

Research Article

A Comprehensive Analysis on Nutritional Composition of Floral honeys Commonly Available in Bangladesh

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Abstract

Honey, a natural product of honeybees, boasts a complex composition that varies greatly depending on its floral source. Its therapeutic and antimicrobial activity can be attributed to its rich nutritive composition, including sugars, amino acids, vitamins, minerals, and bioactive compounds like phenolics, flavonoids, and hydrogen peroxide. This study delves into the nutritional values of various types of honey, emphasizing the significance of understanding their unique compositions and potential therapeutic properties associated with diverse floral sources. The study encompassed eight different honey varieties, including monofloral and polyfloral types, and scrutinized their proximate composition, dietary elements, and nutritional factors. The results revealed that among the honeys, Khalisha blossom honey boasts the highest carbohydrate content at 78.18%, with protein levels ranging from 0.30% to 0.95% and no fat particles detected. Additionally, the energy content ranged from 293 to 316 kcal per 100 grams of honey. Overall, Khalisha blossom honey emerged as the honey variety with the highest nutritional value, exhibiting its potential as a robust and healthy food choice for the country people. Furthermore, the research highlights notable differences in nutritional composition when compared to honey from other regions, such as Africa, Asia, and Europe, particularly in terms of carbohydrate, moisture, and vitamin content. This analysis is pivotal for understanding the unique nutritional and therapeutic attributes of Bangladeshi honey varieties, promoting informed dietary choices, and advocating for standardized quality assurance practices.

Keywords

Floral Honey, Nutritional Factor, Proximate Composition, Minerals

1. Introduction

Honey is created by honeybees as a supersaturated solution using the nectar of flowers. The bees collect nectar from flowering plants, take it back to the hive, and process it through regurgitation and enzymatic activity. The enzymes in the bees' saliva break down the complex carbohydrates into

simpler sugars, transforming them into honey. The resulting hypertonic solution is then stored in the honeycombs within the hive, where it undergoes further ripening.

In Bangladesh, two primary types of honeybees are utilized for honey production. *Apis dorsata*, which primarily produces

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honey but is not usually domesticated, and *A. cerana indica*, domesticated by beekeepers [1]. The Sundarbans, a mangrove area in the delta formed by the confluence of the Ganges, Brahmaputra and Meghna Rivers in the Bay of Bengal, contributing 50% of the total production, serves as a focal point for large-scale honey manufacturing and marketing [2]. The annual honey production in 2020 reached about 445.2 metric tons, signifying a booming industry. Moreover, Bangladesh is home to a thriving community of over 15,000 beekeepers, reflecting the country's deep engagement with apiculture as a vital agricultural practice [3] and thus, showing the urgent need of assessing and controlling the quality of Bangladeshi honeys [4]. The mechanism of honey synthesis by bees is same all over the world but the differences in honey observed in their physical and chemical properties are basically on geographical and botanical origins. The major constituents of honey are nearly the same in all honey samples. However, the variation in taste, flavor, aroma and colour determines whether honey is produced from different flora substances majorly from plants [5, 6]. Thus, it has been reported that the chemical composition and physical properties of natural honeys varies greatly according to the plant species on which the bees forage [7-9]. Mono-floral honey, distinguished by its unique flavor, aroma, and color profile specific to a single plant species, includes varieties such as Black cumin blossom honey, Mustard blossom honey, Plum blossom honey, and litchi blossom honey. Conversely, polyfloral or wildflower honey, comprising nectars from various flowers, provides a diverse and nuanced flavor profile.

Honey mainly consists of monosaccharides and oligosaccharides and additionally contains at least many of its 181 constituents reported to date [10]. These include various bio-active compounds such as phenolic compounds, flavonoids, organic acids, carotenoid-derived compounds, nitric oxide

metabolites, ascorbic acid, Maillard reaction products, aromatic compounds, trace elements, vitamins, amino acids, and others. Among these, mentionable vitamins are A (Retinol), E (Tocopherol), K (Anti-Haemorrhagic Vitamin), B1 (Thiamine), B2 (Riboflavin), B6, Niacin, C (Ascorbic acid), Pantothenic acid, and others [11]. Additionally, honey contains specific compounds such as apigenin, pinocembrin, acacetin, abscisic acid, and ferulic acid [12]. Its amino acid content, including arginine, cysteine, glutamic acid, aspartic acid, and proline, adds to its nutritional value. Thus, this study aims to determine the qualitative value of various monofloral and polyfloral honey types commonly found in Bangladesh. This research will emphasize examining the biochemical composition and nutritional characteristics of these diverse honey varieties.

