Studii şi Cercetări	Biologie	11	127 - 131	Universitatea din Bacău	Mai 2006

EVALUATION OF PHYSICAL, CHEMICAL AND BIOCHEMICAL MODIFICATIONS OF THE CULTURE STOR STURGEON MEAT (*ACIPENSER STELLATUS* PALLAS) UNDER REFRIGERATION

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Key words: *sturgeon, stor sturgeon (Acipenser stellatus Pallas), proteins, aminoacids, glycogen, lactic acid, inorganic phosphorus, refrigeration*

INTRODUCTION

The fish belongs to the category of slightly perishable food products which makes it to be consumed or preserved immediately after catch.

If the fish is not preserved by means of one of the methods of preservation, such as: chilling, keeping in the ice, freezing, etc., the nutritive value of the meat decreases gradually so that, in state of advanced decomposition the fish meat becomes toxic. The main cause that makes fish get deteriorated is the activity of contaminant micro-organisms to which the autolysis processes are added. Avoidance of fish meat degradation is achieved by using appropriate methods of preservation.

Sturgeons are known and appreciated by consumers for the quality of their meat and especially of the caviar. The fish meat, including the sturgeon is appreciated for its dietary value derived from the content of n-3 and n-6 fatty acids which go into the composition of cell membranes and play an important role in the preservation of cardiovascular diseases.

As the last decade has registered an increased use of the technologies of sturgeon breeding based on intensive system, the sturgeon meat derived from fish farms represents a new offer on the international and EU markets. The commercial significance of the sturgeons and their economic value have determined excessive catch of these species in our country. Thus, the culture of sturgeons based on intensive and recycled system, and in fish ponds has been imposed as an alternative to the dramatic decrease of the populations of anadromous sturgeons in the river Danube. A disadvantage of the culture sturgeon breeding is represented by the influence of the aquatic environment and fodder on the taste of the meat. The environmental changes affect the endocrine balance modifying the physiology of the fish and the quality of its meat. The nutritional quality of the sturgeon meat is influenced by the method of preservation.

As part of our study, by the meat of the culture stor sturgeons under chilling preservation conditions.

MATERIAL AND METHOD

The biological material under study consisted of culture sturgeons from the species *Acipenser stellatus* (stor sturgeon) witch the average mass/fish of 652,5g.

The samples of culture sturgeons were gathered within the Station of breeding sturgeons in recycling system belonging to ICDEAPA Galati.

Immediately after catch, the specimens of culture sturgeon were processed and examined in state of first freshness aiming at the ponderal anatomy, the sensorial, micro-biological characteristics and the physical, chemical and biochemical analysis.

In order to assess the modifications occurred in the sturgeon meat in conditions of chilling preservation, there were collected samples which were stored at cooling temperature (4^0C) until the sensorial indicators of meat degradation appeared. The cooled samples were examined every other day.

The humidity, proteins and fats were determined using the methods recommended by AOAC, 1990. The content of free aminoacids, non-protein nitrogen, ammonia nitrogen was analyzed accordance with the methods recommended by Ionescu (1992).

RESULTS AND DISCUSSIONS

The investigations performed were aimed at estimating the modifications of the physical, chemical and biochemical indicators which occur in the meat of the culture sturgeons immediately after catch and in conditions of cooling preservation.

The ponderal anatomy of culture sturgeon

The results regarding the anatomo-ponderal examination of culture sturgeon specimens belonging to the species Acipenser stellatus are shown in table 1.

The culture stor sturgeon samples aged 18 months have the mass ranging between 0.555 kg and 0.750 kg.

The statistical analysis of the anatomical ponderal characteristics shows that the average percentage values of the culture stor sturgeon for the head (26.76%), viscera (7.3%), skin (14.95%) and fins – 4.75 % are close or sometimes lower than the results reported on other species of sturgeon.

