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Quality Assessment of Bee Honey from Western Sudan Regions

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الملخص
تهدف هذه الدراسة لتقييم نوعية العسل المنتج محلياً من مناطق مختلفة في غرب السودان. تم شراء 30 عينة عسل منتجة فى خمسة مواقع معروفة للإنتاج (كبم و سنقو و كَرتْى و أُم دافوق و وادى صالح) من السوق المحلى لمدينة نيالا. شمل تحليل العينات نسبة الرطوبة و نسبة المواد الصلبة الكلية و نسبة الرماد وتراكيز بعض الأملاح (الكاسيوم و المغنسيوم و البوتاسيوم و الصوديوم و الحديد والزنك). تراوحت نسبة الرطوبة من 13.0±2.4% (وادى صالح) الى 14.2±3.2%(ام دافوق) و تراوحت نسبة المواد الصلبة الكلية من 84.2 ±5.39%(كبم) إلى 87±1.5 % (وادى صالح). أما نسبة الرماد فكانت 1.0±0.001% فى كبم إلى 1.8±0.05% (كَرتْى). وُجد أن البوتاسيوم من أكثر العناصر تركيزاً ويتراوح من 9.2±7.2 جزء من المليون (جفم) (وادى صالح) إلى 19.9±4 جفم (سنقو) يتبعه الكاسيوم 0.38±0.2 جفم (وادى صالح) إلي 14.3±6.5 جفم (سنقو) ، الحديد 2.49±1.7 جفم (ام دافوق) إلي 6.02±3.8 جفم (كبم و سنقو) والصوديوم 1.39±0.001 جفم (وادى صالح) الي 6.77±0.001 جفم (كبم) و المغنسيوم 0.1±0.01 جفم (سنقو) إلي 50.05±0.04 جفم (كبم)، الزنك 0.05±0.001 جفم (وادى صالح) إلي 0.065±0.01 جفم (كبم). أثبتت النتائج وجود إختلافاً معنوياً فى تراكيزالكاسيوم و المغنسيوم و الصوديوم و البوتاسيوم فى العسل المنتج من المناطق المحتلفة. كما بينت النتائج أن نسبة الرطوبة و نسبة المواد الصلبة الكلية و الكاسيوم والمغنسيوم والحديد فى بعض المناطق تتناسب مع المواصفات العالمية برغم أن بعض المناطق الأخرى أوضحت خلل فى المعدلات مما يعكس إمكانية غش فى العسل.

Summary

The objective of this study was to assess the quality of locally produced honey from different areas in Western Sudan. Thirty honey samples, originated from five well-known honey producing locations (Kabum, Songo, Kerte, Om Dafoug and Wadi Salih) in Western Sudan, were purchased from the local market of Nyala city. The analysis included moisture content, total solids, ash and concentrations of selected minerals (K, Na, Ca, Mg, Fe and Zn). Values recorded for moisture content ranged from 13.0±2.4 % (Wadi Salih) to 14.2±3.2% (Om Dafoug), total solids 84.2±5.39% (Kabum) to 87±1.5% (Wadi Salih), ash 1.0±0.001% (Kabum) to 1.8±0.05 % (Kerte). Potassium was the most abundant element ranging from 9.2±7.2 ppm (Wadi Salih) to 19.9±4.1ppm (Songo), followed by Calcium [0.38±0.2ppm (Wadi Salih) to 14.3±6.5ppm (Sango)], Fe [2.49± 1.7ppm (Om Dafoug) to 6.02±3.8 ppm (Kabum - Songo)], Na [1.39±0.001 ppm (Wadi Salih) to 6.77±0.001 ppm (Kabum)], Mg [0.1±00.01 ppm (Songo) - 0.5±0.04 ppm (Kabum)] and Zn [0.05±.001 ppm (Wadi Salih) to 0.065±0.01ppm (Kabum)]. Result indicated significant ($p \leq 0.05$) variations among the mean values of Ca, Mg, K and Na contents of honey samples produced in the various areas. Results obtained from this study show, however, that moisture, total solids, Mg, Ca and Fe contents of honey in some study areas conform to the international standards. On the contrary, some areas showed altered parameters, reflecting possible adulteration.

Introduction

Bee keeping has been practiced since ancient times and honey is considered by many cultures a valuable and precious commodity that is used, in traditional rituals, as a medicine for treating various ailments, and healer, or as food (Lay-flurrie, 2008; Lietaer, 2009). It is rich in micro-nutrients and is also a good source of energy. In general, honey is composed of sugar (mainly fructose and glucose), water, minerals, vitamins, traces of protein and antioxidants (Kumar *et al.,* 2013). The composition of honey depends on the type of flowers visited by bees, climatic conditions in which the plants grow and maturation (Gairola *et al.*, 2013).

