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Short communication

The ecological assessment of metals in local brands of honey in Southwest Nigeria

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The ecological assessment of honey was undertaken by determining some physico-chemical parameters of honey from six different locations in Southwest Nigeria. Among the groups of honey, there were no statistically significant differences in colour, pH, refractive index, electrical conductivity and insoluble matters. The mean contents of risk elements, Pb, Zn, Cr, Co, Ni and Mn were far below the allowable limits and showed no significant differences in individual groups of honey. The pH of the honey sample range from 4.01 to 5.10 with a least mean of 4.02 ± 0 from Ondo State. The mean highest electrical conductivity was 180. 7l±0.01 with a range of 145.52 to 180.72. The mean highest refractive index was 1.460 ± 0.03 from Osun State, with a range of 1.442 to 1.475. Differences were not found in moisture content and insoluble matter. The average color and conductivity varied in individual groups of honey; however, these differences were not statistically conclusive. However, the content of Cu (32.73 ± 5.75) and Fe (43.20 ± 11.00) differ significantly ($P < 0.05$) in individual groups. The results of this study suggest that pollution may contaminate honey in several ways. There are potential prophylactic uses of honey. Unscreened and direct use of honey may therefore be of concern as it could serve as a potential source of pollutant–induced harm.

Key words: Honey, heavy metals, bioaccumulation, pollution, environmental induced harm.

INTRODUCTION

The potential uses of honey as environmental bio-indicator have been reported by several authors (Accorti et al., 1990; Leita et al., 1996; Porrini et al., 2003). However, there is still a lack of understanding of toxic contaminants from which to assess the usefulness of honey as food (Adebiyi et al., 2004), in aiding the healing of wounds (Phuapradit et al., 1992), as a substance with antimalarial activity (Allen et al., 1991; Obi et al., 1994) and for oral hydration (Haffejee et al., 1985).Honey is harvested in many parts of Nigeria especially by apiculture. Increased industrialization allows various environmental contaminants to be emitted in a continuous manner by various natural and anthropical sources. For example, some harvesters use pesticides (Porrini et al., 2003) and in Nigeria smoke are used to keep off the bees before harvesting. Smoke contains a variety of contaminants, which can be toxic especially when petroleum products are used as fuel. Besides, a variety of materials are brought into the bee-hive and stored in verifiable containers. A network of apiculture may provide information on pollution of honey with heavy metals from a point source. There are reports showing patients with leg ulcers experienced a burning sensation when honey was applied (Wood et al., 1997). While apparently uncommon, use of honey has been reported to be associated with adverse reactions varying from cough to anaphylaxis (Kiistale et al., 1995). Others reported untoward effects included itching in the throat, nose, eyelid and skin, feeling of oedema in the throat or lips, running nose, headache and redness of the skin (Palmer-jones, 1965).The aim of the present study was to assess different physicochemical characteristics and heavy metal contents of honey from six locations in Southwest Nigeria with a view to determining whether the contaminants can serve as potential sensitive indications of pollutant-induced harm.

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MATERIALS AND METHODS

Samples

The honey samples were collected from six locations in Osun, Oyo, Ogun, Ondo, Ekiti and Lagos states in Southwest Nigeria. A total

Table 1. Physico-chemical characterizations of the honey samples.

Location	Colour	Conductivity	Refractive index	pH	Moisture content	Ash
Osun	286 ± 6.67	136 ± 0.8	1.460 ± 0.4	5.05 ± 0.03	30.28 ± 0.02	0.121 ± 0.02
Oyo	222.50 ± 7.5	162.36 ± 3.57	1.450 ± 0. 01	4.32 ± 0.02	27.17 ± 0.01	0.220 ± 0.00
Ogun	225.00 ± 2.0	161.15 ± 1.31	1.467 ± 0.05	4.55 ± 0.05	31.54 ± 0.00	0.389 ± 0.00
Ondo	249.83 ± 0.8	180.71 ± 0.01	1.458 ± 0.02	4.017 ± 0.00	26.39 ± 0.06	0.386 ± 0.00
Ekiti	210.00 ± 0.00	160.62 ± 0.00	1.449 ± 0.00	4.20 ± 0.00	28.46 ± 0.08	0.364 ± 0.07
Lagos	226.67 ± 1.67	144.69 ± 3.78	1.449 ± 0.07	4.93 ± 0.13	31.35 ± 0.17	0.364 ± 0.06

N = 6.

collection of 30 samples were analyzed. The physicochemical properties were determined following the procedure reference material and methodological suggestions described in EUR Reports of E C environment and quality of life. The characteristics determined for each sample include: colour, pH, conductivity, moisture, ash and refractive index (Bogdanov et al., 1999).