Table 1. Ponderal anatomy of stor sturgeon samples (*Acipenser stellatus)*

Sample	Fish weight, g	Fillets		Head		Viscera		Fins		Skin shields		Notochord+ losses at filleting	
		g	%	g	%	g	%	g	%	g	%	g	%
1	750	350.2	46.7	195.0	26.0	50.2	6.7	20.2	2.7	94.5	12.6	40.0	5.3
2	675	292.3	43.3	171.5	25.4	40.5	6.0	18.2	2.7	102.0	15.1	50.6	7.5
3	730	317.6	43.5	200.8	27.5	51.1	7.0	21.9	3.0	89.8	12.3	48.9	6.7
4	580	207.1	35.7	159.5	27.5	44.7	7.7	34.8	6.0	81.8	14.1	52.2	9.0
5	555	140.4	25.3	157.6	28.4	46.6	8.4	41.0	7.4	104.9	18.9	64.3	11.6
6	625	209.4	33.5	161.2	25.8	50.0	8.0	41.9	6.7	104.4	16.7	58.1	9.3

The edible part of the marketable sturgeons represents 88% on the average whereas the inedible one, only 12% (Billard, 2002). Moreover, the consumption value of the culture sturgeon may rise up to approximately 81% if the fish is exploited to the point where only the inedible parts (viscera, gills, shields) have been removed (Ionescu et al, 2005). At the common sturgeon (Black Sea sturgeon) the edible part reaches a maximum percentage of 85.6%.

As for the specimens under our study with the average mass/specimen of 0.652 kg, the meat percentage is 39% on the average (figure 1).

This percentage gets higher, the bigger the specimens are. In case of the sturgeon species Acipenser ruthenus and Acipenser baerii, the fillet percentage is 40 ± 1 and 42 ± 3.5 respectively (Mele et al.2001).

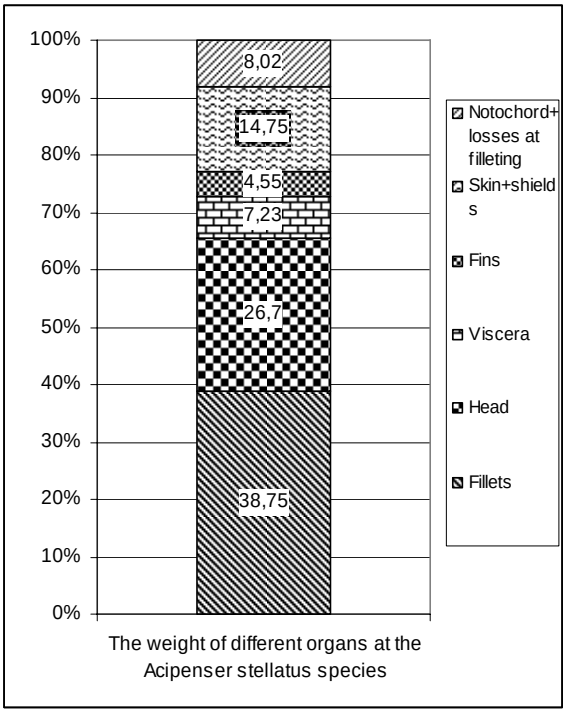

Fig. 1. The ponderal average of the organs of *Acipenser stellatus*, aged 18 months

Table 2. The global chemical composition for stor sturgeon meat (*Acipenser stellatus*)

Time of storage at 4^0C, days	Fish weight, g	Moisture, g%	Total nitrogen, g%	Proteins, g%	Fat, g%	Ash, g%
Immediately after catch	750	76.9	2.72	16.98	4.57	1.23
2	675	77.2	2.68	16.73	4.32	1.12
4	730	77.1	2.73	17.04	4.47	1.27
6	580	78.8	2.60	16.23	3.64	1.02
8	555	78.9	2.65	16.55	3.28	1.10
10	625	78.0	2.71	16.95	3.58	1.14

The physical, chemical and biochemical analysis of the sturgeon meat

In order to assess the modifications which appeared in the fish meat during the cooling preservation, there have been periodically analyzed (at regular 48 hour intervals) the main biochemical indicators for the culture stor sturgeon meat.

