Advanced Food Science, Technology, and Nutrition Journal
ISSN 3065-0968
Volume 13 Issue 3
July-September 2025
Impact Factor: 7.88
Enquiry: contact@continentalpub.online
Published by Continental Publication | https://cspjournals.org/index.php/Science-Technology-Nutrition

EXPLORING THE ECONOMIC AND NUTRITIONAL BENEFITS OF PURE HONEY

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Abstract:
This study evaluated the economic and nutritional values of honey produced and sold in Nasarawa State, Nigeria. Honey, a natural sweetener made by bees from plant nectars, is rich in sugars (mainly fructose and glucose), organic acids, vitamins, enzymes, and other nutrients. A total of 100 honey samples were collected from local bee farmers and open market sellers across 10 locations in different senatorial districts. Pricing data was gathered through questionnaires and on-the-spot assessments. Samples were analyzed at the Chemistry Laboratory, Isa Mustapha Agwai I Polytechnic, for nutritional composition and quality indicators such as carbohydrates, proteins, fats, ash content, moisture, pH, energy, specific gravity, total titratable acidity (TTA), and refractive index.
Findings revealed that honey holds high economic value, with potential earnings ranging from ₦45,312.50 daily to ₦8,820,000 annually. Nutritional analysis showed average pH values between 4.49 and 4.51, with high carbohydrate content (62.07–65.64%) and notable levels of protein and fats. Processed and unprocessed honey showed similar profiles, though some market samples were found to be adulterated—typically diluted with water or sugarcane. In contrast, honey from local farmers remained largely unadulterated, highlighting the need for quality control in open markets.
Keywords: *Honey, Honey Bees, Quality, Physiochemical, Economic, Nutritional*

INTRODUCTION

Honey is a natural sweet substance produced by bees (*Apis melifera*) from the nectar of plants or secretions of living parts of plants or plant secretions which bees collect, transform by combining with specific substances of their own deposit. It dehydrates, stores and leave in the honeycomb to ripen and mature (Folayan and Biafrin, 2013; Adenekan et al., 2015 and Ahmed et al., 2013). Honey is often regarded as a natural energetic food that is produced by honey bees (*Apis melifera*) and widely source product due to its economic and unique nutritional values (Babatunde et al., 2007 and Bogdanov et al., 2008). Natural (unadulterated) honey is composed of mainly sugar and water with other constituents such as enzymes, esters, lipids, minerals, organic acids, proteins and vitamins (Lawal et al., 2000; Adenekan et al., 2015). These constituents were known to have distinctive nutritional, economic and medicinal values too (Adenekan et al., 2015 and Oyeyemi et al., 2015). Honey is of great economic value in the world as it is being used as food, medicine and industrially (Bogdanov, 2016). Its economic uses include bread, cakes and biscuit making as it enhances longer storage due to its preserving quality (Gule et al., 2007 and

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DOI: https://doi.org/10.5281/zenodo.15855402
Folayan and Biafrin, 2013). The bee wax is used in the manufacturing of carbon paper, cosmetics, Face cream, paints, plastic work lubricant, polishes and for microtomy in the laboratory (Ahmed et al., 2013; Folayan and Biafrin, 2013; Lawal et al., 2000 and Strayer, 2010). Honey is now being sold at exorbitant prices in the open market. A study revealed that a 75cl plastic water bottled is sold at #2500 and above while a 20-30L paint bucket of the freshly harvested honey sells for #40,500 to #80,000 and above (Field survey, 2022). Like any other food commodities, honey is marketed based on a number of attributes of the consumer's judgement of its quality based on many factors. According to Ismaiel et al (2014), these factors include appearance, organoleptic perception, flavor, taste, texture, colour, safety, nutritional value, clear labelling ingredients, price and brand packaging reputation. He further stated that the economic value of honey depends on the income derived by the farmer and seller and the consumer's income level. Again, the quality awareness of maintaining a healthy lifestyle and nutrition are among the important factors that determine the economic value of pure honey. Available studies also show that there is a strong relationship between income and food expenditure (Praise and Houthakker, 2001; Davis, 2001 and Adenekan et al., 2015).

The general believe that honey is a food nutrient, a drug, an ornament and a job opportunity has resulted in creating more awareness in its economic and nutritional values worldwide (AlvarezSuarez et al., 2010; USDA, 2008; Bogdanov, 2016; Baharami et al., 2009; AHB, 2005 and FAOUN, 2022). It has been reported that in United States of America (U.S.A.), honey production earning was estimated at 148 million Dollars in 2007 but decreased by 4% in 2008 while Canada had an annual honey production of 62 million Dollars in 2008 (Lawal et al., 2009 and USDA, 2008). Therefore, there is a reported high demand for honey because of its high economic, nutritional and medicinal values (Lawal et al., 2009 and Ahmed, 2013). Honey is now a scarce commodity, highly demanded for consumption and other uses.