2. Methods and Materials

2.1. Collection of Honey

Eight different varieties of honey, including monofloral and polyfloral honey, were collected from various geographic locations in the Satkhira and Khulna regions of Bangladesh for analysis. The collected samples were named based on the source plant from which they were collected and were numbered randomly from 1 to 8. For instance, "Mustard blossom", "Plum/Jujube blossom", "Khalisha blossom", "Mixed (Sundarban)", "Grass pea blossom", "Litchi blossom", and "Mixed (Village)" were numbered 1 to 8, respectively. All the honey samples were stored at ambient temperature in plastic bottles with tight-fitting lids during the period of analytical investigation (see Figure 1).



Figure 1. Different types of honey varieties.

2.2. Determination of Proximate Composition

2.2.1. Determination of Moisture Content

The moisture content of honey was determined by drying the sample at a high temperature. The difference between the collected and dried forms of honey was considered the amount of moisture present in the sample. In brief, empty crucibles were weighed, and 10 g of honey was transferred into the crucibles. The honey samples were dried in the oven at 100 °C for up to 12 hours and then weighed again. The amount of moisture was calculated by using the following equation:

$$\text{Moisture (\%)} = \frac{W_1 - W_2}{W_1 - W_0} \times 100$$

Here, weight of clean dry conical flask = W_0 , weight of clean dry conical flask + Wet sample = W_1 and weight of clean dry conical flask + Dry sample = W_2 .

2.2.2. Determination of Ash Content

The ash content of a sample refers to the organic residue that remains after the organic matter has been burnt at approximately 120 °C, as per the Association of Official Analytical Chemists (AOAC) method from 2004 [13]. To elaborate, each honey sample weighing 2 g was incinerated at around 120 °C for 20 minutes. Subsequently, the conical flasks containing the honey were taken off the burner and allowed to cool to room temperature. The amount was calculated by using the following equation:

$$\text{Total Ash (\%)} = \frac{W_2 - W_0}{W_1 - W_0} \times 100$$

Here, weight of clean dry conical flask = W_0 , weight of clean dry conical flask + Dry sample = W_1 , Weight of clean dry conical flask + Ash = W_2 .

2.2.3. Determination of Protein Content

The Biuret method was used to determine the presence of proteins or peptides in the honey samples. To prepare the Biuret reagent, NaOH was mixed with a solution of CuSO_4 to create an alkaline solution. Then, 1 ml of honey was taken from each variety and mixed with one of the Biuret reagents. After waiting for 5 minutes, a color developed. The color intensity, which indicates the amount of protein present in the honey samples, was compared with a standard BSA curve at 540 nm to calculate the amount of protein.

2.2.4. Determination of Fat Content

Mixing the food sample with organic solvents causes the fat to dissolve and the other components remain as precipitate. (Association of Official Analytical Chemists (AOAC) method, 1990) [14]. In brief, 1 g of honey was mixed with 100 ml of

diethyl ether and kept in the dark for three days with regular shaking. Then, the solution was filtered with filter paper. The filtrate was then reduced using a Buchi Rotavapor. The extract was then dried and weighed to get the amount of fat molecules in the samples. The amount was calculated by using the following equation:

$$\text{Total Extracted Fat (\%)} = \frac{W_2 - W_1}{S} \times 100$$

Here, the initial weight of the conical flask = W_1 , the final weight of the conical flask = W_2 , Weight of the sample = S .

2.2.5. Determination of Crude Fiber Content

Crude fiber is a measurement of the indigestible plant material in food, mainly made up of cellulose, hemicellulose, and lignin. It represents the fibrous components of plant-based foods that resist digestion in the human gastrointestinal tract. To determine the weight of the fiber, a moisture and fat-free sample is sequentially treated with 1.25% sulfuric acid and 1.25% sodium hydroxide, followed by filtration, washing, drying, and incineration. The following formula was used to measure crude fiber content.

$$\text{Crude Fibre (\%)} = \frac{(\text{Weight of residue} - \text{Weight of ash}) \times 100}{\text{weight of the sample}}$$

2.2.6. Determination of Total Sugar Content

The honey's total sugar content was measured using the phenol-sulfuric acid method. In this method, carbohydrates reacted with phenol under acidic conditions, resulting in the formation of colored compounds. The intensity of the color directly correlates with the concentration of carbohydrates, allowing for a quantitative estimation of sugars in a given sample. The total sugar content was determined using visible spectroscopy at 489 nm and a calibration curve of standard D-(+)-Glucose.

