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METHOD OF OPERATIONAL QUALITY CONTROL OF MEAT RAW MATERIALS AND MEAT PRODUCTS

МЕТОД ОПЕРАТИВНОГО КОНТРОЛЮ ЯКОСТІ М'ЯСНОЇ СИРОВИНИ І МЯСНИХ ПРОДУКТІВ

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Abstract. *Taking into account the prevalence of methods and means of measuring electrical quantities in metrological practice, it is advisable to carry out their analysis regarding the possibility of application for operational identification of types of meat. The advantage of organoleptic methods is their availability and simplicity, and the disadvantage is their lack of reliability. Therefore, they cannot be the only criteria for identification, and to increase the reliability of control, as a rule, physicochemical methods are used. Physico-chemical indicators characterize the physical and chemical properties of goods and are determined by laboratory methods. Therefore, the use of physico-chemical methods for the identification of meat types is difficult due to their complexity and the duration of measurements. For operational control of meat quality, it is necessary to identify the most characteristic features of a specific type of meat for the consumer and classify them, for example, using pattern recognition theory and modern software tools. Pattern recognition has wide application and is used in the creation of all computer systems that rely on intelligent functions, that is, functions related to decision-making instead of a person: medical diagnostics, forensic examination, information retrieval and intelligent data analysis, etc. Therefore, the application of pattern recognition theory to assess the quality of meat products is a reasonable and promising way to ensure quality.*

Key words: *physical and chemical methods, control, quality, meat, taste, aroma, colorimetric method of analysis*

Today, only organoleptic and physico-chemical indicators, which characterize the actual consumer properties of the product itself, are suitable for the purposes of operational identification of meat [8].

Microbiological indicators belong to food safety indicators that depend on the influence of external factors and therefore are not used for operational identification.

Organoleptic indicators are the main indicators that characterize the consumer properties of goods to the greatest extent and are determined with the help of human senses. General organoleptic indicators include: appearance, taste and smell (bouquet, aroma), consistency. In addition to general organoleptic indicators, some products are characterized by specific characteristics: internal structure and transparency (vodka, wine, beer), the ratio of solid and liquid fractions (compotes, preserves).

The advantage of organoleptic methods is their availability and simplicity, and the disadvantage is their lack of reliability. Therefore, they cannot be the only criteria for identification, and to increase the reliability of control, as a rule, physicochemical

methods are used.

Physico-chemical indicators characterize the physical and chemical properties of goods and are determined by laboratory methods [8; 9]. Therefore, the use of physico-chemical methods for the identification of meat types is difficult due to their complexity and the duration of measurements.

Based on the above analysis of traditional methods of measuring meat quality indicators, it can be argued that they, as a rule, do not meet the requirement for their widespread use by ordinary consumers.

Therefore, those that use optical and electrical methods of measuring meat properties can be considered promising ways of developing methods for operational identification of meat.

Optical methods of analysis are based on the interaction of the investigated substance with electromagnetic radiation of the optical range. Depending on the nature of such interaction, optical methods can be distinguished, listed in the table. 1.

Table 1 - Optical methods of analysis

Methods of analysis		Characteristic
The absorption method of analysis is based on the ability of substances to absorb electromagnetic radiation	colorimetric method of analysis	is based on a visual comparison of the color or color intensity of the standard and test solution
	photoelectrocolorimetric method of analysis	is based on the measurement of light absorption in the visible part of the spectrum by substances (ions) using devices (photoelectrocolorimeters) with a simplified method of monochromatization
	spectrophotometric method of analysis	is based on measuring the absorption of monochromatic light by substances (ions) in the ultraviolet (UV), visible or infrared (IR) parts of the spectrum
	atomic absorption method of analysis	is based on measuring the absorption of monochromatic light by atoms of substances in a gaseous state
Nephelometric method of analysis		is based on the measurement of the intensity of scattered light (measurement of the reflected light flux); is used for heterogeneous systems
Turbodimetric method of analysis		is based on the measurement of the turbidity of the system, which is caused by the scattering of light by suspended substances (measurement in the passing light stream); used for analysis of suspensions, emulsions, cloudy solutions
Refractometric method of analysis		is based on the measurement of the index of refraction of light by the solution
Luminescent method of analysis		is based on the measurement of radiation that appears as a result of the release of excess energy by excited atoms of the analyzed substance
Emission spectral method of analysis		is based on the study of light emitted by gaseous atoms of matter

Optical methods of analysis require the use of modern technical devices of various complexity, which gives a number of advantages in comparison with classical

chemical methods: efficiency, inviolability of samples, simplicity of the methodology, use of a small amount of substance for analysis, the ability to analyze compounds of any nature, carrying out express analysis of multicomponent mixtures . In addition, they simplify the possibilities of increasing the sensitivity, accuracy and reproducibility of the results of measurements of quantitative values.

Taking into account the prevalence of methods and means of measuring electrical quantities in metrological practice, it is advisable to carry out their analysis regarding the possibility of application for operational identification of types of meat.

Due to the heterogeneity of measuring objects of control, the methods of measuring electrical quantities are divided into conductometric, impedance, dielectric, frequency-dispersive, shown in table. 2.

