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SAFETY AND QUALITY OF MARINE FISH DEPEND FROM THE METHOD OF CONSERVATION

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In recent years, there has been a significant overfishing of fish and aquaculture in the Black Sea, which has led today to a general decline in fishing in our region. Catches of sturgeon, salmon, bull, mullet and other Black Sea fish, both marine and migratory, have decreased. Some species of Black Sea ichthyofauna: listed in the Red Book of Ukraine; are in a depressed state; in recent years, their commercial fishing has been prohibited. In addition, from February 24, 2022 until today, a rather dangerous ecological situation has developed in the Black Sea, which requires and requires the most thorough control and regulation of checking the content of harmful substances of exogenous origin in fish and aquaculture, which can pose a danger to human health and animals

Safe and high-quality live sea fish, regardless of the place of catch, must be mobile. well-fed, skin condition without damage, shiny eyes and red gills, and most importantly, a pleasant smell. The main methods of storing fish are: cooling, freezing, freezing, salting, drying, drying. Each of these methods is based on suppressing or completely stopping the vital activity of microorganisms that are in the fish's body. Over time, fish begin to spoil due to enzymatic processes and the vital activity of microorganisms.

Key words : *sea fish, microstructural analysis, safety, quality.*

INTRODUCTION

At today's stage of human development, fisheries play the most important role in providing the food base of many countries of the world. The fishing industry in many countries that have access to oceans and seas provides the population with well-being and jobs. [1, 15-17]

Fish and fish products are valuable and, in most cases, irreplaceable food products that can provide human needs for proteins, fats, vitamins, macro- and microelements, and other biologically active substances. [2, 3, 9]

Today, the range of fish in Ukraine is represented by both domestic and, in most cases, imported products. [3]

Ukrainian products: carp, crucian carp, pike, gobies, flounder, capelin, tench, mackerel, a few are presented mainly in the markets of the country, and the assortment line is larger only in cities located near water bodies (sea, lake, estuary, river). [4, 5]

A significant range of imported products is represented by both fish and seafood, and in most cases these products are sold in supermarkets in frozen form. Such imported products include the following types of fish and seafood: sea bass, pangasius, salmon, butterfish, hake, pollock, capelin, notothenia, herring, mackerel, cod, tuna, tilapia, sea trout, hake, hake, squid, octopus, scallops and other types Ukrainians are very fond of fish and seafood, especially residents of seaside cities (Odesa, Kherson, Mykolaiv, etc.) consume a lot of fish. [6, 7, 11-14]

According to experts, quality live fish, regardless of the place of catch, should be mobile, well-fed, skin condition without damage, shiny eyes and red gills, and most importantly, a pleasant smell. In a healthy, high-quality, safe fish, the body is fleshy, the scales are intact and tightly attached to the skin. [6, 8]

But over time, the fish begins to spoil due to enzymatic processes and the vital activity of microorganisms. There are many methods for its storage. The main methods of storing fish are: cooling, freezing, freezing, salting, drying, drying. Each of these methods is based on suppressing or completely stopping the vital activity of microorganisms that are in the body of fish and that got on its surface during the process of catching, transporting and processing. [3, 10-14]

THE PURPOSE OF THE WORK

Carrying out a sanitary and hygienic assessment of fish according to different storage methods, which is sold in the trade network of the city of Odesa.
The object of research is fish sold in the markets of Odesa. The subject of the research is the sanitary and hygienic evaluation of fish, sensory analysis, microstructural analysis of fresh fish and changes in these indicators according to different methods of fish storage. All comparisons were made between the studied samples (fresh fish – chilled – frozen; fresh fish – chilled – salted).

TASKS

To investigate organoleptic indicators of fish according to different storage methods (fresh, chilled, frozen, salted) and changes in these indicators during storage; conduct a microstructural analysis of the studied fish samples; conduct a sensory analysis of fish in accordance with international ISO standards. carrying out a sanitary and hygienic assessment of fish, which is sold in the markets of Odesa.

