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ORIGINAL PAPER

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# Physicochemical Characteristics of Yemini Honey

**Abstract:**. Popular types of Yemeni honey were evaluated for their physical and chemical properties. Fourteen parameters were determined in tested honey: moisture, pH, acidity (free, lactone and total), ash, electrical conductivity (E. C.), hydroxymethyl furfural (HMF), proline, Diastase number (Goth scale), reducing sugar, sucrose, glucose and fructose. Results indicated that Buckthorn (Zizyphus spina-christi, sidir) honey had the highest ($P<0.05$) means in ash and E. C. Significant sucrose contents ($P<0.05$) and lowest reducing sugar (%) were the main features of sugar-fed bees' honey, 'sugar honey'. Acacia spp. Honey (Acacia honey) was different ($P<0.05$) from other types in total acidity, proline and fructose. It could be concluded that floral Yemeni honey types were in conformity with honey regulations laid down by many regional and international standard organizations; e. g. the Saudi Arabian standards and Codex Alimentarius Commission (FAO/WHO).

**Key words:** Yemini honey - Charachteristics - Physical Properties - Chemical Properties

الصفات الطبيعية والكيميائية للعسل اليمني

نجيب الزريقي

المستخلص : تم تقويم بعض الخواص الطبيعية والكيميائية لأنواع من العسل ، وذلك فيما يتعلق بمحتواها من الماء ، والحموضه ، والمعادن ، والفيورفيورال ، والبرولين ، والسكريات وغيرها . كانت أعلى نسب للمعادن والتوصيل الكهربائي مقترنة بعسل السدر . أنتج النحل المتغذي على محاليل سكرية عسلاً غنياً في محتواه من السكروز ، ومنخفضاً بالسكريات المختزله . إختلف عسل الأكاسيا عن الأنواع الأخرى للعسل ، في نسب الحموضه ، والبرولين ، وكذلك سكر الفركتوز . أكدت الدراسة بأن مواصفات العسل اليمني مطابقة للإشتراطات والمعايير الخاصة بالعسل ، والتي تحددها معظم الهيئات الإقليمية والعالمية للمواصفات والتقييس – مثل هيئة المواصفات السعودية ولجنة دستور الأغذية التابعة لمنظمتى الأغذية والزراعة والصحة العالمية .

كلمات مدخلية: اليمن – عسل – صفات – خواص فيزيائية – خواص كيميائية

## Introduction

Honey is the natural sweetener produced by honeybees from blossom nectars (floral honey) or secretions of living plants or sucking insects (honeydew honey), as defined by the Codex Alimentarius (1994). World wide, major honey producers are China, the former USSR and the U.S.A. (Jones and Bryant 1992). Unlike other sweeteners, honey commands premium prices and its authenticity can not be compromised. In this regard, Yemeni honey of Buckthorn (Zizyphus spina-christi, sidir or ceder) is one of the most expensive types (Alkathiri and Khanbash 1996). In fact, adulteration of honey using inexpensive sugar (e. g. high fructose corn syrup) is a major concern for consumers and honey packers as well as international standard authorities. Healthwise, honeybee products were effective against gastric lesions and disease-causing microorganisms (Ali 1995, White 1987). As far as honey composition, it contains various carbohydrates, water, organic acids, pigments, wax and pollens (Sporns *et al.* 1992, White 1987). Several factors such as nectar source influence physical and compositional properties of honey. To this effect, physiochemical attributes (acidity, proline, reducing sugar, color, etc.) were used in discriminative analyses for classification of genuine honey (Mateo-Castro, *et al.* 1992; Krauze and Zalewski, 1991; Sancho, *et al.* 1991). Accordingly, honey's quality is of paramount importance in judging its authenticity.

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Floral honey types of Zizyphus spp., Acacia spp. and Euphorbia spp. are commercially available in Yemeni markets, and some of the local production of honey is exported to some Arab Gulf states. Zizyphus spp. is a prevalent plant in Yemen and the Arabian Peninsula (Haloubi, 1996). Sensory research stated that sidir honey produced in Yemen was the most preferred type compared to other domestic and imported varieties (Alkhathiri and Khanbash, 1996). However, the composition of sidir types as well as other floral honey was not provided in the previous study. Not only is sidir honey widely preferred by consumers in Yemen, but also it is a superior type in neighboring countries such as the Kingdom of Saudi Arabia (Abu-Tarboush, *et al.* 1993). Unfortunately, data is not available on the detailed composition of local honey types. Besides, standards on Yemeni honey are also lacking.

