ISSN: 1220-3173; E-ISSN: 2457-7618

THE INFLUENCE OF FISH FOR SALE STORAGE CONDITIONS ON ITS QUALITY PARAMETERS

INFLUENŢA CONDIŢIILOR DE DEPOZITARE A PEŞTELUI DESTINAT VÂNZĂRII ASUPRA PARAMETRILOR DE CALITATE AI ACESTUIA

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ABSTRACT | REZUMAT

Fish meat is a rich source of nitrogenous substances, brings a great supply of iron and fluoride and contains large amounts of phosphorus and vitamins. Due to the introduction of fish more and more into human nutrition, the main objective of the study was to identify the conditions under which the fishery products intended for sale are kept and to verify if the evaluated parameters are within the allowed limit. The study was conducted between March 2017 - May 2019 in a unit for fish breeding, but also in the retail store of fishery products obtained from a specialized unit, located in the south of Romania. During the study period, procedures specific to the food quality and safety management system were documented and implemented. Monitoring checklists have been designed for a series of parameters that demonstrate compliance with the legal requirements applicable to the studied field. At the retail store of fishery products obtained from the specialized unit, the fish is offered for sale in live, chilled and frozen form. In order to identify the technological particularities of growth and primary processing of the fish, the technological flows within the aquaculture unit were followed. The conditions for maintaining a favourable environment for the fish destined for sale in the living state were checked, monitoring the temperature, the pH and the oxygen of the water in the aquarium destined for the presentation for sale of the fish in the living state. At the same time, in the retail store of fishery products, there were made determinations regarding the parameters of keeping the fish intended for sale under refrigeration and freezing conditions. The temperature of the water in the aquarium where the fish intended for sale in the live state are kept, was between the values of 11.1°C and 14.1°C, the pH of the water in the aquarium, during the study period, varied between 6.9 and 7.4, and the oxygen level of the water was between 9.2 and 10.6 mg/l. In connection with the monitoring of the fish preserved by refrigeration, it was concluded that it has a temperature on the ice layer between 3°C and 4°C, and the thickness of the ice layer

Carnea de pește reprezintă o sursă bogată de substanțe azotate, aduce un mare aport de fier și fluor și conține mari cantități de fosfor și vitamine. Datorită introducerii peștelui din ce în ce mai des în alimentația omului, principalul obiectiv al studiului a fost identificarea condițiilor în care sunt păstrate produsele pescărești destinate vânzării și verificarea încadrării parametrilor evaluați în limitele admise. Studiul s-a desfășurat în perioada martie 2017 - mai 2019 într-o unitate pentru creșterea peștilor, dar și în magazinul de desfacere a produselor pescărești obținute de la o unitate specializată, situată în sudul României. Pe perioada de desfășurare a studiului, au fost documentate și implementate proceduri specifice sistemului de management al calității și siguranței alimentelor. Au fost concepute fișe de monitorizare pentru o serie de parametri care demonstrează respectarea cerințelor legale aplicabile domeniului studiat. În punctul de desfacere organizat de unitate, peștele este pus la vânzare atât în formă vie, refrigerată, cât și congelată. În scopul identificării particularităților tehnologice de creștere și prelucrare primară a peștelui, s-au urmărit fluxurile tehnologice din cadrul unității de acvacultură. S-au verificat condițiile de menținere a unui mediu prielnic peștilor destinați vânzării în stare vie, monitorizându-se temperatura, pH-ul și oxigenul apei din acvariul destinat prezentării spre vânzare a peștelui în stare vie. Totodată, în incinta magazinului de desfacere a produselor pescărești, s-au efectuat determinări în ceea ce privește parametrii păstrării peștilor destinați vânzării în condiții de refrigerare și congelare. Temperatura apei din acvariul în care sunt păstrați peștii destinați vânzării în stare vie, s-a situat între valorile de 11,1°C și 14,1°C, pH-ul apei din acvariu, pe perioada studiului, a variat între 6,9 și 7,4, iar nivelul de oxigen al apei a fost cuprins între 9,2 și 10,6 mg/l. În legătură cu monitorizarea peștelui conservat prin refrigerare, s-a concluzionat că acesta are o temperatură pe patul de gheață cuprinsă între 3°C și 4°C, iar grosimea stratului de gheață s-a situat pe perioada studiului în jurul valorii de 4 cm. Produsele din pescuit congelate sunt depozitate la o temperatură de cel puțin -18°C. Pentru a menține caracteristicile de prospețime ale peștelui refrigerat, prin procedurile specifice implementate,s-a

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was during the study period around 4 cm. Frozen fishery products are stored at a temperature of at least −18°C. In order to maintain the freshness characteristics of the chilled fish, through the specific procedures implemented, it was decided to increase the initial thickness of the ice layer from 4 cm to 5 cm, which resulted in a decrease of the total volatile basic nitrogen, registering in 2018 an average value of 15.16 mg/100g, lower compared to the average value of 2017 of 17.12 mg/100g. As a result of the determinations made, it is concluded that the evaluated parameters are respected, the registered values being within the veterinary sanitary norms in force.

