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Comparative Study of the Nutritional Compositions of Pure and Adulterated Honey Samples Collected from Kano South Senatorial District of Kano State, Nigeria

Datti Ya'u, Usman Lado Ali and Ummi Umar Ahmad

ABSTRACT

Honey, the sweet, nutritious substance produced by honeybees, is of good nutritional and medicinal importance to consumers. The present study aimed at comparing the nutritional compositions of pure and adulterated honey samples collected directly from the honey beekeepers from Kano South Senatorial District of Kano State, Nigeria. For this purpose, a total of three samples each were randomly collected from three randomly selected local governments of the Senatorial District and analyzed for some nutritional values. Similarly, an adulterated honey sample was randomly collected from each of the three local governments. The mean nutritional values obtained for the pure sample were as follows: Moisture content (17.69-18.02%); crude fat (0.89-1.29%); crude protein (0.02-0.13%); ash content (0.44-0.51%); carbohydrate content (80.16-80.75%); energy values (1386.613-1396.157 KJ/100 g). While the adulterated honey sample recorded the following results: Moisture content (24.01%); crude fat (0.94%); crude protein (1.26%); ash content (2.64%); carbohydrate content (71.15%); energy values (1247.847 KJ/100 g). These results indicate that the pure honey sample analyzed are of good quality, as such could be used for both nutritional and medicinal purposes, having met the international honey standards. On the other hand, the adulterated honeys should always be used with care since they usually fall below the international honey standards.

Keywords: Adulteration; Honey; Kano South; Nutritional Composition.

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I. Introduction

Honeybees *(Apis mellifera)* are the common producers of honey from the nectar of plants or from honeydew [1]-[3]. Honey is a unique, natural, liquid sweetening agent whose composition mainly varies depending on its environmental and geographical location, as well as climatic conditions, the plant species, the methods employed during collection and storage [4]-[6].

Sugars are the principal components of honeys, with other nutritional components including some varieties of proteins, enzyme, vitamins, hormones, minerals, some heavy metals, yeast, as well as organic acids (mainly pyruvic, lactic, and formic acids) are also present [3], [7]-[11]. With the analysis of these parameters of honeys serving as quality indicator of individual honeys [6], [12].

Principally, honey is widely used as food and as sweetening agent, but it is reported to have many medicinal applications [13], [14], exhibiting many healing powers [15], [16], as well as antioxidant, anti-inflammatory, antifungal, antimicrobial, and antibacterial activities [16]-[20].

Many researches to determine the nutritional composition and physicochemical properties of honeys samples have been conducted and reported [3], [6], [12], [21]-[31]. With more researches are still on-going, because knowledge of the physicochemical properties, the nutritional compositions and the possible toxicological effects of all the locally available honeys is paramount importance, especially it helps in eliminating all dietary problems associate with either deficiency or consumption of such honey [32], [33].

It is in line of this that this study was carried out to analyze and compare the nutritional composition of pure and adulterated honey samples collected from Kano South Senatorial District.

II. Materials and Methods

A. Samples Collection

Three samples of both pure and adulterated honey samples were directly collected from different honey beekeepers from each of the three randomly selected local governments from the Kano South Senatorial District. Similarly, adulterated honey samples were randomly collected from the markets of each of the three randomly selected local governments. In order to avoid the growth of microorganisms as well as absorption of moisture, all the collected samples were separately stored in clean, labelled, airtight bottles at an ambient temperature [6], [16]. The samples were collected from the following local government areas of the Kano Senatorial District; Bebeji, Kibiya and Ajingi local

government areas.

B. Determination of Moisture Content

The moisture contents of the honey samples were analyzed in accordance with the procedure by Association of Official Analytical Chemists [34]. Two grams each of the honey samples were weighed and then transferred into pre-weighed crucibles, then placed into an oven at 105 °C for 5 hours. Each crucible and its content were then removed from the oven and then cooled in a desiccator, then re-weighed. Triplicate results were obtained for each sample and the mean value was reported to three decimal points according to the following formula:

$$Moisture\ Contents\ (\%) = \frac{W1 - W2}{W1} \times\ 100\%$$

where
W1= Sample weight before drying.
W2 =Sample weight after drying.

C. Determination of Crude Fat Content

The fat contents of the honey samples were analyzed according to the AOAC [34], as adopted by Ibe *et al.* [35]. In this procedure, 2 g of each of the honey samples was weighed into a clean dry beaker, and then concentrated HCl was added, followed by petroleum ether, in order to digest the sample. The chemicals and the honey samples were separated using a separation funnel, and the floatable part of the mixture was collected and transferred into a separate beaker and then heated for 5 minutes to dryness. After drying, the residue was then oven-dried then weighed, with the fat content calculated using the formula below:

$$\text{Fat Content}\ (\%) = \frac{(M_2 - M_1)}{M_3} \times 100$$

where
M_1 = Mass of the flask.
M_2 = Mass of flask + fat.
M_3 = Mass of the sample.