RESULTS OF WORK

Changes in physical and chemical parameters of marine fish depending on the storage method. A certain type of canning is chosen for storing both sea and freshwater fish. The main purpose of canning is to create conditions in fish raw materials in which the microflora either stopped its activity or completely died. But there are enzymes in the meat, the action of which needs to be somewhat slowed down, which can improve the taste of the fish during storage. Therefore, it is necessary to choose the most pleasant storage methods for each type of fish.
The main condition for any kind of storage is that the fish must be safe and not lose its nutritional and taste qualities.
Therefore, any method of canning should be harmless to raw materials, not have a negative impact on its quality - organoleptic and physicochemical indicators.
There are many methods of preserving fish and seafood in the fishing industry. For each type of fish, the following preservation methods are used for storage, which allow you to preserve its taste and nutritional qualities for a longer time.
Fresh fish spoils quickly, so it must be canned for storage. There are the following methods:
- cold preservation (cooling, freezing, freezing).
- ambassador (using salt and spices),
- drying (slow partial dehydration of the product under natural conditions after the action of food salt),
-drying (slow, almost complete dehydration of the product under natural conditions after the action of food salt solutions),
- smoking (heat treatment with smoking substances, the fish partially compacts and loses moisture, the storage period increases).
In our research, we used three storage methods:
- freezing,
- salting,
- freezing – thawing – freezing.
We have analyzed how the quality and safety of marine fish changes with different methods of its storage.
At the beginning of the study, we conducted a study on the study of marine fish on the "Filyn" device in order to confirm its quality and to further compare changes in quality with different storage methods.

During the research, attention was paid to the change in the color of individual parts of the fish (gills, eyes, body surface, muscles, blood).

The study of all types of sea fish on the "Owl" device confirmed that the fish is of high quality. The data are given in Table 1.

Table 1 . Sea fish quality indicators for using the "Owl" luminoscope device

Types of fish	A bull is a whip	Black Sea trout	Black Sea flounder (flounder)
Gill	no luminescence, dark	no luminescence, dark	no luminescence, dark
Eyes	no luminescence	no luminescence	no luminescence
Body surface	a faint gray color with a purple tint	a faint gray color with a purple tint	a faint gray color with a purple tint
Muscle tissue	gray-purple color	gray-purple color	gray-purple color
Blood	dark brown color	dark brown color	dark brown color
Conclusion	quality	quality	quality

As can be seen from the table, the quality of the fish is confirmed by a specific glow in the luminoscope, which is characteristic of high-quality raw materials. At the beginning of the study, all types of fish had almost the same indicators:

- no gill luminescence, dark color,
- there is no luminescence in the eyes, the color is dark,
- the surface of the body has a weak gray glow with a purple tint,
- muscle tissue - glow of gray-violet color,
- glow blood has a dark brown color.

Thus, the glow indicators confirm the quality of the fish.

To study the changes that can occur in fish during its long-term storage, we took 3 samples of meat raw material weighing 100 g from each type of fish.

1 sample of each type of fish – frozen,

2 samples of each type of fish: - frozen - thawed - frozen

3 samples of each fish were salted with table salt.

We stored sea fish meat samples in closed glass containers to prevent liquid loss and airing. Keep raw materials frozen and salted for 6 weeks. 2 samples were thawed and re-frozen for 3 weeks.

On the day of the study, each fish sample was minced using a meat grinder "Moulinex ME626132" and examined on the "Foodscan" and "Filyn" devices.

The appearance of meat changes depending on the method of storage. First of all, we noticed a change in color after freezing: minced meat of all types of marine fish acquired a lighter pink color, minced meat after freezing - thawing and re-freezing acquired an even lighter color, becoming pale pink, minced meat after salting acquired a somewhat grayish color.

