UDC 65.012.14:664 **doi: 10.20998/2079-0821.2025.01.08**

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RESEARCH OF SYSTEM WATER OF JELLY PRODUCTS FROM DIFFERENT MANUFACTURERS BY THERMODYNAMIC METHODS

The object of the study was jelly products from different manufacturers: TM "Biscuit-Chocolate"; TM "Stymul"; TM "Klim"; TM "Jelini"; TM "Haribo"; TM "Roshen". Studies of the hygroscopic properties of jelly products from different manufacturers by the tensometric method have established that when choosing packaging and formulating requirements for storage conditions, it should be taken into account that the studied jelly products from different manufacturers can be stored in vapor-permeable packaging without spoilage at a relative moisture of no more than 70...75 %. At the same time, storage in vapor-permeable packaging without drying out the product or without its excessive moistening is possible at the following moisture ranges: TM "Biscuit-Chocolate" – from 45 to 55 %; TM "Stymul" – from 45 to 55 %; TM "Klim" – from 35 to 45 %; TM "Jelini" – from 45 to 55 %; TM «Haribo» – from 45 to 55 %; TM «Roshen» – from 35 to 45 %. Storage of the studied jelly products at a relative moisture of more than 70…75 % or under the condition of strict preservation of its initial moisture content is possible only in vapor-tight packaging. Studies of the system water of jelly products from different manufacturers by the low-temperature calorimetric method have established that the largest amount of system water, which has the properties of bulk or, so-called, free water, is contained in samples of jelly products from TM «Roshen» and TM «Biscuit-Chocolate» (0.31 and 0.29 kg/kg, respectively), and the smallest – in samples from TM «Haribo» and TM «Klim» (0.13 and 0.15 kg/kg, respectively). Other samples occupy an intermediate value in terms of the amount of frozen system water: TM "Stymul" – 0.27 kg/kg; TM "Jelini" – 0.25 kg/kg. Based on the data obtained, it can be assumed that during the development of the technology for the production of jelly products, organoleptic properties were prioritized for TM "Roshen" and TM "Biscuit-Chocolate", and for TM "Klim" products – extended shelf life. As for jelly products from TM "Haribo", unlike other studied samples, which belong to jelly marmalade, it belongs to chewing marmalade, the requirements for which in terms of organoleptic properties and consistency differ from other samples.

Keywords: jelly products; system water; tensometric method; low-temperature calorimetric method

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ДОСЛІДЖЕННЯ СИСТЕМНОЇ ВОДИ ЖЕЛЕЙНОЇ ПРОДУКЦІЇ ВІД РІЗНИХ ВИРОБНИКІВ ТЕРМОДИНАМІЧНИМИ МЕТОДАМИ

Об’єктом дослідження були желейні вироби від різних виробників: ТМ «Бісквіт-Шоколад»; ТМ «Стимул»; ТМ «Klim»; ТМ «Jelini»; ТМ «Haribo»; ТМ «Roshen». Дослідженнями гігроскопічних властивостей желейних виробів від різних виробників тензометричним методом встановлено, що під час вибору упакування та формулювання вимог до умов зберігання слід враховувати, що зберігатися досліджувана желейна продукція від різних виробників у паропроникному упакуванні може без псування за відносної вологості повітря не більше 70…75 %. При цьому зберігання у паропроникному упакуванні без підсихання продукції або без надмірного її зволоження можливе за діапазонів вологості: ТМ «Бісквіт-Шоколад» – від 45 до 55 %; ТМ «Стимул» – від 45 до 55 %; ТМ «Klim» – від 35 до 45 %; ТМ «Jelini» – від 45 до 55 %; ТМ «Haribo» – від 45 до 55 %; ТМ «Roshen» – від 35 до 45 %. Зберігання досліджуваної желейної продукції за відносної вологості повітря більше 70…75 % або за умови необхідності суворого збереження її вихідного вологовмісту можливе лише у паронепроникному упакуванні. Дослідженнями системної води желейної продукції від різних виробників низькотемпературним калориметричним методом встановлено, що найбільшу кількість системної води, яка володіє властивостями об’ємної або, так званої, вільної води, утримують зразки желейної продукції від ТМ «Roshen» та ТМ «Бісквіт-Шоколад» (відповідно 0.31 та 0.29 кг/кг), а найменшу – зразки від ТМ «Haribo» та ТМ «Klim» (відповідно 0.13 та 0.15 кг/кг). Інші зразки займають проміжне значення щодо кількості виморожені системної води: ТМ «Стимул» – 0.27 кг/кг; ТМ «Jelini» – 0.25 кг/кг. Виходячи із отриманих даних, можна припустити, що під час розробки технології виробництва желейної продукції пріоритетними для ТМ «Roshen» та ТМ «Бісквіт-Шоколад» були у більшому ступені органолептичні властивості, а для продукції ТМ «Klim» – подовжені терміни зберігання. Щодо желейної продукції від ТМ «Haribo», то вона на відміну від інших досліджуваних зразків, які відносяться до желейного мармеладу, відноситься до жувального мармеладу, вимоги до якого за органолептичними властивостями за консистенцією відрізняються від інших зразків.