Honey is generally evaluated by the physicochemical analysis of its constituents. Indeed, physicochemical characteristics such as electrical conduction, pH, ash content and specific rotation are widely used for differentiation of botanical and geographical origins of honey and their complete pollen analysis (Fredrick *et al.,* 2013). Knowledge of honey characteristics allows packaging and storage of honey in appropriate conditions so as to preserve their qualities. In addition, it provides information regarding the energetic and nutritional quality, as well as the possibility of falsifying honey (Kayode and Oyeyemi, 2014).

Despite the huge potential for apiculture and diversified honey floral resources, production of honey is far below its potential in the Sudan. Moreover, the apiculture sector has received little research and development attention; production is limited and still under traditional system. There is a little information on physicochemical properties and quality of Sudanese honeys. Previous works that have focused on microbiological properties, phenolic and antioxidants contents and nutritive value of honey collected from different floral sources (Idris *et al.,* 2011; Musa *et al.,* 2013; Yousif, 2015).

The objective of the current study was to assess the quality of Western Sudan honey in comparison to international honey standards.

Materials and Methods

Honey samples

Thirty honey samples obtained from five well-known honey producing areas (Kabum, Songo, Kerte, Om Dafoug and Wadi Salih) in Western Sudan were purchased from the local market of Nyala city and used in this study. Preliminary information was collected from the local market honey sellers. Before being analyzed, all honey samples were kept at room temperature and protected from light.

Analysis of each sample was carried out in triplicates for each test for determining the chemical properties, average moisture content, total ash content and selected minerals concentrations [(Calcium (Ca), Potassium (K), Sodium (Na), Iron (Fe), Magnesium (Mg) and Zinc (Zn)].

Determination of moisture content

The moisture content of each sample was determined as follows: 1g of the sample was placed in a pre–weighed crucible. The sample was dried to constant weight in an oven at 105 ºC for 4 hrs under vacuum (AOAC, 1990). The percent of moisture content was calculated as:

Moisture content = M1 – M2 / M1 – M0 X 100

Where:

M0 = Weight of empty crucible, M1= Weight of the fresh sample + crucible, and M2= Weight of the dried sample + crucible.

Estimation of total solids

The percentage of total solids of each sample was determined using the equation: Total solids (%) = 100 – Moisture content

Determination of ash content

One gram of each honey sample was separately weighed out into a porcelain crucible previously ignited and weighed. Each sample was dried in an oven at 105 °C for 3 hrs to prevent loss by foaming. After cooling it was ashed in a muffle model furnace at 600 °C overnight (12 hrs). It was then cooled and weighed to a constant weight (AOAC, 1990).

The percent ash was calculated as:

Ash (%) = (Weight of crucible + ash) − (Weight of empty crucible) / Sample weight X 100

Mineral analysis

Five ml of diluted nitric acid solution (6:1) were added to the aforementioned ashed samples and the mixture was stirred on a heating plate to almost complete dryness. Then, the mixture was made up to 25 ml with distilled water and concentrations of Ca, Fe, Mg and Zn were determined directly in the ash solution by atomic absorption spectrometry (Phoenix 8625, UK) at 422.7, 248.3, 285.2 and 213.9 nm wavelength, respectively, using air-acetylene flow (Silva *et al.,* 2009). Na and K concentration were determined by Flame photometer (Corning 400, UK) (AOAC, 1990).

Statistical analyses

The results were expressed as mean values with standard deviations (SD). The significant differences were obtained by one-way analysis of variance (ANOVA) followed by Duncan's multiple range test ($p \leq 0.05$).

Results

The result of chemical characterization of honey samples from different Western Sudan areas are presented in Table 1. Values recorded for moisture content varied from 14.2±3.9 (Om Dafoug) to 13.0±2.4 % (Wadi Salih) with a mean of 13.92± 2.47%. Total solids varied from 84.2±5.39% (Kabum) to 87±1.5% (Wadi Salih) with an averge of 85.72±3.3%. The ash content of honey samples varied from 1.0±0.001% (Kabum) to 1.8±0.05% (Kerte), with an average of 1.4±0.4%. Moreover, significant increases ($P \leq 0.05$) of ash content were observed in honey from Songo, Om Dafoug and Karte.

The concentration of minerals in honey samples was different and depended on the sampling areas (Table 1). Potassium was the most abundant element, followed by Ca, Fe, Na, Mg and Zn. The honey samples from Kabum and Songo had significantly ($p \leq 0.05$) high quantities of Ca. The honey samples from Kerte and Wadi Salih had significantly ($p \leq 0.05$) high Mg levels (2.1±0.01, 1.6±0.08ppm). Wadi Salih honey had significantly ($p \leq 0.05$) the lowest values of K and Na (9.2±7.2 and 1.39±0.001 ppm).