It is now ''economically motivated adulterated'' (EMA) in the common language of vendors (sellers) (Strayer et al., 2010). The result is lack of quality control in the international market. Strayer et al., (2010) further explained that EMA is a ''fraudulent intentional addition or substitution of a substance for the purpose of increasing the apparent value of the product or reducing the cost of its production for economic gain''. EMA can occur in all products displayed for sale and in food it is referred to as food fraud or food adulteration (Bogdanov, 2016; Lawal et al., 2009; Guler, 2007 and Kerkvliet, 1999). The adulterated honey usually loses its nutritional and medicinal values. The adulterated product can be detected by physical and chemical tests. Strayer et al., (2010) and Lawal et al., (2010) reported several types of adulterated honey can be identified in the honey industry, including dilution with less expensive syrups, intensive supplemental feeding of honey bees, unapproved use of antibiotics and masking the true country of origin. These has led to quality control vulnerabilities in the international markets. One of the challenges with identifying adulteration in honey is the lack of a federal standard of identifying honey although some countries have (Strayer et al., 2010). Other challenges include insufficient analytical testing methods and trade policy (Strayer et al., 2010). It has been revealed that pure honey is not easy to come by and will burn while impure will not or may burn with cracking sound. Again, pure honey settles at the bottom of a water glass without dissolving readily while the adulterated one do not (Lawal et al., 2009 and Ahmed et al., 2013). At normal room temperatures, honey is saturated with glucose and fructose sugars and exists as a clear syrup that is preferred by consumers (Omode and Ademukola, 2008 and Lawal et al., 2009). It has been noted for its high nutritional values

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mainly carbohydrates (fructose and glucose) and other minor but important qualities such as amino acids (proteins), minerals, lactic acids, formic acids, pyruvic acids and vitamins (Oyeyemi et al., 2015; Bogdanov, 2009; Lawal et al., 2009 and Folayan and Bifarin, 2013). Estimated nutrients of honey as reported by Oyeyemi, 2015; Bogdanov et al., 2008 and USDA, 2008, includes carbohydrates (300Kcal), glucose (26.12%) sucrose (1.10%), fructose (52.95%), moisture contents (23.33%), amino acids/proteins (0.07%), mineral content (1.6-17 mg) while vitamins detected were biotin, ascorbic acid, riboflavin, folic acid, thiamine (ppm). Similar findings were reported differently by Adenekan et al., 2015; Ajanaku et al., 2009; Guler et al., 2009 and Yaboue et al., 2021). Therefore, honey has important nutritional qualities that qualifies it to be used as food, medicine and industrial raw material. The following health claims were also attributed to the nutritional values of honey, namely; Antibacterial effects, Antioxidant action, Antimicrobial effects, Anti brain tumour activities, body weight regulation, diet related cancer cure, bone health and osteoporosis effects, immunity and diabetes risk reduction (Bogdanov, 2016; Bogdanov et al., 2008; Omale and Ademukola, 2008; Jeffery and Echazarreta, 1996; Guler et al., 2007 and Alvarez et al., 2010).

This work therefore, was to investigate the economic and nutritional values of pure honey. Honey, however, has several disadvantages when adulterated. These disadvantages include allergy and potential health hazards due to adulterated toxic compounds and loss in economic values (Bogdanov et al., 2008).

MATERIALS AND METHODS

This study was conducted in selected districts across the three Senatorial Districts of Nasarawa State, North-central Nigeria. Nasarawa State is located between latitudes 7˚45′ N and 9˚25′ N and between longitudes 7˚ E and 9˚37′ E.

