PREDICTION OF SANITARY-MICROBIOLOGICAL SAFETY OF PASTEURIZED MEAT PRODUCTS

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Introduction

In production of meat products their safety should be guaranteed for consumers. Various microorganisms including those pathogenic for humans can be revealed in the meat raw materials.

Taking this into account the mandatory condition for the implementation of process technologies of any meat product is the application of regimes, ensuring the loss of viability of the microflora one representatives of which are dangerous for human health, and others can be the cause of products spoilage during storage.

Heat treatment is one of the main factors ensuring safety and quality of the manufactured products.

This work is devoted to prediction of safety ensurance of meat products with their optimum thermal exposure during production.

The objective of the present work was designing of automated system of the calculation of pasteurization regimes of meat products which should ensure the calculation of the curve of viability of microorganisms, the calculation of the value D_T^0 according to the obtained curve of viability; the calculation of F_T^0, L.

Materials and methods

To study the possibility of use of modern information technologies in thermal treatment of meat products an analytical investigation and mathematical modelling of the process of their pasteurization was carried out. The adequacy of the model was verified according to results of the laboratory experiment. Death of microorganisms of type *Listeria monocytogenes serovar 1/2b*, introduced into the comminuted beef and pork mixture that was placed into metal container, was studied in the experiments. The containers with samples were placed into the thermostat, where they were kept at pasteurization temperature. The range of pasteurization temperature was 68-75□C. The number of microorganisms cells was calculated at preset time periods with the use of standard techniques.

A fundamental law of substance conservation was the basis of the mathematical model (Norenkov I.P., 1980)

$$\frac{\partial V_i}{\partial \tau} = -div\rho \pm G \qquad (1)$$

where V_i – vector of the phase variable of the substance (energy, mass, information); ρ - flow of the phase variable; G – vector of the velocity of generation (conversion) of the substance; τ - время.

Results and discussion

Use of the heat energy as a substance from (1) allowed to find the equation of dynamics of change of product temperature in the bank in dimensionless form

$$J_1^{-1}\frac{dT_B}{d\tau} + T_B = T_H \qquad (2)$$

where $J_1 = \frac{4\alpha(h+d/2)}{\rho c d h}$ - coefficient of intensity of product heating at: α - coefficient of heat transfer from heating medium to the product; h – height of the formed product ; d – diameter; ρ - density of the meat product; c – heat capacity of the meat product,

$T_B = \frac{t_B}{t_H}$, $T_H = \frac{t_n}{t_H}$; t_m – temperature of the heating medium; t_B – temperature in the center of the product.

Assuming the mass (number of microorganisms) as a substance and supposing that the rate of death of microorganisms depends upon the volume occupied by them, V_m, and resistance to thermal heating and properties of the medium R_m,, similar to (2), we found a mathematical model of the dynamics of death of microorganisms which is written as:

$$J_2^{-1}\frac{dN_T}{d\tau} + N_T = -N_H \qquad (3)$$

where $J_2 = \frac{1}{R_m V_m}$ - coefficient of intensity of microorganisms death; $R_m = f(a_\omega, pH, T)$

$N_T = \frac{n_T}{n_0}$ $N_H = \frac{n_H}{n_0}$ at n_T – current count of microorganisms and n_0 – their initial count.

J_2 value is determined by experimental curves for particular species of microorganisms and the content of the product being treated..

Solution of equations (2) and (3) is in the form of the sum of exponentials (4) and agrees with the models represented in the review (Xiong R., 1999):

$$N(\tau, T) = A \cdot \exp(\alpha \cdot \tau) + B \cdot \exp(\beta \cdot \tau), \quad (4)$$

where *A, C, B* are coefficients depending on the initial amount of microorganisms of physical and thermodynamic properties of the product being heated; $\alpha \approx J_1$; $\beta \approx J_2$.

Curves of destruction of *Listeria monocytogenes serovar 1/2b* microorganisms are approximated rather precisely by the species dependence (4).

Results of the experiment for prime grade beef and their approximation are given in Fig. 1.