Table 1: Chemical characterization of honey samples from different areas in Western Sudan.

Parameters	Kabum	Songo	Om Dafoug	Kerte	Wadi Salih	Average
Moisture %	14.0±1.7	13.8±2.8	14.2 ±3.2	13.0±2.5	13.0±2.4	13.92±2.4
Total solid%	84.2±5.3	86.2±2.8	85.8±3.1	85.4±3.3	87.0±1.5	85.72±3.3
Ash%	1.0±0.001[a]	1.6±0.5[b]	1.5±0.5[b]	1.8±0.5[b]	1.1±0.2[a]	1.4±0.4
Ca(ppm)	13.82±8.7[a]	14.3±6.5[a]	4.25±2.1[ab]	0.38±0.2[b]	6.5±1.8[ab]	7.97±1.9
Na(ppm)	6.77±0001[a]	2.91±0.94[b]	5.65±2.7[a]	6.3±0001[a]	1.39±0.001[b]	5.75±1.35
K(ppm)	17.69±4.12[a]	19.9±3.9[a]	18.7±5.5[a]	18.98±6.2[a]	9.2±7.2[b]	17.19±6.2
Mg(ppm)	0.5±0.04[a]	0.1±0.01[ab]	0.5±0.04[a]	2.1±0.1[b]	1.6±0.08[b]	0.116±0.09
Fe(ppm)	5.76±4.6	6.02±3.8	2.49±1.7	5.3±2.66	5.91±3.65	5.03±1.09
Zn(ppm)	0.06±0.01	0.05±0.01	0.06±0.012	0.05±0.009	005±0.05	0.06±0.01

Different letters (a, b) in the same row indicate a significance different at $p \leq 0.05$.

Discussion

The quality of honey is mainly related to humidity, ash and pH. Based on this point, different standards have been codified by different countries. According to Codex Alimentarius (2001) and European Commission (2000) standards of honey, the maximum value of moisture content in honey is 21%; thus, our findings are conforming to the aforementioned standards. Similar results were detected by Al-Khalifa and Al-Arify (1999), Nanda *et* *al.* (2003), Idris *et al.* (2011) and Musa *et al.* (2013). 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. Harvesting of honey with high water content leads to spoilage by fermentation resulting in a product with an off taste and high levels of yeast (Fredrick *et al.,* 2013). The low moisture content of honey also forms an important part of the system which protects honey from attack by microorganisms. The hyper osmotic nature of honey would prevent the growth of bacteria and yeasts (Kumar *et al.,* 2013).

The total solid contents of our samples are quite higher than those of 77.8–80.4% reported by Gulzar and Nanda (2015), and are similar to the values of 82.20 – 84.33% reported by Al-Khalifa and Al–Arify (1999).

The floral origin has been reported to be responsible for differences in ash content and it is also a quality criterion for honey botanical origin (European Commission, 2000). The ash content of honey is generally small and depends, in its formation, on nectar composition of predominant plants (Al-Khalifa and Al-Arify, 1999). All honey samples analyzed in this work had ash contents higher than the acceptable level of 0.6% (Codex Alimantarius, 2001). However, our results are in agreement with those reported by Agbagwa *et al.* (2011) for honey collected from different regions in Nigeria. Also result obtained from Kabum and Wadi Salih honey samples are in agreement with the levels of 0.357 and 4.187% reported by Idris *et al.* (2011), and Yousif (2015), respectively.

Minerals can be highly indicative of honey geographical origin and can be used as environmental indicators (Sanna *et al.*, 2000; Buldini *et al.,* 2001). Bee honey can be a good source of major and trace elements needed by humans (Przybylowski and Wilczynska, 2001). The general features and minerals composition of honey depend on its botanical and geographical origin (Kebede *et al.,* 2012).

The ash content is a measure of mineral content of honey. Although the minerals quantities are small, they play a vital role in determining the colour and nutritional value of honey (Derebasi *et al.,* 2014). Also variations such as aroma, flavour, medicinal value and keeping qualities of honey are largely dependent on its mineral content (Fredrick *et al.,* 2013).

