High hydrostatic pressure treatment of meat

Rogov I.A. , Nefedova N.V., Mitaseva L.F., Sizykh E.V.
Moscow State University of Applied Biotechnology.

INTRODUCTION

Recently the developments of food technologies based on the conventional methods of action are underway. One of the such methods is the treatment with high hydrostatic pressure (HHP). The original use of the HHP in the food production later on dictates the utility of studies of gelatinization [1,2], changes of the enzyme systems and vitamin properties as well as the sterilization of foods. The last alongside the all factors is of a great importance, since allowing for staying products for a long time.

It is known that a death of the microbial cells under the action of the high pressure depends upon it's magnitude and the ambient temperature. However the effect of the cooperative action of the temperature and pressure is not stable and finally is determined by the species of microbes. The spore forms are tolerant to the pressure in comparison with the vegetative cels. Whereas the HHP above 100 MPa produces the rapid inactivation of most vegetative bacteria, the bacterial spores can survive at the pressure of 1200 MPa due to the peculiarities and the thick of the membrane. The hydrostatic pressure intensifies the spore formations, especially under the conditions when the treatment with steam is performed at the presence of the nutritive components [3]. It was stated that lasily incipient spore bacteria (B. polymyxa: B. cereus) are sensitive to the low pressure, and not germinating fractions of the such bacteria spores, called the superdominating,are more stable than original total population by a factor of 20-160. Presented to the consideration information is important at the selection of the optimal conditions and temperature parameters, under which the maximal decrease of spores is observed. The inactivation of the thermophilic spores B. stearothermophilus is appeared to a greater extent when the spores are previously treated at 100 MPa, t 50°, 60° C with the subsequent decrease of the pressure to 0,1 MPa [4].

The studies of the high pressure effect on the foodstufts showed the possibility of their storing under the action of pressure and temperature below 0° C in the not frozen state, as well as the possibility of the defrost of foods without the substantial changes [5]. At the storing meat in the container under the pressure of 200 MPa and temperature from - 5° to 20° C on the nitrogen of the volatiles meat is changed likewise the meat stored at atmospheric pressure excluding the increase in water holding capacity [6]. The defrost of meat under the pressure above 150 MPa as shown by Dauti and Hayashi [7] change its colour,but at the pressure of 50 MPa the meat retains the rich colour; the amount of the exudated meat juice is significantly less than from the meat defrosted under the natural conditions.

MATERIALS AND METHODS

Our experiments were carried out on the equipment with the following performances: limit load, kn 1000-loading rate, kn/s, maximal 100, minimal 1, conrolling the loading non stepped rate, maximal pressure in the - 1000 container MPa, dimensions of the work area mm, diameter - 44, height - 200, operating liquid - distilled water, mode of the equipment operation static, cyclic.

Subject of inquiry was a muscle tissue sampled from chilled beef and pork carcasses, the time of autolysis was 72-96 h, t 2-4° C. The meat was cutted into the samples with the sizes 120x50x20 mm and vacuum-packed into polyethylenelavsan. As standards were used meat before and after heat treatment in water to the temperature 70+2° C within the thickness of the product.

To provide the neccessary quality of the product the main factors (contents of water, fat, protein and minerals; digestability, sanitary-microbiological characteristic)must occur within the definite range, characteristic for each of them obviously, that the evaluation of the product quality is possible only after the sequence of experiments on the base of which these factors can be obtained.

The computer factor analysis of the experimental data using mathematic model was carried out. It was made with the aim to determine the optimal number of factors which characterize the product quality impartially. In general this model postulates the possibility of the factor determination by the experimentally measured parameters as follows: $F_{il} = \sum_{j=1}^{m} a_{jl} x_{ij}$

where i - number of the objects analysed; j=1 - M - quantity of the experimentale measured parameters; l - number of the revealed internal factors.

The meaning of the model is in the informativity, namely, the first factor has the maximum of information, the second maximum of the retained information and so on. The model described allows for determining the better sets of the factors. Matrix of the loads (parameters and values of the factors) is turned in such a manner that the loads are most distinguished. Such turning, called VARIMAX, allows for isolating the groups of the intercorrelated parameters optimizing the experiment.

