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TWELFTH MEETING OF EUROPEAN MEAT RESEARCH WORKERS

SANDEFJORD, NORWAY, AUGUST 14 - 19, 1966.

COMPARISON AND APPLICATION OF VARIOUS METHODS FOR DETERMINATION OF COOKING RATE OF MEAT PRODUCTS

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COMPARISON AND APPLICATION OF VARIOUS METHODS FOR DETERMINATION OF COOKING RATE OF MEAT PRODUCTS

In order to obtain proper quality of meat products and particularly of canned hams, it is of the utmost importance to achieve the certain rate of thermal treatment. Canned ham is a product which requires thermal treatment considerably less rigorous than other canned meat products in order to avoid organoleptic degradation. In some countries, however, regulations specify certain temperatures in the center of the product itself in order to prevent intake of particular zoonoses by food. Considering all that, canned ham producers must endeavour to secure favourable quality and shelf-life by using sufficiently low temperatures of thermal treatment in order to satisfy consumers, and on the other hand, by applying sufficiently rigorous pasteurization to meet the justifiable requirements of the regulations.

There are several methods used for cooking rate determination, such as: Corretti's test, flocculation test, and Körmendy's method for phosphatase determination. The

application of any of the methods is difficult due to influence of various factors, many of which are still unknown. Having all that in mind, we decided to compare the listed methods, which we modified to some extent, and to investigate factors which, to our opinion, could affect accuracy and the applicability of various tests mentioned above.

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Throughout a year we carried out our investigations in a large number of Yugoslav meat packing plants where we permanently evoluated the cooking rate of canned hams having chate on temperatures in their center.

Our investigations were divided in two parts: a) temperature changes in the center of the product during pasteurization; pH measurements of hams; percentage of cooked-out jelly; percentage of N_2 and NaCl in extracts used for determination of cooking rate; and b) evaluation of the cooking rate according to the methods listed above.

Experimental

A. 1. Temperature checking in the center of the product during pasteurization - for this purpose Ellab thermocouple was used.

2. pH Measurement of ham in extract (1:1o) - PYE pH-meter.

3. Determination of cooked-out jelly - cans were opened a week after pasteurization and the meat and jelly were weighed. The ratio was given in percentages.

4. N_2 percentage in extract intended for determination of cooking rate - Micro-Kjeldahl method.

5. Determination of NaCl in the extract - this test was made by titration according to Mohr.

6. Ham thermal treatment - We recorded temperatures in the center of products in all tested canned hams.

Canned ham pasteurization was adjusted in such a way that maximum temperatures in the center of products ranged from 6o to 74.5°C and times for hams heating time interval over 65°C ranged from o ~~was~~ to 12o minutes.

B. Determination of Cooking Rate

1. Corretti's test: 5 grams meat sample taken from the center of the ham was homogenized with 25 milliliters of distilled water and then after two or three minutes filtered. The filtrate was divided, into two parts: one was used as a control and the other was heated in a glass tube in a water bath (67°C) until it reached the temperature of 65°C, this temperature being maintained for two minute. The reaction was determined after cooling. Detection of floccules in the extract would have to show that 65°C were not reached in the product center during pasteurization.

2. Flocculation test

a) Solution 1: loo grams sample of ground ham was homogenized with 2oo ml of o.9% NaCl solution; b) Solution 2: loo grams sample of ground ham was homogenized with 2oo milliliters of 3% NaCl solution. After an hour the solution was decanted and then filtered through a filter cell. The

filtrate was poured into two glass tubes, one of which was used as a control and the other was dipped into a water bath which temperature was being rised slowly. As soon as flocculation of the filtrate was observed heating of the water bath was stopped and the temperature checked by thermometer immersed in the heated filtrate read off. The temperature should represent the maximum temperature reached in product center by thermal treatment.