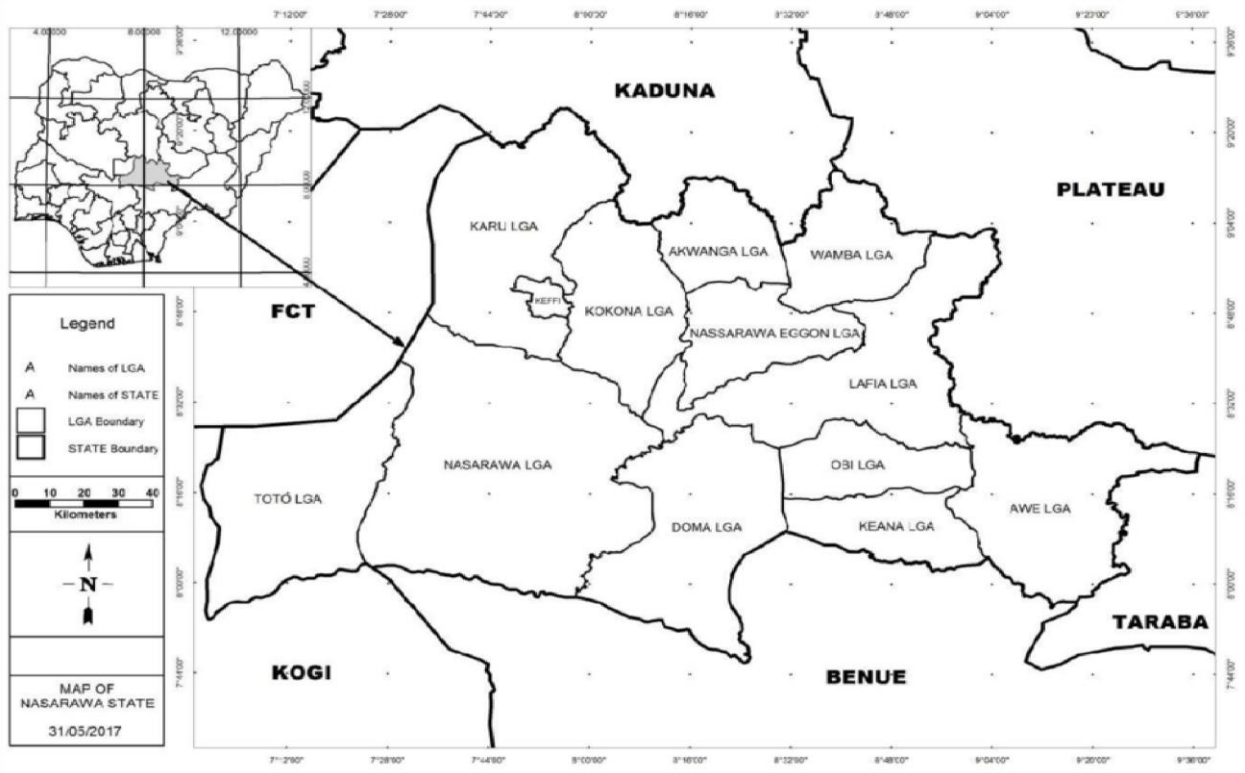

Figure 1: Map of Nasarawa State showing the study areas.

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The honey farmers, retailers (middlemen) and the street/market vendors (or sellers) were interviewed orally using simple market survey check lists questionnaire an the daily, weekly, monthly and annual income rate and consumption rate of honey.

The freshly harvested honey by bee farmers and the processed one on sale by street vendors on the open market were purchased and labelled at the point of purchase as FH_1 to FH_{10} for freshly harvested honey and PH_1 to PH_{10} for the processed honey. Two samples each were collected from five Senatorial District of the State. The collected samples were put in clean sterile plastic bowls for the FH samples and 1L glass bottles for the PH samples and were taken to the Science Laboratory Technology's Chemistry Laboratory of the Isa Mustapha Agwai 1 Polytechnic, Lafia (IMAP). In the Chemistry Laboratory, the samples were stored in a clean dark cupboard a room temperature to prevent photodecomposition at ambient temperature conditions. They were then analysed for nutrient content values using Association of Official Analytical Chemists (AOAC, 2012) method while the mineral contents of the sampled honey were determines using atomic Absorption Spectrometer (AAS) machine, the Buck Scientific UG 210 model.

RESULTS AND DISCUSSION

The earning from honey business are shown in Table 1 below.

Table 1: Average Income from Honey Business

Sales description	FH (kg)	Rate #/kg	Amount #	PH (L)	Rate V/L	Amount #	Average #
Daily	0.25	2,500	6,215	50	1,800	90,000	45,312.5
Weekly	1.5	2,500	3,750	200	1,800	360,000	181,875
Monthly	6	2,500	15,000	800	1,800	1,440,000	727,500
Annually	72	2,500	180,000	9,600	1,800	17,280,000	8,820,000

