Veterinary and Sanitary Examination of Commercially Important Broad Whitefish in Ust-Yansky Municipality, Yakutia

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Abstract. This paper presents the results of veterinary and sanitary examination of fish caught in Ust-Yansky Municipality, Republic of Sakha (Yakutia). Subject to examination was broad whitefish. The goal was to see if the catch was in line with the safety regulations per GOST. To that end, fish freshness was tested organoleptically, physically, chemically, and microbiologically. Veterinary and sanitary examination concluded that all the broad whitefish caught in the Ust-Yansky Municipality was "dubiously fresh" in terms of organoleptic indicators applicable to the mucus, scales, mouth, eyes, gills, fins, anus, muscles, abdominal cavity, and internal organs. Physical and chemical tests (pH, peroxidase reaction, copper sulfate reaction, ammoniacal nitrogen content, and hydrogen sulfide content) returned indicators that matched the category of 'fresh fish'. Microbiological tests showed that TVC, CFU/g was within the acceptable limit of $1 \times 10^3$, coliforms, S. Aureus, Salmonella, and Listeria monocytogenes were not isolated. Parasitological testing did not detect helminths or their larvae in the muscles. Reason being, fish carry many species of helminths that threaten humans. Toxicological testing revealed Pb content of 1.1±0.2 mg/kg, which did not correspond to the maximum acceptable concentration. HCH and DDT levels were within acceptable limits as well. Radionuclide testing reveled cesium$^{137}$ and strontrium$^{90}$ contents within the acceptable concentrations per TR TS 021/2011 Food Safety. Broad whitefish was subjected to all veterinary and sanitary tests, one of which indicated dubious quality.

1. Introduction
Veterinary services are tasked, among other things, to make sure that people have access to safe, high-quality fish and fish products.

Fish, fish products, and catch other than fish are a virtually inexhaustible source of multiple nutrients that the human body requires, primarily native proteins, lipids, carbohydrates, vitamins, and minerals. Yakutia’s rivers (Anabar, Olenyok, Lena, Yana, Indigirka, and Kolyma) are home to 39 fish species, 20 of which are of commercial importance [17,30]. Fish are susceptible to invasive diseases, some of which compromise their own health and may cause mass death of fish; others threaten consumers of fish, be it humans, animals, or birds. Invasive diseases deteriorate the quality of fish; infected fish is often wasted and has decreased content of nutrients (fats, proteins, carbohydrates, vitamins, and micronutrients) in its tissues. Invasive diseases also have pronounced clinical signs, which ruin the appearance of fish [19,22]. Being of poor commercial and nutritional quality, human and animal consumption of affected fish is either limited or requires pretreatment [1]. Such fish is
sorted into a lower grade, has worse quality; sometimes, whole batches need to be rejected; even fresh catch might be unsellable [23,24].

Broad whitefish is one of the most nutritionally valuable commercially important fishes, as it is rich in fats but at the same time easily digestible and highly nutritional for human consumption [27,28].

Ust-Yansky Municipality is known for its gold mining, logging, and repair of mining and roadwork machinery; these businesses generate toxic waste that fish can absorb and accumulate.

2. Research methods

The goal hereof was to carry out veterinary and sanitary examination of broad whitefish caught in the Ust-Yansky Municipality, Republic of Sakha (Yakutia) in order to collect the following data: organoleptic, physical, chemical, and microbiological indicators; HCH and DDT; toxins; radioactivity; parasitic infestation.

Research was carried out by Yakutia Veterinary Testing Lab and by the Department of Veterinary and Sanitary Examination and Hygiene, Faculty of Veterinary Medicine, Arctic State Agrotechnological University in 2021.

Tests were taken on broad whitefish caught in Fall in the Tenkeli River, village of Tenkeli, Ust-Yansky Municipality, Republic of Sakha (Yakutia). Tests were done on three samples.

Sampling was guided by GOST 7630-96 Fish, marine mammals, marine invertebrates, algae and products of their processing. Labelling and packing [14,25].

Physical and chemical tests were carried out per applicable standards. Freshness was studied by reactions to peroxidase, hydrogen sulfide and CuSO4, coupled with potentiometric pH testing, ammonia testing by commonly accepted methods, and bacterioscopy. For bacterioscopy, we sampled smears from superficial and deep layers of muscle tissue in fish.

Microbiological tests were carried out per GOST ISO 7218-2011 Microbiology of food and animal feeding stuffs. General requirements and guidance for microbiological examinations. Raw material and muscle tissue surface microflora was tested by Gram staining and making microbial counts under a microscope in ten fields of view. Total viable counts (TVC) were made per GOST 10444.15-94 Food products. Methods for determination of quantity of mesophilic aerobes and facultative anaerobes [2,3,4,5,7,8,9,16].

HCH and DDT content was measured per GOST R 51209-98 Method for determination of chlorine-organic pesticides by gas-liquid chromatography [15,18].

Toxic elements (lead, cadmium, mercury, and arsenic) were quantified by inverse voltammetry [6,13].

Cs$^{137}$ content was measured per GOST 32161-2013 [10,12].

Sr$^{90}$ was measured per GOST 32163-2013, GOST 32164-2013 [11,12].

For parasitological testing, muscle tissue of broad whitefish was examined for the presence of Myxosporidia cysts [2].

