COMPRESSION CHARACTERISTICS OF MINCED MEAT DURING SAUSAGES FORMING

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INTRODUCTION

For the purpose of minced meat compression properties study during sausage production the factors of minced meat volume compression during forming and thermal treatment and their influence on the finished products characteristics were studied.

MATERIALS AND METHODS

Minced meat of different fat and water content was tested at the pressure range of $(0-5)\cdot 10^4$Pa. To determine the influence of form rigidity and permeability artificial casings, such as Kutisine, Saran and reinforced viscous on the basis of equal-strength paper, and rigid aluminium moulds were used. To find out the tension of casings thermal shrinkage the samples of equal length were studied by the method of cycle heating from 20° to 90°C with an interval of 10°C and pressure generation in the casing itself at the range of $(0.1-1)\cdot 10^5$Pa due to air discharge. Minced meat was heated up to 70°C in the centre and then cooled to 30°C. The apparatus for plastic-viscous materials properties determination was used for the study into pressure influence on the minced meat thermal treatment (A.S.USSR No.847196). The following parameters were tested: weight losses during thermal treatment and storage for 2 hours at 4-5°C, a_w value and consistency.

During heating the following pressure is being generated in artificial casings: 0.1×10^5Pa; 0.3×10^5Pa and 0.5×10^5Pa for Saran, Kutisine and reinforced viscous, respectively. Casing strength during its pumping with minced meat is defined by its material strength; diameter; coefficient of minced meat lateral pressure; stuffing pressure and medium temperature.

While studying meat volume characteristics it was found that with sausage diameter increase the value of the relative volume deformation(RVD) is becoming higher, and with length increase it lowers.

At the initial stage the RVD sharply grows (Fig.1) due to surface temperature increase. With temperature growth there is a constant increase of the RVD and during cooling it decreases almost up to the initial value. At the zero value of forming pressure the RVD transfers into the positive area. Based on it it is possible to assume the centre temterature reduces during sausage heating and increases at cooling. But the study into the pressure kinetics for minced meat in Kutisine, as related to the temperature, showed pressure increase with temperature growth (Fig.2). At the initial forming pressure of 0.1×10^5Pa it increases almost at once, i.e. the pressure generated by the surface layers extension compresses the inner layers of minced meat. As the result of protein denaturation the surface layers structure changes from viscous-plastic to elastic-firm; they act as a rigid cell of inner layers. That is why inner layers denaturation during further heating also increase the pressure of minced meat in casing. At the initial forming pressure of 0.3 x 10^5 and 0.5 x 10^5Pa the centre temperature does not change as the inner layers pressure inhibits pressure distribution in a sausage; the latter is being generated by surface layers proteins denaturation. They fully exhibit on the surface, particularly, explains the RVD growth with the forming pressure increase (Fig.1). While cooling it decreases due to the compression of air and water particles presenting in minced meat.

RESULTS

It was found, during thermal treatment, that the optimum value of forming pressure, that corresponds to the lowest weight losses, is directly proportional to a product fat level. At a higher fat level the optimum value of forming pressure during product heating in a protein casing equals to 0.5 x 10^5Pa. The lower value of 0.1 x 10^5Pa corresponds to the less fatty minced meat. Thermal treatment of such type minced meat in different artificial casing under pressure allowed to determine that the optimum pressure value depends on the pressure generating during casing thermal shrinkage. The sum value of forming and thermal shrinkage pressure equals to 0.4 x 10^5Pa. Consequently, it is necessary to create minced meat pressure of 0.4 x 10^5Pa at the initial stage of thermal treatment to have minimum weight losses. For this conclusion varification the same minced meat was treated in a rigid mould at different pressures. The minimum losses were found at 0.4 x 10^5Pa.

Finished product consistency was determined by a penetration degree. Forming pressure value, corresponding to a less tough product consistency, coincides with the forming pressure value corresponding to the minimum heating weight losses. It is explained by the fact that weight losses increase causes the decrease of finished product water content that influences the consistency.

