ANALYSIS OF THE CHEMICAL COMPOSITION OF HONEY BY CHROMATOGRAPHIC METHOD

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Abstract

This study analyzes the dry matter content and optical density of honey samples collected from Kashkadarya using refractometer methods. The results reveal significant differences among cotton, camel thorn, alfalfa, and mountain honeys, reflecting their floral and geographical origins. The study underscores the effectiveness of refractometer analysis for honey quality assessment and highlights the potential for classification and market promotion of regional honey varieties.

Keywords Honey, dry matter content, optical density, refractometer, Kashkadarya, botanical origin, quality assessment.

INTRODUCTION

Honey is a natural, sweet, viscous liquid produced by bees (Apis mellifera) from the nectar of flowers [1]. This product has played an important role in food and medicine since ancient times [2]. The complex composition and properties of honey are significantly influenced by its geographical and botanical origin, the nectar sources utilized by bees, as well as storage and processing conditions [3].

Honey comprises over 180 biologically active substances, including carbohydrates, proteins, vitamins, and minerals, forming a rich mixture [4]. These components determine its nutritional and therapeutic value. Additionally, the authenticity and quality of honey are crucial for ensuring safe delivery to consumers [5]. The chemical composition of honey can change during storage and processing, including processes such as fermentation, oxidation, and Maillard reaction [6].

The concentration of 5-hydroxymethylfurfural (5-HMF), a product of the Maillard reaction, particularly increases during heat treatment and long-term storage of honey [7]. Excessive amounts of this compound negatively affect honey’s quality, reducing its nutritional properties [8]. Modern chromatographic methods—such as gas chromatography, high-performance liquid chromatography, and mass spectrometry—are widely used to analyze the chemical composition of honey [9].

A literature review shows that the composition and quality of honey depend on flowers, geographical regions, and bee species, as well as on processing, packaging, and storage conditions [10]. The possibilities of using chemometric methods to identify the origin of honey are expanding [11]. These methods help evaluate the aromatic characteristics related to the botanical and geographical origin of honey [12].

Moreover, research on the concentration of volatile compounds in honey is essential to ensure its naturalness and protection against adulteration [13].

Studying the chemical properties of honey not only ensures its quality but also enhances its competitiveness in the international market [14]. This article presents the results of analyzing the composition of honey using chromatographic methods and develops quality criteria based on the obtained data [15]. Scientific approaches to preserving the purity of honey and preventing adulteration are discussed.

MATERIALS AND METHODS

Study Object

For the study, four samples of honey collected from different regions of Kashkadarya were used:

1. Cotton honey from Khujakhayron village, Kasbi district, Kashkadarya region.
2. Camel thorn honey from Uymovut village, Kukdala district, Kashkadarya region.
3. Alfalfa honey from Koratikan village, Guzar district, Kashkadarya region.
4. Mountain honey from Gilon village, Shahrisabz district, Kashkadarya region.

Honey is a natural and complex food produced by bees (Apis mellifera) from floral nectar or honeydew. It primarily consists of sugars (60-85%) [11], including fructose (32-44%) and glucose (28-38%), which dominate the carbohydrate composition. Fructose dissolves well in the honey matrix, remaining in solution for extended periods, contributing to the hygroscopicity of the product. Less soluble glucose is responsible for the crystallization observed in some honeys. Water is the second most important component of honey, with moisture content ranging from 13% to 25%, optimally around 18% [12].

Determination of Dry Matter Content Using a Refractometer

Standards: GOST ISO 2173–2013.

The refractive index of the test solution is measured at a temperature of (20.0 ± 0.5) °C using a refractometer. The mass fraction of soluble solids (in terms of sucrose) corresponding to the measured refractive index is determined from tables or directly read from the refractometer.

Reagents: Only reagents of specified analytical purity are used.

Water: The water used must be double-distilled or at least equivalent in purity.

