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## THE INFLUENCE OF PRE-TREATMENT AND LOW-ESTERIFIED PECTINE SUBSTANCES ON QUALITY OF FROZEN FISHERY SEMIFINISHED PRODUCTS

*Ability of a mixture of low-esterified pectin and acid to cause structural changes of mesopelagic small fish proteins is determined. These changes lead to a decrease in the MRP and an increase in water yielding. Such a influence mechanism on the moisture index rate can be used for directional control of the process of fish semi-finished products freezing. The optimal modes of polysaccharide-acidic treatment of muscle tissue are developed for Baltic sprat, Black Sea sprat, as well as for haarder. The researched pre-treatment allowing to obtain frozen fish semi-finished products with high organoleptic properties.*

**Keywords:** *Solutions of organic acids; Pectin; Mesopelagic fish; Freezing; Water yielding; Organoleptic properties.*

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## ВЛИЯНИЕ ПРЕДВАРИТЕЛЬНОЙ ОБРАБОТКИ И НИЗКОЭТЕРИФИЦИРОВАННЫХ ПЕКТИНОВЫХ ВЕЩЕСТВ НА КАЧЕСТВО ЗАМОРОЖЕННЫХ РЫБНЫХ ПОЛУФАБРИКАТОВ

*В данной работе установлена способность смеси из низкоэтерифицированного пектина и кислоты вызывать структурные изменения белков мелких мезопелангических рыб, ведущие к уменьшению ВУС и увеличению влагоотдачи. Такой механизм влияния на показатель влагосодержания может быть использован для направленного регулирования процесса замораживания рыбного полуфабриката. Получены оптимальные режимы проведения полисахаридно-кислотной обработки мышечной ткани кильки балтийской и черноморской, а также пиленгаса. Исследованная предварительная обработка позволяет получать замороженные рыбные полуфабрикаты с высокими органолептическими свойствами.*

**Ключевые слова:** *Органические кислоты; Низкоэтерифицированный пектин; Мезопелангические рыбы; Замораживание; Влагоотдача; Органолептические свойства*



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### I. INTRODUCTION

Solving the problem of dehydration of fish muscle tissue for technological needs in the production of frozen fish semi-products is possible through redeployment of the forms of bonds of moisture with proteins of muscle tissue of fish.

Muscle tissue of fish can be seen as a complex polydisperse system in which water is the dispersion medium and dispersed phase includes a large number of organic and inorganic substances. In various parts of the tissue composition of the aqueous solution may be different, such as in cells and intercellular spaces.

In the muscle tissue of fish moist is divided among bundles of fibers, the individual fibers and the fibers themselves. Fiber shells and bundles also contain moisture. Moisture amount that lies in various parts of the muscle is not equal, the largest amount is revealed between the bundles of fibers [1].

According to the widely accepted classification of bonding forms of moisture with the material, proposed by P.A. Rebinder, there are distinguished: the chemical bond, physicochemical bond, and mechanical bond.

Due to the chemical or physicochemical bond between water and matter, about 70% of the water is associated with myofibril tissue proteins.

Other classification of water and material bond, proposed by H.B. Chizhov, divides it on structural-free and bound [2].

Bound water (ion or hydrational) is firmly held with mostly proteins, and other substances with the hydrophilic group of proteins: carboxyl, amine, carbonyl and phenol.

The interaction between the dipoles of water and protein hydrophilic centers forms hydrogen bonds [3].

According to the existing notions fish meat can be seen as colloidal or capillary-porous body of a complex structure. The basis of this body is a structural mesh of proteins that are at swollen state, which include viscous solutions. They hold soluble proteins, nitrogen and mineral substances with hydrophilic properties. Bound water is held firmly enough with protein, its dielectric constant is close to zero, it has no solvent capacity, does not freeze at low temperatures.

Protein substances in the water environment are multivalent amphoteric electrolytes, because the nature of

their interaction with water depends on the active reaction of the medium.

In minimal hydration in animal tissues is observed in protein isoelectric state where acidic and basic groups of protein molecules mutually blocked, and their role is played by other hydrophilic polar groups (cysteine, serine, tyrosine) [4].

Isoelectric point of most proteins in muscle fibers, which determines the nature of the transformation of proteins in the process of fish treatment is located within 5,2-5,5 pH [3]. According to some researchers, the isoelectric point is at pH 4-4,5. On the isoelectric point is related to the ability of protein hydration and dissolution; change in pH leads to a decrease or increase hydration and solubility of proteins [6].

Bound water does not play a significant role in the biochemical processes that occur in the muscle tissue. The removal of bound water from the muscle tissue of fish is needed to break its relationship with fibers by heating the meat, add it to the electrolytes or other methods that cause conformational changes in proteins and weaken hydrophilic substances. The binding of water with protein or other hydrophilic substance changes its physical properties that should be considered during the scientific substantiation of the processing of fish [2].

## II. MAIN PART

Previous heat treatment that is performed in the production of various kinds of canned food is aimed to remove the moisture (20%), along with other major tasks.