3. Objective flocculation test - Extracts prepared as described above were poured into cuvettes (volume 3o ml, and breadth 3o mm) of Lange's universal colorimeter. The heating unit was fixed at the bottom of the cuvette, the thermocouple being immersed into the extract to the depth of 5 mm below the surface of the liquid. The cuvette holder, which opening was towards the photocell and equipped with a green filter (VG 9), was positioned into the instrument cell and the colorimeter adjusted to the zero point. When the heater was switched on, extract temperature and absorption rate were recorded each minute.

4. Determination of phosphatase was made by Körmendy's test (4).

Results with brief duscussion

A. 1. pH.- Determinations were done for samples deriving from variously pasteurized hams (74°, 76°, 78° and 8o°C). Results of cooking rate tests were compared with pH determinations but-here was not found any correlation. Flocculation appeared at temperatures 48°C to 95°C while pH varied from 6 to 6.7.

2. N_2 percentage in extract intended for cooking rate determination - Assumping that the results of the cooking rate test are dependent upon the quantity of extracted proteins, we determined the total N_2 content. Results varied from o.28% to 1.4%. The extracts with a low N_2 content exhibited flocculation in equal numbers of casses both at lower and at higher temperatures. The same was with extracts having high N_2 quantity.

3. Cooked-out jelly in tested hams - Thermal treatment, i.e. time and temperature, among other factors, influence the quantity of cooked-out jelly. Therefore, it was fully justified to expect that there is a correlation between the quantity of separated jelly and the flocculation temperature in determining the cooking rate. But during these investigations it was not possible to prove this assumption.

4. NaCl content in extract used for the determination of the cooking rate - In extracts in which the NaCl percentage was from o.9 to 1,o, flocculation occurred at temperatures between 48 and 7o°C. When the NaCl percentage varied from 1.o to 2.o, flocculation occurred between 69 and 73°C, and when the NaCl percentage was between 2.o and 2.o8, flocculation occurred between 7o and 75°C. These results refer to hams in which the maximum temperature in center of product during pasteurization ranged from 7o° to 73°C. This ratio could not be established in hams

subjected to less rigorous thermal treatment.

B. Cooking rate determination.

1. Coretti's test: Our results are in agreement with those obtained by Došlić (2). A positive reaction, i.e. flocculation, was observed only in those products where the maximum temperature reached in the center was lower than 64°C.

2. Körmendy's test: By using the test described by Körmendy and knowing the temperatures in the center of products, we attempted to plot center temperature-extinction diagram. Since the extinction value is not always proportional to reached temperature, the application of this modification is not possible. In Table 3, several characteristic examples obtained during our investigations are presented.

Table 3

No	Temperature product in center °C	Extinction
1	6o	1
2	66.5	o.54
3	68	o.63
4	71	1.29
5	71	1.25
6	72	1.3
7	72.5	1.22
8	72.5	1.8
9	73	1.1
1o	74.5	1.8

3. Flocculation test - In Figure 1 presented objective floculation test was obtained by measuring the absorption in extract samples of sufficiently cooked hams wich maximum center temperature was 72.5°C. *

The diagram for samples of hams which maximum center temperature was 61°C is presented in Figure 2.

Fig. 1.