2.2.7. Estimation of Total Energy Content

The total energy of the food is obtained by adding the energy from carbohydrate, protein, and fat content.

$$\text{Energy (Kcal)} = (4 \times \text{Carbohydrate (\%)}) + (4 \times \text{Protein (\%)}) + (9 \times \text{Fat (\%)})$$

2.3. Estimation of Reducing Sugar Content

The Nelson-Somogyi method was used for the quantitative assessment of reducing sugars. In this method, glucose undergoes a reaction with alkaline copper tartrate, causing the reduction of copper ions from a cupric to cuprous state and resulting in the formation of cuprous oxide. Subsequent treatment of cuprous oxide with arsenomolybdic acid causes a reduction of molybdic acid to molybdenum blue. The intensity of the developed blue color is then compared against a

series of predetermined standards using a colorimeter set at 660 nm to reveal the quantification of reducing sugars present in the sample.

2.4. Estimation of Amylose Content

Amylose was extracted from samples using diluted alkali. The extracted amylose reacted with triiodide ions to produce a blue color. The absorbance of the blue color produced was measured using a UV-spectrophotometer at 620 nm. The amylose content of various honey varieties was determined using a standard curve.

2.5. Determination of Vitamins

2.5.1. Estimation of Vitamin C

The level of vitamin C was determined using the modified di-nitro phenyl hydrazine method. To begin, 0.2 ml of honey was combined with 0.8 ml of 5% TCA using a vortex mixer. The mixture was then centrifuged at 3000 rpm for 10 minutes. After centrifugation, 0.6 ml of the supernatant was mixed with 0.25 ml of 2,4-dinitro phenyl hydrazine-thiourea-Copper sulfate solution. Following a one-hour incubation at 60 °C, the test tube was cooled, and 65% sulfuric acid was added. The absorbance was measured after a 30-minute incubation at 520 nm against the blank using a spectrophotometer.

2.5.2. Estimation of Vitamin A

The amount of Vitamin A was measured using the Carr-Price reaction. In this process, Vitamin A reacts with Trichloroacetic Acid (TCA) in chloroform (CHCl_3) to produce a blue solution. To begin, 2 ml of 95% ethanol and 4 ml of petroleum ether ($\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$) were added to each honey sample. The solutions were then shaken and the petroleum ether layers were separated. The solvent was evaporated, and the remaining substance was dissolved in CHCl_3 . After adding the TCA solution, readings were immediately taken at 620 nm against a blank.

2.6. Determination of Mineral Content

2.6.1. Inorganic Phosphorus

The quantification of inorganic phosphate was performed using the molybdenum blue phosphorus method. In this method, the formation of a phosphomolybdate complex was tracked through the reaction of molybdate with phosphate,

followed by the reduction of the complex in an aqueous sulfuric acid medium. The colored solutions were then allowed to incubate for 15 minutes, after which the optical density (OD) was measured at 660 nm following the Association of Official Analytical Chemists (AOAC) method from 1990. [14]

2.6.2. Iron

The amount of iron was determined using the thiocyanate method. In this method, iron ions (Fe^{3+}) reacted with thiocyanate ions (SCN^-) to form a blood-red colored complex known as ferric thiocyanate ($\text{Fe}(\text{SCN})^{2+}$). The intensity of the color was directly proportional to the concentration of iron ions in the solution. The absorbance at 480 nm was then measured, and the concentration of unknown solutions was determined.

2.6.3. Calcium

The calcium ion was determined using the method described by Vogel in 1978 [15]. In this method, the calcium present in the honey sample was precipitated as oxalate. Then it was dissolved in sulfuric acid, and the liberated oxalic acid was titrated using a standard permanganate solution. Therefore, from the titration result, the mole number of oxalic acid is equal to the mole of calcium, as one mole of oxalic acid reacts with one mole of calcium.

3. Statistical Analysis

All the experiments were performed in triplicate. Results were presented as the mean values \pm standard error of mean.