Keywords: желейна продукція; системна вода; тензометричний метод; низькотемпературний калориметричний метод

Introduction. The food industry includes about 50 branches of production that produce food products of various origins [1]. The confectionery industry occupies a significant place in the food industry, providing both the domestic market and exports of products to many countries of the world [2].

At present [3] the confectionery industry of Ukraine is 30 large specialized enterprises, as well as a mass of small workshops. Every year, Ukraine produces 750 thousand tons of confectionery products, a third of which is exported to over 100 countries of the world, including the USA, Canada, China, the EU and the countries of Central Asia and the MENA region [4]. It should be noted that current production volumes are about 80% of the pre-war ones. The beginning of active hostilities in Ukraine became the main factor in a significant reduction in the volume of confectionery production by almost all national manufacturers. Thus, one of the primary tasks facing manufacturers is to restore production to pre-war conditions [5].

Analysis of recent research and publications. The confectionery market in Ukraine is developing quite rapidly: production volumes are increasing [6]. At the same time, consumers need new types of confectionery. In order not to lose income, the industry must quickly respond to this by expanding the range without stopping the production of traditional products. Unlike 35% in, for example, 2018, currently 42% of consumers worldwide prefer online shopping. They encourage confectionery companies to expand their offer and improve the presentation of finished confectionery products.

For a long time, the trend of increased demand for confectionery from different countries of the world was popular [7]. It is important for consumers to try something unique or exclusive. However, the situation has changed recently. Currently, about 39% of people buy products from local confectioners or confectionery enterprises at least weekly, as well as products made from local ingredients.

Most people monitor their health and therefore prefer natural and organic sweets made from plant-based products. Due to this, the plant-based food segment is currently growing at the fastest pace. The basis for the development of the trend is the spread of veganism and vegetarianism among young people, the rejection of animal-based food in favor of plant-based food.

A healthy lifestyle, adherence to therapeutic diets and careful attention to the composition of the product is a new trend among consumers [8]. Positioning products as those that contain only natural ingredients (without artificial dyes and flavors, with real pieces of fruit, “GMO-free”) is a huge success among those consumers who want to be sure of the benefits of the product.

Another important trend today is conscious consumption, orientation towards ecological production and green marketing. These trends are already perceived as a necessity, not just a fashion trend. Accordingly, the main goals of confectionery manufacturers are to gain the loyalty of consumers and partners by caring about the environment and rational consumption of resources. This trend largely determines the concept of business development in the confectionery industry [9].

Among confectionery products, from the point of view of health benefits and environmental friendliness of production, one should single out such a group of goods as sugar products, namely jelly products. This type of confectionery is promising in view of the possibility of developing technologies that will contribute to the high biological value of this product [10].

The main characteristics that provide an objective assessment of the quality of jelly products are organoleptic, chemical and physicochemical indicators. It should be noted that information on physicochemical indicators, as well as their compliance with regulatory documentation in force in Ukraine, is usually not provided. At the same time, it should be noted the relevance of expanding the boundaries of the application of physical and mathematical methods for assessing product quality during its commodity examination, which are widely used in EU countries [11].