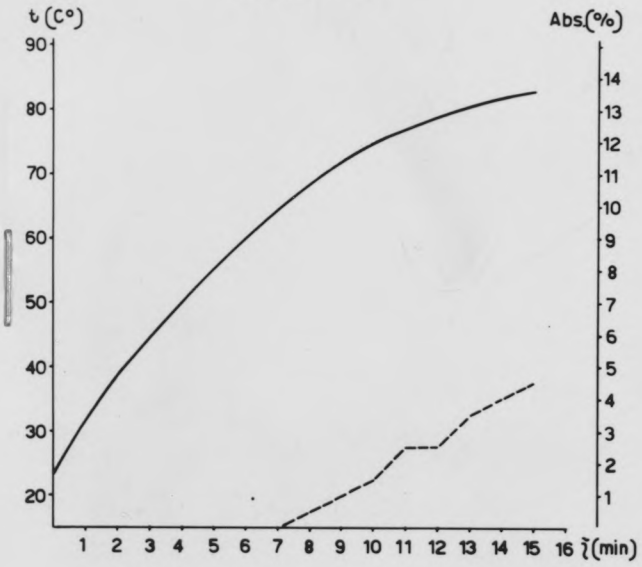
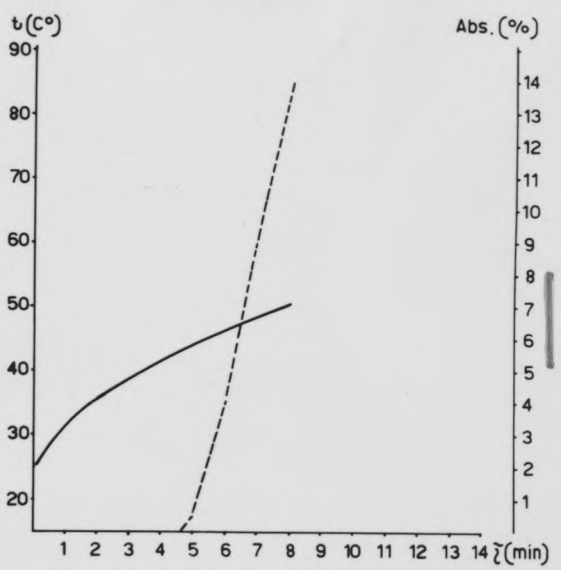


Fig. 2.



As Figures 1 and 2 show, it is characteristic that in a well cooked meat product the difference between the flocculation temperature and the actually obtained temperature in the center is considerably lower. It was observed that the rate of flocculation (higher percent of absorption) is considerably higher in extracts obtained from insufficiently cooked products.

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* The full curve indicates the extract temperature changes, while the dotted line indicates the percentage of the light absorption. This applies to all figures.

Assuming that solutions of different ionic strenghts would influence protein extraction, we made the flocculation test in two concentrations of solutions NaCl i.e. o,9% (I = o,15) and 3% (I = o,41).

Fig. 3.

