Technological aspects of veterinary and sanitary control and safety of consumption of fin-footed mammals

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Abstract. The meat of fin-footed mammals contains complete protein with high biological value, as well as vitamins and minerals that are so necessary for the vital functions of the human body in the Far North. Nowadays fin-footed mammals are hunted only to provide food for indigenous people. In accordance with this, it was found that the procedure of the determination of the quality and safety of products obtained from marine mammals is outdated and requires changes. It is necessary to include in the regulatory and technical framework (GOST, SanPin) this type of meat and by-products of marine mammals, since this type of product is specific and the norms suitable for meat of all other slaughtered animals do not quite fit this category of meat because they do not contain indicators characterizing the quality and first of all, the safety of this type of product. The article considers the organization of the development of quota allocations for the fishing of marine mammals in the Chukotka Autonomous Region and the organization of veterinary and sanitary inspection of the products of slaughter of commercial animals.

1. Introduction

Marine mammals live in all the seas of our planet. Thus, in the Chukotka Autonomous Region, marine mammals for thousands of years not only ensure the existence of Eskimos and coastal Chukchi, but they are the basis of their culture and the spiritual world.

A type of food typical of the indigenous population of the Arctic with high consumption of proteins and fats leads to a prolonged increase in the level of basic metabolism. The type of physical activity also plays the important role. The daily work of the residents of the North requires significant energy consumption, and with regular long-term work outdoors in the cold, the basic metabolism itself increases by 10-16%. As a result, a person in such conditions requires about a third more energy than a resident of a temperate climate [1, 2].

The only source of this energy is food. Its composition and availability over millennia are determined by the environmental conditions of the Arctic regions. Easily digestible carbohydrate foods are not widely available in the Arctic. Traditional plant foods are primarily a source of vitamins, fiber and trace elements, but not sugars and starch - the main sources of carbohydrates for residents of non-Arctic regions. However, there is a sufficient amount of protein food in the Arctic. Therefore, the meat of fin-footed mammals and whales is actively used in food of the indigenous population, since it
has high calorie content due to the content of animal protein with high biological value, polyunsaturated fatty acids, vitamins A and D, iron and other minerals. Therefore, products from fine-footed mammals are very popular in terms of dietary and therapeutic nutrition. [3–5]

Nowadays, in Russia, the fishing of mammals is carried out only to provide food for the indigenous peoples of the North and for cultural and educational purposes. According to the majority of scientists, there is a weak use of the meat of marine mammals for food, significantly inferior to the possibilities of their fishing, since many scientific aspects of this problem remain undocumented. One of them is the lack of the “Rules of veterinary sanitary inspection of carcasses and organs of fin-footed mammals”.

All territorial-neighboring communities of the indigenous peoples of the North, which are engaged in the fishing of marine mammals, are geographically located very far from the city of Anadyr, where the only veterinary laboratory is located. Since communities have a very low level of health education, this leads to the difficulties in veterinary and sanitary inspection of slaughter products and assessment of their safety.

In addition, it is necessary to note that eating meat and by-products of marine mammals that have not passed the veterinary and sanitary inspection is unsafe.

In this regard, the purpose of our research was to analyze the conduct of veterinary and sanitary inspection and veterinary and sanitary assessment of products of slaughter of commercial animals in the conditions of the Chukotka Autonomous Region.

To achieve this purpose, the following tasks were set and solved:
• To assess the organization of the development of quotas for marine mammals’ fishing
• To assess the current regulatory framework for veterinary and sanitary assessment of slaughter products of marine mammals
• To conduct the analysis of the organization and characteristics of the veterinary and sanitary inspection and laboratory studies of marine mammals.

2. Materials and methods
The research materials were samples of meat of marine mammals, which were obtained by farms and communities of the Chukotka Autonomous Region for indigenous people.

The sampling was carried out by veterinary specialists in coastal villages, according to GOST 7636-85. Then, each sample was placed in a safe bag, sealed and sent by air to the Regional Veterinary Laboratory. The received samples were examined for quality and safety indicators, according to the plan of diagnostic studies, veterinary prophylactic and anti-epizootic measures approved by the main state veterinary inspector of the Chukotka Autonomous Region. The samples of meat of marine mammals were subjected to laboratory studies for the following types: organoleptic, microbiological, physico-chemical and parasitological. During the organoleptic studies, attention was paid to the appearance, body, smell and color of the samples.