FH=Fresh honey. PH=Processed honey

Table 1, shows the earnings daily, weekly, monthly and annually from the sales of both freshly harvested honey (FH) by the bee farmers and the processed honey (PH) by the street vendors in the study area. These were obtained by oral interview and pricing of honey on sale. Daily, weekly and monthly sale of honey ranges from #45,312.50K per day, #181,875 per week and #727,500 per month averagely for the sale of freshly harvested and processed honey coded as FH for the freshly harvested and unprocessed honey, PH, for the processed product (Table 1). It is estimated that from honey business alone, one can earn up to #8,820,000 annually. Honey production and marketing therefore, has the potential to provide self-employment and reduce poverty in Nigeria (Table 1). Similarly, findings on economic values of honey attested to these findings (Abdullazeez, 2011; Oyeyemi, 2015 and Babatunde et al, 2007). Other economic values of honey are its use as sweetener in cakes, jam and jelly, etc, which gives it some economic values (Babatunde et al, 2007 and Lawal et al., 2000). Honey business is a high yielding profit business hence, Nasarawa State in 2005 reported that it assisted about 100 honey bee farmers (Abere and Lameed, 2012; Nasarawa State Economic Strategy, 2005).

Results in Table 1 also indicated that the freshly harvested honey is sold at a higher rate that the processed one. A freshly harvested honey is sold at #2,500 per kg while the processed product is sold

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at approximately #1,800 per litre. For fear of adulteration, most consumers prefer to buy the freshly harvested products. Despite the great potential in honey business, the business seems to be going down. The farmers and vendors complained of lack of active market and awareness on the economic and medicinal values of honey. Similarly, Abdullazeez (2002), observed that the honey export in Nigeria is decreasing despite quality of honey from Nigeria. Nigeria's honey is not accepted in the international market for export properly due to the producers adulterating it before placing in the market (Field survey, 2022; Abere and Lameed, 2012 and Bogdanov, et al, 2008). Consumption pattern and economic status of the consumers is a big factor that affects honey market demand (Ismaiel et al, 2014). Most consumers with low income per annum do not have the capacity, so they avoid buying honey and consider it as the big man or rich man food and so may likely not consider it in their diet (Ismaiel et al., 2014). Worse still, the high price of honey compared to other food is a set-back factor in moving the market forward (Ismaiel et al., 2014) as one litre is sold for #1,800 (Table 1). Nigerian unemployed youths should be encouraged to go into bee farming as it has greater economic potential.

Honey may differ in appearance, sensory perception and composition due to the source variation of botanical origin (Bogdanov et al., 2008; Ismaiel et al., 2014 and Strayer et al., 2010) but it is a mixture of different essential compounds predominantly carbohydrates in the form of sugars mainly fructose , glucose and sucrose as well as other substances such as organic acids, proteins, fats, enzymes, vitamins and other solid particles (Table 2) (Oyeyemi, 2015; Bogdanov, 2016 and Bogdanov et al., 2008).

Table 2: Proximate Composition Analysis of Honey Samples

Sample Code	PARAMETERS									
	Carbohydrates (%)	Ash Content (%)	Crude Protein (%)	Crude fats (%)	Energy (kcal/100g)	Moisture Content (%)	pH	Refractive Index	TTA	Specific Gravity
FH_1	65.64	0.67	6.28	5.25	506.68	20.51	4.51	1.47	3.03	1.27
PH1	61.97	0.41	5.64	9.05	281.43	21.85	4.72	1.49	2.61	1.20
FH2	65.74	0.66	6.27	5.36	506.68	20.43	4.94	1.46	2.93	1.23
PH2	62.07	0.42	5.62	9.06	280.44	21.72	4.71	1.48	2.11	1.19
FH3	65.84	0.65	6.26	5.37	506.69	20.39	4.50	1.45	2.83	1.20
PH3	62.17	0.43	5.63	9.07	281.44	21.83	4.72	1.50	2.21	1.18
FH4	65.94	0.64	6.23	5.42	507.18	20.38	4.51	1.48	2.83	1.18
PH4	62.27	0.44	5.64	9.08	281.42	21.82	4.68	1.51	2.31	1.21