RESULTS AND DISCUSSION

Based on the experiments on the treatment of beef muscle tissue by HHP five groups interconnected parameters were estabslished. The changes within the group are interconnected in a greater extent than between groups. For the rapid evaluation

of the product quality one can use more representative parameters including maximal contribution into the corresponding factor. It is enough to have five factors, namely, quantity of microoprganisms, number of SH -groups, mineral content, water content, and digestability "in vitro".

We established that the treatment of meat by the pressure of 300-900 MPa renders meat harmless from the coliforms, Proteus bacteria.

Samples of meat (beef, pork) treated by the HHP in the range of 500-700 MPa and stored at 2-4° C attest about the decrease in their microbial contamination in comparison with the samples treated by conventional heat. Under the conditions of freezing the beef treated with the HHP at - 5 - 8° C for 30 days, the psychrophile microflora is inactivated more rapid than mesophile in comparison with the meat in native state.

According to our results presented in the table the contamination of pork treated by the pressure of 700 MPa and stored at +2...4° C after 5 days was decreased to $9{,}0x10^1$ CFU/1g. Then the microorganisms quantity in meat was increased and after 10 days was $5{,}3x10^4$ CFU/1g. Psychrophile microorganisms in the standards tend to the increase on 10 days of storing,

Table

Microorganisms in 1 g of product	Shelf life							
	24 h		72 h		120 h		10 days	
	standard	experiment	standard	experiment	standard	experiment	standard	experiment
Mesophile aerobe and facultative-anaerobe microorganisms CFU (colony forming units)	$9{,}1x10^5$	$1{,}7x10^3$	$2{,}1x10^6$	$1{,}5x10^3$	$3{,}2x10^6$	$9{,}0x10^1$	$4{,}3x10^6$	$5{,}3x10^4$
Coliforms	+	-	-	-	-	-	-	-
Coagulase positive Stahylococcus	-	-	-	-	-	-	-	-
Sulfite reducing clostridia	-	-	-	-	-	-	-	-
Psychrophile microorganisms, CFU	$8{,}2x10^5$	0	$1{,}8x10^6$	0	$5{,}6x10^6$	0	$7{,}0x10^6$	0
Revealing Proteus bacteria	-	-	-	-	-	-	-	-

- absense of microorganisms growth
+ presence of the microorganisms growth

Other factors effected to the meat quality reflect the depth of the changes taken place under the HHP treatment. By the number of SH - groups and protein digestability "in vitro" it was established that trekatment with the HHP leads to the specific structural changes of the protein components of meat and as a consequence it's biological fixation is improved. The representative data are left as follows: content of water and mineral: in the treated samples the water content is in average higher by a factor of 12-15%, and the mineral content is less by a factor of 15% than in the untreated samples.

CONCLUSION

Thus we revealed the peculiarities of the microorganisms inactivation in the meat after HHP treatment and during further storage. For the rapid evaluation of meat quality it is worthwhile to account for five main factors such as the quantity of microorganisms,number of SH - group, digestability "in vitro", and contents of water and minerals. However, they are absent in the samples treated with the HHP.

REFERENCES

1. 3-30640 Japan, MKI A23 L 1/01 Manufacture of gelatinizated foods. Publ. 08.02.91
2. 4-218344 Japan, MKI A23 L 1/06, A23l 1/212. Method to produce the jelly with fruit pieces. Publ. 07.08.92
3. Sale A.G.H. Jould G.H., Hamilton W.A. Inactivation of bacterial spores by hydrostatic pressure. // j. Gen. Microbiol, 1970.- v.60 -p. 323-334.
4. Seyderhelm I. Knorr D. Reduction of Bacillus stearothermophilus spores by combined high pressure and temperature treatments // Leitschrift fur Lebensmitteltechologie. - 1992. -43. -4. -p. 17-20
5. Use of pressure for the storage of non frozen foods and their defrosting. / Sekukhin Kaidakhu, 1990-12, p. 25
6. Dauti T., Hayashi K, Foodstuffs treated with pressure // Saney suppan, 1990,
7. Dauti T., Hayashi K, // Node Kagaku daasi - 1990, -64, p.787