D. Determination of Crude Protein Content

The protein contents of all the honey samples were analyzed using Kjeldahl method according to the AOAC [34] procedure, as adopted by Adeniyi *et al.* [30]. In this method, the nitrogen content of each sample was first determined, and then used to estimate the protein content using the 6.25 conversion factor.

E. Determination of Ash Content

The ash contents of each of the honey samples were determined according to the method according to the AOAC [34] procedure, as adopted by Adeniyi *et al.* [30]. Here 5 g of each of the honey sample was transferred into a pre-weighed, tarred porcelain crucible and the placed into a muffle furnace (Model Box 1200) at 550 °C until a white-gray ash was obtained. The crucible was then brought out and then transferred to a desiccator where it was cool to room temperature and then reweighed. The ash contents of all the honey samples were then calculated as a percentage based on the initial weight of the sample using the following formula:

$$Ash\ Contents\ (\%) = \\ = \frac{(Weight\ of\ Crucible + Ash) - (Weight\ of\ Crucible)}{Initial\ Weight\ of\ the\ Sample} \times\ 100\%$$

F. Determination of the Carbohydrate

The carbohydrate contents of all the honey samples were obtained using the following formula as reported by Adeniyi *et al.* [30] and Oyeyemi *et al.* [36].

% Carbohydrate=100% - (% Moisture Content + % Crude Fat + % Crude Protein + % Ash Content)

G. Determination of the Energy Values

The energy values of the samples were determined using the following formula as reported by Adeniyi *et al.* [30] and Buba *et al.* [37].

Energy (KJ/100 g) = 4.186[(% Crude Protein × 4) + + (% Crude Fat × 9) + (% Carbohydrate ×4)]

III. Results and Discussion

The nutritional compositions of all the honey samples analyzed are presented in the Table 1 below.

TABLE 1: Nutritional Compositions of the Honey Samples

Sample	Moisture Content (%)	Crude Fat (%)	Crude Protein (%)	Ash Content (%)	Carbohydrate Content (%)	Energy Values KJ/100 g
KS A	17.83	0.89	0.06	0.47	80.75	1386.613
KS B	17.69	1.21	0.13	0.44	80.53	1396.157
KS C	18.02	1.29	0.02	0.51	80.16	1391.133
KS AH	24.01	0.94	1.26	2.64	71.15	1247.847
WHO/ FAO	≤ 20	0-10	0.1-1.5	≤ 0.6	75-85	

Key: KS A = Bebeji; KS B = Ajingi; KS C = Kibiya; KS AH = Adulterated Honey.

Moisture content is one of the most important parameters in evaluating the quality of honey [38]. A moisture content higher than the range of <20%, the international standard, might increase the chance of fermentation [39] and possible attacks by microorganisms [40], as well as reduces the honey's shelf life [41]. In this study, the moisture contents of all the three pure honey samples were found to be within the internationally accepted range of <20%. The moisture contents of the samples ranged between 17.69% (Ajingi sample) to 18.02% (Kibiya sample), indicating that the results are in agreement with the Codex Alimentarius Standard for honey [42]. The results are also in agreement with similar reports by Laleh *et al.* [6]; Omafuvbe and Akanbi [17]; Boussaid *et al.* [31]; Ahed and Khalil [38]; Nayar *et al.* [40]; Atrouse *et al.* [43]; Malika *et al.* [44]; Ibrahim Khalil *et al.* [45] and Eleazu *et al.* [46]. However, the moisture of the

adulterated honey sample was found to be 24.01% and this is an indication of adulteration [47]. And according to El-Bialee and Sorour [2], moisture content increase ranging from 20.7 to 39.6% could be due to adulteration by starch, glucose, or water.

Fats, one of the three main macronutrients, are a necessary part of the diet of both humans and animals, and the most efficient form of energy storage [48]. They are mainly present in honey as sterols, glycerides and sometimes as phospholipids. Low fat level in honey is an indication of its virginity [12]. The fat contents of the honey samples investigated in this research fall within the range of 0.89% (Bebeji sample) to 1.29% (Kibiya sample). Low fat content reported in this study is supported by similar reports from other researchers [36] [37] [49] [50] [51] [52] whose reports showed little or no fat in honey samples. This indicates that honey cannot be considered a good source of fat. The result from the adulterated honey sample was also found to be low, and this may possibly be attributed to the fact that the adulterants used did not contain fatty substances. However, both the pure and adulterated honey samples have recorded fat contents within the 0 to 10% range of fat content recommended by the World Health Organization.