According to the finished product a_w value it is found that losses at the optimum forming pressure depend on water-binding capacity of the samples made at this pressure. At minced meat compression under the given pressure some amount of water is being separated as the nergy of its bond with the product is lower than of compression tension. Acting pressure increase is followed by the growth of separated water amount. It shows a negative effect of forming pressure upon minced meat water-binding capacity. Simultaneously the water balance in capillaries is being disturbed. It transfers from the surface into capillaries as influenced by pressure change before the balance achievement. Due to it part of loosely bound water become stronger bound. At the pressure lower than the optimum one the second factor function predominates; as a result minced meat water-binding capacity increases, and, consequently, heating losses de-

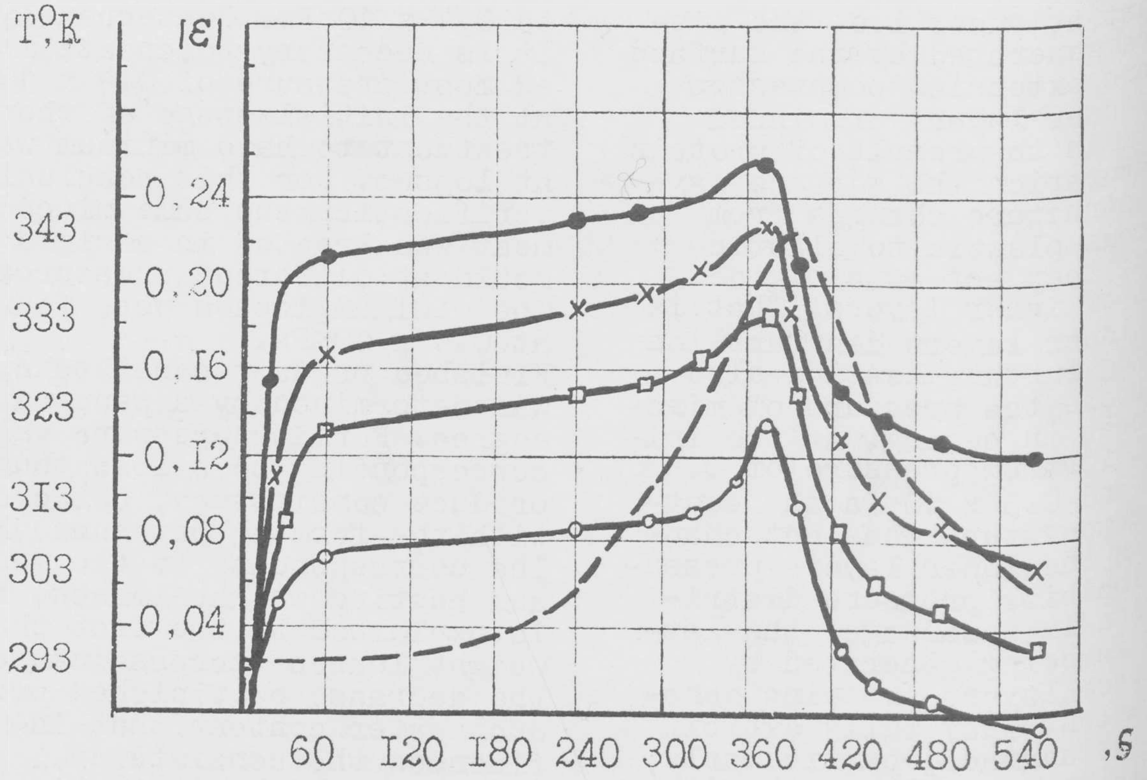

Fig. 1. Kinetics of RVD changes for minced meat in Kutisine casing as related to centre temperature at the following forming pressure: -o- - 0.1 x 10^5Pa; -□- - 0.2 x 10^5Pa; -x- - 0.3 x 10^5Pa; -●- - 0.5 x 10^5Pa; ---- - centre temperature.

