; Sancho, Muniategui, Huidorbo, & Simal, 1992).

There are many types of commercially available honey in Saudi Arabia, but consumers prefer some particular honeys more than others. They believe that a particular type of honey is superior to other types produced locally or imported from other countries around the world. Therefore, the present work was conducted to investigate the quality of ten types of Saudi honeys.

2. Materials and methods

2.1. Sample collection and floral type identification

Ten samples of honey collected from bee-keepers were classified according to their botanical origin using the method of Crane (1979). The ten types of honey identified were the following (Table 1): Sidir Aseer (*Ziziphus Spina-christi* (L)), Sidir Albaha (*Ziziphus Spina-christi* L), Talh Tehamh (*Acacia* spp.), Samra Taif (*Acacia etbaica*), Magra Aseer (*Hypericum perforatum*), Doarm Taif (*Levandula dentata*), Shorm Taif (*Ocimum repandra*), Talh Medina (*Acacia* spp.), Farm Riyadh (*Heliantemum chamaecistus*), and Farm Qaseem (*Cheno Podium* spp.). Botanical classification was achieved when the pollen spectrum contained >40% of the corresponding dominant pollen. All samples showed no sign of fermentation or granulation.

3. Physicochemical analysis

The samples of honey were analyzed according to the AOAC (1995) and Saudi standard organization SASO (1978,1990), to determine moisture, refractive index, optical rotation, ash content, hydroxymethyl furfural (HMF), diastase, invertase, and, total enzyme activities, viscosity, water-insoluble solids, total solids, specific

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0308-8146/99/$ - see front matter
PII: S0308-8146(99)00096-5

Table 1
Ten types of Saudi honeys

Honey/location	Floral sources	
	Species	Family
Sidir Aseer	*Ziziphus Spina-Christi* (L.)	Rhamnaceae
	Acacia Spp.	Leguminosae
Sidir Albaha	*Ziziphus Spina-Christi* (L.)	Rhamnaceae
	Acacia Spp.	Leguminosae
Talh Tehamh	*Acacia* Spp.	Leguminosae
	Ziziphus Spina-Christi (L.)	Rhamnaceae
Samra Taif	*Acacia Etbaica*	Leguminosae
	Althaea ludwigii (L.)	Mallvaceae
Magra Aseer	*Hypericum Perforatum*	Gutteferae
Doram Taif	*Levandula Dentata*	Labiatae
	Hypericum Perforatum	Gutteferae
	Ocimum Repandra	Labiatae
Shoram Taif	*Ocimum Repandra*	Labiatae
	Hypericum Perforatum	Gutteferae
Talh Medina	*Acacia* Spp.	Leguminosae
	Ziziphus Spina Christi (L.)	Rhamnaceae
Farm Riyadh	*Heliantemum Chamaecistus*	Helianthemum
	Trifolium Spp.	Leguminosae
	Vicia Spp.	Leguminosae
	Ziziphus Spina Christi (L.)	Rhamnaceae
Farm Qaseem	*Cheno Podium* spp.	Cheno Podiece
	Cucumis sortivus	Cucurbitaceae
	Ziziphus Spina Christi (L.)	Rhamnaceae