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FH5		66.04	0.63	6.24	5.41	507.16	20.37	4.50	1.49	2.53	1.17
PH5		62.27	0.45	5.65	9.09	281.43	21.81	4.67	1.52	2.11	1.17
FH6		66.04	0.58	6.25	5.40	507.17	20.42	4.49	1.50	2.43	1.18
PH6		62.37	0.46	5.64	9.10	281.41	21.80	4.66	1.53	2.51	1.16
FH7		66.14	0.56	6.29	5.43	507.15	20.50	4.50	1.47	3.03	1.19
PH7		62.47	0.47	5.63	9.08	281.40	21.79	4.65	1.47	2.31	1.21
FH8		66.24	0.51	6.28	5.39	507.16	20.49	4.51	1.51	2.73	1.20
PH8		62.57	0.43	5.65	9.12	281.45	21.84	4.66	1.50	2.21	1.20
FH9		66.34	0.52	6.27	5.38	507.14	20.44	4.50	1.52	2.93	1.21
PH9		61.97	0.42	5.65	9.13	281.44	21.78	4.67	1.48	2.41	1.19
FH10		66.44	0.53	6.26	5.43	507.13	20.45	4.50	1.48	2.83	1.22
PH10		62.07	0.43	5.65	9.08	281.42	21.73	4.65	1.48	2.41	1.18
Range	FH	65.64-66.44	0.51-0.67	6.23-6.28	5.35-5.43	506.68-507.18	20.38-20.51	4.49-4.51	1.45-1.52	2.43-3.03	1.17-1.23
	PH	61.97-62.57	0.41-0.47	5.62-5.65	9.05-9.13	280.44-281.44	21.72-21.84	4.65-4.72	1.48-1.53	2.11-2.61	1.16-1.21
Average	FH	66.04	0.60	6.27	5.39	507.01	20.44	4.50	1.48	2.81	1.20
	PH	62.22	0.44	5.64	9.09	281.43	21.76	4.68	1.50	2.30	1.19

TTA = Total Titratable Acid

Table 2 revealed carbohydrate, ash content, crude protein, crude fat, energy and moisture to be within the ranges of 62.07-65.64%, 0.51-0.67%, 6.23-6.28%, 5.35-5.43%, 506.68-507.18kcal per 100g and 21.72-21.80% respectively. Other parameters such as pH, refractive index, total titratable acid (TTA) and specific gravity ranged from 4.49-4.51, 1.45-1.52, 2.43-3.03 and 1.17-1.23 for freshly harvested (unprocessed) honey while the street vendor honey had similar parameter ranges from 4.65-4.72, 1.48-1.53, 2.11-2.61 and 1.16-1.21 respectively.

On the average, the compositions of the sampled honey are summarized in table 3.

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Table 3: The Range and Average Values of Honey Parameters.

Parameters	FH Honey		PH Honey	
	Range	Average	Range	Average
Ash Content (%)	0.51 to 0.67	0.60	0.41 to 0.47	0.44
Carbohydrate (%)	65.64 to 62.07	66.04	61.97 to 62.57	62.22
Crude Protein (%)	6.23 to 6.28	6.27	5.62 to 5.65	5.64
Crude fat (%)	5.35 to 5.43	5.39	9.05 to 9.13	9.09
Energy (kcal/100g)	506.68 to 507.18	507.01	280.44 to 281.44	281.43
Moisture Content (%)	20.38 to 20.51	20.44	21.72 to 21.80	21.76
pH	4.49 to 4.51	4.50	4.65 to 4.72	4.68
Refractive index	1.45 to 1.52	1.48	1.48 to 1.53	1.50
TTA	2.48 to 3.03	2.81	2.11 to 2.61	2.30
Specific Gravity	1.17 to 1.23	1.20	116 to 1.21	1.19

TTA = Total Titratable Acid

The ash content of the honey samples analyzed were 0.60% and 0.44% respectively for freshly harvested and the street vendor's honey (table 3). These results obtained corroborate with the work of Oyeyemi et al, (2015); Abdullazeez, (2011) and Adenekan et al, (2010) who differently reported a similar range of 0.51 to 0.60 for the freshly harvested honey and 0.30 to 0.43% for the street vendor honey. The values of this work were slightly low compared with the range of 1.1% to 1.73% reported by Ndife et al, (2014) and Oyeyemi et al, (2015). However, the results for the honey samples were within the acceptable level as proposed level of not more than 0.6% ash content which was given by Codex Alimentarius Commission Standard, (2014). The main nutritional and health important components of honey are carbohydrate, mainly fructose and glucose. The analyzed samples of honey showed a mean value of 66.04% and 62.22% for unprocessed honey and processed street vendor honey. This shows that honey has a variety of nutritional carbohydrate which is in agreement with the opinion of Bogdanov et al, (2008). Furthermore, they reported that about 95% of the honey dry matter is composed of carbohydrates, mainly fructose and glucose and that 5 to 10% of total carbohydrates are oligosaccharides, totally about 25 different di- and tri-saccharides. Thus, as a result of honey high carbohydrate content and functional properties, it is an excellent source of energy for athletes (Bogdanov et al., 2008). The carbohydrates are the main constituents of honey, having about 95% of honey dry weight.it is also reported that a daily dose of 20g honey will cover about 3% of the required daily energy (Bogdanov et al., 2008; Bogdanov, 2016; Babatunde, 2007 and Agbagva et al., 2011). The results of this finding are in agreement with a similar research finding by Agbagwa et al., 2011; Bogdanov, 2016 and Ismaiel, 2009). The results of the samples analyzed differ from the finding of

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Adebiyi et al, (2004 and Adenekan, (2012), who separately reported a higher value range of about 77.60% to 86.20% in six states from Southwestern Nigeria. Similarly, Lawal et al., (2009) reported a higher value range of similar value range.

