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THE RESEARCH OF OPTICAL CHARACTERISTICS OF THE HONEYCOMBS

Research article

Abstract

This article presents the results of the research of the optical characteristics of honeycombs. This research should be considered when using infrared drying. The research of the optical characteristics of honeycombs in all ranges of infrared radiation was carried out in a PerkinElmer Frontier FTIR spectrometer. The technique of the research and the general view of the installation during the research of the optical characteristics of honeycombs are described in the article. According to the results of the research, the spectral characteristics of honeycombs were constructed. The results of the experiment show that the honeycombs are a good absorber of IR energy, and the highest values of absorption by honeycombs of native humidity are observed at temperature ranges of 55 - 56 ºC, 51 - 52 ºC and 46 - 48 ºC.

Keywords: honeycomb, bee bread, infrared radiation, vacuum drying, optical characteristics.

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ИССЛЕДОВАНИЕ ОПТИЧЕСКИХ ХАРАКТЕРИСТИК ПЕРГОВЫХ СОТОВ

Научная статья

Аннотация

В данной статье представлены результаты исследования оптических характеристик перговых сотов. Данные исследования необходимо учитывать при использовании инфракрасной сушки. Исследование оптических характеристик перговых сотов во всех диапазонах инфракрасного излучения производили в ИК-Фурье спектрометре PerkinElmer Frontier. Методика проведения исследования и общий вид установки во время проведения исследования оптических характеристик перговых сотов описаны в статье. По результатам исследования были построены спектральные характеристики перговых сотов. Полученные результаты эксперимента показывают, что перговые соты являются хорошим поглотителем ИК энергии, а наибольшие значения поглощения перговыми сотами нативной влажности наблюдаются при диапазонах температур 55 – 56 ºC, 51 – 52 ºC и 46 – 48 ºC.

Ключевые слова: пчелиные соты, перга, ИК излучение, вакуумная сушка, оптические характеристики.

1. Introduction

The most important role of beekeeping is the pollination of crops with the aim of improving the quality of fruits and seeds and increasing their yield [1]. In addition, the main source of income of beekeeping farms is the sale of honey. To increase profitability it is necessary to develop technologies that allow obtaining additional bee products. One of these technologies is getting bee bread. Saturated with biologically active components, bee bread is a unique natural medicinal preparation used for the treatment and prevention of a number of diseases [2].

Currently, the most promising drying technology is vacuum infrared drying [5, 6]. The advantages of this method are the high intensity of the drying process by reducing the boiling point of water. However, the intensity of the heating material when using infrared drying depends only on the optical characteristics of the product [3].

At present, A. Wroblewska, Z. Warakomska, M. Kaminska, N. Hudz, O. Bobiş and other authors have been studying the optical characteristics of honeycombs to identify the chemical composition (amount of sugars, vitamins and other substances). As the main method for studying the optical characteristics of honeycombs, the authors selected spectrophotometric analysis of the contents of honeycomb dissolved in water [4].

However, these researches of the optical characteristics of honeycombs are not applicable for infrared drying, since they only consider the near range of infrared radiation.

2. Methods

However, these researches of the optical characteristics of honeycombs are not applicable for infrared drying, since they only consider the near range of infrared radiation

The research of the optical characteristics of honeycombs in all ranges of infrared radiation was carried out in a PerkinElmer Frontier FTIR spectrometer.

The main part of the FTIR spectrometer is a Michelson interferometer consisting of a source of IR radiation 1, a fixed 2 and a moving 3 mirrors, a beam splitter 4 and a photodetector 5. The signals received by the photodetector 5 pass through the amplifier 6, are processed by the analog-digital converter 7, and then sent to the computer 8 (Figure 1). The obtained data is converted by the method of fast Fourier transform and displayed on the screen.