The chemical composition of the fish highly fluctuates from on species to another and from specimen to specimen according to sex, age, environmental conditions and season.

The fluctuations in the chemical structure of the fish meat are closely related to the type and composition of the ingested food, to the migrations and the modifications appeared during the reproduction period. There are periods in the fish growth when the food consumption is decreased owing to several natural and physiological causes (migrations, reproduction, etc.) or some external causes, such as lack of food. As for the experiment we carries out, the chemical composition of the fish meat was influenced by the environmental conditions offered by the recycling breeding system, the food (proteins 45%, lipids 12%) and also the mass of the examined samples as well as the preservation conditions.

The analysis of the aquatic environment in the recycling breeding system has shown normal values and for the principal physico-chemical indicators of the water.

At the culture stor sturgeon, the global chemical composition determined every other day and pointed out in table 2, showed insignificant variations from sample to sample.

The fish raised under various aquaculture systems as we have done may indicate a fluctuation in the chemical composition, in which case several variation factors can be controlled. In this way, there is the possibility to predict the chemical composition that may be obtained at the fish raised in fish farms depending on the goals the farmer has in view.

The factors that may influence the chemical composition and the quality of the fish in aquaculture are: the food structure, the environmental conditions, the size of the fish, the genetic inheritance, etc. Yet, the factor with the greatest impact on the chemical composition and implicitly on the quality of the fish is the structure of the food. Farmers are interested in obtaining important crops within a short while and with a small amount of food.

As in the case of the culture white sturgeon (Ionescu et al. 2005), the chemical composition of the culture stor sturgeon meat shows a high content of water (76.9 – 78.9%), an average content of proteins (16.23 – 17.04 %) and a low one of lipids (3.28 – 4.57%), the ash percentage being maintained ad a low and constant level.

Taking into consideration the analysis of the data obtained, it has been ascertained that humidity and the concentration of fat content vary within high levels at the examined sample; thus, the variation of the water content is 2% and of the lipids 1.3%, which is due to the preservation conditions by cooling.

Autolytic modifications of the culture stor sturgeon under refrigeration

Immediately after catch, the fish gets into autolysis. As a result out the four stages in the process of the cod meat degradation and modification of sensorial quality, the first two are due to, autolysis and the following two the bacterial activity (Huus,1976). The autolysis in the stor sturgeon meat under preservation conditions by cooling has been identified by means of determining the pH value, the accumulation of lactic acid, the titrable acidity and the concentration of phosphorus (table 3) during the 12 days of refrigeration.

Table 3. pH, lactic acid, titrable acidity and inorganic phosphorous during storage of culture stor sturgeon juveniles in air, at 4°C

Storage period, days	pH	Total titrable acidity, g%	Lactic acid, g%	Inorganic phosphorus, g%
Initial	7.10	0.173	0.144	0.345
2	6.95	0.191	0.157	0.357
4	6.80	0.214	0.165	0.379
6	6.70	0.219	0.178	0.385
8	6.65	0.226	0.196	0.397
10	6.60	0.232	0.221	0.427

The autolytic reaction of fish is produced by glycolisis enzymes, enzymes that involve the degradation of nucleotides, the enzymes of the digestive tract, calpain, collagenases, TMAO demethylase, etc.

After the fish death, the amount of oxygen directed towards the muscle tissues is interrupted and the necessary of energy stored in ATP molecules is obtained anaerobically, by means of glycolisis.

Under anaerobic conditions, glycogen and/or fats are glycolitically changed into lactic acid which is accumulated in tissues and, as a result, lowers the pH of the muscle.