The number of mesophilic aerobic and optional anaerobic microorganisms was determined according to GOST 10444.15-94. The identification and determination of the number of bacteria of the group of Escherichia coli (coliform bacteria) was carried out according to GOST 31747-2012, the determination of bacteria of the Salmonella genus - according to GOST 31659-2012; the determination of hydrogen ions concentration (pH) was carried out according to GOST R 51478-99; the determination of products of primary protein breakdown in broth was performed according to GOST 23392-2016.

One of the most important factors which guarantee product safety is the veterinary and sanitary inspection, carried out in accordance with current instructions and regulatory documents.

Veterinary-sanitary inspection and veterinary-sanitary examination of the products of slaughter of marine mammals (bay seal, ringed seal, bearded seal, walruses and other species of fin-footed) are carried out in the strictly prescribed manner.

Along with the primary post-mortem processing, the external examination is carried out. Inspection project includes: the eye and conjunctiva, the mucous membranes of the nasal and oral cavities, the
anus. Particular attention is paid to the presence on the skin of wounds, seals, abrasions, neoplasms, abscesses and other pathological processes that subsequently affect the quality of the meat of marine mammals.

In order to precisely determine the time of death of an animal, it is worth determining the condition of the abdominal wall: the abdominal wall is soft and elastic (during the first 1-1.5 hours); the abdominal wall is tense due to the formation of gases in the stomach and intestines (after 1.5-2 hours).

Then, after skinning, the process of inspection includes: subcutaneous fat and subcutaneous fascia.

Particular attention is paid to the presence of pathological changes in the head, chest and abdomen (the presence of infiltration, hemorrhage, phlegmon, smudges and other changes).

When processing carcasses, each eye fillet is inspected; special attention is paid to the degree of bleeding of muscle tissue and the presence of pathological changes in it.

During the study of the internal organs of fin-footed animals, generally accepted examination methods are applied, which are carried out in the following order:

- Spleen, stomach and intestines. The external examination of the mesenteric lymph nodes and serous membranes is performed. On the dorsal surface of the stomach, the spleen is adhered to it by two ligaments. Spleen color: lead blue with a reddish yellow tinge. The color of the serous membrane: white-blue from the surface, the serous membrane is dense, shiny. The stomach is not open; examination is carried out from the surface. In addition, lymph nodes, forming a chain along the intestine and located in the root of the mesentery mesenteric, are also well accessible for inspection.

- Liver with portal lymph nodes. In the gates of the liver there are portal lymph nodes from brown to dark brown color. In marine mammals, the liver is brown in color with a yellowish-cyanotic hue. The consistency of the liver is different in different species of fin-footed. Blood vessels are filled with blood.

- Kidneys with renal lymph nodes. The kidneys have perinephric fat, the capsule is freely removable and two layers are preserved in the section.

- Lungs with bronchial and mediastinal lymph nodes. The inspection is performed outside, the incision is made along the lung tissue and the large bronchi, then the mediastinal lymph nodes are opened. The lungs are small in size, from pink to red-gray, soft and elastic, the pleura surface is dry.

- Heart. The heart is opened along great curvature, examining the pericardium, myocardium and endocardium. There is a small amount of clear fluid in the heart bag. The heart muscle in the section is dark red with a bluish tint, dense and elastic. During the process of autolysis, the heart becomes flabby and takes on the color of boiled meat.

It is not allowed to use the meat of fin-footed mammals in food in the following cases:

- in case of the presence of inflammatory processes and purulent foci;
- in case of dystrophic changes in the muscles;
- in case of tumors in organs and tissues;
- in case of hemorrhages in organs and tissues;
- in case of staining fat in a brown color;
- in case of icteric staining of tissues;
- in case of infectious and invasive diseases dangerous to humans;
- in case of trichinosis;
- in case of changes in the chemical composition of meat (autolysis) accompanied by a change in the consistency, color and smell of meat.

In accordance with the rules of veterinary and sanitary inspection of slaughtered animals and veterinary and sanitary examination of meat and meat products, the carcasses of marine mammals are subject to mandatory research for trichinosis. Material for research (muscle tissue) is selected from the eyelid of the eye and the tip of the tongue of fin-footed mammals.