4. Results

4.1. Moisture, Ash, Protein, Fat, Carbohydrate, Dietary Fiber Contents of Eight Honey Varieties

The proximate composition, including moisture, ash, protein, fat, carbohydrate, and dietary fiber content, was measured in eight different varieties of honey. The moisture content ranged from 12.56 to 16.75%, ash content ranged from 0.62 to 1.80%, and dietary fiber content ranged from 0.11 to 0.28% (see table 1).

Table 1. Proximate composition of different honey varieties.

Variety No	Moisture (%)	Ash (%)	Protein (%)	Carbohydrate (%)	Dietary Fiber (%)	Energy (kcal)
1	14.18 \pm 0.02	0.86 \pm 0.21	0.60 \pm 0.12	73.78 \pm 0.05	0.15 \pm 0.01	297.52

Variety No	Moisture (%)	Ash (%)	Protein (%)	Carbohydrate (%)	Dietary Fiber (%)	Energy (kcal)
2	15.67±0.01	0.91±0.09	0.48±0.02	74.80±0.03	0.28±0.05	301.12
3	14.58±0.12	0.73±0.12	0.25±0.21	75.27±0.12	0.17±0.04	302.08
4	12.56±0.09	1.8±0.13	0.95±0.14	78.18±0.10	0.21±0.02	316.52
5	13.34±0.13	0.62±0.15	0.67±0.11	77.93±0.09	0.26±0.03	314.40
6	15.40±0.15	0.65±0.18	0.30±0.02	72.90±0.08	0.12±0.01	292.80
7	16.75±0.09	0.90±0.16	0.88±0.02	72.50±0.07	0.17±0.03	293.52
8	15.56±0.16	0.74±0.19	0.52±0.19	77.52±0.15	0.11±0.01	312.16

Here, data represent the mean value \pm standard error of mean.

The carbohydrate content varied between 72.50% and 78.18%, while the protein content ranged from 0.30% to 0.95%. Variety 4 had the highest levels of both carbohydrate and protein, whereas variety 7 had the lowest. Interestingly, no fat was found in any of the honey samples. The dietary fiber content ranged from 0.11% to 0.28%, with variety 2 having the highest and variety 8 having the lowest. In terms of energy content, variety 4 had the highest with 316 kcal, while variety 6 had the lowest with 292 kcal.

4.2. Composition of Reducing Sugar, Glucose, and Amylose Content of All Honey Varieties

The reducing sugar content in the honey samples ranges from 61.67% to 68.05%. Sample number 8 exhibited the lowest value, while sample number 4 demonstrated the highest value. Glucose content varied from 32.67% to 38.66%, and amylose content ranged from 0.43% to 0.72% (see [table 2](#)).

Table 2. Reducing sugar, glucose, amylose content of different varieties honey.

Variety No	Reducing Sugar (%)	Glucose (%)	Amylose (%)
1	65.88±0.01	36.30±0.02	0.67±0.02
2	61.67±0.01	34.53±0.04	0.56±0.05
3	66.20±0.02	32.76±0.05	0.59±0.01
4	68.05±0.01	32.67±0.08	0.43±0.06
5	63.17±0.03	36.98±0.03	0.67±0.03
6	60.90±0.01	35.78±0.08	0.72±0.02
7	64.55±0.02	38.66±0.07	0.69±0.07
8	63.06±0.01	37.79±0.02	0.64±0.02

Here, data represent the mean value \pm standard error of mean.

4.3. Mineral Content in Honey

The honey samples collected were tested for iron, calcium, and phosphorus. Among these, it was found that the samples contained relatively high amounts of calcium. The iron content ranged from 0.67 to 2.86 mg, while the phosphorus content ranged from 7.52 to 13.35 mg. The honey with the highest

amounts of calcium, iron, and phosphorus was Plum, Khalisha, and Sundarbans mix honey, respectively. The levels of ascorbic acid and retinol in the collected honey samples were also measured. No significant amount of retinol was found in the honey samples. In contrast, the amount of ascorbic acid ranged from 0.56 to 1.21 mg per 100 grams, with the highest content in variety 7 and the lowest in variety 1 (see [table 3](#)).

Table 3. Minerals and Ascorbic acid (vitamin C) contents in different varieties of honey.