gravity, minerals and sugars. Three replicate analyses were made from each sample to obtain the reported data. Moisture in honey was determined in the refractometer (AO), Model (10480 S/N) (AOAC, 1995). Optical rotation was measured in a Bellingham and Stanley, Polarimeter, U.K (AOAC, 1995). Ash percentage was measured by calcination overnight at 550°C in a furnace to constant mass (AOAC, 1995). Total soluble solids were determined by means of refractrometer (AO, scientific instrument model 10481 S/N) and corrections were made for temperature variations (SASO, 1990). Water-insoluble solids (WIS) were calculated as given in the Saudi standard Organization and the viscosity of honey was determined according to Mitschka (1982), at speed 4–5 and 40°C, using Brookfield model (DV-111,USA). Total acidity was determined according SASO (1990) by the titrimetric method; 10 g of the sample were accurately dissolved in 75 ml CO_2-free distilled water and titrated with 0.1 N NaOH. The pH was measured by a pH meter (Corning M240) from a solution containing 5 g honey in 10 ml of CO_2-free distilled water. Hydroxymethyl furfural was determined after dillution with distilled water and addition of *p*-toluidine solution (SASO, 1990). Absorbance was determined at 550 nm using a 1 cm cell in a Biochrom spectrometer. Results were expressed as mg/kg. The diastase activity was measured using a buffer solution of soluble starch and honey which was incubated in a special glass test tube. Results were expressed as ml of 1% of starch hydrolysed by an enzyme in 1 g honey in 1 h. (AOAC, 1995). Invertase activity was measured according to the method of Siegenthaler (1977) based on the spectrophotometric measurment of 4-nitrophenol. The fructose, glucose, and sucrose were determined by HPLC (Shimadzu model, Lc-10AD, Japan), using a refractive index (RTP-6A) detector, on 30 cm shimpack LC-NH_2 column. Sample preparation and chromatographic procedure were conducted as described in AOAC (1995) and minerals were determined according to Fodor and Molnar (1993) using a Perkin–Elmer, ICP-1000 (Emission spectrometer) including ultrasonic nebuliser (USN).

4. Statistical analyses

Data were statistically analyzed using of analysis of variance (Steel & Torrie, 1980) and the differences among the means were determined for significance at 5% level using Duncan's test and SAS computer program (SAS, 1982).

5. Results and discussion

The results of the honey pollen analysis are shown in Table 1. The dominant pollen is $>40\%$ of the pollen spectrum. The botanical families Rhamnaceae, Leguminosae, Malvaceae, Labiatae, Gutteferae and Helianthemum were most frequently found in the samples. Tables 2 and 3 show the mean and standard error ($\pm$SE) results obtained from the physicochemical and sugar content analysis of honey samples. Moisture content varied due to the type of honey. Thus, average moisture ranged from 14.0 to 16.90%, while current Saudi regulation requires $<21\%$ moisture in honey for safety from fermentation. However, the difference in moisture content was significant between all honey types. These values are similar to those of 13.5–18.2%, and 13.8–15.6% for some locally produced honey in Saudi Arabia, reported by Abu Tarboush et al. (1993) and Mesallam and El-Shaarawy (1987), respectively. As expected from the low moisture content, the total soluble solids (TSS) of all samples are high. The ash contents in different honey types studied differed widely. Farm and Magra Aseer honeys had the highest ash contents when compared with others. Honey normally has a low ash content and this depends on the material collected by the bees during foraging. All samples studied complied with requirements of SASO. Soluble solids content indicate the cleanness of the product, this fraction represents suspended wax particles, insect and vegetable debries of honey (Rodgers, 1979). All Samples were below the limit of 0.5% in pressed honey set by SASO (1990).

Table 2
Anaiysis of some Physicochemical parameters in ten types of Saudi honeys[a]