Refractometer Types:

1. A refractometer with a scale graduated in refractive index units, with a division value of 0.001 and a reading accuracy of up to 0.0002. Such refractometers must be calibrated to a refractive index of 1.333 for distilled water at a temperature of (20.0 ± 0.5) °C.

2. A refractometer with a scale graduated in mass fraction of sucrose units, with a division value of 0.10%. Such refractometers must be calibrated so that the mass fraction of soluble solids (sucrose) is zero for distilled water at (20.0 ± 0.5) °C.

Sample Preparation: Laboratory samples must be representative and not damaged during transport or storage.

For Transparent Liquid Products: Laboratory samples are thoroughly mixed and used directly for determination.

Procedure:

During the determination process, the temperature of the refractometer prisms must be maintained within the range of 15°C to 25°C, with a stability of ±0.5°C, using a water circulation system.

Bring the temperature of the test solution to the measurement temperature. Place 2-3 drops of the solution on the fixed prism of the refractometer and immediately cover it with the movable prism. Illuminate the field of view appropriately. Using a sodium vapor lamp improves accuracy, especially for colored or dark food products.

Align the dividing line between the dark and light fields precisely with the crosshairs in the eyepiece and read the refractive index or the mass fraction of sucrose, depending on the refractometer used.

Results Processing:

If soluble solids determination is performed at a temperature different from (20.0 ± 0.5) °C, the following corrections are applied:

a) For scales in refractive index units, calculations are performed using the formula:

$$\eta D20 = \eta Dt + 0.0013(t - 20),$$

where:

- ηD20 = refractive index at 20°C;
- ηDt = refractive index at the measurement temperature;
- t = measurement temperature, °C.

b) For scales graduated in mass fraction of sucrose units, results are corrected according to Table 1 of Appendix A.

Table 1 provides adjustments for refractometer readings with sucrose-based scales at measurement temperatures differing from (20.0 ± 0.5) °C.

Harorat, °C	**Refraktometr shkalasida eriydigan quruq moddalarning massa ulushi, %**									
	5	10	15	20	25	30	40	50	60	70
	Asbobni o'qishdan ayirish									
15	0,29	0,31	0,33	0,34	0,34	0,35	0,37	0,38	0,39	0,40
16	0,24	0,25	0,26	0,27	0,28	0,28	0,30	0,30	0,31	0,32
17	0,18	0,19	0,20	0,21	0,21	0,21	0,22	0,23	0,23	0,24
18	0,13	0,13	0,14	0,14	0,14	0,14	0,15	0,15	0,16	0,16
19	0,06	0,06	0,07	0,07	0,07	0,07	0,08	0,08	0,08	0,08

	Asbobni o'qishga qo'shing									
21	0,07	0,07	0,07	0,07	0,08	0,08	0,08	0,08	0,08	0,08
22	0,13	0,14	0,14	0,15	0,08	0,15	0,15	0,16	0,16	0,16
23	0,20	0,21	0,22	0,22	0,23	0,23	0,23	0,24	0,24	0,24
24	0,27	0,28	0,29	0,30	0,30	0,31	0,31	0,31	0,32	0,32
25	0,35	0,36	0,37	0,38	0,38	0,39	0,40	0,40	0,40	0,40

ANALYSIS AND RESULTS

Four types of honey samples were analyzed using the digital refractometer method to determine the dry matter content at a temperature of 20°C. The analysis results are presented in Table 2.

Table 2: Analysis of Honey Samples

No.	Sample	Dry Matter (%)	Optical Density	Temperature (°C)	Correction
1	Cotton Honey	81.2	1.4945	20.0	1.4945
2	Camel Thorn Honey	80.1	1.4909	20.0	1.4909
3	Alfalfa Honey	80.2	1.4838	19.8	1.48354
4	Mountain Honey	83.0	1.4894	20.0	1.4894

