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APPARATUS FOR THE MEASURMENT OF MEAT AND MEAT PRODUCT WATER ACTIVITY (a_w)

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РЕЗЮМЕ

Для мяса и мясопродуктов водяная активност (a_w) имеет значение, подобное значению pH. Предлагается комбинированный электропсихрометр для измерения водяной активности мяса и мясопродуктов. Аппарат является подходящим для серийных определений и для научно-исследовательской работы. Описан принцип работы прибора.

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L'activité d'eau a presque la même importance pour la viande et les produits carnés que la valeur du pH. On propose l'usage d'un psychromètre électrique pour mesurer l'activité d'eau de la viande et des produits carnés. L'appareil est convenable aux déterminations courantes et au travail de recherche scientifique. On décrit le principe de fonctionnement de l'appareil.

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For meat and meat products, water activity (a_w) has a significance similar to that of pH. A combined electropsychrometer is proposed, for the measurment of meat and meat products water activity. The apparatus is suitable for serial determinations and for research. The principle of operation of the apparatus is described.

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Die Wasseraktivität (a_w) hat für Fleisch und Fleischprodukte eine gleichartige Bedeutung wie der pH-Wert. Es wird ein kombiniertes Elektropsychrometer zur Messung der Wasseraktivität von Fleisch und Fleischprodukten vorgeschlagen. Das Gerät ist für laufende Serienbestimmungen, sowie auch zur Forschungsarbeit, geeignet. Es wird das Arbeitsprinzip des Gerätes beschrieben.

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The water activity $a_w = \frac{P}{P_o}$ is a concept introduced for the first time by Scott during 1953 (1). It is defined as a relation between the steam pressure of wter steam (P) in the system of the steam pressure of clean water (P_o) at the same temperature (2). The water activity of a given food product could be measured and expressed in a_w values from 0 to 1. The distilled water has a a_w activity of 1, while a product totally dried - 0. It could be said, that for a given food product, the water activity shows the part of the present water, which is not bound with the dissolved salts, sugars, proteins and others, i.e., that part of the water, which is at the disposition of the microorganisms.

The water activity is of a special importance for the meat industry. It has a basic impact on the development of the microflora, as different microorganisms have their own optimum of development with different a_w activity (3). Moving away from it, their development is supressed and with a determined maximal or minimal a_w value their development stops. The water activity has also an impact upon the resistance of the microorganisms toward different influences, such as thermal treatment and different irradiations (4,5). The thermostability for different values of a_w changes, generally in the beginning with the decrease of a_w it increa-

ses and later falls down. Meat products can be grouped according to the value of a_w, as easely spoiled - a_w between 0,989 - 0,967; semi-dry 0,955 - 0,934 and dry 0,908 - 0,842. The traditional technological processes as salting; drying, refrigerating influence on the water activity of meat products. Increase in the storage life could be achieved by adding of permitted additieves (4). As a_w acts on the microbiological, enzymatic, chemical and physical reactions in meat and meat products, and from there to the ripening (6) storage life (7)and spoilage, it is essential that the a_w value could be measured exactly.

There are in existence many direct and indirect methods for the measurment of the a_w value. From the indirect methods for the meat products, the method of Landrock and Proctor (8) give satisfactory results, but is very long and involves too much work. Durotherm hygrometer of the "Luft works" (9) is adapted for serial measurments in the practice. Known are also more precise instruments on the bases of the conductometric hygrometer and stabilized Lithium chlorid - the instrument of SINA (10). With the condensation hygrometer M880 of Waltham, the a_w value of meat and meat products could be measured precisely without any need of constant temperature (11). With similar measurments of a_w values in soil or vegetable samples, as a established and precise method is accepted already the thermoelectric psychrometry (12), which is applied normaly with high values of relative humidity (13).

The scope of the present work is the construction of an instrument for automatic, mean, and precise evaluatuion of the water activity a_w in samples of meat products in a belanced measuring chamber, by measuring the relative humidity of the air closed above the sample in a range between 65 and 100%, after the establishment of the related balance of the temperature and the steam pressures.