The colour of each sample was determined using lovibond comparator. Electrical conductivity measurement was done at 25°C using pH/conductivity meter model 20 (Denver Instrument). The instrument was calibrated using 0.01 M KCl (Potassium chloride solution). The refractive index was measured with a refractor meter (ChemTech) previously cleaned with acetone. The measurements were made at room temperature (28°C). The pH was measured using a digital pH model H1 8519 (Hannan Instrument). Each sample weighing 2.5 g was dried in the oven at 105°C for three hours, coded, weighed and stored in a dessicator. The process was repeated until a constant weight was obtained. The ash content was determined in a muffle model furnace at 600°C overnight, cooled and weighed to a constant weight.

The dry digestion technique was used to extract the heavy metals to solution. The method involves initial high temperature heating, followed by addition of nitric acid. Additional 50 ml of deionized water was added to the sample placed on hot plate for a two hour period. Following the digestion, ten drops of H_2O_2 were added and centrifuged. An Alpha 4 atomic flame absorption spectrometer (AAS) (Central Science Laboratory, Obafemi .Awolowo University., Ile – Ife) was used to quantify the total heavy metal concentration; Cu, Fe, Pb, Cr, Co, Ni, Mn, and Zn. The advantage of the dry digestion method is that it provides more consistency in analyses since all samples are dried and the effect of the water content are avoided.

Statistical comparison among means of more than two groups was performed by one-way ANOVA. When ANOVA was significant, the Student-Newman-Keuls (S-N-K) test was employed for the comparison. Differences were considered significant at $P < 0.05$. SPPS software version 10.0 (SPSS Inc. Chicago, Il. USA) was used for statistical analysis.

RESULTS AND DISCUSSION

Summary of the physical characteristic of groups of honey from six locations in Southwest Nigeria are presented in Table 1. Among the physical parameters observed, the colours of all honey samples were in the ember to dark ember shade, which on the lovibond comparator scale range from 210.00 to 295.00 with a mean from Osun State (286 ± 6.67) topping the least. The dark honeys are known to contain more minerals than the lighter ones (White, 1975b). The pH of the honey sample range from 4.01 to 5.10 with a least mean of 4.02 ± 0 from Ondo State. The mean highest electrical conductivity was 180.7l ± 0.01 with a range of 145.52 to 180.72. The mean highest refractive index was 1.460 ± 0.03 from Osun State, with a range of 1.442 to 1.475. Differences were not found in moisture content and insoluble matter. The average colour and conductivity varied in individual groups of honey; however, these differences were not statistically conclusive.

There is great variability in the amounts of heavy metals collected from different locations in Southwest Nigeria (Table 2). All samples contained Cu, Fe, Pb, Cr, Co, Ni, Mn and Zn in varying degrees. The mean contents of risk elements Pb (0.23 ± 0.14 mg/kg), from Ondo State is closely followed by Ekiti State with 0.19 ± 0.07, Zn (0.216 ± 0.09 mg/kg) from Oyo State is closely followed by Ogun State with 0.13 ± 0.01. Ondo State exhibited the highest mean of Cr (0.69 ± 0.15 mg/kg), closely followed by Ekiti State, whereas Ogun State has the highest mean contents of Co (0.41 ± 0.1 mg/kg), Ni (2.6 ± 0.25 mg/kg) and Mn (3.59 ± 0.45 mg/kg).