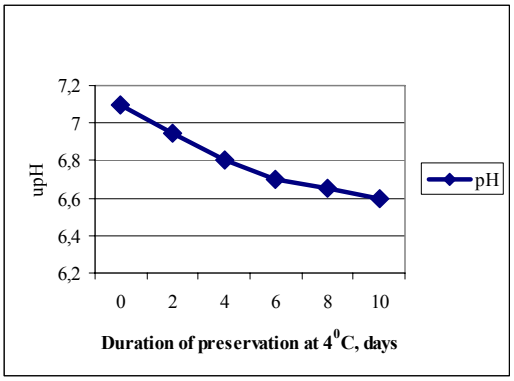

Fig. 2. Evolution of pH during preservation culture sturgeon at 4°C

The decrease of PH has consequences upon the physical properties of the fish muscle. Thus, at a low pH, the muscle loses its capacity of water retaining which affects the meat texture.

Under conditions of preserving samples of culture stor sturgeon at 4°C, the pH gets 0.15 units lower during the first two days of exposure to cold and then the decrease is less emphasized (figure 2). By losing water, the fish gets more rigid, the connection between the pH decrease an the muscle hardness being inversely proportional.

The concentration of lactic acid in the fish muscles depends on the quantity of glycogen stored in the live muscle. In general, the level of glycogen in fish is lower than at mammals and in addition stress leads to the reduction of the glycogen concentration. At the culture stor sturgeon the lactic acid presented an approximately constant accumulation in the muscles during the whole period of investigation (table 3, figure 3).

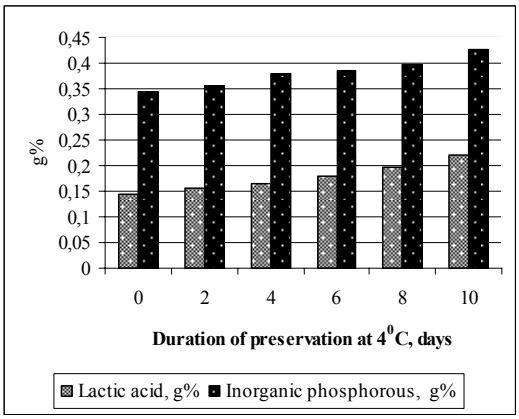

Fig. 3. Evolution of lactic acid and inorganic phosphorous during preservation culture sturgeon at 4°C.

The inorganic phosphorus is accumulated in the fish muscles through the process of enzymatic hydrolysis of some constitution phospholipids and phosphoproteids.

The cartilaginous fish are characterized by a lower level of nucleotides compared to the boned fishes as well as phosphocreatine, another integrated factor in the activity of the muscle, where it serves as a donor or acceptor phosphate groups (Ionescu A., 1992). The accumulation of inorganic phosphorus evolved positively with respect to continuous growth during the entire period of storage at 4^0C, from 0.345 g% to 0.427 g% after 10 days of preservation (figure3).

The nitrous extractive matter represents between 9-18 % from the total nitrogen in teleosteen fishes. The most important components of this fractions are volatile bases (ammonia and trimethylamine), the creatine, free aminoacids, nucleotides and purine bases and with cartilaginous fishes, urea.

The concentrations of non-protein nitrogen that was determined by us at the culture stor sturgeon immediately after catch indicated 295 mg%, which represented approximately 11% of total nitrogen (table 4). Thus, the longer the duration of fish preservation through cooling, the higher the quantity of non protein nitrogen, so that in 10 days of preservation in cold air at 4^0C, the fish reaches the weight of 426 mg%.

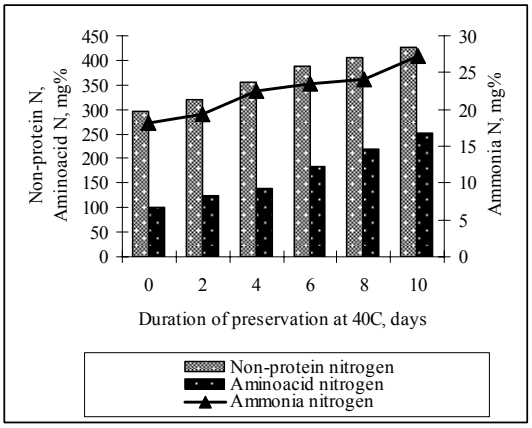

Fig. 4. Evolution of nitrogen compounds during preservation culture sturgeon at 4^0C.