The laboratory tests are performed according to SanPin 2.3.2.1078-01 in order to determine the quality and safety of fin-footed mammals.
Thus, during the veterinary and sanitary inspection of meat and by-products of marine mammals, the presence of pathogens of infectious and invasive diseases and the total bacterial contamination are assessed. It is also necessary to conduct studies in order to determine the radionuclides in meat. The standards suitable for the meat of all other slaughtered animals do not quite fit into this category of meat since the meat of marine mammals is special. [6.7]

Therefore, it is necessary to include more precise indicators of physicochemical studies for this category of meat, namely the determination of PH, amino-ammonia nitrogen, CuSO4, reaction to peroxidase, formal reaction and determination of the acid number of fat.

3. Results
Over the past few years, the populations of ice seal species in the seas surrounding the Chukotka Autonomous Region are not subject to active indigenous fishing due to the lack of large-scale marine hunting. The exception to this is the ringed seal, which serves as the basis for the traditional fishing of the indigenous population of Chukotka.

Due to the rare consumption of bay seal meat for food due to the low quality of meat, and the habitat in open water spaces of banded seal due to non-development of the coastal fishery, the development of quotas of these fin-footed mammals is insignificant.

Indigenous fishing in the coastal waters of Chukotka is conducted only to meet the demand for meat, leather and fur raw materials. In several villages, Inchoun and Lorino, the meat of seals is used as food for cage ice foxes.

Fishery for cetaceans by indigenous peoples living in the coastal zones of the Chukotka Autonomous Region serves as a traditional type of fishing, and whales that are caught are used for food. It is known that whales belong to rare and protected species of marine mammals, and as a result are included in Red List of IUCN, Russia and the Chukotka Autonomous Region; their fishing is regulated by quotas established by the International Whaling Commission.

According to the decision of the 6th session of the International Whaling Commission, the indigenous peoples of the North of Russia (Chukotka Autonomous Region) and the United States (the state of Washington and Alaska) were granted 6-year quotas of whale fishing for the period 2013-2018: gray whales of the Californian-Chukchi population of 620 individuals and 280 harp whales of the West Arctic population.

The annual Russian share in the total for two countries (Russia-USA) for 2013-2018 makes up 135 gray and 5 bowhead whales.

In Russia, fishing for cetaceans is permitted only for the indigenous population of Chukotka. Fishing is carried out in traditional ways: from kayaks, whaleboats and motor boats using rifled hunting weapons, American large-caliber rifles and rotary harpoons.

9 communities from 16 whaling villages conduct whale hunting in the Chukotka Autonomous Region.

According to statistics, over the past 10 years in the Chukotka Autonomous Region, the average of 119 whales were caught per year, although previously fishing reached up to 200 individuals.

The main reason for the underdevelopment of the gray whale quota in the West Bering Sea zone is the complex logistics in the region. The largest whale fishery is carried out on the Chukchi Peninsula, and small villages of the Arctic coast cease to engage in whale fishing due to the complex and unreliable transport scheme from the regional centers and Anadyr.

In 2016, the quota allocation for the gray whale fishery in the West Bering Sea zone was 10 animals, and 8 animals were fished, and the development of the quota was 80%. In 2017, the quota amounted to 6 animals, and 3 whales were produced, as a result of which the development of the quota was 50%. Greenland whale quota for 2016-2017 was not allocated.

However, it is necessary to note that according to the information from surveys and socio-economic studies, the volume of the allocated quota satisfies the needs of the local population. Therefore, taking into account the low population density of the Chukotka Autonomous Region, which is 1 person per 14.9 km² and the exploration of some water bodies, the quotas allocated to meet the
needs of the indigenous population of Chukotka can be further increased without harming the state of the stocks of aquatic biological resources.

In the Chukotka Autonomous Region, according to the allocated quotas the hunters of Pacific walruses are hunters of 8 clan communities and farms from 3 districts of the Chukotka Autonomous Region. In addition, in another 7 villages (2 communities), fishing is not conducted annually or privately. The allocation of quotas by species, regions and years of production, presented in table 3, reflects the amount of withdrawal of only those communities that have state financial support from the regional government and regularly submit reports on the production of marine mammals to the Department of Agricultural Policy and Environmental Management of the Government of the Chukotka Autonomous Region.

According to reports, the annual fishing of Pacific walrus by communities in Chukotka from 2007 to 2017 amounted to 998 animals in average. The indigenous people of Chukotka fish walruses in private (as individuals) for the implementation of the traditional way of life. Reporting on walrus fishing by individuals in this case is not obligatory.