One of the main objective physical properties of jelly products, the information about which is not fully studied, is information about the state and structure of the system water contained in this product.

It is the state and structure of the system water, the forms of its connection with the dry substances of food products that determine the intensity of processes that change the initial properties of this product. Therefore, information about the system water makes it possible to predict irreversible changes in the product during its storage, and is also a starting point for the manufacturer's analysis of the recipe if it is necessary to rationalize it.

The aim of the article is to obtain new information about the state and structure of the system water of food products, as well as to expand the limits of application of physical methods for assessing the quality of such food products as jelly products during their commodity examination.

Description of the main research material. One of the defining functional and technological properties of jelly products is its ability to maintain its original quality indicators. The preservation of product quality indicators is largely determined by its hygroscopic properties [12].

Hygroscopic properties refer to the behavior of products in the surrounding gas environment with different relative moisture. That is, it is meant to establish whether the evaporation of the system water of the sample occurs (desorption), or whether the absorption (sorption) of water vapor from the surrounding gas environment occurs by the sample. The objective characteristics of this mass transfer process are sorption isotherms and desorption isotherms. Sorption and desorption isotherms are determined when the samples are in a humid gas environment with a relative moisture in the range from 0 to 100 %.

The object of the study is jelly products from different manufacturers, namely: TM "Biscuit-Chocolate"; TM "Stymul"; TM «Klim»; TM «Jelini»; TM «Haribo»; TM «Roshen».

The samples under study are colloidal bodies. It should be noted that the initial moisture of the samples is intermediate, that is, it is not the maximum possible (moisture at a relative moisture of 100 %) and is not the minimum possible (moisture at a relative moisture of 0 %), which is determined by consumer requirements for jelly products. Based on this, for jelly product samples both sorption and desorption will occur simultaneously. That is, obviously, for them, as the relative moisture of the gas medium tends to 0 %, desorption will occur, and as the relative moisture of the gas medium tends to 100 %, sorption will occur. Thus, the result of the study will be sorption-desorption isotherms.

The study of sorption-desorption and the study of the equilibrium moisture content of samples at different relative moisture of the environment were carried out using the tensometric method [13]. The samples under study were cubes measuring 5×5×5 mm, obtained from the corresponding jelly products, previously cleaned of sugar and the surface layer. The cubes in an amount corresponding to a sample weighing 4…5 g were placed in boxes and placed in desiccators. Desiccators with a fixed relative moisture of air in the range from 10 to 90 % were used. The temperature at which the desiccators were located during the study was maintained within 23…25 °C.

The samples under study were weighed periodically with an interval of 2 days. The samples were studied by the tensometric method until they reached a constant mass. For the samples under study from different manufacturers, the duration of achieving equilibrium moisture content at different relative moisture of the environment in which the samples were located was no more than 4 weeks.

Then, by drying the samples for at least 3 hours in a vacuum drying oven at a temperature of 120…130 °C under reduced pressure, the mass of dry substances of these samples was determined. Using the mass of dry substances of the samples, their current moisture content was determined according to the formula:

$$w = \frac{m_{w.}}{m_{s.s.}}, \tag{1}$$

where $m_{s.s.}$ – the mass of dry substances of the sample, kg; $m_{w.}$ – the mass of system water held by the sample and which is determined as the difference between the current value of the sample and the mass of dry substances that it holds, kg.

The sorption-desorption isotherms, which represent the values of the equilibrium moisture content of the samples at different relative moisture of the environment, are shown in Fig. 1.