The energy values of the honey samples (FH and PH) (Table 2 and 3) ranges from 506.68 kcal to 507.18kcal and 280.44kcal to 281.44 kcal/100g with average values of 507.01kcal/100g and 281.43kcal/100g respectively. These findings were in agreement with the reported calorific value ranges of 280-303kcal/100g recorded by Adenekan et al., 2015; Adenekan et al., 2012 and Adeneyi et al., (2004). The results for honey sample FH was higher than for honey sample PH which were in agreement with reported values of 507.16 kcal/100g and 281.45kcal/100g. These calorific values in the analyzed honey samples serve as a good source of dietary calories. Honey is an essential high energy carbohydrate food as its sugars are easily metabolized by the human body unlike the refined sugar (Bogdanov, 2006 and Adenekan et al., 2015). It is therefore, a good food for both young and adults.

The analyzed honey samples (FH and PH) gave the moisture content of 20.44% and 21.76% respectively (Table 2 and 3). These were closely in agreement to the results of Oyeyemi et al., (2015), who reported a range of 20.50% and 21.78% respectively. Ajao et al., (2013) and Adeniyi et al, (2014) showed a closely reported value of 19.30% and 22.09% for honey samples from the Western States of Nigeria. One of the important parameters that contribute greatly to the quality of pure honey is moisture content. Moisture generally affects honey shelf life and processing characteristic (Bogdanov, 2008; Adebiyi et al., 2004 and Babatunde et al., 2007). Moisture content is reported to play a major role in the viscosity and savour of honey (Kayode and Oyeyemi, 2014; Bogdanov et al., 2008 and Adenekan et al., 2010). The findings of this research are within the approved limit of 21% recommended by the Codex Alimentarius Commission (2001).

The analysis of the honey samples indicated the crude protein content of 6.27% and 5.64% respectively. These values were relatively higher when compared with the findings of Adeniyi et al., (2004); Adenekan et al., (2012) and Ahmed et al., (2013), whose reported values ranged from 1.43-2.72%. Agunbiade et al., (2012) and Lawal et al., (2009), reported similar findings in different States of Nigeria. Honey proteins which are reported to be mainly in the form of enzymes are fond in various honey to be about 8-11 forms but only four are common to all and appear to originate from the honey bees during formation rather than from plant nectar (Adebiyi et al., 2004; Agbagva et al., 2011 and Babtunde et al., 2007).

The analysis revealed the crude fat content of the honey samples, FH and PH, to be within the range of 5.35% to 5.43% and 9.05% to 9.13% respectively (table 3). Literature available revealed that honey contained little or no fat (Abgagwa et al., 2011; Babatude et al., 2007 and Ajao et al., 2013).

The reported values from this study were relatively higher compared with the value range of 1.43 -2.72 reported by Lawal et al., (2009) and Agbagwa, 2011, while Oyeyemi et al., (2015) reported a range of 1.23% to 0.80% respectively. This low crude fat content in honey indicated that they are not adequate sources of lipid.

The honey samples FH and PH analyzed had total titratable acidity (TTA) range of 2.43 to 3.03 and 2.11 to 2.61, average values of 2.81 and 2.30 respectively. These average values were in agreement with those of Oyeyemi et al., (2015), who reported average values of 2.73 and 2.31 for similar honey samples obtained in Ado-Ekiti, Ekiti State, Nigeria. However, the study values were higher than those previously reported by Lawal et al., (2009), to range from 0.30 to 0.19 but lower than the findings of Kayode and

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Oyeyemi, (2014), when compared. The analyzed honey samples may be with the acidity range which improves the self-stability of the honey so as to prevent easy spoilage by microorganisms (Oyeyemi rt al., 2015; Agunbiade et al., 2012 and Willian et al., 2009). This may be one of the factors that make honey have antimicrobial effects (Bogdanov, 2016 and Babatunde et al., 2007).

The analyzed honey samples, FH and PH, revealed specific gravity range of 1.17 to 1.23 and 1.16 to 1.21, with mean values of 1.20 and 1.19 respectively (Tables 2 and 3). These values were relatively close to the findings of Oyeyemi et al., (2015) and Lawal et al., (2009), when compared.