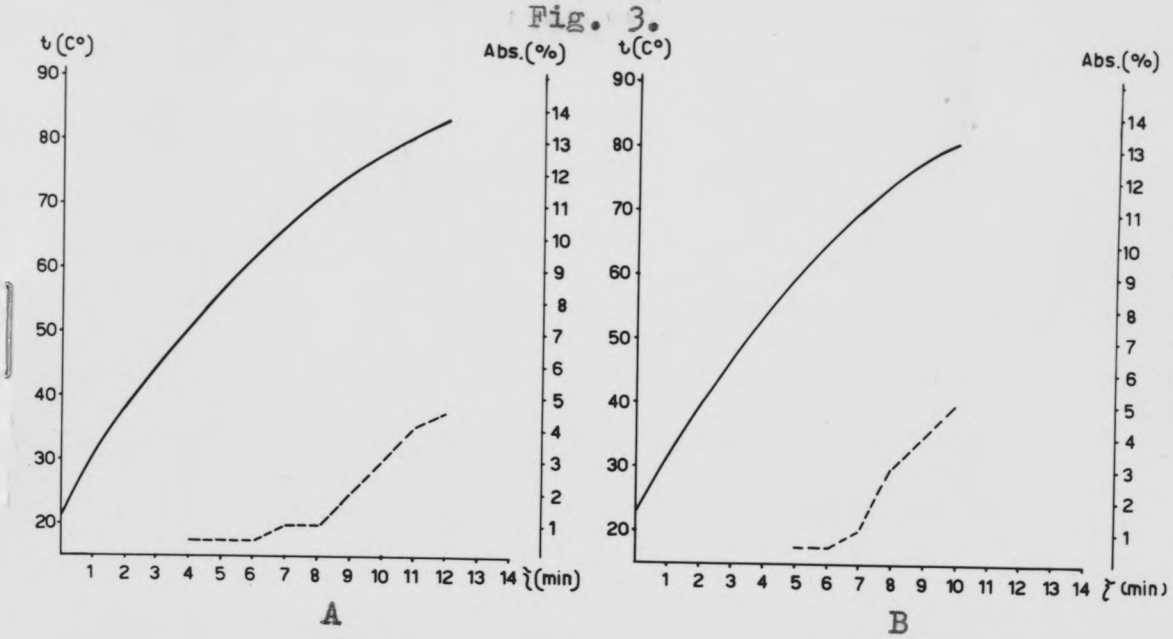
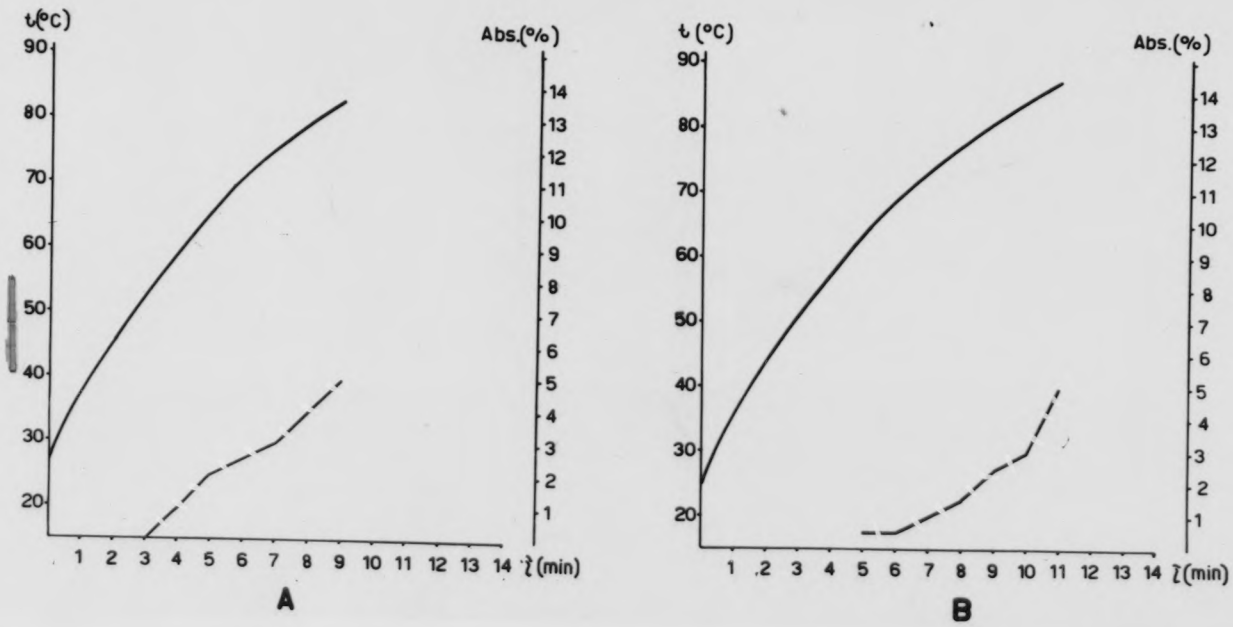


Fig. 4.



Temperatures and absorption rates presented in Figures 3 and 4 were recorded during heating of extract, obtained by means of solutions of different ionic strengths.

From these Figures it is evident that the 3 percent solution (A) in one case produces flocculation at lower temperature, and in another at higher temperature than extracts in the o.9% solution (B).

The ionic strength of the NaCl solution influence the rate of proteins flocculation but not regularly. In fact, in a 3% NaCl solution, the extracted proteins coagulate both at lower and at higher temperatures than those achieved in the center of the product. We observed that the flocculation temperature of proteins obtained by extraction in a o.9% NaCl solution is nearer to the temperature obtained during pasteurization than the flocculation temperature of proteins extracted in a 3% NaCl solution.

