Method of fish quality preservation at deep handling of raw materials

Tatyana Boitsova[1], *Natalia* Dementieva[1,*], *Olga* Sakharova[1], *Elena* Fedoseeva[1] ,and *Valery* Bogdanov[1]

[1]Department Technology of food products, Far Eastern state technical fisheries University, Lugovaya St 52 – b, Vladivostok, 690087, Russian Federation

Abstract. Deep cutting of fish raw materials is a priority for fish processing enterprises. The the influence of high-pressure processing of fish fillets has been studied and it has been shown that the impact of pressure above 100 MPa leads to a decrease in the total contamination by microorganisms. Further increase in pressure leads to an even greater decrease in the total number of microorganisms. The structural and mechanical properties of the fillet change slightly. High pressure makes the fish's muscle tissue more dense. Pressure-treated fillets supposed to be stored chilled or frozen for much longer, since their initial quality indicators are much higher than those of fillets not treated with high pressure. The possibility of enriching the whole muscle tissue of fish with vegetable oil lipids when exposed to high pressure is shown.

1 Introduction

In accordance with the food security Doctrine of the Russian Federation approved by presidential decree No. 20 of 21.01.2020, the strategic goal is to provide the country's population with safe, high-quality and affordable food products and raw materials for its production. To achieve this goal, the food industry is faced with the task of providing production with raw materials that meet the established environmental, sanitary and epidemiological requirements, taking into account the need to use it in the production of technologies that are safe for human health. One of the ways to solve this problem is the widespread introduction of deep processing of raw materials into production, which will ensure its comprehensive and rational use. The principle of deep processing of fish raw materials is primarily cutting it into fillets and minced meat.

Cutting fish into fillets is carried out manually or using specialized equipment. In both cases, internal organs, spinal, costal bones, and fins are removed. Fish fillets are produced with or without skin.

Fish mince is produced from the fillet, which is obtained by grinding it on the equipment of the "Neopress" type (in the case of fillet with skin) or on a top if the fillet has been desiccated**.**

To obtain minced meat, the method of disintegration of the fish's muscle tissue can also be used, when cutting is carried out in a stream of water, that is, without piece-by-piece cutting. This minced meat can be attributed to washed minced meat of the "surimi" type, during the production of which water-soluble proteins, extractives, lipids and other components are removed from the crushed muscle tissue, which do not participate in gelation when obtaining structured products.

When implementing these technologies for the production of fillet and minced meat, the food waste remaining after cutting the fish (fragments of raw materials, liver, milk, caviar) can be used to obtain biological active substances, other types of food or feed products.

Minced meat or fillets are sold to the consumer as independent products, or other groups of fish products are produced from them: cooking and canned food. From the washed minced meat, structured, emulsion products and analogues of delicatessen products can be obtained. The advantage of using shredded muscle tissue is the ability to add various ingredients to fish raw materials and get enriched products that meet the requirements of a healthy and balanced diet [1, 2].

However, deep cutting of raw materials leads to a sharp reduction in the shelf life of both chilled and frozen raw materials in comparison with undivided raw materials. On average, the shelf life of the fillet is about half that of undivided fish, and the minced meat is still half that of the fillet. The reduction in shelf life is due to the fact that when cutting fish, contamination of raw materials increases by microorganisms that enter it from the environment, production equipment, and the hands of workers. Contact of raw materials during cutting with air oxygen accelerates oxidative processes, which contributes to a faster decrease in the quality characteristics of fillet and minced meat.

To increase the shelf life of fillets and minced meat, various cryoprotective additives and preservatives are used. However, all these technological methods lead to a decrease in the biological value of raw materials [3-5].

* Corresponding author: dnvdd@mail.ru

To reduce the environmental impact of processing fish for fillet and minced meat, there are also mechanical methods for processing raw materials. Which include the impact on the object of high and ultra-high pressure [6, 7]. This method was proposed by Japanese scientists to increase the shelf life of animal raw materials [8-13]. Studies show that pressure is used to reduce the total number of microorganisms, inactivate enzymes of fish muscle tissue, form a secondary structure, gel formation, and release biologically active substances from plant raw materials [14,15]. A distinctive feature of the method is that the covalent bonds of organic substances are not violated and the components that determine the organoleptic characteristics of the product undergo minimal changes [10-13]. It is established that such processing of raw materials one save all the nutritional properties of the product and only to some extent change its physical properties [16-18].

2 The purpose of the study

The purpose of this work is to investigate the the influence of high pressure on the quality of fish fillets after the production process is completed before being stored.

The object of the study is the the influence of high pressure on fish fillets.

The subject of the study is the qualitative characteristics of the fillet.