Thus, in 2016 in the West Beringovomorsky zone a quota for walrus fishing was allocated in the amount of 203 animal and 170 animals were caught, which amounted to 83.7% of the quota development. In 2017, the quota amounted to 195 animals, but actually 135 animals were produced, which amounted to 69.2% of the quota development.

In the Chukotka zone in 2016, the quota amounted to 536 animals, 357 animals were caught. Therefore, the volume of development of the quota for walrus fishing was 66.6%. In 2017, the quota size amounted to 539 animals, only 340 animals were produced, as a result of which the quota development volume was 63.1%.

In the Chukchi Sea in 2016, the value of the quota for the fishing of Pacific walruses amounted to 746 animals, and only 444 animals were harvested, which was 59.5% of the quota development. In 2017, the size of the quota was 758 animals, only 545 animals were produced, and this was 71.9% of the quota development.

In the East Siberian Sea, the size of the allocated quota in 2016-2017 was 4 animals of Pacific walruses, but it was not completed.

In total, in all fishing areas, the development of the generally acceptable volume of fishing for Pacific walruses amounted to 65-68% over the past few years.

The veterinary and sanitary inspection of the Reginal Veterinary Laboratory receives the meat of marine mammals, namely the meat of seals (ringed seal, bearded seal, bay seal), walruses and whales.

In total for 2016-2017 50 samples of meat of marine mammals were received, this data is presented in Table 1.

| Table 1. The number of samples of meat of marine mammals in the Regional Veterinary Laboratory |
|---------------------------------------------------------------|
| Product type | 2016 | 2017 |
| Seal meat (ringed seal, bearded seal, bay seal) / sample | 6 | 10 |
| Walrus meat / sample | 10 | 16 |
| Whale meat / sample | 3 | 6 |
| **Total amount of samples:** | **19** | **31** |

Along with the organoleptic assessment of meat, laboratory studies on safety indicators according to SanPin 2.3.2.1078-01 were conducted:

- microbiological (QMAFAnM, UFC / g, Coliform bacterias, salmonella, listeria);
- physical and chemical (determination of PH, amino-ammonia nitrogen, CuSO4, reaction to peroxidase, formal reaction, determination of the acid number of fat);
• parasitological (trichinosis).

The number of samples received at the Regional Veterinary Laboratory is presented in Figure 1.

![Figure 1. The number of samples of meat of marine mammals for 2016-2017 in the Regional veterinary laboratory of Anadyr](image)

According to the presented diagram, we can conclude that walrus meat comes to the laboratory for research in the majority of cases, then seal meats and the last one is whale meat. In addition, in relation to the previous year, the supply of meat of marine mammals increased slightly. However if we compare the production indicators, the volume of incoming samples to the laboratory for research remains low.

Thus, in 2016 in the Chukotka Autonomous Region 2038 seals were obtained, and only 6 samples were delivered for laboratory research (1 sample of ringed seal meat was obtained, 2 samples of bay seal and 3 samples of bearded seal). All 6 samples were subjected to microbiological, physico-chemical and parasitological indicators. According to the results of the study, 1 positive result was obtained, the bearded seal meat (1 sample) belonging to the enterprise of the Chukotka region, did not meet the requirements of SanPin 2.3.2.1078-01 according to organoleptic, physico-chemical and microbiological indicators, the bacteria of the *Proteus* genus were found in the meat sample.

In 2017, 1867 seals were obtained, and only 10 meat samples were subjected to laboratory tests (bearded seal- 3 samples, ringed seal - 7 samples). No positive samples were found.

Figure 2 shows the number of seals obtained and laboratory-tested for 2016-2017.

![Figure 2. Indicators of production and laboratory studies of seal meat for 2016-2017](image)
According to the data obtained in 2016-2017 it was found that only 0.41% of the seal meat of the total catch was subjected to laboratory research.

In 2016, 971 walruses were obtained in the coastal zones of Chukotka. Only 10 meat samples were sent to the Regional Veterinary Laboratory for research. The research showed that 3 samples of meat belonging to the Chukotka region, according to physicochemical indicators of doubtful freshness were found and bacteria of the *Proteus* genus were found in one sample. In addition in one meat sample, *Trichinella spiralis* larvae were found. According to the results of laboratory studies, it was found that these meat samples are not valid for consumption.