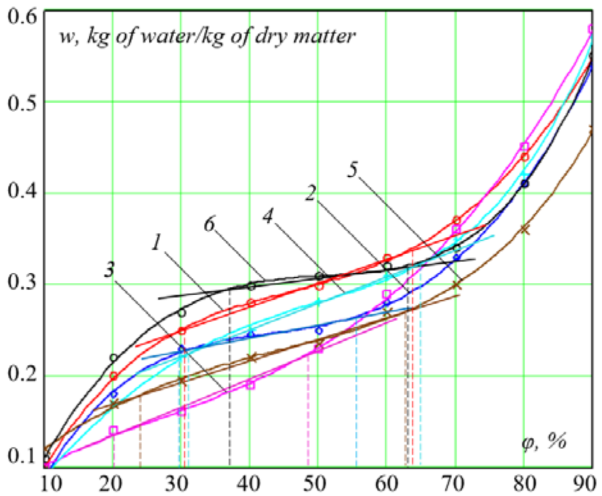

Fig. 1. Sorption-desorption isotherms of jelly product samples from different manufacturers: 1 – TM “Biscuit-Chocolate”; 2 – TM “Stymul”; 3 – TM “Klim”; 4 – TM “Jelini”; 5 – TM “Haribo”; 6 – TM “Roshen”

The sorption-desorption isotherms of the studied samples have a typical character for colloidal bodies, to which jelly products belong. There are areas of monomolecular and polymolecular sorption, as well as a section of the isotherm corresponding to the swelling of the samples.

However, these sections are manifested for different samples to different degrees. First, these sections have a different angle of inclination to the $O\varphi$ axis, on which the relative moisture of the gas environment in which the sample is located is plotted, and secondly, the range to which one or another section of the sorption-desorption isotherm should be attributed for different samples is different.

The division of the sorption-desorption isotherms into sections corresponding to different forms of connection of system water with dry substances of the studied sample was carried out by performing a linear approximation of the experimental data [14]. Fig. 1 shows a linear approximation only of the areas corresponding to the polymolecular sorption of system water by the dry matter of the sample, since the linear approximation of all areas makes the figure cumbersome. However, it should be noted that it is the central area of the sorption-desorption isotherm that makes it possible to determine the relative moisture of the surrounding gas environment, at which the transition between different forms of bonding of system water with dry matter of the sample under study occurs.

Table 1 shows the ranges of values of the relative moisture of the gas environment in which the samples are located, corresponding to their monomolecular and polymolecular sorption, as well as swelling of the samples.

Table 1 – Ranges of relative moisture corresponding to different forms of bonding of system water with dry matter of the samples

Sample	Monomolecular sorption, %	Polymolecular sorption, %	Swelling moisture, %
TM "Biscuit-Chocolate"	10…31	31…64	64…90
TM "Stymul"	10…30	30…56	56…90
TM "Klim"	10…20	20…48	48…90
TM "Jelini"	10…32	32…66	66…90
TM "Haribo"	10…24	24…63	63…90
TM "Roshen"	10…37	37…63	63…90

From Fig. 1 and Table 1 it is seen that the largest range corresponding to monomolecular sorption has the sample TM «Roshen» (10…37 %), and the smallest – TM «Klim» (10…20 %). The largest range corresponding to the swelling of the samples has the sample TM «Klim» (48…90 %), and the smallest – TM «Jelini» (66…90 %). Other samples occupy an intermediate value of the width of the ranges of monomolecular sorption and swelling moisture.

It is the ranges of monomolecular sorption and swelling of jelly products that determine the preservation of its original properties during long-term storage. Since during the stay of this product in the region of monomolecular sorption, its drying will occur, and during its stay in the region of swelling – excessive moistening. This entails a deterioration in the original organoleptic quality indicators.

To clarify the behavior of jelly product samples when they reach equilibrium moisture content at different moisture of the gas environment, the kinetics of sorption-desorption of these samples were studied [14]. The kinetics of sorption-desorption of jelly product samples from different manufacturers are presented in Fig. 2. They were obtained by the strain gauge method in the process of achieving equilibrium moisture content by the samples.

The discreteness with which the duration of measurements is given is a multiple of a week and is 4 weeks. Planes corresponding to the initial moisture content of the sample under study are given to each of the surfaces representing the kinetics of sorption-desorption. The initial moisture content is the moisture content recommended by the manufacturer, that is, the one at which the sample has a moisture content that meets the recommended organoleptic indicators.

Fig. 2 shows that there is a range of values of the relative moisture of the gas environment at which moisture absorption by the samples takes place. This value corresponds to the part of the surface located above the plane, which corresponds to the initial moisture content of the sample under study.