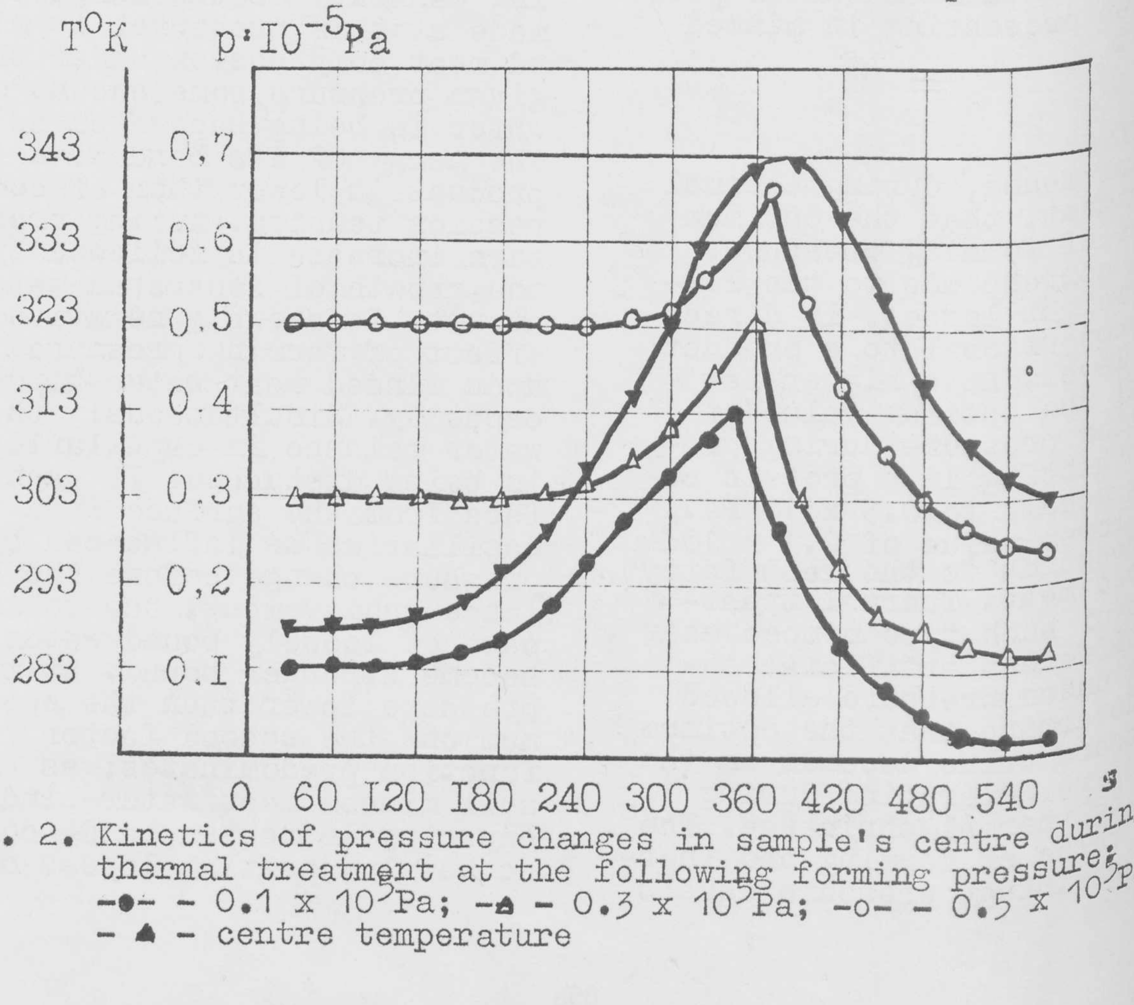

Fig. 2. Kinetics of pressure changes in sample's centre during thermal treatment at the following forming pressure: -●- - 0.1 x 10^5Pa; -△- - 0.3 x 10^5Pa; -o- - 0.5 x 10^5Pa; - ▲ - centre temperature

creases. At the pressure higher than the optimum one the first factor function predominates, and a reverse process takes place.
The value of the optimum pressure during stuffing the same minced meat into different casings is not equal and depends on the value of pressure of casing thermal shrinkage, i.e.

$$P_{compression}=P_t+P_{th.sh.} \quad (1)$$

where P_t - total pressure in sausage during thermal treatment;
$P_{th.sh.}$ -pressure in a product generated by casing thermal shrinkage.

Meat ability to hold water is directly proportional to protein content and back proportional to fat content. Based on this it is possible to make up minced meat complex characteristics. The degree of product waterabsorption represents the relationship between absolutely dry substances weight (muscle tissue mainly) and fat weight, (2).

$$K_w=W_{a.d.}/W_f=1-(W_f+W_w)/W_f, \quad (2)$$

where $W_{a.d.}$ -weight of absolutely dry substances;
W_f -fat weight;
W_w -water weight.

On the basis of test results the relation of total pressure for minced meat in casing generated during thermal treatment on the degree of waterabsorption has been developed:

$$P_t= 10^4\exp(1.7K_w + 2.5),Pa \quad (3).$$

The formule (3) is true for cooked sausages meat with fat content of 0.13 - 0.38.

CONCLUSIONS

While working on an automated sausage line an operator programmes the type of casing and product. Microprocessor calculates, by a programmed algorythm, the operation regiemes for mineed meat stuffer and casing speed to provide an optimum (given in advance) pressure of meat in casing taking into account the value of pressure,generated by casing shrinkage and meat extension during heating.
Scientifically substantiated operation of sausages forming and thermal treatment based on reguliarities of artificial casings and minced meat behaviour, as related to pressure and temperature, will allow to reduce the reject, to stabilize quality and to increase finished product yield.

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