Errors in determining flocculation moment are usually considered subjective (varying heating rate individual differences among persons who carry out the cooking rate test). An objective analysis eliminated all these sources of errors: we always used a heater of the same power, and the temperature and flocculation were recorded by instruments. The comparison of results obtained by original flocculation test is given in Fig. 5.

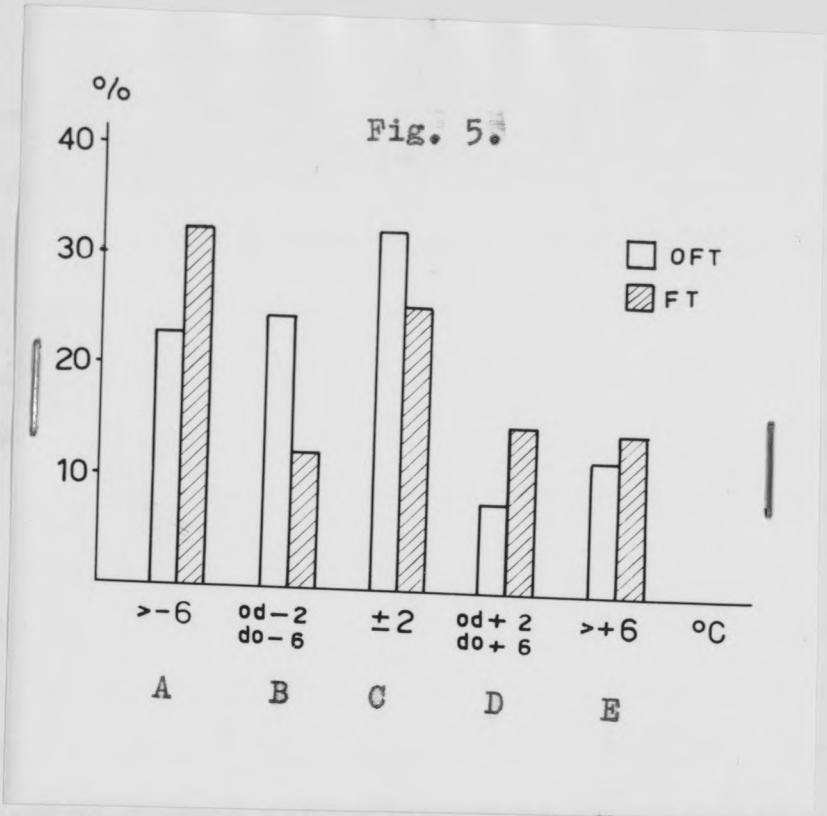


Fig. 5.

The data in Column A show a number of samples in percents which flocculation temperatures were lower for 6°C or more in comparison with actually achieved temperatures; Column B presents number of samples in percents which flocculation temperatures being from 2 to 6°C lower; Column C presents number of samples in percents which differences in two temperatures were ± 2°C; Column D presents a number of samples in percents which flocculation temperatures were from 2° to 6°C higher than those actually obtained; and, finally, Column E presents a number of samples in percents which temperatures were for 6°C and more higher than those actually obtained.

As may be seen from Figure 5, the objective method (OFT) yields results somewhat more accurate than those obtained by usual methods (FT) but even this one is not satisfactory.

The percentage of the results with error ± 2°C, evaluated according to temperatures in the center of hams checked by a thermocouple is 32.5 percents, while the percentage obtained by the original flocculation test is only 25.5 percents. At the same time, it should be mentioned that in determining the cooking rate, only products listed in Column A would be considered as insufficiently cooked, while samples from other columns are considered as well cooked. It is necessary to point one of the interesting data which we established during our investigations. No extract of a sample deriving from ham treated less than an hour at 65°C in the centre showed flocculation at 65°C. This leads to the conclusion that definite minimum time is required for quantitative denaturation of proteins at definite temperatures.