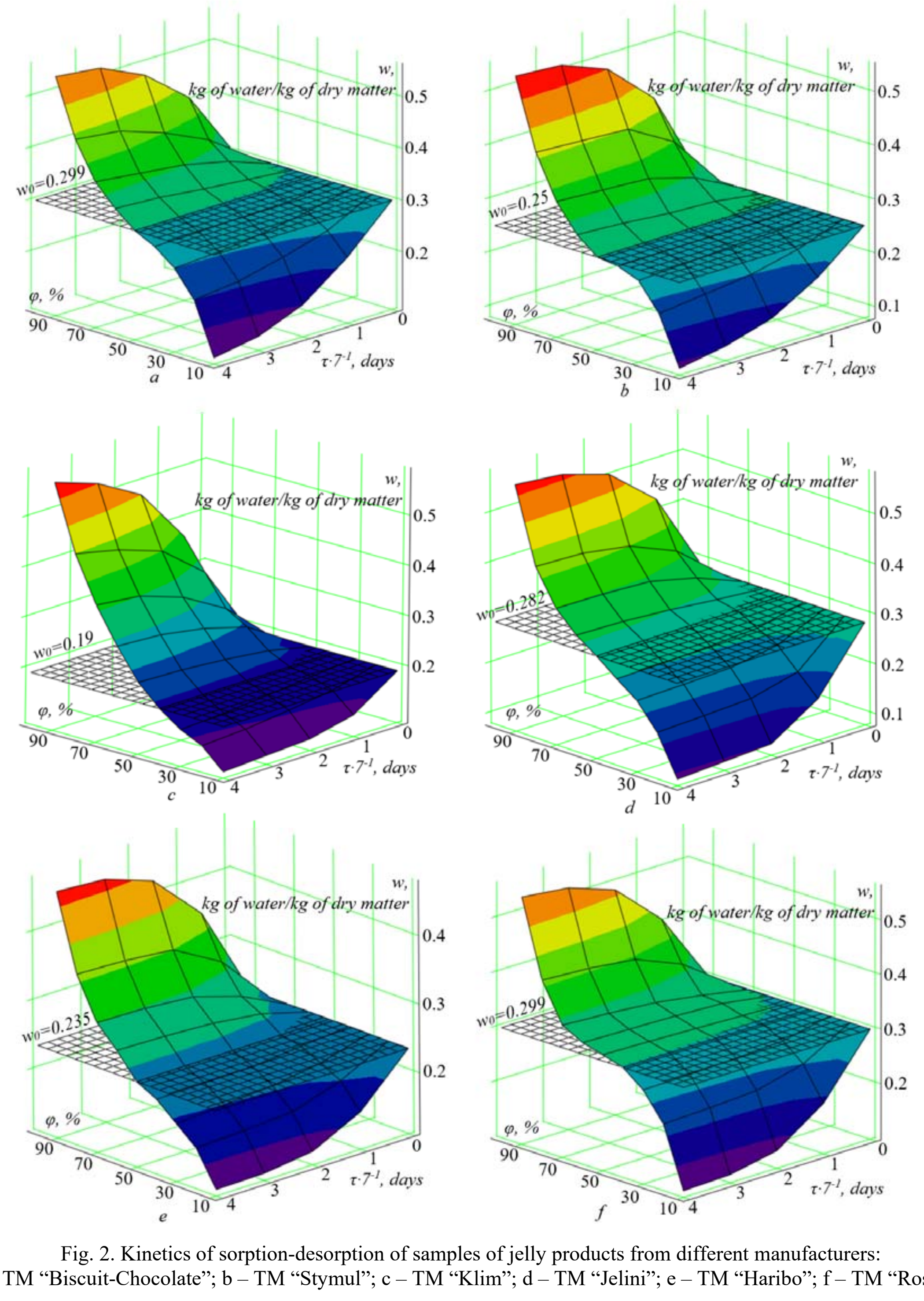

Fig. 2. Kinetics of sorption-desorption of samples of jelly products from different manufacturers:
a – TM "Biscuit-Chocolate"; b – TM "Stymul"; c – TM "Klim"; d – TM "Jelini"; e – TM "Haribo"; f – TM "Roshen"

In this case, there is also a range of values of the relative moisture of the gas environment, at which evaporation of system water from the sample takes place. This value corresponds to the part of the surface located below the plane, which corresponds to the initial moisture content of the sample under study.