The reduction of the loss of nutrients and improvement of the quality of canned goods is possible through using of organic and inorganic acids as pre-treatment and bringing in of low-esterified pectin. This allows to reduce processing time in several times, and preserve the organoleptic properties of native materials with significant energy savings.

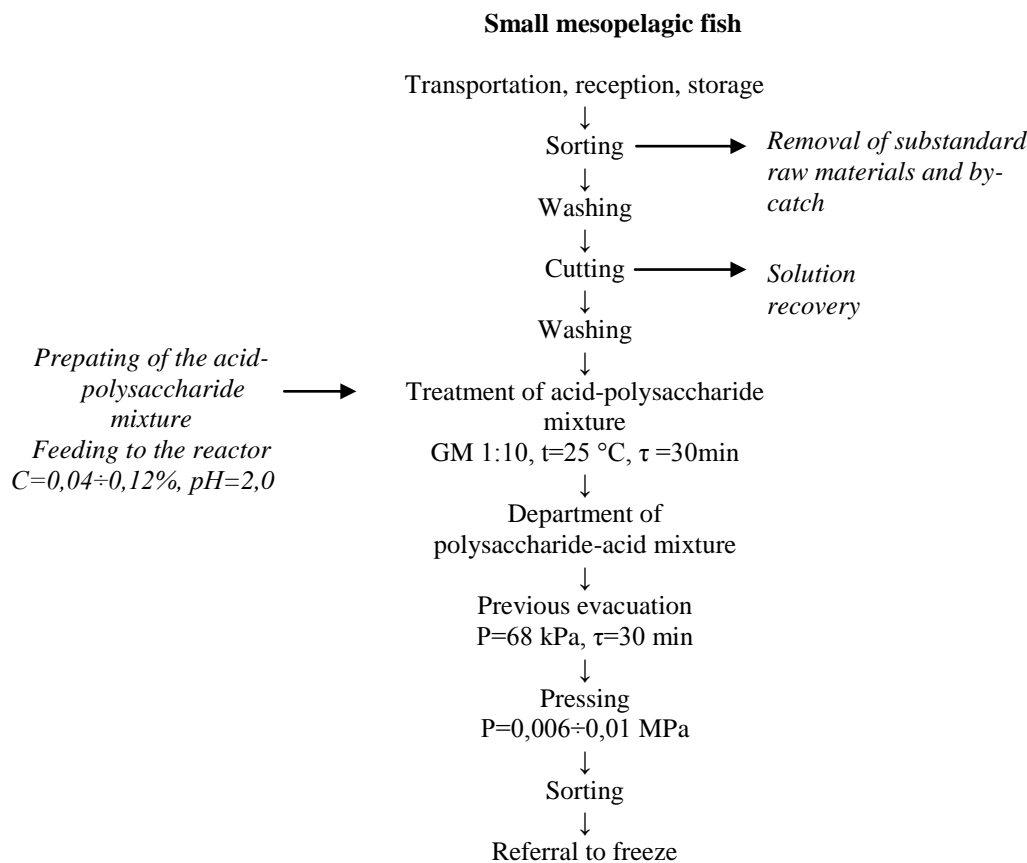
The goal is achieved with using a mixture solution of hydrochloric acid and pectin for processing and bringing pH of muscle tissue to isoelectric point values of most of muscle proteins of mesopelagic fish, which leads to a redistribution of forms of moisture proteins bonds [3].

As an indicator of the degree of change in the properties of the muscle-polysaccharide acid treatment, using water-retaining capacity of muscle tissue (MRP).

The proposed technology is based on the properties of biological polymers to retain moisture. While processing electrolyte polar molecules get covered with protein hydration shell. Changing the structure of muscle tissue reduces the number of immobilized moisture and increase free moisture.

Affecting the proteins of muscle tissue with polysaccharide-acid mixture causes the diffusion of ions in the electrolyte object tissue, water molecules diffuse from fish meat in an electrolyte solution, which explains the decrease in the total amount of moisture in the product and prevent losses during unfreezing fish semis .

The proposed method effects as follows, allowing to realize preliminary processing of semi-finished product and to reduce weight by 20% (Fig. 1).



**Figure 1** - Technological scheme of pretreatment fish with polysaccharide-acid mixture

The experimentally set processing parameters are: temperature processing (t), processing time ( $\tau$ ), hydrological module (GM), and the concentration of polysaccharide-acid mixture (C).

In order to establish the optimum pH of action polysaccharide-acid mixture (PAM) dehydration process was carried out at different values (Table 1).

**Table 1** – Parameters of process of fish muscle tissue dehydration

Initial muscle pH	Initial PAM pH	PAM concentration, C, %	duration of exposure, $\tau$ , min.	ratio of fish and PAM, GM	exposure temperature, t, °C	final pH of the current PAM solution	final pH of muscle tissue
6,8	2,3	0,04	25	1:6	25	3,35	5,84
6,8	2,3	0,04	30	1:10	25	3,65	5,2
6,8	2,4	0,035	25	1:6	25	3,3	5,85
6,8	2,4	0,035	30	1:10	25	3,95	5,2
6,8	2,5	0,031	25	1:6	25	3,55	6,2
6,8	2,5	0,031	30	1:10	25	3,6	5,35

For organoleptic characteristics semi-product has the following characteristics (Table 2).

