

Modern ecological and hygienic problems of the agricultural economy associated with development of pond fish farming

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Abstract. The materials on the study of the content of heavy metals and organochlorine pesticides in fish are presented. It has been established that the level of heavy metals and pesticides in fish is influenced by the territorial location of the pond production. Therefore, the content of lead, cadmium and mercury in the liver and gonads of carp was higher than the permissible values for fish growing in ponds located in the city limits near highways. The pesticides DDT and HCH were detected in the organs of fish in the territories of pond fish farming of farms. Residual concentrations of pesticides contained in fish did not exceed the maximum permissible levels. In order to safely consume fish grown near highways by the population, we recommend the removal of internal organs (liver and gonads) from fish products.

1 Introduction

One of the priority tasks of the state policy of the Russian Federation is the development of fisheries in inland waters. Wherein, the share of pond fish farming, as one of the main sectors of commercial aquaculture, must constantly develop. Fish farming is a very promising direction of agricultural activity, since these products are not only in high demand among the population, but also among entrepreneurs who sell them. In real conditions, even in the well-known fish farms of the Astrakhan and Rostov regions, fish production is extensive, due to sea and river fisheries, and not the development of pond fish farming. In general, in Russia, 60 % of the volume of aquaculture production falls on the south of the country (Rostov, Astrakhan and Volgograd regions, as well as Krasnodar and Stavropol territories) [1]. However, if we compare the economic efficiency of fish production with other sectors of agriculture, it shall be stated that the product of fish production when sold from one hectare of land will be several times more economically feasible than selling the amount of grain crops from the same area.

Moreover, pond fish is a food product necessary for humans, containing complete proteins that are easily digestible at any age, as well as essential (not synthesized in the body): fatty acids of the omega-6 group (linoleic and arachidonic) and omega-3, vitamins

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(A, D, E, K), mineral (calcium, phosphorus, magnesium, potassium, sulfur, chlorine) substances [2-4]. Considering the above, in recent years, there has been an increase in pond fish farming in Russia. So, in the territory of the middle Volga, namely, in Saratov region, practically in the urban area, near the bypass road, ponds for joint water use have appeared for fish farming. These include: a pond near the village of Kleshchevka; a cascade of three ponds located behind the Volzhsky district of the city, near the Elshanka river; two ponds located behind the Zavodskoy district of the city, one near the bypass road, on the Latryk river, near the village of Novoaleksandrovka, another pond near the village of Ereemeevka. A number of large fish farming ponds are now being developed on the agricultural lands of the agro-industrial centers of the Saratov region in the Engels, Yekaterinovskiy, Rtishchevskiy, Pugachevskiy, Ivanteevskiy districts. All of the above reservoirs are provided with a convenient year-round access to the territory of pond fish farming.

The filling of ponds is mostly natural. The ponds are mostly stocked with carp, sazan, silver carp, crucian carp and tench. We selected for study the fish-breeding enterprises of the Saratov region, which switched to extensive forms of pond carp breeding, by growing carp in polyculture with carp [1].

In the territories of pond fish farming, trade pavilions for the sale of fresh fish have been installed, places for paid fishing have been organized.

In the territories of pond fishing, thanks to introduction of new technologies, all conditions have been created for the wintering of fish in the pond and the absence of unpleasant consequences in the form of suffocation. For this purpose, oxygen supply (aeration) is organized in a winter reservoir covered with ice with the help of electric air compressors. Also, by organizing holes, or openings on the surface of ice-covered ponds, toxic gases (ammonia and hydrogen sulfide) are removed from the water, which are formed in silty organic sediments from the waste products of fish and plants [5].

Wherein, there are numerous publications indicating the presence in water bodies of a colossal amount of various chemical pollutants capable of accumulating in aquatic ecosystems and, especially, in bottom sediments [6-7]. However, even if the concentration of ecotoxicants does not go beyond the maximum permissible values, commercial fish have the ability to deposit pollutants in the liver, kidneys, muscles, gonads and gill leaves [8]. Wherein, if data on the pollution of environmental objects by ecotoxicants (atmospheric air, water of reservoirs, soil), food products are widely presented in the available references [9], then information on the content of pollutants in the organs and tissues of the body of fish grown in pond fish farming are very limited and controversial, which served as the basis for this study.

2 Materials and Methods

For carrying out field studies, two reservoirs were selected: a pond in the area of the city limits near the village of Kleshchevka and a fish pond in the Ivanteevskiy district of agro-industrial farms. In both reservoirs, pond carp breeding was carried out by growing carp in polyculture with carp. At least three to five specimens of each fish species (carp and sazan) were taken from each pond. The total combined weight of a particular test fish species from a particular pond, as a rule, did not exceed 3.0 kg.

Sampling of pond fish for laboratory tests and study was carried out taking into account the recommendations drawn up by MosMR 2.3.2.006-03. The recommended sample mass during the examination of the sample for the chemical investigation of the content of heavy metals (HM) and organochlorine pesticides (OCP) was at least 500 g.

To compile a combined sample from each specimen of a specific species of pond fish (carp and sazan), in order to further study, the concentration of chemical contaminants in

tissues and organs, three point samples were cut out from the cut fish: muscle tissue of the sidewall carcass, liver and milk. Therefore, each spot sample represented a minimum amount of production (about 3-5 grams) taken from a specific location of a specific fish species with the aim of further compiling a combined research average. Each of the pooled average product spot samples was packed in a sealed thermal container with a lock, which was labeled and the contents of the bag described. The labeled sample was transported to the certified analytical laboratory of the branch of CEP Ecomir LLC in a chilled form in a refrigerator bag. The marking contained information about the serial number of the sample, the type of fish, the place of taking a spot sample from the opened fresh fish, as well as the specific place of catch - the collection of products (pond, area).