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Subjective errors in checking start of flocculation cannot be ascribed to results of objective flocculation test(OFT). We must have in mind fact that in 35 percents of casses deviations of temperatures determined by OFT from temperatures checked in the center of the product were higher than 6°C. The reason for this phenomenon should not be considered as due to techniques and methods of investigations, but to state of proteins. The results of NaCl determinations after

extraction in a o.9% NaCl solution indicate that flocculation temperatures of extracted proteins are increased with increase of extracted NaCl quantities. This points to the fact that the state of proteins at the moment of brine injection has significant influence upon the changes in the course of curing and thermal treatment. Depending upon changes occuring different fractions of non-denatured proteins by thermal treatment will be extracted, and therefore different values of the flocculation test will be obtained. For this reason, the assumption that the extract flocculation will always occur at the maximum temperature obtained in the center of the product is not acceptable.

COMPARISON AND APPLICATION OF VARIOUS METHODS FOR DETERMINATION OF THE COOKING RATE OF MEAT PRODUCTS

Summary

Comparison is made of the applicability of methods for determination of cooking rate of canned hams: flocculation test and Körmendy's method for determination of phosphatase. At the same time, we examined influence of thermal treatment pH the quantity of cooked-out jelly, the percentage of N_2 and NaCl in an extract used for the determination of flocculation temperature and the ionic strength of the NaCl solutions on flocculation temperature.

The results of the investigations indicate that none of the methods listed above can be considered to be a satisfactory test of the cooking rate.

Excepting the percentage of NaCl in the extract used for determination of the cooking rate, all other factors show no correlation with temperatures at which extracted proteins flocculate.

A high percentage of samples in which flocculation occurred at temperatures considerably higher (i.e., those in which a temperature of 7o°C or even higher was obtained in the center of the product), or considerably lower, than those actually obtained in the center of the product during thermal treatment indicates that, regardless of the used technique, flocculation tests are not a methods for the determination of the cooking rate.

VERGLEICHEN UND DIE ANWENDBARKEIT VERSCHIEDENEN METHODEN FÜR DIE BESTIMMUNG DES ERHITZUNGSGRADES VON FLEISCHERZEUGNISSEN

Zusammenfassung

Es wurden Flockulations-Methoden-und die Bestimmung der Phosphatase nach Körmendy geprüft, mit dem Ziel, die Anwendbarkeit dieser Methoden zwecks Bestimmung des Erhitzungsgrades von Dosenschinken festzustellen. Parallel wurde auch der Einfluss der thermischen Behandlung, des pH gekochten Schinken, der abgesetzten Gelle-Menge, des N_2 und NaCl Prozentsatzes in Extrakten für die Bestimmung von Flockulationstemperatur und Ionenstärke in den NaCl-Lösungen, auf die Flockulation geprüft.

Die Ergebnisse zeigen, dass keine von den erwähnten Methoden für die Bestimmung des Erhitzungsgrades von Dosenschinken als verlässliche angesehen werden können.

Ausser des NaCl Prozentsatzes im Extrakt, für die Überprüfung des Erhitzungsgrades, stehen alle übrigen geprüften Faktoren nicht in Korrelation zu Temperaturen bei dennen die extrahierten Eiweisstoffe flockulieren.

Ein höherer Prozentsatz von Proben bei welchen die Flockulation bei bedeutend höheren Temperaturen (der Fall bei den Dosenschinken die im Kern auf 7o° und über 7o°C erhitzt wurden), sowie bedeutend niedrigen Temperaturen im Bezug auf die tatsächlich im Laufe der thermischen Behandlung erreichten, eingetreten ist, sprechen dafür, dass die Flockulations-Methoden-ohne Rücksicht auf die Durchführungs-Weise-unverlässlich sind.

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