In this study, the concentration of minerals in the test honey is different depending on the production area. There are some differences and similarities among the honey samples of different areas. This observation can be related to various factors, such as botanical flora and geographical conditions which are expected to affect the mineral content. The levels of minerals are, in general, less than the minimum recommended limit by different organizations. These differences in mineral content are dependent on the type of soil in which the original nectar bearing plant was growing (Anklam, 1998). In our study, it has been determined that K is quantitatively the most abundant mineral. Another study from other geographical locations has also revealed that potassium is the most abundant element (Derebasi *et al.,* 2014). The present results show statistically significant differences among K, Mg, Na and Ca contents of honey from the different areas. In a similar study, in Sudan, the mean concentrations of minerals were as the same as reported herein (Yousif, 2015), whereas high values for the same minerals were reported in Egypt and Spain (El-Sherbiny and Rizk, 1979; Downey *et al*, 2005). On the basis of our results and considering previously reported findings, mineral content of honey is highly variable with species of honeybee, soil composition, plant type, season, and environmental conditions (Pisani *et al,* 2008). Potassium was the most abundant element, followed by Ca, Fe, Na, Mg and Zn; this is similar to that reported by Agbagwa *et al.* (2011).

It is concluded that most honey samples from Western Sudan conform to the international standards. However, few samples showed altered parameters, reflecting a possibility of adulteration.

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References

Agbagwa, O.E.; Otokunefor, T.V. and Frank-Peterside N. (2011). *J. Microbiol. Biotech. Res.,* **1:** 20-31

Al-Khalifa, A.S. and Al-Arify, I.A. (1999). *Food Chem.*, **67**:21–25.

Anklam, E. (1998). *Food Chem.*, **63**: 549-562.

AOAC. (1990). 15th edn., index of method number 920, Arlington.USA.

Buldini, P.L.; Cavalli, S.; Mevoli, A. and Sharma, J.L. (2001). *Food Chem.,* **73**:487-95.

Codex Alimentarius (2001). Standard for Honey, CODEX STAN 12-1981, FAO and WHO, Rome, **1:** 19- 26.

Derebasi, E.; Bulut, G.; Melek, C.; Güney, F.; Yaşar, N. and Ertürk, O. (2014). *Fre. Env. Bull.*, **23**:10-17.

Downey, G.; Hussey, K.; Kelly, J.; Walshe, T. and Martin, P. (2005). *Food Chem.*, **91**: 347–354.

El-Sherbiny, G.A. and Rizk, S.S. (1979). *Food Sci.,* **7:** 69–75.

European Commission (2000). Scientific Committee on Veterinary Measures Relating to Public Health on Honey and Microbiological Hazards. Management of Scientific Committees; Scientific co-operation and networks, pp 1- 15.

Fredrick, N.; Anam, O.; Antony, G. and Elijah, N. (2013). *Food Sci. Qua. Man.,* **12:**30-36.

Gairola, A.; Tiwari, P. and Tiwari, J.K. (2013). *India J. Glo. Bio.,* **2:**20-25

Gulzar, A. and Nanda, V. (2015). *Pol. J. Food Nutr. Sci.*, **65**:101–108.

Idris,Y.M.; Abdalbasit, A.M. and Somia, I.H. (2011). *Inter. J. Food Prop.*, **14:** 450-458.

Kayode, J.J. and Oyeyemi, S.D. (2014). *IJBAS*, **3**:63-73

Kebede, N.; Subramanian, P.A. and Gebrekidan, M. (2012). *Bull. Chem. Soc. Ethiop.*, **26**: 127-133.

Kumar, M.; Manu, A.P.; Ananda, D.V. and Siddagangaiah, V. (2013). *Int. J. Pharm. Life Sci.*, **4:** 3159-3165.

Lay-flurrie, K. (2008). *Br. J. Nurs.*, **17**:32-36.

Lietaer, C. (2009). XIII World Forestry Congress Buenos Aires, Argentina, 18– 23.

Musa, M.Y.; Ahmed, E. and SeifEldin, A.M. (2013). *Br. Microbiol. Res. J.*, **4**:715-722

Nanda, V.; Sarkara, B.C.; Sharma, H.K. and Bawa, A.S.V. (2003). *J. Food Comp. Ana.,***16:**613–619.

Pisani, A.; Protano, G. and Riccobono, F. (2008). *Food Chem.,***107**: 1553-1560.

Przybylowski, P. and Wilczynska, A. (2001). *Food Chem.,***74:** 289-295.

Sanna, G.; Pilo, M.I.; Piu, P.C.; Tapparo, A. and Seeber, R. (2000). *Anal. Chim. Acta.*, **415**:165-173.

Silva, L.R.; Videira, R.; Monteiro, A.P.; Valentão, P. and Andrade, P.B. (2009). *Microchem. J.*, **9:**73–77.

Yousif, N.E. (2015). Physicochemical Properties of Honey From Different Floral Sources, MSc Thesis. U of K. Sudan.