These results are in conformity with other reports (Adebiyi et al., 2004; Molan, 1992; White, 1975). The lower pH agrees with honey scientific report of Bogedanov et al. (1999), which confirms that the lower pH inhibits enzyme activity and glucose oxidase, which further inhibits peroxide production as a result of higher production of gluconic acid, a key factor in antibacterial activity.

Some of these heavy metals were far below the international allowable limits for heavy metals (Bogdanov et al., 1999) and showed no significant differences in individual groups of honey (Table 2). In particular, the high contents of Cu and Fe characterized the environmental pollutions of honey from all sampling areas. However, the content of Cu and Fe differ significantly ($P < 0.05$) in individual groups. There is a probability that the heavy metals concentrations are selectively and naturally available in the ecosystem. In contrast to Cu and Fe, Zn, Cr, and Co pollutants may contaminate honey in several ways which are likely to be encountered either in gaseous form when petroleum products are used as fuel or packed (Leita et al., 1996; Shukla et al., 2007). These

Table 2. Heavy metal concentrations in honey.

Location	Metals							
	Cu	Pb	Zn	Cr	Co	Ni	Mn	Fe
Osun	28.830 ± 19.50	0.07 ± 0.06	0.09 ± 0.08	0.11 ± 0.04	0.31 ± 0.06	1.45 ± 0.05	1.62 ± 0.39	29.75 ± 0.85
Oyo	21.563 ± 7.15	0.13 ± 0.12	0.216 ± 0.09	0.29 ± 0.04	0.37 ± 0.06	1.4 ± 0.40	1.96 ± 0.05	26.10 ± 5.70
Ogun	32.729 ± 5.15	0.04 ± 0.00	0.13 ± 0.01	0.24 ± 0.08	0.41 ± 0.11	2.6 ± 0.25	3.59 ± 0.45	43.20 ± 11.00
Ondo	24.312 ± 0.69	0.23 ± 0.16	0.06 ± 0.04	0.85 ± 0.11	0.24 ± 0.01	1.35 ± 0.25	2.49 ± 0.33	32.30 ± 9.10
Ekiti	21.83 ± 6.29	0.19 ± 0.07	0.13 ± 0.06	0.69 ± 0.15	0.26 ± 0.02	1.55 ± 0.55	2.16 ± 0.20	19.40 ± 1.60
Lagos	23.56 ± 7.15	0.11 ± 0.00	0.06 ± 0.04	0.20 ± 0.07	0.34 ± 0.01	0.85 ± 0.25	2.15 ± 0.10	24.35 ± 6.65
Mean	25.49 ± 3.94 *	0.13 ± 0.09	0.14 ± 0.08	0.39 ± 0.07	0.32 ± 0.08	1.41 ± 0.56	2.33 ± 0.71	29.18 ± 9.78*

*Significantly different $P < 0.05$ from other metals.

heavy metals are toxic because they cause DNA damage and their carcinogenic effects in humans are caused by their mutagenic ability (Baudoiun et al., 2002). A very important biological property of metals is their tendency to bioaccumulate (Bousquet et al., 1984; Shukla et al., 2007). A potential threat is that heavy metals are not readily degradable and without intervention may progressively bioaccumulate in the body. These toxic elements may therefore constitute pollutant-induced harm.

Most studies on honey have focused on the beneficial impacts of the product. Direct use of honey may quantitatively be toxic to some target organs and symptoms of honey poisoning may be exhibited, depending on the source point (Helbling et al., 1985). Some plant toxins may in some cases be transferred to honey from their nectar (Deinzer et al., 1977; Hooda, 2007; Acar et al., 2010; Eziashi et al., 2010). While apparently uncommon, allergies to honey have been reported and can involve reactions varying from cough to anaphylaxis (Kiistale et al., 1995). Other symptoms may include dizziness, nausea, vomiting, convulsions, headache, palpitations and death in some cases (Bogdanov et al., 1999). Additionally, long term ingestion of honey containing heavy metals such as Cu and Fe may lead to significant reactions including gastrointestinal disorders (Salem, 1982). Since bioaccumulation of metals is an important factor in hazard evaluation strategies, results of this study suggest that honey may be a sensitive indicator of pollutant induced harm.

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