Following the basic scheme of the device (fig. 2) the instrument consists of a balanced chamber with a measuring head (CEP) contacting command time relay (h)with a feeding

block (u) and recording milivoltmeter (mV). The balanced chamber (fig. 3) serves to place the sample to be measured, for attaining a balance of temperatures and the steam pressures in the system "sample-air" and for accepting and reforming of the signal for the relative humidity of the closed above the sample air. The chamber is made of heat transmittent duraluminium alloy metal. It consists of a cylinder and measuring head. The cylinder (13) is polished on the inside and closed at the bottom. The measuring head (2) closes the cylinder from above and carries the sensitive elements. For measuring the relative humidity of the system, is accepted a battery of thermocouples (fig. 2) consisting of two groups of thermocouples, placed on two concentric circumferences. The "dry" thermosolders (C) are isolated by lacquered paper pipe and are placed in a semitroidal channel, chiseled out in the base of the head, pressed by the threaded over cover of the head from the outside circumference. Their temperature is equal to that of the metal mass of the chamber (t_M) which is kept donstant by placing the balanced chamber in a laboratory thermostat. In the passage to the inside of the head, the thermocouples are additionally covered with a compound mass for improving the diffusion of the joule losses and the thermal inductance of the conductors which tend to balance the temperatures between the "dry" and "wet" solders. The inside ends of the thermocuples are solded in sequence-opposite, forming the "wet" solder 5 to 10 cm under the cover, placed cymetrical to the surrounding surface. Thus, after being moistened, receive a temperature (t_B). The wet solders are fitted for moistening two ways - by preliminary placing in distilled water or by periodically putting on the cooling current of Peltier. The ensured possibility for combined use of the psychrometric battery arbitrary with condensation or "drop" moistening, is resoluted by the construction of the thermocouples. Two construction variants are possible with two measuring heads,each prepared for one of the two types of moistening, or only one head fitted for condensation moistening, or only one head fitted for condensation moistening which could be used also for