**Table 2** – Organoleptic indexes of semi-products

Indexes	The content of ions Cl, %	Semi-product characteristics
Appearance	0,17	The coverlet is integral, with a strong guanine color. Uniform canopy, without large gaps.
Taste and smell		Pleasant, typical fish, do not feel sour taste.
Muscle tissue color		Bleached, inherent heat-treated muscle.
Consistence		Elastic, from 50 to 100 g penetrometer effort that meets the soft tender consistency.

As a result of the impact occurred changes of proteins (denaturation), which leads to increased muscle water yielding. This indicator reached the limits stipulated by the technological instructions for frozen food.

We have tested several variants of solutions with small values of acceptable concentration of 0,04 to 0,12%. The studies showed that when all things being equal, the change in concentration at this level has no significant impact on the MRP.

The study of polysaccharide-acid treatment of other species of fish, soiyu mullet, showed that our proposed method is selective and its use is conditioned by species and morphological features of raw materials and features of chemical composition. A distinctive feature of the target species is high moisture capacity in muscle tissue (80% moisture) and weakened structure of muscle tissue, which prevents its use in the manufacture of frozen semi-products. It is shown that under the same conditions, the mass fraction of moisture loss while acidic polysaccharide-processing for the Black Sea and Baltic sprat ranged from 6.4% to 33% with a slight increase in MRP, but for soiyu mullet observed a slight decrease in weight, and in some cases, significant swelling of the muscle tissue and sustained increase in mass, which is caused by the difference in the composition of myofibrillar and sarcoplasmic proteins of the objects, various fishing season, rigor mortis time.

Studies of the soiyu mullet protein fraction showed that the muscle tissue of the target species is much less salt-soluble protein than other species.

## CONCLUSIONS

The results of microbiological studies found that treatment with acid-polysaccharide mixture leads to a decrease of the probability of specific corruption agents development in fish semi-products after unfreezing. This is primarily due to the decrease in the number of free moisture - the main factor of growth of any microorganisms, in addition, lowering the pH of the surface layers of fish in the acidic polysaccharide-processing prevents contamination with spontaneous microflora. Such an effective influence on the spontaneous flora of new method semi-products is in line with the concept of scientific substantiation of thermal stabilization.

The resulting method was tested during freezing of semi-finished products with some of the pre-polysaccharide acid processing, which had highly appreciated organoleptic characteristics and have appropriate documentation of physical and chemical indexes [4].

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## **ВПЛИВ ПОПЕРЕДНЬОЇ ОБРОБКИ ТА НИЗЬКОЕТЕРИФІКОВАНИХ ПЕКТИНОВИХ РЕЧОВИН НА ЯКІСТЬ ЗАМОРОЖЕНИХ РИБНИХ НАПІВФАБРИКАТІВ**

*У роботі встановлена здатність суміші з низькоетерифікованим пектином і кислоти викликати структурні зміни білків дрібних мезопелангічних риб, що веде до зменшення ВУС і збільшення вологовіддачі. Незважаючи на значну кількість з'єднань, що викликають зміну конформації (денатурацію) білків, вибір таких хімічних модифікаторів для використання їх при виробництві продуктів з регульованим вологовмістом дуже обмежений, тому що головною характеристикою цих з'єднань повинна бути абсолютна нешкідливість для організму людини. Такий механізм впливу на показник вмісту води може бути використано для спрямованого регулювання процесу заморожування рибного напівфабрикату. Отримано оптимальні режими проведення полісахаридно-кислотної обробки м'язової тканини кількі балтійської і чорноморської, а також піленгаса. Опрацьована попередня обробка дозволяє отримувати заморожені рибні напівфабрикати з високими органолептичними властивостями. Вплив хімічних речовин дозволив домогтися позитивного результату, а саме скоротити час обробки в десятки разів; витримати технологічний регламент, знизивши вміст води; домогтися значного підвищення соковитості зразків у порівнянні з традиційною обробкою. Отримані продукти з заданим вологовмістом при ефективному впливі на фізико-хімічні властивості води, зв'язаної білками, що пройшли конформаційні зміни під дією комбінованих факторів. При цьому ступінь гідратації білків зазнала значні зміни, що обумовлені кількістю і розподілом заряджених полярних і неполярних молярних груп між поверхневою і внутрішньою частиною молекул. Таким чином проведена попередня обробка дозволила варіювати співвідношення таких гідрофільних і гідрофобних радикалів на поверхні білка, впливаючи на його молекулярне оточення і викликаючи при цьому конформаційні зміни білкових молекул.*

**Ключові слова:** Органічні кислоти; Низькоетерифікований пектин; Мезопелангічні риби; Заморожування; Вологовіддача; Органолептичні властивості.

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