Honey type	Refractive index	Moisture	Specific gravity	Total solids	Water-insoluble solids	Ash content	pH	Total acidity	Viscosity
Sidir Aseer	1.4982e ±0.00	15.40c ±0.01	1.4223f ±0.01	82.90e ±0.08	0.35c ±0.02	0.05fg ±0.00	6.06a ±0.01	14.2g ±0.14	204c ±16.0
Sidir Albaha	1.5019a ±0. 00	14.03g ±0.03	1.4420a ±0. 00	84.20a ±0.06	0.22e ±0.01	0.09ef ±0.002	3.93e ±0.01	30.5b ±0.5	360ab ±9.12
Talh Tehamh	1.4979e ±0. 00	15.50c ±0.02	1.4223f ±0.01	82.83e ±0.00	0.28d ±0. 00	0. 17d ±0. 01	3.75g ±0.01	30.7b ±0.33	106.7d ±4. 60
Samra Taif	1.5000b ±0.00	14.50f ±0.02	1.4284d ±0.01	83.70b ±0.02	0.47f ±0.01	0.07gf ±0.00	5.08b ±0.01	21.5c ±0.28	233c ±8.09
Magra Aseer	1.4964f ±0.00	16.10b ±0.06	1.4405a ±0.01	84.33a ±0.01	0.19f ±0.00	0.49b ±0.02	4.98c ±0.01	10.0h ±0.12	197c ±21.9
Doarm Taif	1.4987d ±0.00	15.20d ±0.02	1.4343c ±0.02	83.10d ±0.02	0.019h ±0.00	0.37c ±0.04	3.48i ±0.01	19.3d ±0.33	247c ±37.5
Shoram Taif	1.5018a ±0.00	14.00g ±0.11	1.4411a ±0.00	84.20a ±0.01	0.36c ±0.016	0.14de ±0.012	3.70h ±0.014	17.2c ±0.16	376.7a ±10.11
Talh Medina	1.4976f ±0.00	16. 10b ±0.12	1.4276d ±0.00	82.20f ±0.01	0.62a ±0.02	0.02h ±0.00	4.61d ±0.01	39.7a ±1.45	151d ±7.42
Farm-Riyadh	1.4948g ±0.000	16.90a ±0.02	1.4251e ±0.01	81.73g ±0.06	0.13g ±0.02	0.59a ±0.01	3.87f ±0.00	15.3gf ±0.33	104d ±2.12
Farm-Qaseem	1.4995c ±0.00	14.90e ±0.20	1.4364b ±0.00	83.40c ±0.10	0.14g ±0.01	0.02gh ±0.002	3.76g ±0.28	16.0ef ±0.0	319b ±9.38

[a] Means in a column followed by different letters are significantly different. All values are means, ± SE of triplicate determination.

Table 3
H.M.F. invertase diastase and sugar contents in ten types of Saudi honey[a]

Honey types	Specific rotation	Fructose	Glucose	Sucrose	Fructose /Glucose	H.M.F	Diastase activity	Invertase activity
Sidir Aseer	+10.3d ±0.33	38.9b ±1.287	24.8b ±0.72	6.23a ±0.01	1.56	1.54g ±0.11	4.00e ±0.11	20.0f,g ±3.33
Sidir Albaha	−23.5i ±0.50	42.8a ±0.67	29.1c ±0.58	0.06g,h 0.03	1.47	5.63e ±0.06	9.3b ±0.10	73.3 a,b ±3.33
Talh Tehamh	−5.00c ±0.11	37.5b,c ±1.33	33.8b ±1.38	1.00e,d ±0.06	1.11	13.6a ±0.85	3.47f ±0.03	26.7e,f ±3.33
Samra Taif	−8.0e ±0.12	34.2e ±1.03	28.2e ±0.79	0.73d,e ±0.06	1.20	0.83g ±0.13	4.93d ±0.08	40.0d ±3.00
Magra Taif	−10.0f ±0.44	35.5c,e,d ±0.26	38.2a ±0.65	1.11c ±0.21	0.93	3.71f ±0.65	3.30d ±0.07	66.7b ±3.30
Doram Taif	−17.0h ±0.12	36.6b,c,d ±0.638	32.3b,c ±0.635	0.32f,g ±0.10	1.13	11.1c ±1.18	5.10f ±0.15	50.0c ±3.00
Shoram Taif	−14.0g ±0.14	37.3b,c ±0.16	32.8b,c ±0.36	1.66b ±0.03	1.14	9.79c,d ±0.19	5.47d ±0.02	30.0e ±3.00
Talh Medina	−6.0d ±0.22	37.8b,c ±0.19	29.7d,e ±0.32	0.49e,f ±0.05	1.27	12.9a,b ±0.48	3.27c ±0.02	76.7a ±3.33
Farm-Riyadh	−16.8h ±0.17	34.6d,e ±0.38	31.33c,d ±0.43	0.028h ±0.03	1.10	8.45d ±0.07	12.5f ±0.01	16.7g ±3.33
Farm-Qaseem	+6.00b ±0.21	+29.4f ±10.40	25.8f ±0.16	6.10a ±0.10	1.13	11.5b,c ±0.12	5.50c ±0.10	30.0e ±3.30

[a] Means in a column followed by different letters are significantly different. All values are means ±SE of triplicate determination.