In the research laboratory, the delivered samples were passed through a meat grinder, ground in a homogenizer and ground in a mortar until smooth. Chemical analysis of the samples taken was aimed at investigating the content of four HMs of lead (Pb), cadmium (Cd), mercury (Hg) and arsenic (As). Determination of the content of metals Pb, Cd, As in organs and tissues of fish was carried out using adsorption stripping voltammetry on an IVA-5 analyzer. The Hg content in the studied fish samples was determined by the method of flameless atomic absorption spectrometry of cold vapor with preliminary mineralization of the sample under pressure on a RA 915 M analyzer with a RP-92 pyrolytic attachment. The content of residual amounts of organochlorine pesticides DDT, HCH in homogenized fish samples was analyzed by gas-liquid chromatography on a Chromatek Crystal gas chromatograph with an electron capture detector in the measurement range of 0.005 - 0.5 mg/kg. The assessment of the permissible levels of safety for the detection of heavy metals and pesticides was carried out according to the Unified Sanitary and Epidemiological and Hygienic Requirements for Products (Goods) Subject to Sanitary and Epidemiological Supervision from 2010. Toxic elements were determined by standard methods: lead — according to GOST 26932, cadmium — according to GOST 26933, zinc — according to GOST 26934, copper — according to GOST 26931, arsenic — according to GOST 26930, mercury — according to GOST 26927 and MU 5178.

3 Results and Discussion

It is widely known that one of the main and most dangerous anthropogenic pollutants of water bodies today are heavy metals and organochlorine pesticides [10-22]. Through ecological trophic chains, ecotoxicants first enter the body of the inhabitants of water bodies, and then they can pose a significant danger to human health [23].

The studies carried out (see Tables 1 and 2) found that the accumulation of TM and KhOP more intensively took place in the organs (liver and milk) of fish than in muscle tissues. Wherein, the content of metals Pb, Cd, Hg in the organs of carp (Table 1) living in ponds located in the city limits near the highways near the village of Kleshchevka was 1.5-2.5 times higher than the maximum permissible values. Similar data were previously obtained by I.N. Bedritskaya, 2000 [24] in the study of fish toxicosis, taking into account the habitat and the nature of the diet when growing carp on the warm waste waters of the Kirishskaya GRES-19 and Kirishskaya NPP. The intake, followed by the accumulation of TM in the liver and gonads of carp, was apparently associated with the cumulating ability of benthophages (chironomids, oligochaetes), which are the main natural food for this fish species. Wherein, it shall be noted that in the bodies of carp inhabiting the ponds of the Ivanteevsky district, located on farmland, far from major highways, the detected concentrations of heavy metals were significantly lower than the regulated AEL. Moreover, the metal arsenic not present in the emissions of road transport, regardless of the place where pond fish was grown, was detected in organs (liver and gonads) in background

concentrations, 100-1000 times lower than permissible levels, and in muscle tissue samples of carp and sazan was absent. The studies carried out revealed significant differences in the content of heavy metals and organochlorine pesticides in the organs and tissues of the organism of farmed fish. So, if the concentrations of heavy metals were present in quantities exceeding the permissible levels in the organs (liver and milk) of carp and carp living in ponds near major highways of the city, then organochlorine pesticides, on the contrary, were found only in the body of fish grown in artificial reservoirs in the territories of the rural farming agglomerations. Wherein, residual concentrations of organochlorine pesticides (DDT and HCH) were either not detected, which was typical for fish muscle tissue, or were found in carp organs at the level of permissible concentration values. Similar results were obtained by us in the study of the content of heavy metals and pesticides in the tissues and organs of the carp, as well as the places of their breeding (Table 2).

Table 1. Distribution of HM content in tissues and organs of carp grown in ponds near the village of Kleshchevka and Ivanteevsky district of Saratov region

Heavy metals (AEL for fish content)	Concentrations of heavy metals (mg/kg) in tissues and organs of carp grown in fish ponds					
	near the village of Kleshchevka			Ivanteevsky district		
	liver	milk	muscle	liver	milk	muscle
Pb (1.0 mg/kg)	2.5±0.3	1.1±0.02	0.1±0.03	0.9±0.2	0.2±0.01	No
Hg (0.6 mg/kg)	0.9±0.07	0.7±0.05	0.4±0.05	0.3±0.05	0.1±0.01	No
Cd (0.2 mg/kg)	0.3±0.06	0.3±0.06	0.1±0.02	0.1±0.02	0.05±0.001	No
As (1.0 mg/kg)	0.01±0.002	0.001±0.0003	No	0.01±0.002	0.001±0.0003	No

Table 2. Distribution of the content of organochlorine pesticides in the tissues and organs of carp grown in ponds near the village. Kleshchevka and Ivanteevsky district of Saratov region

Names of organochlorine pesticides (AEL for fish content)	Concentrations of organochlorine pesticides (mg/kg) in tissues and organs of carp grown in fish ponds					
	near the village of Kleshchevka			Ivanteevsky district		
	liver	milk	muscle	liver	milk	muscle
DDT and its metabolites (0.3 mg/kg)	0.01±0.002	No	No	0.3±0.02	0.2±0.01	No
HCH (α, β, γ - isomers) (0.03 mg/kg)	0.007±0.07	No	No	0.03±0.004	0.03±0.004	No

4 Conclusion

Therefore, the studies carried out have established that the greatest threat to public health can be posed by fish that inhabit ponds near major highways of the city limits, which are sources of heavy metal emissions. For the safe use of such products, the removal of internal organs (liver and milk) from fish products shall be recommended. It shall also be recommended to limit the work associated with creation of ponds within the city limits and along major highways.

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