3 Materials and methods

For research, they used Pollock fillet (*Theragra chalcogramma*), which was cut into 20 × 6 × 6 cm pieces and Packed under vacuum in polymer bags. Samples were treated with high pressure on a hydrostatic frame structure with an external drive (UNGR – 3000 pump). The prepared samples were placed in a plastic bag filled with water and subjected to pressure for 10 minutes. The Structural and mechanical properties of the fish's muscle tissue were determined using the Instron-1122 universal machine. The microstructure of fillet tissues was determined using the "Inoval" light microscope.

Microbiological studies were carried out in accordance with the guidelines adopted for the study of food products.

4 Discussion of the results

The results of studies have shown that when the pressure reaches 100 MPa, an inhibitory effect is observed. He total quantity of mesophilic aerobic and facultative anaerobic microorganisms (QMAFAnM) and spores of mesophilic aerobes is reduced by more than 2 times. With a further increase in pressure, there is also an even greater decrease in the total number of microorganisms (Fig. 1, 2).

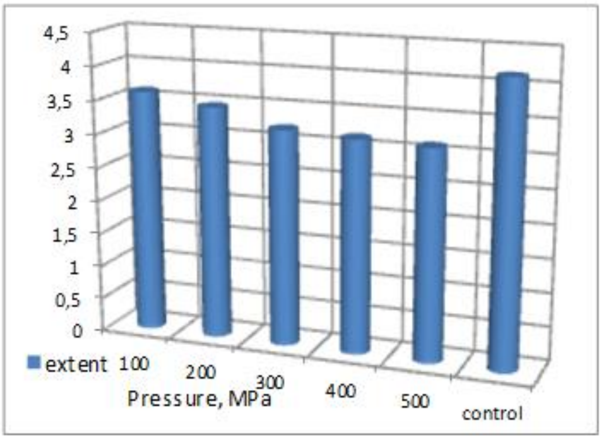

Fig. 1. The influence of high pressure on inhibition of muscle tissue microorganisms QMAFAnM, CFU/g, at 20 °C.

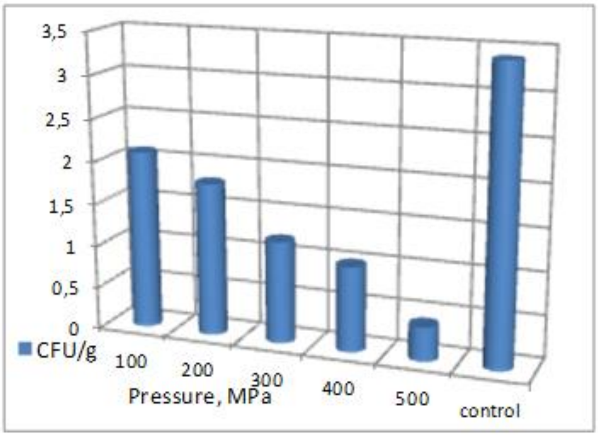

Fig. 2. The influence of high pressure on inhibition of muscle tissue microorganisms Spores mesophilic aerobes, CFU/g at 20 °C.

It was found that if the pressure is increased at a lower temperature, the inhibitory the influence of high pressure is much higher (Fig. 3).

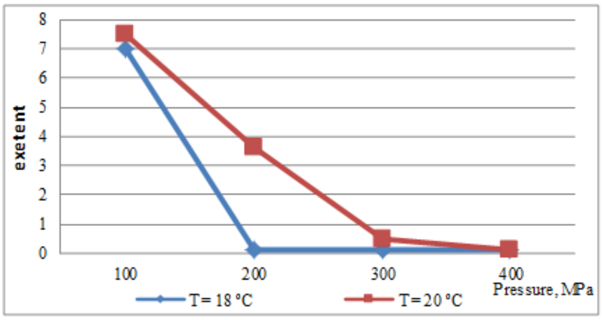

Fig. 3. The influence of high pressure and temperature on survival rate in BGCP fillet, CFU/g.

This is growth suppression is probably due to phase changes in the membrane structures of microorganisms, in most organic substances [6]. So inactivation of yeast cells reaches 100 % at a pressure of more than 500 MPa at room temperature, and at minus 20 ºC this effect is achieved at 200 MPa.

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When processing fillet pressure in the range from 50 to 500 MPa, there is a seal of the tissues, but the separation of free water does not occur (Fig, 4).