Based on this nature of the behavior of the sorption-desorption kinetics, it follows that there is such a range of relative moisture of the gas environment, being in which, the sample will maintain the initial (recommended by the manufacturer) moisture content.

These ranges of relative moisture of the gas environment surrounding the studied samples are:

– TM “Biscuit-Chocolate” – from 45 to 55 %;
– TM “Stymul” – from 45 to 55 %;
– TM “Klim” – from 35 to 45 %;
– TM “Jelini” – from 45 to 55 %;
– TM “Haribo” – from 45 to 55 %;
– TM “Roshen” – from 35 to 45 %.

When storing jelly product samples from different manufacturers in vapor-permeable packaging at the relative moisture of the external gas environment from the corresponding ranges given, the moisture content of the products will be maintained at the level recommended by the manufacturer. Under other external storage conditions in vapor-permeable packaging, either the absorption of water vapor from the environment by the products or the drying of the products due to the evaporation of the system water that it holds will occur.

It should be noted that the sorption-desorption isotherms (Fig. 1) do not have pronounced asymptotes to the moisture content axis at relative moisture greater than the upper limit of the polymolecular sorption ranges given for the studied samples of jelly products from different manufacturers, presented in Table 1. That is, above these limits, only swelling of the samples occurs. At the same time, swelling can be considered significant for all samples starting from the relative moisture of the gas environment, which lies in the range of 70…75 %. This indicates the possibility of storing the studied samples of jelly products in vapor-permeable packaging without spoilage due to excessive system water at a relative moisture of no more than 70…75 %. Thus, when choosing packaging and formulating requirements for storage conditions, it should be taken into account that the studied jelly products from different manufacturers can be stored in vapor-permeable packaging without spoilage at a relative moisture of no more than 70…75 %. At the same time, storage in vapor-permeable packaging without drying out the product or without excessive humidification is possible in the following moisture ranges: TM "Biscuit-Chocolate" – from 45 to 55 %; TM "Stymul" – from 45 to 55 %; TM "Klim" – from 35 to 45 %; TM "Jelini" – from 45 to 55 %; TM "Haribo" – from 45 to 55 %; TM "Roshen" – from 35 to 45 %. Storage of the studied jelly products at a relative moisture of more than 70...7 5% or under the condition of strict preservation of its initial moisture content is possible only in vapor-permeable packaging.

Another thermodynamic method for studying the state and structure of system water is the low-temperature calorimetric method [5]. The method consists in indirectly determining the amount of heat released through the phase transition of type I (crystallization) or II (transition to an amorphous state) of system water during cooling of the test sample to a temperature maintained in the thermostat. The idea of the method is to register the difference between the initial and final temperatures of the coolant that washes the test sample, which is located in a special measuring chamber inside the thermostat [13]. Part of the system water that passes into a crystalline state at a temperature of 0 °C has the properties of so-called free or bulk water [15]. This water is a favorable environment for the flow of oxidative and microbiological processes. It should be noted that the presence of microbiological and oxidative processes is one of the main causes of spoilage of food products during long-term storage. Part of the system water, which passes into a crystalline or amorphous state at lower temperatures, is connected by one mechanism or another with the dry substances of the food product. The flow of microbiological and oxidative processes in this part of the system water is complicated by the presence of this connection. Given this, manufacturers of such products as jelly products, in terms of extending the shelf life, seek in various ways to reduce the part of the system water that has the properties of free water and increase the part of the water that is connected to the dry substances by one mechanism or another. However, it is not advisable to connect all the system moisture from the point of view of organoleptics, since this will lead to a discrepancy between the organoleptic properties and the requirements for jelly products. Thus, during the production of jelly products, as a rule, a rational ratio is determined, from the manufacturer's point of view, between the bound and free system water of the product, based on the priorities set.

The study of jelly products by the calorimetric method was carried out at a calorimeter temperature of minus 12 °C. Under these conditions, it is possible to determine two components of system water, namely, frozen and unfrozen water at a temperature of minus 12 °C.