Fig.3. - The color of minced meat after freezing

Fig. 4. - The color of minced meat after freezing thawing and re-freezing

Fig. 5. - The color of minced meat after salting

Changes in the chemical composition of marine fish meat during freezing. For a better perception of changes, we took the primary indicators (of fresh fish) as 100% and calculated the changes in percentages.

Our data show that in the process of freezing, certain irreversible changes occur in meat raw materials, as a result of the formation of ice crystals in the tissues at the beginning of freezing, the integrity of some tissues and cells is damaged, and the contents of the cells of these tissues can come out. juice flows from clear raw materials, which contains proteins, fats and other nutrients. Therefore, the chemical composition of meat in all types of marine fish changes. The loss of nutrients affects the nutritional value and quality of raw materials. Changes depend on the speed and duration of freezing.

When freezing, the following losses of nutrients occur in raw materials:

A bull is a whip

- moisture 98.25%, - protein 96.31%,
- fat -89.48% - ash 96.62%

Black Sea trout

- moisture 96.51%, - protein 98.12%
- fat 91.02% - ash 98.75%

Black Sea turbot (flounder)

- moisture 95.78% - protein 96.20%
- fat 91.09%, - ash 99.33%

From the obtained data, it can be seen that of the three types of fish:

- bull-whip loses the least amount of moisture - - 1.75%, ↓
- Black Sea trout loses the least amount of protein - - 1.88% ↓
- black sea turbot loses the least amount of fat - - 8.91% ↓

Changes in the chemical composition of fish meat during freezing-thawing and re-freezing. Changes in raw materials during long-term freezing - thawing and repeated thawing are even greater, as the destruction of raw materials and loss of meat juice, loss of all components (proteins, fats) are noted.

A bull is a whip

- moisture 94.14%, - protein 89.98%
- fat 79.90%, - ash 93.91%

Black Sea trout

- moisture 94.11%, - protein 93.43%,
- fat 75.82%, - ash 93.16%

Black Sea turbot (flounder)

- moisture 92.84% - protein 90.71%
- fat 88.54%, - ash 97.98%

From the obtained data, it can be seen that of the three types of fish:

- the least amount of moisture is lost by the whip calf – - 5.86% ↓,
- black sea turbot loses the least amount of protein - - 6.57% ↓
- black sea turbot loses the least amount of fat - - 11.46% ↓

Change in the chemical composition of fish meat during salting. As can be seen from the data in the table, the chemical composition of the meat of all types of marine fish during salting changes significantly, and these changes depend on the duration of salting of raw materials.

A bull is a whip

- moisture 88.22%, - protein 71.61%
- fat - 69.33%, - ash 93.24%

Black Sea trout

- moisture 82.69%, - protein 70.17%,
- fat 64.83%, - moisture 96.66%,

Black Sea turbot (flounder)

- moisture 86.75%, - protein 75.52%

- fat 73.45%, - ash 94.66%

From the obtained data, it can be seen that of the three types of fish:

- bull calf loses the least amount of moisture - - 11.78% ↓,
- black sea turbot loses the least amount of protein - - 24.48% ↓
- black sea turbot loses the least amount of fat - - 26.55% ↓

Microstructural analysis of sea fish meat depending on different storage methods. Fresh fish means freshly caught or chilled fish that has been kept for a short period at normal cooling temperature before purchase or use.

In fresh sea fish, the tissues are elastic, thanks to the tight fit of the fibers.

In marine fish, after short-term storage in an unrefrigerated state, spaces filled with liquid appear between individual fibers.

In fresh-frozen marine fish, changes in histological structure are smaller than in fish frozen after previous storage.

Microstructural analysis of fresh fish. Our analysis showed that the microstructure of fresh fish of different types of marine fish is identical and characterized by certain specific changes in the raw material.

In histological preparations, muscle tissue with areas of adipose tissue on the periphery is revealed (Fig. 4).