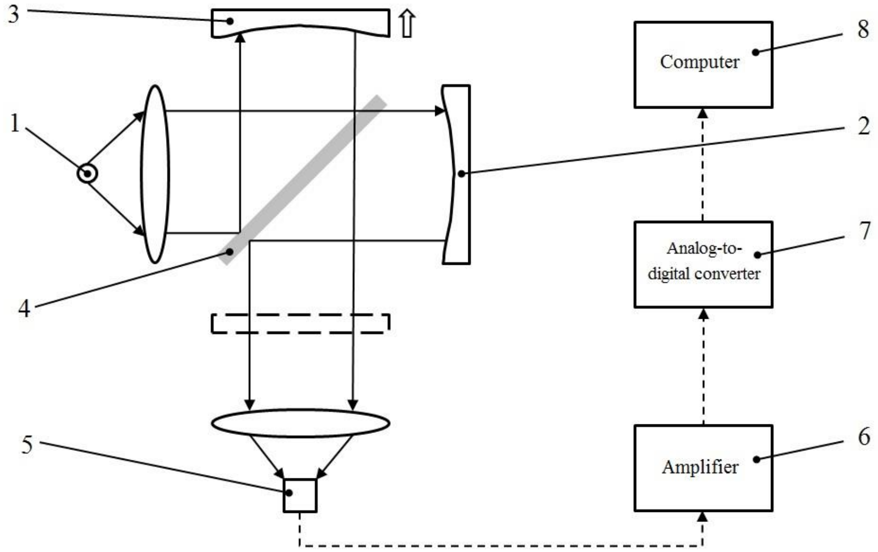

Figure 1 - Block diagram of the IR - Fourier spectrometer:
1 — IR source, 2 — fixed mirror, 3 — movable mirror, 4 — beam splitter, 5 — photodetector, 6 — amplifier, 7 — analog-to-digital converter, 8 — computer.

According to the results of processing the recorded frequencies, the computer generates a table with spectral reflection coefficients R.

Spectral reflection coefficients R can be converted to units $log(1/R)$. These units show the relative amount of infrared energy absorbed when measured in reflection mode. In this way they are equivalent to an optical density (absorption) A and calculated by the formula:

$$A \equiv log(1/R) = log(100/\%R). \quad (1)$$

Wavelength conversion λ_i corresponding to a maximum optical density at radiation temperature t produced by the Wien equation:

$$\lambda_i = \frac{b}{t+273}, \quad (2)$$

Where $b = 2.9 \cdot 10^{-3}$ м·K – Wien constant.

The calculation of the normal reflection coefficient at a standard temperature of 283K was produced by the spectral reflection coefficients $R_n\ (\lambda_i)$, measured at 30 wavelengths λ_i according to the formula:

$$R_n = \frac{1}{30}\sum_{i=1}^{30} R_n\ (\lambda_i). \quad (3)$$

Normal Emissivity (Normal Blackness) ε_n at 283 K was determined by the formula:

$$\varepsilon_n = 1 - R_n. \quad (4)$$

Since the maximum used wavelength of the PerkinElmer Frontier FTIR spectrometer is 40 μm, the measurement error is compensated by the introduction of a correction factor to calculate the emission coefficient.

To conduct the research were selected honeycombs from different regions of the Ryazan region. From honeycombs harvested two samples size of 50×50 mm, and then one of the samples was subjected to convective drying for 50 hours.

The prepared sample 1 was placed into the cuvette 2 of the IR - Fourier spectrometer 3, the instrument lid was closed and measurements were started.

A general view of the installation for determining the optical characteristics of the honeycombs is shown in Figure 2.

Figure 2 - General view of the installation for determining the optical characteristics of the honeycombs: 1 - sample; 2 - cuvette; 3 - IR - Fourier spectrometer.

At the end of the research, the samples were weighed and the humidity was determined in accordance with the method corresponding to the requirements of GOST 31776-2012, and the table formed by the computer with spectral reflection coefficients exported to MS Excel for further processing of the received data.

3. Results

The statistical data obtained during the processing of the data is shown in Table 1.

Table 1 - Optical Characteristics of honeycombs

Sample	Humidity, %				Normal reflection coefficient R_n				Normal Emissivity ε			
	repetitions			W_{cp}	repetitions			R_{ncp}	repetitions			ε_{cp}
	W_1	W_2	W_3		R_{n1}	R_{n2}	R_{n3}		ε_1	ε_2	ε_3	
1	23,7	22,1	23,5	23,1	0,0693	0,05	0,055	0,0581	0,875	0,893	0,888	0,885
2	13,1	14,6	13,5	13,7	0,0554	0,0618	0,0554	0,0575	0,888	0,882	0,888	0,886

According to the results of the research of the optical characteristics of honeycombs, the spectral characteristics presented in Figures 3 - 4 were constructed.