The thermogram obtained during cooling of the studied samples has a typical form [15] and represents a change over time τ of the temperature difference ΔT between the inlet and outlet of the measuring chamber in relative units. Fig. 3 shows, as an example, a thermogram obtained for a sample of jelly products from TM "Biscuit-Chocolate".

The thermograms obtained during cooling of the studied samples in a thermostat to a temperature of minus 12 °C can be divided into three main sections. The first section (I) corresponds to the cooling of the sample to the crystallization temperature of part of the system water, which passes into a solid or solid amorphous state at a temperature of 0 °C and which has the properties of free water. The second section (II) corresponds to the crystallization of this part of the system water. In this case, the sample temperature remains constant and is equal to 0 °C, the temperature difference ΔT is different from zero and is also constant. The third section (III) is the cooling of the sample to the equilibrium temperature of the thermostat. The area under each of the sections corresponds to the amount of heat released during the corresponding heat exchange process: sections I and III – cooling; section II – phase transition of the first kind (crystallization).

The division of the thermogram into sections is carried out as follows. At the first stage, the experimental data is approximated. For the experimental data, the approximating function $\Delta T(\tau)$ is selected. Next, it is assumed that since during the cooling of any body, the temperature changes according to an exponential law (sections I and III), and during the phase transition of water of the first kind (section II) the temperature is constant, then during the transition between sections the approximating function will have inflections. These inflection points (the boundary between I and II and between sections II and III) are found by determining the position of the extrema of the first derivative of the approximating function.

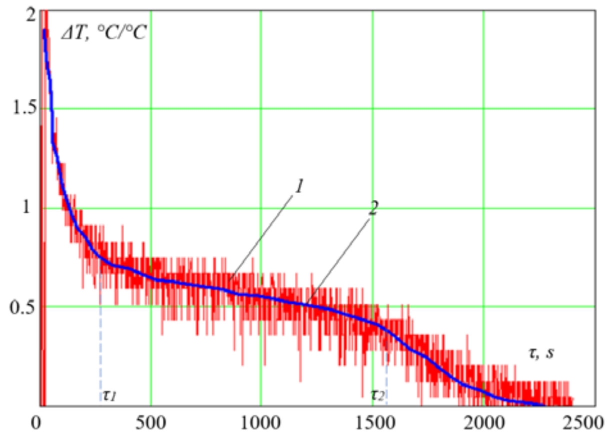

Fig. 3. Thermogram obtained using the low-temperature calorimetric method for a sample of jelly products from TM "Biscuit-Chocolate": 1 – experimental data; 2 – approximation function

It should be noted that the area under the second section S_{fr} multiplied by the corresponding scale factor $coef_{fr}$ is proportional to the amount of system water w_{fr}, which passes into a crystalline or solid amorphous state at a thermostat temperature of minus 12 °C:

$$w_{fr} = coef_{fr} \cdot S_{fr}. \quad (2)$$

The area under the corresponding section of the thermogram is found as an integral of the approximation function within the limits determined by the positions of the extrema of the first derivative of it:

$$S_{fr} = \int_{\tau_1}^{\tau_2} \Delta T(\tau) d\tau. \quad (3)$$

The value of the scale factor $coef_{fr}$ was determined when cooling the reference sample under the same conditions. A container made of a material with high thermal conductivity filled with drinking water was used as the reference.

In this case, the total amount of system water $w_{s.w.}$ is normalized and is the sum of two parts – frozen w_{fr} and unfrozen w_{nfr} water at a given thermostat temperature (minus 12 °C):

$$w_{s.w.} = w_{fr} + w_{nfr} = 1. \quad (4)$$

The results obtained in this way are given in Table 2.