Weakness of muscle fibers, their slight detachment due to the development of moderate intermuscular edema is noted (Fig. 5). In the preparations, areas are noted in which focal swelling of the cells of the muscle fiber sheaths and pyknosis of the nuclei is found. There are foci of swelling of muscle fibers with lysis of the nuclei, which alternate with fibers with unchanged transverse striation (Fig. 6). No signs of necrobiosis were detected.

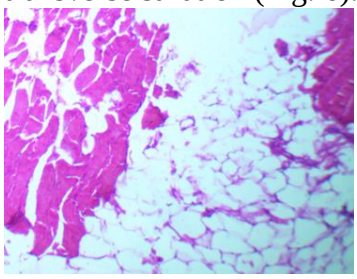


Fig. 4.- Muscle tissue with areas of adipose tissue on the periphery is revealed

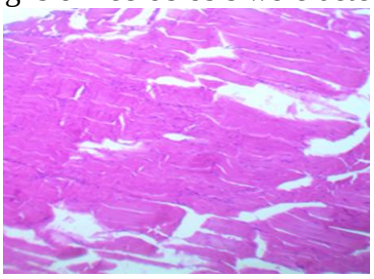


Fig. 5 - Muscle fibers are weak in places due to moderate intermuscular edema

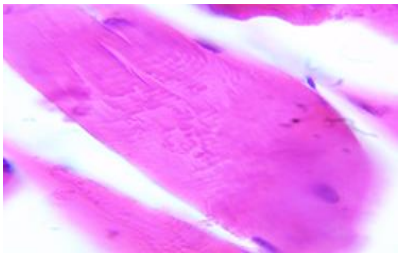
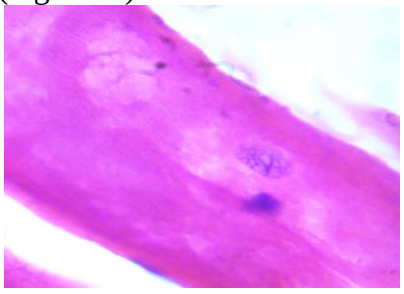


Fig. 6.- Foci of swelling of muscle fibers with lysis of nuclei, alternating with fibers with unchanged transverse striation.

Microstructural analysis of frozen fish. With rapid freezing and rapid thawing, the histological structure of fish meat changes less than with slow thawing.

A large amount of muscle tissue with large focal inclusions of fatty and connective tissue was found in the preparations. A significant number of muscle fibers are disconnected from each other due to unevenly expressed intermuscular edema.

Swelling of muscle fibers is noted, their cytoplasm becomes inhomogeneous, the presence of a large number of "voids" is noted in the fibers. Some of the nuclei of the fibers are lysed, there are preserved nuclei with signs of karyorrhexis. Thinning, disappearance of the cells of the sheath of muscle fibers is noted. Weakly expressed necrobiosis, gross structural changes of the cytoplasm are noted. (Fig. 7-10)



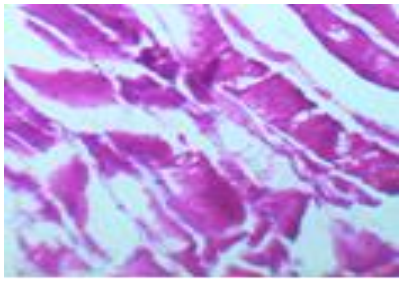


Fig. 7.- Swelling of muscle fibers, inhomogeneity of their structure, the appearance of large voids in the cytoplasm, thinning of the fiber sheath, x1000

Fig. 9 – Muscle tissue: swelling, inhomogeneity of cytoplasm, formation of voids, lysis of nuclei, x400.

Fig. 8.- Muscles, significant intermuscular edema is noted, cytoplasmic swelling in the fibers, voids in the fibers, x100.