When compared to the previous work of Ajao et al.., (2013) and Ndife et al., (2014), who reported values of 1.42 to 1.44, the values were higher. It is one of the important parameters for honey quality evaluation, especially when testing for adulteration.

Tables 2 and 3 indicated a range values of 1.45 to 1.52 refractive index for the sampled honey, FH and PH. Also, mean values of 1.48 and 2.30 were obtained respectively. The FH samples analyzed gave a similar value when compared with the previous work of Oyeyemi et al., (2015), while the PH samples indicated a much lower value as most of their products are adulterated (Agbagwa et al., 2011). This difference may be due to the slight adulteration of the sampled honey, PH, by the street vendors.

The result of the hydrogen ion concentration, pH of the two types of honey samples (FH and PH) investigated indicated ranges of 4.49 to 4.51 and 4.65 to 4.72 with mean values of 4.50 and 4.68 respectively. These values were relatively higher than those previously reported by Ahmed et al., 2013 and Agunbiade et al., (2012), who separately reported value ranges of 3.2 to 4.5 and 4.74 to 6.75. acidity is an important quality criteria or factor for determining the quality and purity of honey (Ahmed et al., 2013 and Lawal et al., 2009). Fermentation due to adulteration by water causes increase in acidity hence, higher acidity values make consumers suspect EMA in the honey (Strayer et al., 2010 and Bogdanov, 2016). Agbagwa et al., (2011) reported that the pH of some Nigerian honey ranged from 3.10 to 4.20. lower range values indicated higher acidity while ranges from 6.95 to 7.15 tends toward neutrality. Higher values of pH indicate high alkalinity (Agbagwa et al., 2011 and Aasima et al., 2008).

Table 4 represented the mineral composition and other trace substances content of the two types of honey samples analyzed. The recommended adult daily intake requirements are also given in table 4.

Table 4: Mineral Composition of Honey Samples and other Trace Substances.

Mineral Elements (mg/100g)	FH	PH	Recommended Adult Daily Intake (g)
Ca	296.63	262.00	1000-0200
I	10	100	N.S.
Mg	72.29	51.35	300-400
Cr	0.03	0.30	0.03-1.50
Fe	171.52	239.12	10.00-15.00
Mn	1.02	4.47	2.00-5.00
F	0.4	1.34	N.S.

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Cu	0.38	0.92	0.50-1.00
Pb*	0.04	0.92	0.001-0.03
Ni	0.32	0.64	N.S.
Cl-	0.4	4.6	N.S.
Zn	124.24	89.92	7.00-10.00
K	246.89	223.25	2000
Na	123.20	149.81	550
Cd*	0.00	0.01	0.05-2.40
Co	0.10	0.35	0.10-0.35
Ca	296.63	262.00	1000-0200
I	10	100	N.S.
Mg	72.29	51.35	300-400
Cr	0.03	0.30	0.03-1.50
Fe	171.52	239.12	10.00-15.00
Mn	1.02	4.47	2.00-5.00
F	0.4	1.34	N.S.
Cu	0.38	0.92	0.50-1.00
Pb*	0.04	0.92	0.001-0.03
Ni	0.32	0.64	N.S.
Cl-	0.4	4.6	N.S.
Zn	124.24	89.92	7.00-10.00
K	246.89	223.25	2000
Na	123.20	149.81	550
Cd*	0.00	0.01	0.05-2.40
Co	0.10	0.35	0.10-0.35

* Elements regarded as toxic
(Bogdanov et al., 2007)

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Honey contains small amounts of minerals and trace elements (Bogdanov et al., 2008). The results revealed that the honey samples analyzed contain small amount of minerals measured in mg/100g such as Calcium (296.63, Magnesium (72.29), Iron (171.52), Manganese (1.02), Copper (0.38), Lead (0.04), Nickel (0.32), Zinc (124.24), Potassium (246.89), Sodium (123.30), Cadmium (0.00) and Cobalt (0.1) for analyzed honey samples FH while values for honey samples PH are 362.00 for Calcium (Ca), 51.35 for Magnesium (Mg), 239.12 for Iron (Fe), Manganese (Mn) 4.47, Copper (Cu) 0.92, Lead (Pb) 0.92, Zinc (Zn) 89.92, Nickel (Ni) 0.64, Potassium (K) 223.25, Sodium (Na) 149.81, Cadmium (Cd) 0.01 and Cobalt (Co) 0.35. Trace substances detected included Chloride (Cl^-) 0.32 and 0.64, Iodide (I^-) 10.00 and 100.00 and Fluoride (F^-) 0.4 and 1.34 for FH and PH respectively (table 4). The minerals daily requirement, according to Bogdanov et al., (2008) were also reported in table 4. From table 4 above, this study revealed that the honey samples contained trace elements such as Ni, Cr and that the honey sampled is rich in minerals. When compared with other studies, Ca and K had the highest content of 296.63mg/100g, 262.00mg/100g and 246.89mg/100g, 223.25mg/100g for samples FH and PH respectively. These values were above the recommended adult daily intake previously reported by Bogdanov et al.,2007 and Bogdanov, (2008), and were also not in agreement with the studies of Abgagwa et al., (2011); Oyeyemi et al., (2015) and Ndife et al., (2014) who reported that only Potassium has highest mineral value over other minerals detected. Oyeyemi et al., (2015) reported that mineral contents in honey may vary due to differences in plant species visited by the honey bees during nectar collection and the soil type in which the floral plants were found.