3. Results

Organeleptic tests showed the following: all specimens had well-pronounced muscle stiffness and no mucus, were weather-beaten and had no foreign odors or blood admixtures; the mouths were shut, the opercula closed rightly. The fish were dark red and had typically shaped, non-swollen abdomens; non had a protruded, mucus-leaking anus. Muscles were elastic and attached to the bones tightly. Internal organs were well-shaped, had natural color and texture. The broth was cloudy and had a specific smell. Thus, the organoleptic conclusion was that all the three samples were “dubiously fresh” [26].

Physical and chemical tests showed the following: Sample 1. pH 6.81, a sign of healthy fish; negative reaction to peroxidase, immediate browning of the gill tissue extract without blue staining; positive reaction to copper sulfate with slight clouding. Conclusion: “dubiously fresh”.

Sample 2. pH 6.80, a sign of healthy fish; negative reaction to peroxidase, immediate browning of the gill tissue extract without blue staining; positive reaction to copper sulfate with slight clouding. Conclusion: “dubiously fresh”.

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Sample 3. pH 6.82, a sign of healthy fish; negative reaction to peroxidase, immediate browning of the gill tissue extract without blue staining; positive reaction to copper sulfate with slight clouding. Conclusion: “dubiously fresh”.

Microbiological tests of broad whitefish sampled in the Ust-Yansky Municipality showed a total viable count (TVC) within the acceptable limits (1x10^3). Coliforms were not found in any 0.001 g sample. S. aureus was not found in any 0.01 g sample. Pathogenic microorganisms including salmonella and listeria were not found in 25 g samples [20,21,29].

Parasite tests did not detect any human-threatening helminths or larvae. The Republic of Sakha (Yakutia) has very high incidence of naturally occurring biohelminthiases.

Table 1. Fish safety indicators per SanPin 2.3.2.10-78.

| Indicator                        | Sample 1            | Sample 2            | Sample 3            | Standard requirement |
|---------------------------------|---------------------|---------------------|---------------------|----------------------|
| **Microbiological indicators:** |                     |                     |                     |                      |
| - TVC, CFU/g                    | ≤ 1 x 10^3          | ≤ 1 x 10^3          | ≤ 1 x 10^3          | 1 x 10^5             |
| - Coliforms per 0.001 g         | not detected        | not detected        | not detected        | not acceptable       |
| - S. aureus per 0.01 g          | not detected        | not detected        | not detected        | not acceptable       |
| - Pathogens, incl. salmonella, per 25 g | not detected | not detected | not detected | not acceptable |
| L. monocytogenes per 25 g       |                     |                     |                     |                      |
| **Toxic elements, mg/kg:**      |                     |                     |                     |                      |
| Cadmium                         | < 0.02              | < 0.02              | < 0.02              | ≤ 0.2                |
| Lead                            | 1.1±0.2             | 0.9±0.2             | 1.0±0.2             | ≤ 1.0                |
| Arsenic                         | 0.2±0.02            | 0.2±0.02            | 0.2±0.02            | ≤ 1.0                |
| Mercury                         | < 0.002             | < 0.002             | < 0.002             | ≤ 0.6                |
| **Pesticides, mg/kg:**          |                     |                     |                     |                      |
| - HCH (α, β, γ-isomers)         | < 0.002             | < 0.002             | < 0.002             | 0.2                  |
| - DDT and its metabolites       | < 0.002             | < 0.002             | < 0.002             | 2.0                  |
| **Radionuclides, Bq/kg**        |                     |                     |                     |                      |
| - Strontium-90                  | 6.4±12.4            | 6.4±12.4            | 6.4±12.4            | ≤ 100                |
| - Cesium-137                    | 3.0                 | 3.0                 | 3.0                 | ≤ 130                |

Thus, chemical tests of broad whitefish sampled in the Ust-Yansky Municipality showed that pesticides and their isomers were within the acceptable limits. The samples were therefore consistent with hygienic standards regulations.

Toxicological testing showed Cd content below 0.02 (acceptable); As within 0.2±0.02 (acceptable), and Hg below 0.002 (acceptable).

Toxicological testing revealed Pb content of 1.1±0.2 mg/kg, which did not correspond to the maximum acceptable concentration.

Radiological testing showed Cs^{137} and Sr^{90} to be within the acceptable limits. No deviations from the standard requirements.

4. Conclusions
Thus, veterinary and sanitary examination concluded that all the broad whitefish caught in the Ust-Yansky Municipality was “dubiously fresh” in terms of organoleptic indicators applicable to the mucus, scales, mouth, eyes, gills, fins, anus, and muscles.
As far as physical and chemical tests are concerned, fish samples reacted negatively to peroxidase and positively to copper sulfate, indicating dubiously fresh fish; however, it was healthy fresh fish pH-wise.

Microbiological tests showed that TVC was within the acceptable limit of $1 \times 10^5$, coliforms, S. Aureus, Salmonella, and Listeria monocytogenes were not isolated; no microbial pathogens.

Parasites or HCH/DDT not found either.

Toxins (cadmium, arsenic, and mercury) were within the acceptable limits. However, lead was above the acceptable limit.

Radionuclide testing revealed cesium$^{137}$ and strontium$^{90}$ contents within the acceptable concentrations per TR TS 021/2011 Food Safety.

5. Conclusion

Thus, organoleptic, physical, and chemical tests showed that fish was of dubious quality. Microbiological, parasitological, and radiological parameters were in line with the requirements. Chemical and toxicological tests showed abnormal lead content of $1.1 \pm 0.2$ mg/kg.

6. References

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