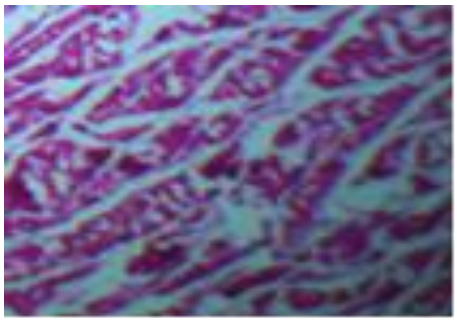


Fig. 10 – Muscle and adipose tissue: fibers and cells are disconnected due to intermuscular edema, x40

Microstructural analysis of frozen-thawed and re-frozen and thawed fish. The study of histological preparations of fish that we froze for 6 weeks, then thawed and re-frozen for 3 weeks and thawed shows gross violations in the structure of muscle tissue. Large ice crystals form in the tissues during repeated freezing. Ice crystals injure the tissues surrounding them, and the liquid from the cells moves into the intercellular and interstitial space - edema develops.

In histological preparations, there is muscle tissue in which adipose tissue is located in the form of small and large foci, and there are also areas of connective tissue. Muscle fibers are strongly disconnected from each other due to the development of uneven intermuscular edema.

A significant percentage of muscle fibers are significantly swollen, their cytoplasm is inhomogeneous, there are large "voids", thinning and disappearance of cells of the sheath of muscle fibers, lysis of a large part of the nuclei. Weakly pronounced necrobiosis, structural changes in the cytoplasm. (Fig. 11 - 12)

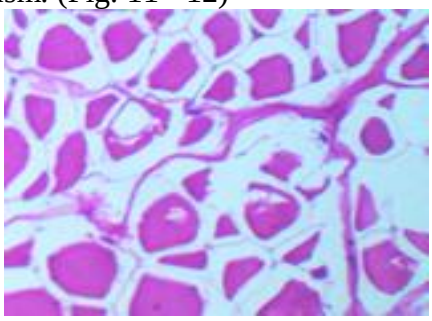


Fig. 11.– Muscle tissue: swelling of fibers, inhomogeneity of the cytoplasm, voids in the cytoplasm, x400.

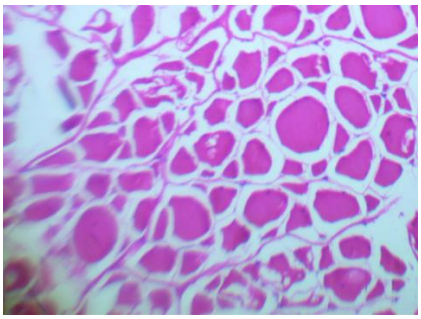


Fig. 12. - Muscle tissue: significant swelling of muscle fibers, x100

Microstructural analysis of salted sea fish meat. During salting, table salt penetrates into the raw meat, gradually the salt begins to displace water, thus a concentrated solution of salt is formed in the tissues. It is this salt solution that prevents the development of microflora and putrefactive processes that are facilitated by microorganisms. The more concentrated the salt solution is, the more the tissues are dehydrated.

When examining histological preparations, there is muscle tissue with focal inclusions of fatty and connective tissue. Muscle fibers are strongly disconnected from each other due to unevenly formed wide cavities between the fibers. Significant thinning of the fibers of the connective framework is noted.

Fig. 13-14. - Muscle tissue: the cytoplasm is inhomogeneous with linear striations, lysis of nuclei, disappearance of muscle fiber sheath cells,x 400

Swelling of muscle fibers is noted, in addition, some of the fibers are wrinkled, their cytoplasm is inhomogeneous with a peculiar "linear" pattern. Lysis of fiber nuclei. (Fig. 13-14).