The dry matter content and optical density of honey samples were measured to assess their quality and physical properties. Cotton honey showed the highest optical density (1.4945) and dry matter content (81.2%), indicating a highly concentrated honey type with no correction required at a stable temperature of 20.0°C. Camel thorn honey exhibited a slightly lower dry matter content (80.1%) with an optical density of 1.4909, remaining consistent with the expected range for this type of honey. Alfalfa honey demonstrated a dry matter content of 80.2% and an optical density of 1.4838 at a measured temperature of 19.8°C, with a corrected optical density of 1.48354 aligning it with standard values. Mountain honey recorded the highest dry matter content (83.0%) and an optical density of 1.4894 at 20.0°C, reflecting its unique composition. The variations in dry matter content and optical density reflect differences in floral sources, environmental conditions, and geographical origins. Cotton and mountain honey samples exhibited higher concentrations, likely due to differences in nectar sources and processing methods by bees. The consistent temperature of 20.0°C in most samples minimized errors, with only alfalfa honey requiring minor correction.

DISCUSSION

The analysis of the four honey samples provides valuable insights into their quality and physical properties. The results highlight the variability in dry matter content and optical density, which can be attributed to the botanical origin, geographical location, and environmental factors influencing nectar collection by bees.

1. Dry Matter Content Variations:
   - Mountain honey exhibited the highest dry matter content (83.0%), which may be a result of the specific floral sources and the altitude of the region, leading to nectar with higher sugar concentration. Such honey types are often preferred for their richer taste and thicker consistency.
   - Cotton honey, with 81.2% dry matter, showed comparably high quality, reflecting the uniformity of nectar sources in the cotton fields of the Kasbi district.
   - Camel thorn and alfalfa honey had slightly lower dry matter content (80.1% and 80.2%, respectively). These values are consistent with the characteristics of their respective floral sources, which are known to yield honey with moderate sugar content.
2. Optical Density Analysis:
   - The optical density readings correlate with the dry matter content, demonstrating the purity and concentration of the honey samples. Cotton honey had the highest optical density (1.4945), indicating its dense and concentrated nature.
   - Alfalfa honey's optical density (1.4838) was slightly lower, likely due to its slightly lower dry matter content and the need for a minor correction at a temperature of 19.8°C.
3. Temperature Consistency:
   - The uniform temperature of 20.0°C across most samples ensured accurate readings and minimized the need for corrections. Alfalfa honey was the only sample requiring a slight adjustment, reflecting the importance of maintaining consistent conditions during analysis.
4. Geographical and Floral Influence:
   - The observed variations among the honey types are closely linked to their geographical and floral origins. Cotton and mountain honeys, collected from areas with specific and abundant nectar sources, showed superior concentrations and optical properties.
   - The camel thorn honey, typical of arid regions, retained its characteristic moderate sugar content and purity, while alfalfa honey, a product of cultivated fields, exhibited balanced properties.

Significance of Findings: The results underscore the importance of analyzing honey’s dry matter content and optical density for quality assessment. These parameters are critical in determining the suitability of honey for various applications, including food production, medicinal use, and export.

The differences in composition provide an opportunity to classify and authenticate honey based on its botanical and geographical origin, enhancing its market value and consumer trust. Furthermore, the data highlight the effectiveness of using refractometer methods for reliable and precise measurements.

Future Implications: To further validate these findings, additional analyses on a larger number of samples from diverse regions and floral sources are recommended. Incorporating advanced analytical techniques, such as spectroscopic or chromatographic methods, could provide deeper insights into the chemical composition and functional properties of the honey.

Overall, this study demonstrates the distinct characteristics of honey samples from the Kashkadarya region, showcasing their quality and potential for wider recognition in domestic and international markets.

CONCLUSION

The study demonstrated that honey samples from different regions of Kashkadarya exhibit distinct characteristics in terms of dry matter content and optical density. Cotton and mountain honeys displayed superior quality and concentration levels, reflecting their unique botanical and geographical origins. The refractometer method proved effective for accurate and reliable assessment of honey quality, emphasizing the importance of temperature consistency during analysis. These findings can aid in the classification and authentication of honey, contributing to its market value and consumer confidence.

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