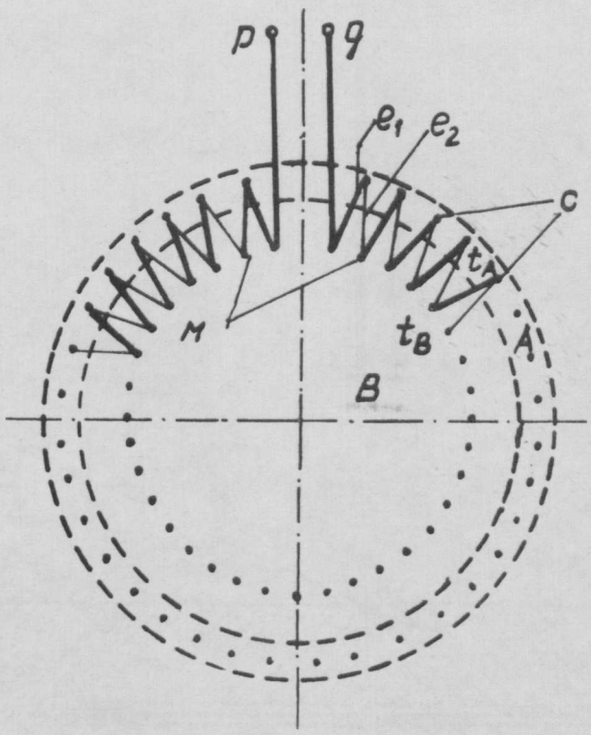

Fig.1

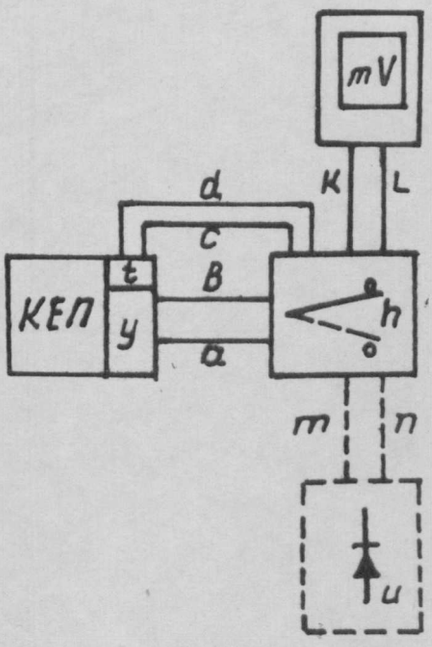

Fig.2

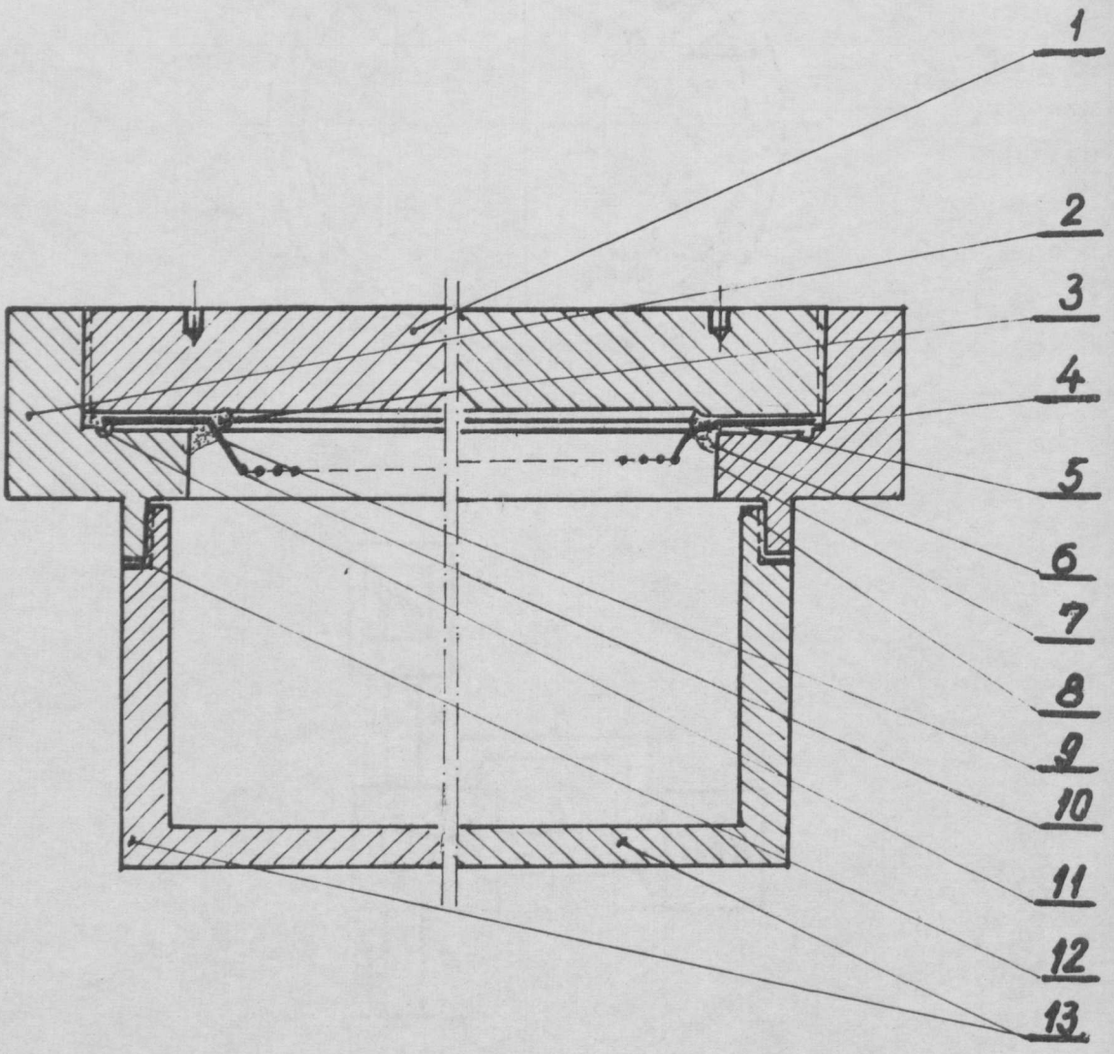

Fig.3

"drop" moistening. In the construction of the condensation head, each thermocuple (e) connecting one "dry" with the following "wet" solder represent a combination of two elements with equal material and different measures. The element which is soldered in the "dry" solder has a bigger diameter and length, consequently with better possibilities for heat exchange and lowered electrical resistance and joule losses. A big part of this element is placed in the corresponding channel of the head. The remaining part gets out through the passage from the compound mass into the inner air layer above the cylinder. The second element is shorter - having a length of 2 mm and a diameter several times smaller than that of the first one, for lowering heat conductance. It is soldered to the first in the air layer and at its end terminates with the "wet" solder, which in turn puts it in contact with a similar type of conductor from the other thermocouple, and so on. Thus the thin elements of both electrodes close between them a charp angle, smaller than 45°, thus forming a micropad for the retention of the moistening drop of water for a longer time. The described construction of the thermoelectric battery permits the use of both ways for moistening of the "wet" solders. Independent of the thermocouple psychrometric battery, as an additional sensitive organ is introduced through the center of the head surface in the air payer of the chamber, the sensitive end of a differential thermocouple, designed for temperature control, or more specifically for establishing of the diagram of the recorder, the moment of ending of the transient temperature process in the balance chamber and the setting of a stationary regime. The contacting command time relay with the feed block serves for the automatic sequence contacting of the recording milivoltmeter, on determined intervals of time for the two signals obtained from the thermocouples of the psychrometric battery and the differential thermocouple. During the interval, when the signal from the differential thermocouple is being registered, the circuit of the psychrometric battery with drop moistening of the air stays open, while with the condensational moistening it is

contacted to the feeding block and closes the current path of the cooling current, set in advance by intensity and time duration so, that an optimal effect of cooling and condensation could be achieved. The relay is connected with a source of constant current with normal stabilization. The recording milivoltmeter serves to register the obtained direct signals for the psychrometric difference and temperature, following each other during the set intervals. The two recordings reflect the path of the process