In 2017, 1,020 walruses were obtained, and only 16 samples were sent to the laboratory. According to the results of laboratory studies, it was found that in one walrus meat sample, physicochemical parameters were higher than normal, and also UFC / g of microbiological indicators were higher than normal, which did not meet the requirements of SanPin 2.3.2.1078-01.

Figure 3 shows the amount of walrus meat obtained and laboratory-tested.

![Figure 3. Walrus meat production and laboratory research indicators for 2016-2017](chart)

According to the data obtained in 2016-2017 it was found that only 1.31% of walrus meat from the total catch was laboratory tested.

As for the whales, in 2016 129 animals were obtained, and only 3 samples were sent to the laboratory to determine the quality and safety indicators. In 2017, 120 animals were obtained, and only 6 samples were tested. During laboratory studies on the organoleptic, physico-chemical, microbiological and parasitological indicators of positive samples were not found.

Figure 4 shows the indicators of whale meat obtained and laboratory-tested.

According to the data obtained in 2016-2017 it was found that only 3.61% of total whale meat was laboratory tested.

Thus, in the course of the above mentioned studies, it was found that the amount of produced meat significantly exceeds the number of meat subjected to laboratory research. The results are shown in Figure 5.
Due to the establishment of trichinosis in the meat products of marine mammals, the Chief State Inspector of the Chukotka Autonomous Region issued a directive on the organization of veterinary and sanitary inspection of meat of marine mammals. According to the directive, all products of marine fishing are subject to veterinary and sanitary inspection with obligatory trichinoscopy of meat.

Veterinary and sanitary inspection of meat of marine mammals is carried out directly at the places of production and in units of the state veterinary service of the region at veterinary stations, stations for combating animal diseases in accordance with the Rules for veterinary inspection of slaughtered animals and veterinary and sanitary inspection of meat and meat products. For trichinoscopy, a veterinarian or representative of a territorial-neighboring community takes samples from the following muscle groups: tip of the tongue up to 20 grams; eyelids and eyes up to 20 grams; intercostal cervical and chewing muscles of at least 50 grams, the total mass of the sample from one animal should be at least 200 grams of muscle mass. The carcasses and samples taken from them should be marked with the same number and they should not be consumed, sold or processed before trichinoscopy and branding, they only can be sent for storage.
Carcasses and meat products recognized as poor by the results of veterinary and sanitary inspection and (or) laboratory tests, affected by trichinosis must be disposed in accordance with relevant documents.

4. Conclusion

According to the analysis of regulatory documentation and laboratory studies, it is found that the fishing of marine mammals is the most important source of livelihood and activity of the indigenous population of Chukotka. The meat and by-products of marine mammals are the staple food of the indigenous people, since this meat is a high-value food product containing a significant amount of protein and important minerals. Therefore, in order to exclude infection with anthroponotic disease of the indigenous population, it is necessary to conduct a veterinary and sanitary inspection of the meat of marine mammals [8, 9].

Thus, the indigenous population, tribal communities and agricultural enterprises of the region can conduct fishing for marine mammals, according to the allocated quotas.

The main reason for undeveloped quotas for marine mammals is the complex logistics in the region. The largest fishing is carried out on the Chukchi Peninsula, and small villages of the Arctic coast cease to hunt due to the complex and unreliable transport scheme from the regional centers and Anadyr.

In addition, during the laboratory studies, the following positive results were obtained: walrus meat by physicochemical indicators of doubtful freshness was found and bacteria of the Proteus genus were found in one sample. Moreover, in one walrus meat sample, larvae of Trichinella spiralis were found. According to the results of laboratory studies, it was found that these meat samples were not valid and did not meet the requirements of SanPin 2.3.2.1078-01.

According to the data obtained in 2016-2017 it was found that only 0.41% of seal meat, 1.31% of walrus meat, and 3.61% of whale meat from the total catch were laboratory tested.

Thus, in the course of the above mentioned studies, it was found that the amount of produced meat significantly exceeds the amount of meat subjected to laboratory research.

The existing standards that are suitable for the meat of other slaughtered animals are not suitable for this category of meat since the meat of marine mammals is special. Therefore, it is necessary to specify the concepts of color, size, condition of fat and norms of safety indicators in the regulatory documents when conducting physico-chemical and other studies of meat and internal organs of marine mammals [10.3]

The studies were carried out using the equipment of the collective use center of “Agrarian and technological research center” of Omsk State Agrarian University.

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