Just like the fat content, very low value was also recorded for the protein content. The World Health Organization has set a standard for protein content to be between the range of 0.1 to 1.5%, and this is an indication that honey is not an adequate source of protein [30]. The protein contents obtained in this study are between the range of 0.02% (Kibiya sample) to 0.13% (Ajingi sample), and these are within the WHO standards, and also in agreement with similar report by Buba *et al*. [37] who reported the protein content of honey in North-East of Nigeria as 0.35 to 1.08%. Other researchers [30], [31], [38], [53]-[57] have also reported similar results. Although most honey proteins are enzymes added by bees, a much higher protein content could be an indication of high pollen content which indicates natural, good-quality honey [38] [56]. But unlike for the fats contents, the results for the protein content from the adulterated honey sample were also found to be a little bit high (though below the WHO maximum limit), and this may possibly be attributed to the fact that the adulterants used might have been protein-containing substances.

Ash contents depend on the mineral content of the honey and it is the measure of the inorganic residue of the honey [58]. The ash contents of all the honey samples analyzed were found to be between the range of 0.44% (Ajingi sample) and 0.51% (Kibiya sample), and these results are supported by similar previous results by Adenekan *et al*. [59] who reported ash contents in the range of 0.12 to 0.50% for honey samples; Gulfaraz *et al.* [41] who reported a range of 0.13 to 0.44% ash contents for various honey types of Pakistan; Buba *et al*. [37] who reported a range of 0.37 to 0.54% for some Nigerian honey samples; Oyeyemi *et al.* [36] who reported a range of 0.44 to 0.58% for honey samples obtained from Ekiti State, Nigeria. The results obtained in this study are however a little below 0.70 to 1.67% ash contents reported by Kambai *et al*. [60] for honey samples from selected hives in Jos Metropolis, Nigeria. However, the Codex Alimentarius Commission [61] standard, as well as the WHO specified an ash content of not more than 0.6% for normal honey. The 2.64% ash content recorded for the adulterated honey sample is a clear indication of adulteration, as adulteration of honey is reported to increase its ash content [62], [63]. The Ash content is an important parameter used in determining the floral origin of honeys. Even though according to the Codex Alimentarius Standards, the ash content of pure honey must fall below 0.6%, it is reported that blossom honeys have mineral contents mostly between 0.1 and 0.3%, while that of honeydew honeys can reach up to 0.6% [9].

Honey carbohydrate mainly includes a complex mixture of monosaccharides (glucose and fructose) up to about 70%, then about 10% of disaccharides, and then small amounts of other higher sugars [58]. The results of the carbohydrate contents of the honey samples analyzed in this study were found to be within the range of 80.16% (Kibiya sample) to 80.75% (Bebeji sample), and these are within the WHO standard of 75 to 85%. The results from this study are in agreement with similar reports by other researchers [30], [35], [37], [64]-[66]. Glucose and fructose are the major components of carbohydrate found in honey and their ratio is a factor in determining the adulteration levels and the honeys suitability in managing cases of diabetes [67], [68]. The low carbohydrate content (71.15%) of the adulterated honey sample might possibly be due to adulteration with non-sugar substances like water [69].

Honey is regarded as an important energy-providing food throughout the world, with the energy value of honey being an important quality that depends on the presence of simple, inverted sugars, such as glucose and fructose, which are an immediate and prompt source of energy for the human body [70], [71]. The mean energy values of all the honey samples analyzed in this study were found to be between 1386.613 KJ/100 g (Bebeji sample) to 1396.157 KJ/100 g (Ajingi sample). These results are in agreement with similar results by other researchers: 329.12 to 333.64 Kcal/100 g reported by Adeniyi *et al.* [30]; 281.45 to 507.16 Kcal/100 g reported by Oyeyemi *et al.* [36]; 1383.23 to 1410.20 KJ/100 g reported by Buba *et al.* [37]; 326.2 to 328.06 Kcal/100 g reported by Ndife *et al.* [66]; 303 Kcal/100 g reported by Blassa *et al.* [72]; 1383.23 to 1410.20 KJ/100 g reported by Amabye and Frehiwot [73]. The energy values obtained in the present study is above the WHO minimum limit of 1228 KJ/100 g. Honey provides enough calories (64 calories per tablespoon), from which it derives its energy value [13]. The energy values in honey samples could therefore be an important source of dietary calories. Honey contains high energy carbohydrate foods which are easily metabolized by the body as against other available refined sugar, and this is why honey is a recommended food for both children and adults of all sexes [36]. The adulterated honey sample recorded a much lower energy value of 1247.847 KJ/100 g, and this might have been due to the fact the adulteration was done with non-energy producing substances [69].

IV. CONCLUSION

This study indicated that pure honey samples contain similar physico-chemical properties, with such properties easily affected during adulteration. In general, this study revealed that the analyzed pure honey samples from Kano North Senatorial District are essential for the human diet,

growth, and health, as the levels of the physico-chemical properties were within the permissible limit set by the FAO/WHO. However, adulterated honey samples may not have that guarantee because some parameters exceed the permissible limit set by the FAO/WHO.

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