Variety No	Calcium (mg/100g)	Iron (mg/100g)	Phosphorus (mg/100g)	Ascorbic acid (mg/100g)
1	18.42	1.53	9.49	0.56
2	15.83	1.65	11.23	0.85
3	21.25	0.76	8.67	1.17
4	16.96	2.86	8.33	0.69
5	18.95	2.21	13.35	1.02
6	12.68	0.67	10.15	0.92
7	17.24	1.58	7.52	1.21
8	15.52	2.45	8.26	0.75

Here, data represent only the mean value, as the standard errors of mean were very close to zero.

5. Discussion

Honey is a globally cultivated and distributed product with remarkable variations in nutritional content and exceptional physiological benefits. Its extraordinary antioxidant, anti-bacterial, and anti-inflammatory properties have been used for therapeutic applications. According to the USDA National Nutrient Database, 100 grams (3+1/2 ounces) of honey provides about 304 kilojoules (72 kilocalories) of energy. Honey contains 17.1 g of water, 82.4 g of carbohydrates, including 0.2 g of dietary fiber, 0.3 g of protein, and 0.0 g of fat. In a 100 g serving, honey contains the following minerals: iron (0.42 mg), magnesium (2 mg), phosphorus (4 mg), potassium (52 mg), sodium (4 mg), zinc (0.22 mg), copper (0.036 mg), and selenium (0.8 ug). Honey also contains small amounts of vitamins such as vitamin C (0.5 mg), Riboflavin (0.038 mg), Niacin (0.121 mg), and vitamin B6 (0.024 mg) [16]. Moreover, honey is a quick source of energy and is easily digestible due to its simple composition of sugars, predominantly glucose and fructose. Glucose gets absorbed rapidly into the bloodstream, providing a quick energy boost, while fructose is absorbed more slowly, offering a sustained release of energy. The enzymes in honey, such as invertase, amylase, and glucose oxidase, help to break down these sugars, making them even easier for the body to absorb. Honey has potential anti-diabetic effects, positively affecting glycemic control, insulin sensitivity, and pancreatic beta-cell function [17]. Consumption of honey may lead to lower postprandial blood glucose levels compared to other sweeteners, showing promise in managing blood sugar levels. Furthermore, honey has been found to improve insulin sensitivity, aiding cells in responding more effectively to insulin. This improved insulin sensitivity is particularly beneficial for individuals with diabetes or those at risk. Additionally, honey has been shown to have a protective effect on pancreatic beta cells, which are important for insulin production and overall regulation of blood sugar

[18].

The composition of honey varies depending on its geographical origin [19]. Therefore, our research aims to assess and compare the nutritional qualities of various honey varieties commonly found in Bangladesh. Understanding the nutritional values of different foods is crucial for making informed dietary choices, promoting health, preventing diseases, and meeting specific nutritional needs. It empowers individuals to plan balanced diets, manage weight, and ensure transparency in the food industry. For this study, we collected eight types of monofloral and polyfloral honey from Khulna and Satkhira regions near the Sundarbans. We meticulously measured and evaluated the carbohydrates, proteins, fats, vitamins, and minerals present in these honey varieties.

Our study's findings on honey nutrition show a range of carbohydrate content from 72.50% to 78.18%, protein from 0.30% to 0.95%, fat at 0%, dietary fiber from 0.11% to 0.28%, moisture between 12.56% and 16.75%, and energy ranging from 292 to 316 kcal/100g. Comparing these results with data from other regions reveals notable similarities and differences. In the African region, a study reported slightly higher moisture content (16-18%) and protein levels (1-1.15%), with carbohydrate and energy values closely aligning with our findings, though the energy content was slightly higher (326-337 kcal/100g) [20]. In contrast, an Asian study [21] observed a broader range of moisture content (20-37%) and lower carbohydrate levels (61-78%), with energy values overlapping with our results (245-316 kcal/100g). In north-eastern Africa, a study provided moisture content (15-17%) and protein (0.01-1%) comparable to ours but reported slightly lower carbohydrate levels (68-74%) and fat (0.12-0.27%) [22]. Overall, while moisture and carbohydrate content vary across studies, the energy content of honey is relatively consistent. The carbohydrate content in Italian honey (77.60% to 83.80%) is generally higher than our findings, while the moisture content (15.1% to 21.0%) is slightly broader but overlaps with the upper range of our results [23].