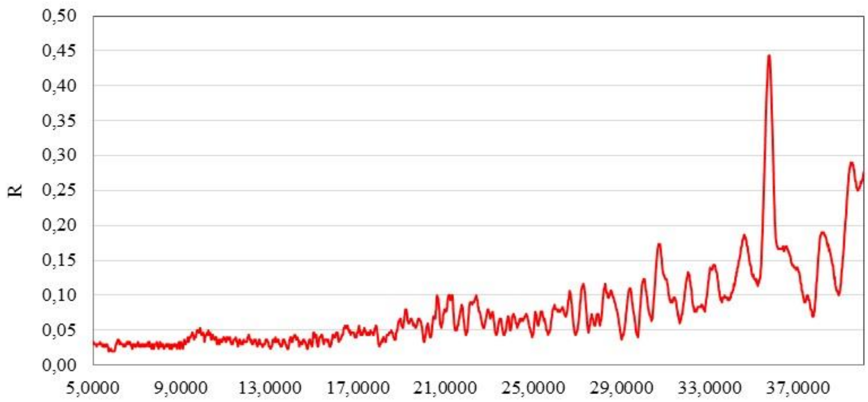

Figure 3 - Spectral characteristic of honeycombs of native humidity

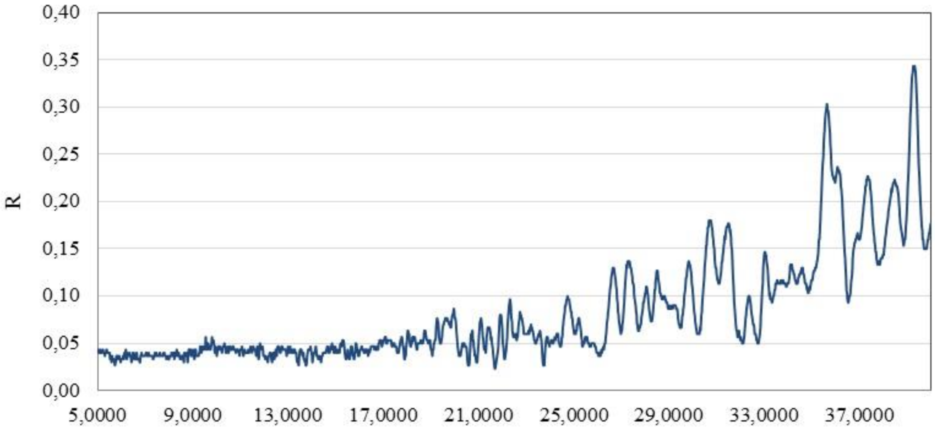

Figure 4 - The spectral characteristic of dried honeycombs

To research the changes in the optical characteristics of the honeycombs in the drying process, a comparison was made of the spectral characteristics in the temperature range from 25 °C to 65 °C (Figure 5).

Figure 5 - Comparison of the spectral characteristics of honeycombs

Based on the processing of the data obtained, it can be concluded that the degree of blackness of the honeycombs practically does not depend on humidity and origin, and its average value is 0.885–0.886. This means that honeycombs are a good absorber of infrared energy. In turn, the value of the normal reflection coefficient decreases slightly from 0.0581 to 0.0575.

From the spectral characteristics built into combs from 25 °C to 65 °C temperature range, it is seen that as the temperature increases the absorption value to 40 °C practically do not differ. However, with a further increase in temperature, the absorption of infrared radiation by honeycombs of native humidity increases by about 4.5%, and that of dried honeycombs - by 2.3%. The highest values of absorption by honeycombs of native humidity are observed at temperature ranges of 55 - 56 ºC, 51 - 52 ºC and 46 - 48 ºC.

Conflict of Interest

None declared.

Конфликт интересов

Не указан.

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