One of the experimental curves N1(t) of reduction of microorganisms number and the corresponding approximating function N(t) are shown on the diagram. As it is seen from Fig. 1, the experimental and the theoretical survival curves coincide, what makes possible to use numerical methods for calculation of D_T^o value.

In this paper Mathcad 6 PLUS system was used for numerical calculation of D_T^o value, but when designing an automated system, production of a separate programming modulus in the high-level languages is possible.

Resulting from calculation, the curve of D_T^o value change depending on the sample heating for 68, 70, 72, 75 °C temperatures was obtained (Fig. 2). Since deviation from the above temperatures in the technological pasteurization process is possible, approximation of the initial curve to determine non-calculated D_T^o values was carried out. The obtained diagram of D_T^o = f(T) function given in Fig. 3, allows to determine D_T^o value for any temperature in the range of 68-73 °C.

Further calculation of technological process parameters (F_T^o and L) was made on PC by the standard procedure.

Conclusions

Information technologies permit to more precisely calculate pasteurization regimes of meat products considering a number of factors (thermal, physical-chemical, etc.) that affect viability of microorganisms. The designed automated system of calculation of heat treatment of meat products should search for the optimal regime, using equations (2), (3), (4). As basic input parameters, the product composition, treatment temperature, density and geometric characteristics of the product, its heat capacity, heating conditions, species and the initial number of microorganisms were used.

References

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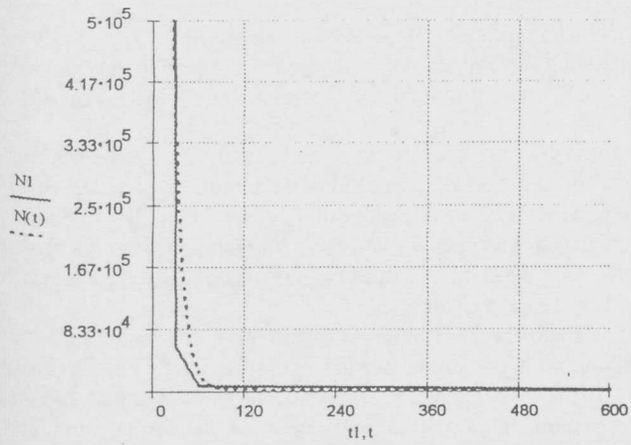

Fig. 1. Change in the amount o *Listeria monocytogenes* durin pasteurization of beef.

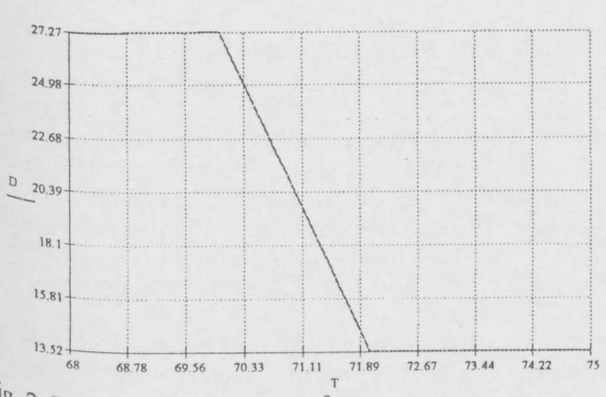

Fig. 2. Experimental values of D_T^0 during heating of beef.

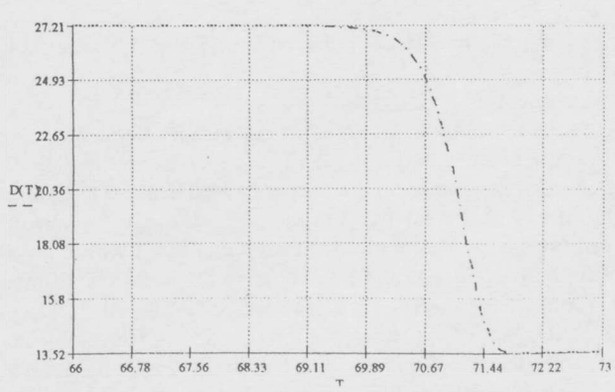

Fig. 3. Diagram of D_T^0 = f(T) function.