Mineral elements play a very important role in biochemical and physiological functions in human and animal health (Atara and Joseph, 2022). Previous studies revealed that Ca is essential for growth and maintenance of bones, teeth and muscles (Atara and Joseph, 2022). Na and K which are components of intercellular fluid assist to maintain electrolyte balance and membrane fluidity while Mg protects and manage high blood pressure and cardiovascular diseases (Oyeyemi et al., 2015; Atara and Joseph, 2022; Ndife et al., 2014; Tural et al., 2003 and Ahmed and Chandhary, 2009). Haemoglobin formation, normal functioning of the central nervous system (CNS) and carbohydrate, fat and protein oxidation require Fe mineral, while Cu and Fe contribute to energy metabolism with Mn acting as a co-factor of many enzymes (Atara and Joseph, 2022; Oyeyemi et al., 2015; Tural et al., 2003; Ahmed and Chandhary, 2009 and Adeleyeye and Okokiti, 1999). Thus, honey is really of great nutritional value.

Table 5: Vitamins in Honey Samples

Vitamins	FH (mg)	PH (mg)	Adult Daily Intake Requirement (mg)
Phyllochinon (K)	0.025	20.00	60.00-70.00
Thiamine (B1)	0.02	0.90	1.00-1.30
Riboflavin (B2)	0.01	0.90	1.20-1.50
Pyridoxine (B6)	0.01	0.32	1.20-1.60
Niacin (B3)	0.01	0.32	13.00-17.00
Folic Acid (B9)	0.01	0.70	1.30-1.70

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Ascorbic Acid (C)	0.10	2.50	100.00

The study revealed that the sampled honey (FH and PH) analyzed contains vitamins namely Vitamin B_1 (0.02mg and 0.90mg), B_2 (0.01mg and 0.90 mg), B_3 (0.01 mg and 0.32m), B_6 (0.01mg and 0.32mg), B_9 (0.01 mg and 0.70 mg, Vitamin C (0.1mg and 2.5mg) and Vitamin K (0.025mg and 20.00mg). Vitamins adult daily intake requirement as reported by Bogdanov et al., (2008), were also shown in table 5. Vitamins are an essential part of a balanced diet that are required in small quantity but are recommended daily for intake in our diet (Bogdanov et al., 2008). Honey therefore, is a complete nutritional food for all age groups.

Honey can be contaminated or adulterated the same as any other food either by the environment or deliberately by humans (Bogdanov et al, 2008). The contamination from the environment could be by heavy metals, pesticides, antibiotics, etc. (Bogdanov et al., 2008). Although the contamination level does not present much health hazard but the major problem recently is the contamination by antibiotics that are used against bee's brood diseases. This is however now under control according to Bogdanov et al., (2008). According to them, in the European Union (EU) countries, antibiotics are not allowed for bee brood diseases and honey containing antibiotics are not allowed to be traded on the market (Bogdanov et al., 2008). Adulteration of honey could be by adding water, sugar (or sweetener) or any other substances for quick cheap economic gains (Ahmed et al., 2013; Bogdanov, 2010; Strayer et al., 2010 and Ismaiel et al., 2014). Cases of honey poisoning are rarely reported in literature but it is advisable to buy honey from approved shops and not on the road sides or from individual bee keepers.

CONCLUSION

Honey is a natural sweet substance produced by bees from plant nectars or from secretions from plants' living parts which bees collect, transform, store and allow to ripen in the honey comb. It mainly contains carbohydrate and small amounts of other nutrients that are of numerous nutritional and biological effects. Several studies have confirmed the nutritional and economic values of honey and its various effects and claims on health after consumption. In the modern-day society, honey is still relevant medically. Studies should be undertaken on health claims of honey and effects of ingesting honey on various age groups of humans.

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