CONCLUSIONS

1. Safe and high-quality live sea fish, regardless of the place of catch, must be mobile. well-fed, skin condition without damage, shiny eyes and red gills, and most importantly, a pleasant smell.
2. Over time, fish begins to deteriorate due to enzymatic processes and the vital activity of microorganisms. The main methods of storing fish are: cooling, freezing, freezing, salting, drying, drying. Each of these methods is based on suppressing or completely stopping the vital activity of microorganisms that are in the fish's body.
3. Based on our research, all species of marine fish selected by us: whip bull (Mesogobius batrachocephalus), Black Sea trout (Salmo trutta labrax), Black Sea turbot (flounder) belong to protein species of fish (the protein content ranges from 15% to 20% ;) have the second category of fat (2 - 8%).
4. With all the most common types of storage we chose, the fish we selected did not lose its nutritional value and quality, and most importantly, it was safe for humans. But with each type of storage, certain chemical changes occur that can slightly reduce the quality characteristics of fish raw materials
5. In the process of freezing, the histological structure of fish tissues changes. In fresh fish, the tissues are elastic, the fibers tightly adhere to each other. In frozen fish, changes in histological structure are smaller than in fish frozen after previous storage.
During slow freezing - thawing - repeated thawing and thawing, the structure of fish meat changes significantly. Larger ice crystals are formed in tissues during freezing, which sometimes leads to tissue damage and the release of fluid into the intercellular space. Such fish loses its juice, which means nutrients.
During salting, muscle tissue with focal inclusions of fatty and connective tissue was detected in the preparations. Muscle fibers are significantly separated due to unevenly formed wide cavities between fibers. Significant thinning of the fibers of the connective framework is noted.
6. In the process of storing marine fish of various species, the development of the following signs is noted: a gradual change in taste, smell, consistency, color. First of all, it depends on the fatness of the fish, the content. The best indicators, regardless of the storage method, were noted by us in all types of sea fish, but Odessans like trout and gobies the most.

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БЕЗПЕЧНІСТЬ ТА ЯКІСТЬ МОРСЬКОЇ РИБИ В ЗАЛЕЖНОСТІ ВІД СПОСОБУ КОНСЕРВАЦІЇ

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В останні роки в Чорному морі спостерігається значний перелов риби та аквакультури, що призвело сьогодні до загального спаду рибальства в нашому регіоні. Зменшився вилов осетрових, лососевих, бичків, кефалі та інших риб Чорного моря, як морських, так і пролітних. Деякі види чорноморської іхтіофауни: занесені до Червоної книги України; знаходяться в депресивному стані; в останні роки їх промисловий вилов заборонено. Крім того, з 24 лютого 2022 року і до сьогодні в Чорному морі склалася досить небезпечна екологічна ситуація, яка потребує найретельнішого контролю та регламентації перевірки вмісту шкідливих речовин екзогенного походження в рибі та аквакультурі, які можуть становлять небезпеку для здоров'я людей і тварин

Безпечна і якісна жива морська риба, незалежно від місця вилову, повинна бути рухливою, вгодованою, стан шкіри без пошкоджень, блискучі очі і червоні зябра, а головне приємний

запах. Основними способами зберігання риби є: охолодження, заморожування, соління, в'ялення. Кожен з цих методів заснований на пригніченні або повному припиненні життєдіяльності мікроорганізмів, які знаходяться в організмі риби. З часом риба починає псуватися через ферментативні процеси і життєдіяльність мікроорганізмів.

За нашими дослідженнями всі відібрані нами види морських риб: бичок (Mesogobius batrachocephalus), форель чорноморська (Salmo trutta labrax), калкан чорноморський (камбала) належать до білкових видів риб (вміст білка коливається від 15% до 20% ;) мають другу категорію жиру (2 - 8%).

При кожному типі зберігання відбуваються певні хімічні зміни, які можуть трохи знизити якісні характеристики рибної сировини. У процесі зберігання морської риби різних видів відзначається розвиток таких ознак: поступова зміна смаку, запаху, консистенції, кольору. В першу чергу це залежить від жирності риби.

Ключові слова: *морська риба, аналіз мікроструктури, безпечність, якість.*