Table 2 – Part of frozen and unfrozen system water at a temperature of minus 12 °C in jelly products

Sample	w_{fr}, kg/kg	w_{nfr}, kg/kg
TM "Biscuit-Chocolate"	0.29	0.71
TM "Stymul"	0.27	0.73
TM "Klim"	0.15	0.85
TM "Jelini"	0.25	0.75
TM "Haribo"	0.13	0.87
TM "Roshen"	0.31	0.69

From the results presented, it follows that the largest amount of system water, which has the properties of bulk or, so-called, free water, is contained in samples of jelly products from TM «Roshen» and TM «Biscuit-Chocolate» (0.31 and 0.29 kg/kg, respectively), and the smallest – in samples from TM «Haribo» and TM «Klim» (0.13 and 0.15 kg/kg, respectively). Other samples occupy an intermediate value in terms of the amount of frozen system water. Based on the data obtained, it can be assumed that during the development of the technology for the production of jelly products, organoleptic properties were of greater priority for TM «Roshen» and TM «Biscuit-Chocolate», and for TM «Klim» products – extended shelf life. As for jelly products from TM "Haribo", unlike other studied samples, which belong to jelly marmalade, it belongs to chewing marmalade, the requirements for which in terms of organoleptic properties and consistency differ from other samples.

The results obtained by thermodynamic (tensometric and low-temperature calorimetric) methods should obviously be considered objective indicators of the quality of jelly products, which have both advantages and disadvantages. The main advantage is their high accuracy compared to express methods, which are most often used during commodity expertise, since these physical and mathematical methods are used in scientific research in the food industry. The main disadvantage of such studies is their specified duration: for the tensometric method – 3...4 weeks; for the low-temperature calorimetric method – 1...2 hours.

Based on the objectivity of the obtained quality indicators of the studied jelly products, they can be used during commodity expertise of these products both in Ukraine and in the EU countries. It should be noted that this allows expanding the possibilities of exporting jelly products to the EU countries, which is important for Ukraine's activities under martial law.

The prospect of research is the further expansion of the range of products that can be examined by tensometric and low-temperature calorimetric methods.

Conclusions. Studies of the hygroscopic properties of jelly products from different manufacturers by the tensometric method have established that when choosing packaging and formulating requirements for storage conditions, it should be taken into account that the studied jelly products from different manufacturers can be stored in vapor-permeable packaging without spoilage at a relative moisture of no more than 70…75 %. At the same time, storage in vapor-permeable packaging without drying out the product or without its excessive moistening is possible at the following moisture ranges: TM "Biscuit-Chocolate" – from 45 to 55 %; TM "Stymul" – from 45 to 55 %; TM "Klim" – from 35 to 45 %; TM "Jelini" – from 45 to 55 %; TM "Haribo" – from 45 to 55 %; TM "Roshen" – from 35 to 45 %. Storage of the studied jelly products at a relative moisture of more than 70…75 % or under the condition of strict preservation of its initial moisture content is possible only in vapor-tight packaging.

Studies of the system water of jelly products from different manufacturers by the low-temperature calorimetric method have established that the largest amount of system water, which has the properties of bulk or, so-called, free water, is contained in samples of jelly products from TM «Roshen» and TM «Biscuit-Chocolate» (0.31 and 0.29 kg/kg, respectively), and the smallest – in samples from TM «Haribo» and TM «Klim» (0.13 and 0.15 kg/kg, respectively). Other samples occupy an intermediate value in terms of the amount of frozen system water: TM «Stymul» – 0.27 kg/kg; TM «Jelini» – 0.25 kg/kg. Based on the data obtained, it can be assumed that during the development of the technology for the production of jelly products, organoleptic properties were prioritized for TM «Roshen» and TM «Biscuit-Chocolate», and for TM «Klim» products, extended shelf life was a priority. As for jelly products from TM «Haribo», unlike other studied samples, which belong to jelly marmalade, it belongs to chewing marmalade, the requirements for which in terms of organoleptic properties and consistency differ from other samples. It is noted that the results obtained are objective indicators of the quality of jelly products, which can be used during the trademark examination of this product.

The research was conducted within the framework of the Erasmus+ program directed by Jean Monet under the project "European concept of dynamic regulation and coordination of examination of goods in customs affairs" / "European concept of dynamic regulation and coordination of examination of goods in customs affairs" (EDETMS) / Project No.: 101127747-ERASMUS-JMO-2023-HEI-TCH-RSCH funded by the European Union.

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