Table 2 - Electrical methods of analysis

Methods of analysis	Characteristic
Conductometric method	is based on measuring the electrical conductivity of control objects. Used to control single indicators of the quality of substances in the liquid state or gaseous medium
Impedance method	involves presenting the object as a complete resistance, the components of which contain information about certain physical and chemical properties. As an informative parameter, the impedance component is used, the value of which varies widely, which creates measurement problems, especially if the humidity values are low (high-impedance measurements)
Dielcometric method	the object of research is a capacitor, the capacity of which is determined by the dielectric permeability of its inter-electrode space or a change in geometric dimensions
Frequency dispersion method	is rapidly developing in both theoretical and practical implementations, recently it is based on the analysis of the amplitude-frequency or phase-frequency characteristics obtained as a result of the measurement of the research object placed in an alternating current circuit

These methods are based on one common feature of a substance, material or product, which is the internal structure through which an electric current can pass at certain levels of the applied test signal [9]. So, the generalized parameter of electrically conductive research objects can be considered complex resistance (impedance) or complex conductivity (admittance), i.e. immittance.

The methods listed above for measuring single quality indicators are partial variants of the implementation of the traditional method of measuring complex passive values (immittance) [10].

Today, many different technical means are offered for identification of food products or assessment of their quality level. These are both stationary and expensive devices designed for laboratory use, as well as portable and cheap devices aimed at the mass consumer in various conditions of use. Since such tools are mainly intended for the control of objects of an electrical nature, their main difference, in the case of use for the control of non-electric quantities, is the processing of an electrical informative parameter containing information about their physico-chemical and other properties. The result of the measurements is mainly the detection of the quantitative content of this or that component in the product for the purpose of comparison with

the maximum permissible norms of such a product or standardized values for this or that level of its quality [7].

For operational control of meat quality, it is necessary to identify the most characteristic features of a specific type of meat for the consumer and classify them, for example, using pattern recognition theory and modern software tools.

Pattern recognition is a branch of the theory of artificial intelligence that studies methods of classifying objects. By tradition, the object subject to classification is called an image [3]. An image can be a digital photograph (image recognition), a letter or number (symbol recognition), a speech recording (speech recognition), etc. [5]. The use of pattern recognition methods in the proposed optical methods of quality control of meat products will increase the reliability and efficiency of control, which will contribute to the spread of these methods in the practice of individual quality assessment.

Within the framework of the theory of artificial intelligence, pattern recognition is included in a broader scientific discipline - the theory of machine learning, the purpose of which is the development of methods for building algorithms capable of learning.

There are two approaches to learning: inductive and deductive. Inductive learning, or learning by precedents, is based on identifying general properties of objects based on incomplete information obtained empirically [4, 8]. Deductive learning involves the formalization of experts' knowledge in the form of knowledge bases (expert systems, etc.).

It should be noted that, like every mathematical discipline, pattern recognition has its own mathematical apparatus, which includes mathematical statistics, optimization methods, discrete mathematics, algebra and geometry.

Image recognition is widely used and is used in the creation of all computer systems that rely on intelligent functions, that is, functions related to decision-making instead of a person: medical diagnostics, forensic examination, information search and intelligent data analysis, etc. [2, 5]. Therefore, the application of pattern recognition theory to assess the quality of meat products is a reasonable and promising way to ensure quality.

An image is a classification grouping in the classification system that unites (selects) a certain group of objects by some feature. Images have a characteristic property, which is manifested in the fact that familiarization with a finite number of phenomena from the same set makes it possible to learn any large number of its representatives.Images have characteristic objective properties in the sense that different people, trained on different observational material, mostly classify the same objects in the same way and independently of each other. In the classical formulation of the recognition task, the universal set is divided into parts-images. Each reflection of an object on the perceptive organs of the recognizing system, regardless of its position in relation to these organs, is usually called an image of the object, and many such images, united by some common properties, are images [6].

When applying optical methods of assessing the quality of meat products, images can be individual structural elements of a given type of meat product, which are characteristic only of this type of meat product. Also, images can be color gamuts

of a specific type of meat products, which will allow the wide use of modern information and communication devices (smartphones), which have become widespread among the population, to identify meat.

It is obvious that recognition of individual product elements must be carried out according to a standardized method. This method of assigning an element to some image is called a decisive rule. Another important concept is the metric, a method of determining the distance between the elements of a universal set. The metric will characterize the probability of an error in recognizing the elements of the evaluated type of product. The smaller this distance, the more similar the objects (symbols, sounds, etc.) are that we recognize. Usually, the elements are given as a set of numbers, and the metric is given as a function. The effectiveness of the program depends on the choice of representation of images and the implementation of metrics, one recognition algorithm with different metrics will be wrong with different frequency.

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Анотація. *Враховуючи поширеність методів та засобів вимірювань електричних величин в метрологічній практиці, доцільно здійснити їх аналіз стосовно можливості застосування для оперативної ідентифікації видів м'яса. Перевагою органолептичних методів є їх доступність, простота, а недоліком їх недостатня достовірність. Тому вони не можуть бути єдиними критеріями ідентифікації і для підвищення достовірності контролю, як правило, використовують фізико-хімічні методи. Фізико-хімічні показники характеризують фізичні і хімічні властивості товарів і визначаються лабораторними методами. Тому застосування фізико-хімічних методів для ідентифікації видів м'яса є затруднене внаслідок їх складності та тривалості проведення вимірювань. Для оперативного контролю якості м'яса, потрібно виділити найбільш характерні ознаки конкретного виду м'яса для споживача та класифікувати їх, наприклад, із використанням теорії розпізнавання образів та сучасних програмних засобів. Розпізнавання образів має широке застосування і використовується при створенні усіх комп'ютерних систем, на які покладаються інтелектуальні функції, тобто функції, пов'язані із прийняттям рішень замість людини: медична діагностика, криміналістична експертиза, пошук інформації та інтелектуальний аналіз даних тощо. Тому застосування теорії розпізнавання образів для оцінювання якості м'ясної продукції є обґрунтованим та перспективним шляхом забезпечення якості.*

Ключові слова: *фізико-хімічні методи, контроль, якість, м'ясо, смак, аромат, колориметричний метод аналізу*