Most honeys are acidic, having a pH in the range 3.5–5. Thus, all samples fell within the Saudi legal regulations for pH value. These values are in agreement with those reported by Pourtallier and Taliercio (1970) and Abu-Tarboush et al. (1993) except that Sidir Aseer honey exceeded 6.06 in pH value.

Total acidity varied significantly among honey types. However, the total acidity of Sidir honey was not significantly different from that of Talh honey. Talh Medina honey had and highest total acidity whereas Magra Aseer had the lowest value. Honey regulations depend on total acidity which can indicate the history of

honey. A high total acidity may mean that the honey had fermented at some time, and that the resulting alcohol was converted into organic acid (Rodger, 1979). Despite the variation in total acidity among honey types studied, all total acidity values fell within the limits of SASO (1990). Generally these values are in agreement with those reported by Abu-Tarboush et al (1993). Reducing sugars, mainly fructose and glucose, represented the largest portion of honey composition; such levels complied with requirements of SASO (1990). These values also agreed with results reported by Arquillue et al (1995), Arquillue et al (1994), and Abu-Tarboush et. al (1993). The fructose/glucose ratios were widely distributed (0.93–1.56), indicating the variety of floral sources, where the honey samples originated. The proportion of sucrose is similar to that found by Mohamed, Ahmed, and Mazid (1982) and Abu-Tarboush et al. (1993). Samples displayed a wide range of sucrose contents, but only Sidir Aseer and Farm Qaseem samples were above the Saudi maximum legal limit of 6% sucrose. Refractive index and specific gravity values ranged from 1.4982 to 1.5020 and from 1.422 to 1.441 (Table 2). These findings agree with Youssef and El-Gadawy (1973) and are comparable to those of the standard values listed for U.S honey, while viscosity values were in the range 104–377 c.p. Honey has the property of rotating the polarisation plane of polarised light. Floral honeys are levorotatory in contrast to honeydew and adulterated honeys, which are usually dextrorotatory. This is a consequence of the normal preponderance of fructose in floral honey, which shows a negative specific rotation over glucose. Only the two samples with high sucrose content were dextrorotatory while other samples were levorotatory.

The diastase activity and hydroxy methyl furfural (HMF) content are widely recognized parameters in evaluating the freshness of honey (Sancho et.al., 1992; White, 1994). Legal regulations in Saudi Arabia set a minimum value for diastase activity of a three Goth's scale and maximum HMF content of 80 mg/kg. Honey samples showed an appropriate diastase number ranging from 3.3 to 12.5 G and HMF content, with a maximum value of 13.6 mg/kg. Table 3 shows the significant differences among samples in HMF content. Samra Taif honey had the lowest value, whereas Talh-Tehamh honey had the highest value. Thus, all samples fell within the Saudi legal regulation for diastase number and HMF content.

These low values of HMF and diastase are in agreement with those reported by Arquillue et al. (1994) and AL-Brahim (1996). The invertase activity in honey types studied differed widely. Talh Medina honey had the highest invertase activity (76.7). while Sidir had the lowest (20). However, a significant difference was found between invertase activies. These values of invertase are in agreement with those reported by Vit and Pulcini (1996). However, variation in enzyme activity from honey to honey has been shown to occur for a variety of reasons (White 1994), including the amount of sucrose in food sources, rate of nectar flow, and even age of the bees.