in the balanced chamber. For each of the measuring heads has been made calibration curves for the a_w with the accepted measuring temperatures. The calibration curves are obtained by filling the balance chamber with standart saturated solutions of salts, which create a determined steam pressure above their surface after the balance (14) obtaining in this way diagrams in the same manner as the measurments. This procedure eliminates the influence of the microquantity of water, introduced by drop moistening of the wet solders. By this method were obtained calibration curves for several limit values of a_w with "drop" head; for a_w = 0,730, 0,805, 0,920, 0,969, and 1,000, and for condensation head for a_w = 0,969 and 1,000 with several repetitions. After that, samples of dry speck sausage, loukanka and ham were evaluated.

The system described, envolving two sensitive groups, uniformly distributed in the bulk of the head and in the air layer above the measured sample, guarantees one common mean signal, true for determination of a mean value of the water activity of the sample. The accepted principle of thermoelement psychrometer with "dry" solder kept under normal temperature, on the other side, permits maximal precision of the measuring. At the same time, a system of psychrometers bonded together in a battery, ensures simultaneously repeated generation and summation of the signals, thus obtaining a resulting multiplied mean signal without any need for special feeding of the measurment system, or amplifying the output signal. In reading the results from the trial calibrations and measurements, the following conclusions could be derived:

When a "drop" head is used for measuring of a_w of speck sausage, loukanka and ham, are obtained repeatable diagrams, clearly defined linear part, competent for measurments if the a_w to an accuracy of 0,001. This result is obtained for not more than 1-2 hrs. This in turn permits, accepting a mean duration for the measuring of 2,5 hrs, to make three determinations in a shift. The results in this stage from constructed condensational head, involving 100 pairs of termocouples of copper-constantan are not well convincing, because of the obtained too small fluctuations. Following the basic resolution in the instrument, the dondensation head should be made of the same thermoelectrodes - chromel kopel as this combination exibits optimal data. With this materiat however, we could not avail ourselves and a test construction was accepted for the condensation head using copper constantan. In the construction of the envisaged condensation head from chromel-kopel with diameter of the conductors for the wet solders in the region of 0,05 mm and with use of a recording potenziometer envolving 1 mV, the constructed a_w-meter could secure a result accuracy of 0,0001.

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