Table 4. Effect of the refrigerated storage duration on the nitrogen fractions in the muscle of the culture sturgeon

Time storage, days	Total nitrogen g%	Non-protein nitrogen		Aminic nitrogen			Ammoniacal nitroge		
		mg%	% din azotul total	mg%	% din azotul total	% din azotul neproteic	mg%	% din azotul total	% din azotul neproteic
Inițial	2.72	295	10.85	101.3	3.71	34.33	18.18	0.67	6.16
2	2.68	320	11.94	124.7	4.65	38.97	19.31	0.72	6.03
4	2.73	355	13.00	139.0	5.09	39.15	22.54	0.82	6.35
6	2.60	389	14.96	184.0	7.08	54.32	23.58	0.91	6.06
8	2.65	405	15.28	220.0	8.30	47.30	24.11	0.91	5.95
10	2.71	426	15.72	251.8	9.26	59.11	27.20	1.00	6.38

The level of aminoacids in the culture stor sturgeon meat increases, the longer the duration of preservation. The initial concentration of free aminoacids – 101.3 mg% is close to the value reported for the shark (100 mg %), and cod fish (75 mg %) (Huus, 1995).

The accumulation of ammonia nitrogen during preservation in cold air at 4^0C, has reached the critical value of quality degradation in the tenth day of preservation (figure 4).

Although the fish considered a perishable food the culture stor sturgeon as well as white sturgeon have shown an extended length of resistance of 10 and 12 days respectively when preserved through cooling (Ionescu et al, 2005). This stands out as an important quality for fish managers.

CONCLUSIONS

Culture sturgeons represent a new offer on the Romanian and European markets. The highly nutritional as well as sensorial qualities of the sturgeon meat make this food to be in greater an greater demand.

The culture stor sturgeon analysed in this paper shows that from the point of view of its nutritional qualities and modifications suffered during preservation through cooling in air at 4^0C, it had an average weight/specimen of 652.5 g. Under these conditions, the fillet percentage was 39% on the average a value similar to the ones reported for other species of sturgeons.

At the age of 18 months with an average mass of 652.5 g%; the chemical composition of the culture stor sturgeon meat indicates a high content of water (76.9 – 72.9%), an average one of proteins (16.23 – 17.04%), and a low content of lipids (3.28 – 4.57%), the ash percentage being kept low and constant.

The physical, chemical and biochemical modifications suffered by the culture stor sturgeon at cooling and expressed by means of the value of nitrogen fractions, the accumulation of lactic acid, the degradation of proteins, of pH increase have led to the conclusion that the maximum duration of culture stor sturgeon preservation through cooling in cold air, at 4^0C is of 10 days.

REZUMAT

Carnea de păstrugă prezintă calităţi nutritive deosebite, conferite de conţinutul ridicat de proteină, de lipide cu grad mare de nesaturare, de vitamine şi substanţe minerale importante.

În vederea evaluării modificărilor fizico-chimice şi biochimice a cărnii de păstrugă de cultură conservată în regim de refrigerare s-au determinat caracteristicile anatomo-ponderale, constituienţii nutriţionali, degradarea nucleotidelor şi glicogenului precum şi efectul enzimelor proteolitice prin evaluarea compuşilor cu azot.

Pentru evaluarea modificărilor survenite în carnea de sturioni (*Acipenser stellatus* Pallas) în condiţii de conservare prin refrigerare, au fost recoltate probe care au fost păstrate la temperatura de refrigerare şi analizate din două în două zile, până la apariţia indicatorilor de degradare ai cărnii.

În urma analizelor efectuate s-a determinat timpul maxim de păstrare a păstrugii de cultură în regim de refrigerare în aer rece, la 4^0C.

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