The carbohydrate range in Moroccan honey (67.06% to 79.85%) closely aligns with our findings, though the lower end is slightly below our observed range. The moisture content (14% to 19%) also aligns closely with our data, suggesting that Moroccan honey shares a similar composition with the honey samples in our study, particularly regarding carbohydrate and moisture levels [24]. Studies on Argentinian honey show a broader range of carbohydrate content (63.61% to 79.46%), with the lower end significantly below our findings. The moisture content (14.28% to 18.60%) is comparable to ours, though slightly higher in the upper range [25]. Chinese honey presents a carbohydrate content range of 72.67% to 81.99%, which is closely aligned with our study's findings. However, the moisture content (17.76% to 19.66%) in Chinese honey is higher than ours, which may affect the honey's texture and stability. The protein content (0.68% to 0.84%) in Chinese honey is also within our study's observed range, indicating a similar nutritional profile in terms of protein content [26].

This study concluded that honey varieties are not a significant source of Vitamin A. In our comparison of Vitamin C content in honey from various regions, we observed significant differences. Our experiment found Vitamin C levels ranging from 0.56 to 1.21 mg per 100 g, which is consistent with findings from Saudi Arabia, where levels ranged from 0.25 to 2.59 mg per 100 g [27]. However, Romania reported a much broader range of Vitamin C content, from 61 to 364 mg per 100 g, exceeding our limit [28]. Honey samples from Nigeria showed even higher Vitamin C concentrations, ranging from 2.41 to 2.68 mg per 100 g, indicating a more substantial Vitamin C presence compared to our findings [29]. The most striking difference was observed in honey from China, where the Vitamin C content was reported between 12500 mg and 14916 mg per 100 g, far surpassing the levels found in our study and other regions [30].

In our study, we found slightly elevated levels of calcium and phosphorus in different types of honey. The plum blossom honey had the highest calcium content, while the Sundarban mix honey contained notable levels of phosphorus. When comparing the mineral content of honey from our study with data from other regions, we noticed both differences and similarities. For example, our experiment found calcium levels ranging from 12.68 to 21.25 mg per 100 g, which is higher than the calcium content reported in Nigerian honey (4.21 to 6.04 mg per 100 g) [31] but falls within the range observed in Croatian honey (3.35 to 32.33 mg per 100 g) [32]. Chinese honey, on the other hand, displayed slightly higher calcium levels, ranging from 20.3 to 29.7 mg per 100 g, which overlap with and slightly exceed the upper range found in our samples [26]. In terms of iron content, our results showed a range of 0.76 to 2.45 mg per 100 g, which is higher than the levels reported in both Nigerian (0.54 to 1.09 mg per 100 g) [31] and Chinese honey (0.06 to 0.11 mg per 100 g) [26]. However, Croatian honey exhibited significantly higher iron concentrations, ranging from 5.0 to 22.7 mg per 100 g, far surpassing

the iron levels found in our study [32].

Honey has gained global acclaim for its extraordinary healing properties. Despite being low in protein, minerals, and vitamins, honey offers unmatched benefits for promoting good health and fortifying the immune system. While Bangladesh is home to a diverse range of honey varieties, there has been a notable lack of detailed nutritional analysis for these products. Therefore, it was imperative to delve into in-depth research to unlock the biochemical secrets behind honey's divine healing properties. Our study aimed to bridge this gap by providing essential insights into the nutritional composition of different Bangladeshi honey varieties. This analysis is crucial because it helps us understand the nutritional value of honey while informing consumers and helping producers ensure its quality and health benefits. As we continue to explore the nutritional profiles of various honey types, this study lays the groundwork for future research and advocates for the development of standards that can ensure the consistent quality and safety of honey in Bangladesh and beyond.

6. Conclusion

This study highlights the nutritional richness and therapeutic potential of Bangladeshi honey varieties, particularly Khalisha blossom honey, which exhibited the highest carbohydrate content and energy value. The findings emphasize honey's role as a quick energy source and its potential in managing blood sugar levels. By comparing regional and global data, the study underscores the unique characteristics of Bangladeshi honey and its value as a health-supportive food. These insights contribute to informed dietary choices and support the development of quality standards for honey products.

Abbreviations

TCA Trichloroacetic Acid
BSA Bovine Serum Albumin

Conflicts of Interest

The authors declare no conflicts of interest.

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