Therefore, this study describes some of the physical and chemical characteristics of common types of Yemeni honey.

## Materials and Methods

*Honey types*

Different floral honeys were obtained from private apiaries and local markets. Prior to physiochemical analyses, melissopalynology (pollen types) and flavor tests were conducted to ascertain botanical (floral) sources of honey.

*Floral source identification*

The standard methods of the International Bee Research Association (Louveaux, *et al.* 1978) were adopted for identification of botanical sources of samples: 10g of honey were completely dissolved in 20 ml distilled water (40°C) or diluted sulphuric acid (0.5% v/v), followed by centrifugation at 3000 rpm for 10 min. Sediments were washed twice with distilled water and centrifuged again. Liquid portions were discarded and sediment was spread onto a glass slide, then left to dry at room temperature. Botanical origins of honey were identified by examining pollens under the microscope (430x), after mounting the prepared slide with glycerin gelatin. Honey pollens were compared to reference types. Confirmed types of honey (35 samples) listed in Table 1 were further evaluated.

*Compositional analyses*

The established procedures of the European Honey Commission (Bogdanov, *et al.* 1997) were followed for determination of pH and acidity (method # 1.4), moisture (method # 1.1), minerals (method # 1.3) HMF (method # 1.5.2), Diastase (Method # 1.6.1), proline (method # 1.10) and reducing sugar and apparent sucrose (method # 1.7.1). Electrical conductivities (method # 1.2) of 20 % honey solutions were measured (Jenway 4010 Conductivity Meter ELE, England). Glucose oxidase-Peroxidase test (GOD-PAP enzymatic kit, Spinreact, Spain) was used for glucose determinations (Krauze and Zalewski, 1991; White 1987). Fructose in samples was calculated from standard fructose solutions (Aurand, *et al.* 1987).

Data were statistically evaluated (Minitab Software Program) and means were separated using both ANOVA and Tukey's HSD procedures at 5% significant levels (Anon, 1992).

## Results and Discussion

Evaluating data on honey types tested are shown in Tables 1-3 A study conducted by Alkathiri and Khanbash (1996) on local and imported honey indicated that sidir honey was preferred by consumers due to its reddish-amber color and viscosity. Color evaluations have been used in determining floral and geographical sources of different types of honey (Mateo-Castro, *et al.* 1992). Undoubtedly, abusive storage and processing may cause color darkness in honey.

### Physiochemical characteristics of honey

**Table 1.** Some physical and chemical attributes (means) of different Yemeni honey types.

| Honey (%) | moisture | pH (meq/kg) | FA[a] | L/FA (meq/kg) | TA (%) | Ash | EC (mg/kg) | Proline | DN (mg/kg) | HMF |
|---|---|---|---|---|---|---|---|---|---|---|
| Buckthorn (Zizyphus spp.) | 14.6[b] | 4.8[b] | 21.8[c] | 1.44[b] | 53.2[c] | 0.48[b] | 0.957[b] | 543.3[c] | 13.9[b] | 11.6[b,c] |
| Acacia (Acacia spp.) | 13.6[b] | 2.9[c] | 31.4[b] | 1.08[c] | 65.6[b] | 0.18[c] | 0.461[c] | 660.2[b] | 11.4[b] | 7.8[c] |
| 'Sugar honey' | 13.8[b] | 3.7[b,c] | 30.1[b] | 0.93[c] | 58.0[c] | 0.12[c] | 0.385[c] | 244.7[d] | 6.1[b] | 18.5[b] |
| SE[c] | 1.93 | 0.92 | 6.27 | - | 13.59 | 0.09 | 0.282 | 56.58 | 2.61 | 8.76 |

[a] FA, free acidity; L, lactone; TA, total acidity; EC, electrical conductivity ($mS.cm^{-1}$); DN, diastase number (0.01g starch/g/h); HMF, hydroxymethyl furfural.[b-d] means, within a column, without common superscripts differ ($P<0.05$).,[c] Pooled standard error.

**Table 2.** Carbohydrate composition (mean, %) of some Yemeni honey types

| Honey | Glucose (G) | Fructose (F) | F/G | R. sugar[a] | F/R. Sugar | Sucrose[a] |
|---|---|---|---|---|---|---|
| Buckthorn (Zizyphus spp.) | 28.3[b] | 33.6[c] | 1.19 | 68.2[b] | 0.4927 | 2.4[c] |
| Acacia (Acacia spp.) | 27.5[b] | 40.8[b] | 1.48 | 71.4[b] | 0.570 | 1.6[c] |
| Sugar honey' | 30.7[b] | 31.4[d] | 1.02 | 63.8[c] | 0.4921 | 6.2[b] |
| SE[c] | 5.26 | 5.48 | - | 4.54 | - | 2.48 |

[a] R. Sugar, reducing sugar; Sucrose, apparent sucrose., [b-d] means, within a column, without common superscripts differ (P<0.05).
[c] Pooled standard error.