The mineral content varied among the honey samples studied (Table 4). Potassium appeared in the greatest proportion followed by phosphorus and sodium. This is in accordance with analysis by other authors (Bonvehl

Table 4
Mineral content of honey samples (mg/kg honey)[a]

Honey type	Zn	Cd	Pb	Fe	Mn	Cu	Al	Na	K	P	B
Sidir Aseer	2.23a ±0.25	ND[b]	0.09a,b ±0.05	1.04c ±0.08	0.08d ±0.00	0.47b ±0.02	0.06a ±0.03	37.1c ±2.92	483e ±4.30	12.8c ±0.40	6.96b ±1.3
Sidir Albaha	3.04a ±1.12	0.008a ±0.008	0.03b ±0.03	1.64a,b ±0.22	0.18a ±0.00	0.60a ±0.03	0.06 ±0.06	27.5d ±0.00	93.3d,e ±4.90	34.3c ±0.60	3.43c ±0.08
Talh Tehama	3.01a ±2.08	ND	0.11a,b ±0.04	1.23b,c ±0.04	0.10c ±0.00	0.46b,c ±0.03	ND	77.5a ±0.00	50.5e,f ±2.02	29.0c ±0.16	9.62a ±0.24
Samra Taif	1.40a ±0.24	ND	0.07b ±0.03	1.91a ±0.27	0.19a ±0.01	0.59a ±0.07	0.05a ±0.05	15.0f ±0.00	1367a ±33.3	170a ±6.73	4.22c ±0.28
Magra Aseer	1.96a ±0.24	ND	0.03b ±0.03	1.12b,c ±0.14	0.04e,f ±0.01	0.43b,c ±0.06	0.17a ±0.16	15.0f ±0.00	538b ±37.2	8.91e ±0.45	2.92c ±0.09
Doarm Taif	1.37a ±0.08	ND	0.03b ±0.03	1.23b,c ±0.2	0.05e ±0.00	0.46b,c ±0.07	0.18a ±0.14	15.0f ±0.00	9.33f ±1.33	14.8e,d ±0.39	3.50c ±0.22
Shoram Taif	1.86a ±0.17	ND	0.24a ±0.14	0.99c ±0.05	0.03f ±0.02	0.43b,c ±0.04	ND	21.0e ±0.00	14.3f ±0.66	11.9e ±0.93	3.15c ±0.03
Talh Medina	1.51a ±0.18	ND	0.04b ±0.02	1.30b,c ±0.04	0.16b ±0.01	0.45b,c ±0.01	ND	35.0c ±0.00	129d ±0.33	69.1b ±2.10	3.27c ±0.09
Farm-Riyadh	1.79a ±0.17	ND	0.03b ±0.03	1.13b,c ±0.02	0.08d ±0.00	0.35c ±0.00	ND	42.5b ±0.00	19.0f ±2.00	15.4d,e ±0.03	3.77c ±0.06
Farm-Qaseem	3.00a ±1.01	ND	0.08b ±0.04	0.97c ±0.36	0.05e ±0.00	0.38b,c ±0.03	ND	21.0e ±0.00	137d ±14.43	19.6d ±0.36	3.69c ±0.07

[a] Means of a column followed by different letters are significantly different all values are means of SE of triplicate determination.
[b] ND: Not detected.

& Tarres, 1993; Rodriguez, Simal, Cepada, 1992). Abu Tarboush et al. (1993) found that phosphrous and potassium were the highest of all minerals in some honey produced in Saudi Arabia. Samra Taif honey was highest in potassium and phosphrous while Magra Aseer honey was higher in potassium and sodium. Talh Tehama, Doarm Taif and Farm Riyadh were higher in sodium compared with other types of honey. Other elements of environmental importance (Cd, Pb), were detected in some samples; however, they were not determinable in comparision to the results of Foder and Molner (1993) and Petrov (1970). The elemental concentrations of honey in Saudi Arabia are lower than in Australia and Hungary. On the other hand, honey is an excellent indicator of environmental pollution.

In conclusion, the physicochemical characteristics of the honey types investigated in this study generally agreed with national and international honey specification, but the preference of Saudi consumers for Saudi honey is not explainable as far as the physicochemical characteristics are concerned.

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