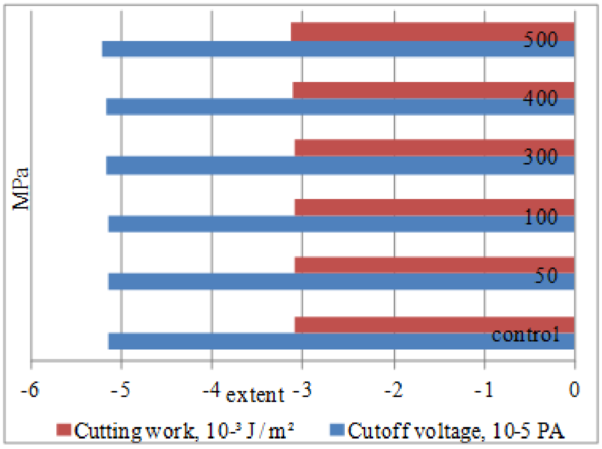

Fig. 4. Structural-mechanical properties of high-pressure fillet muscle tissue.

Studies of changes in the fillet structure on the cut stress and cutting operation, when processed with a pressure of 50 MPa, have little effect on the fabric structure, compared with fillets not treated with pressure (control sample), however, when considering the microstructure, some tissue compaction is still noted. With increasing pressure, the dependence of increasing the density of fish meat in the direction of compaction remains, and the sample subjected to a pressure of 500 MPa is characterized by the values of the cut stress and cutting operation, the values of which are 1.6 times higher than the corresponding indicators of the control sample.

When studying the microstructure of fish muscle tissue, it was found that the impact of a pressure of 50 MPa leads to some compaction and grouping of muscle fibers in comparison with the control sample (without the impact of pressure) (Fig.5,6). The build-up of pressure leads to the destruction of the muscle fiber, the appearance of local cracks and breaks. At the same time, the destruction of the intracellular contents occurs, resulting in the formation of granular destructured masses that fill the numerous cavities between the muscle fibers [19, 20]. In this case, the connecting layers between the plates of muscle fibers remain unchanged and practically do not differ from those in the control sample.

Fig. 5. Microstructure of fish muscle tissue control sample (pressure bars).

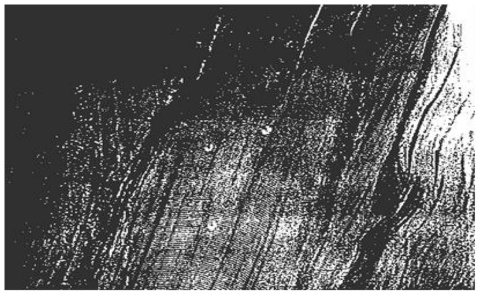

Fig. 6. Microstructure of fish muscle tissue sample after pressure exposure.

Pollock fillets can be used to produce various culinary products. Using it for the production of delicatessen products is extremely difficult, since the introduction of enriching agents into the muscle tissue, in particular the fat component that increases the nutritional value, is possible mainly by holding the fillet in a fatty substance or introducing it during syringing.

The first method is quite long in time, it requires an increase in temperature to accelerate it, which can lead to premature denaturation of protein substances and increased microbiological contamination.

When syringing, there is a need to control the free penetration of the enriching solution and the difficulty in regulating its dosage.

In this regard, the possibility of enriching the muscle tissue of the fillet with vegetable oil lipids under the influence of high pressure was studied.

The results of the research showed that control samples of fillets soaked in vegetable oil for 10 minutes contain almost no fat drops inside the muscle fibers, only in large cavities and in some places between the muscle fibers there are individual drops of oil (Fig. 7).

Fig. 7. Microstructure of control, a sample of muscle tissue of fish, exposed in vegetable oil.

Samples treated with a pressure of 100 MPa contain a much larger number of fat droplets ranging in size from a few microns to several tens of microns, which are located between the muscle fibers. The distribution of fat droplets in the thickness of muscle tissue is uneven and there are areas that do not contain oil at all, and some areas are significantly enriched with lipids, which is in principle characteristic of the native muscle tissue of fatty fish (Fig. 8).

Fig. 8. Microstructure of fish muscle tissue sample after exposure to pressure of 100 MPa in vegetable oil.

5 Conclusion

Thus, studies have shown that the impact of high pressure over 100 MPa on Pollock fillets helps to reduce the microbiological contamination of raw materials. Further increase in pressure leads to an even greater decrease in the total number of microorganisms and to the complete absence of E. coli bacteria.

Moreover, it was found that the inhibitory effect on microorganisms is effective when the pressure increases and the temperature of the processed fillet decreases simultaneously. With this effect, the fillet tissues are compacted, there is no separation of free water, and the change in structural and mechanical characteristics is insignificant, which is important for preserving the water and fat - retaining abilities of the muscle tissue.

Fillet prepared in this way is expected to be stored in chilled or ice-cream form for much longer, since its initial quality indicators are much higher than those of fillet not treated with high pressure.

High-pressure exposure can be used to enrich whole fish muscle tissue, in particular, with vegetable oil lipids. The enriched fillet can be used for preparing delicatessen products, such as hot or cold Smoking.

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