Tables 1 and 2 present parameters of experimental honey. Results indicated that there were not any significant differences (P>0.05) in moisture, Diastase activity and glucose among the different types; % moisture was within acceptable ranges in honey (Codex Alimentarius 1994). In fact, honey's moisture (Table 1) was less than the maximum level permitted by regional (Abu-Tarboush, *et al.* 1993) and international standards (Table 3; Sporns, *et al.* 1992). It is likely that lower moisture contents of Yemeni honey could prolong shelf life of the product and thus enhance its marketability. Canadian regulations require that grade (1) honey "Canada No. 1" must have <17.8% moisture (Canada Agricultural Product Acts, 1997). Moisture contents >20% caused spoilage of ripened honey (Sporns, *et al.* 1992). Assil *et al.* (1991) mentioned that glucose to water ratios, among other things, were indicators of crystallization in honey.

Ash, E. C. and lactone/free acid separated (P<0.05) sidir honey from other types (Table 1). It was previously mentioned that sidir honey was higher in pH and ash (Abu-Tarboush *et al.* 1993).

A good correlation (r = 0.88) was found between E. C. and % ash of Yemeni honey and this in turn supported findings of Sancho *et al.* (1991) on Spanish honey. Compared to other types, Acacia spp. honeys had significant total acidity (Table 1) which could create unfavorable conditions for spontaneous HMF formation; i. e. lowest HMF concentrations. White (1994) stated that Diastase and HMF were affected by storage conditions of honey and therefore the limit of HMF in honey was increased to 80 mg/kg in hot-climate areas such as the Kinqdom of Saudi Arabia. Obviously, 'sugar honey' had the lowest proline and Diastase contents (Table 1). In this regard, it was clearly mentioned that sugar-fed honeybees produced honey with proline levels <200 mg/kg (Krauze and Zalewski, 1991). In contrast, Sporns *et al.* (1992) stated that floral honey may have proline concentrations below the minimum level indicated above. German Standards classify honey with proline <180 mg/kg as non-ripe or adulterated (Bogdanov *et al.* 1997). It is noteworthy to mention that proline alone may not be sufficient in determining authenticity of floral honey; falsified samples of honey had 149 to >300 mg proline/kg (unpublished data). It was succinctly reported by Poncini *et al.* (1994) that climate conditions during honeybee foraging substantially influenced proline levels in honey.

**Carbohydrate of honey**

The highest means in reducing sugar and fructose/glucose were determined in both sidir and Acacia honey (Table 2). Krauze (1991) pointed out that syrup-fed bees produced honey with approximately equal amounts of fructose and glucose (fructose/glucose ≤1.0) while floral types had ratios above 1. As seen in Table 2, sucrose concentration was significant in 'sugar honey', which was agreeable with the data of Abu-Tarboush *et al.* (1993) and Krauze (1991). On the other hand, Acacia honey was distinct in fructose (40.8%) representing 57% of reducing sugar (Table 2).

In general, values of Yemeni honey (sidir and Acacia) were in harmony with limits established by various regulative organizations (Table 3). However, total acidity (free+lactone) in honey was above the permitted level (<40 meq/kg) stated in the Saudi Arabian standards (Abu-Tarboush, *et al.* 1993). Recently, the European Honey Commission (Bogdanov, *et al.* 1997) proposed a maximum of 50 meq/kg as 'free acidity' in honey.

**Table 3.** Summary data on Yemeni honey types [a]

| Parameter | Mean | Codex Standard[b] |
|---|---|---|
| Moisture (%) | 14.1 | ≤23.0 |
| F. acidity (meq/kg) | 26.6 | ≤40.0 |
| Ash (%) | 0.33 | ≤0.6 |
| Diastase no.[c] | 12.65 | ≥3.0 |
| HMF[c] (mg/kg) | 9.7 | ≤80.0 |
| Reducing sugar (%) | 69.8 | ≥65.0 |
| % Sucrose (apparent) | 2.0 | ≤5.0 |

[a] Buckthorn (*Zizyphus spp.*) and *Acacia spp.* honey.
[b] Codex Alimentarius Commission of the FAO/WHO (1994).
[c] Diastase number (0.01g starch/g/h); hydroxymethyl furfural.

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