Keywords: fish, freshness, water pH, refrigeration

decis creșterea grosimii inițiale a stratului de gheață de la 4 cm la 5 cm, ceea ce a determinat o scădere a azotului bazic volatil total, în anul 2018 înregistrându-se o valoare medie de 15,16 mg/100g, mai scăzută comparativ cu valoare medie a anului 2017 de 17,12 mg/100g. În urma determinărilor efectuate, se constată respectarea parametrilor evaluați, înregistrându-se valori care se încadrează în normele sanitare veterinare în vigoare.

Cuvinte cheie: pește, prospețime, pH apă, refrigerare

Fish and fishery products are products of animal origin appreciated by a large part of consumers from around the world. Fish meat has a high dietary value and is an important food reserve for humans (15, 17). In many areas of the world, fish are the main source of animal protein, especially for some communities (2).

For public consumption, ocean fish and freshwater fish are important. Both productions have grown considerably in the last decades, in direct relation with the increase of the consumption of fish in the natural state or prepared (6).

Although fish are noted for many of the health benefits of the human body, it is a perishable food (11), changing its quality immediately after fishing. The impairment of quality parameters incriminates both bacterial and enzymatic actions, which usually feature postmortem changes (4).

In a period when nutrition is dominated by intensively processed products, awareness of the multiple risks and dangers associated with it is the first step in guaranteeing the obtaining of healthy and quality foods, which will protect the public health (11, 14).

MATERIALS AND METHODS

The study took place between March 2017 - May 2019 at a growing fish plant, in a system with recirculated water, in ponds and in concrete pools, but also in the retail store of fishery products obtained from the same specialized unit located in the south of Romania.

In the retail store of fishery products obtained from the study unit, determinations were made to evaluate the refrigeration conditions (12) of the fish intended for sale. At the same time, the conditions for maintaining a favourable environment for the fish destined for sale in the living state were verified, but also some chemical analyses were performed from fresh fishery products (determination of the total volatile basic nitrogen).

Regarding the chilled fish, its temperature on the ice layer was measured using the rod thermometer, and the monitoring of the thickness of the ice layer was determined with a ruler.

In order to determine the quality of the water in which the fish intended for sale are kept, the following were evaluated: the water temperature, the pH of the water and also the dissolved oxygen of the aquarium water. The pH of the water from the fish display basins (zander, carp, Siberian sturgeon and sturgeon) was measured using a pH meter, and the temperature and dissolved oxygen were evaluated using the AZ 86031 multiparameter device.

Zander

Stizostedion lucioperca or *Sander lucioperca* is a freshwater predatory fish in the *Percidae* family.

It lives in flowing waters, ponds that can also have salt water with a concentration of up to 1%. The zander can be easily recognized by the specific shape of the body, as it bears the mark of all the representatives of the *Percidae* family, namely the two dorsal fins, separated from each other by only a small space. The body is long, almost cylindrical, slightly compressed laterally (Fig. 1), covered by small, rough scales, which is why the fish feels rough to the touch. The head is elongated, slightly flattened laterally, has a large mouth, the ends of which reach below the eyes. Both the upper and lower maxilla are provided with a set of sharp teeth, characteristic of predatory fish. The opercules are covered by scales. The dorsal part of the zander is green-gray, the sides are gray-silver, with 8-9 darker stripes, arranged transversely. The abdominal region has a lighter colour. The iris of the eyes is silver, with several black dots. The most common size of the zander is 40-70 cm long and 1-4 kg in weight (15).

The zander reaches sexual maturity at the age of 3-4 years, usually males one year earlier than females. The breeding period begins at the end of March, en-

ding at the end of April. For breeding, the zander needs water of at least 10°C, but the temperature between 12°C and 14°C is preferred. A breeding female 50-60 cm long can deposit 300,000-500,000 eggs.

The spawn are sticky, with a diameter between 0.8 and 1.5 mm, yellowish in colour (15).

Fig. 1. Zander on the ice layer

The hall intended for growing the zander in recirculated water system is divided into two production areas:

- the reproduction and pre-development sector of the zander;
- the breeding sector of the zander.

In the reproduction and pre-development sector of the zander, as the name implies, the reproduction and the growth of the zander from the larval stage to the brood stage is about 15g, when they can be moved to the growth hall.

The breeding sector (hall) comprises 3 modules of 8 circular glass fiber basins with a useful volume for fish growth of 152 m^3/module.

Carp

Cyprinus carpio is a fish of the family *Cyprinidae*, with a body length of up to 1 m and a maximum weight of 40 kg. The body surface is covered with large scales. The back is usually blackish, with blue or green hues, the flanks of brown or brown-yellowish and the abdomen whitish. The oral cavity is subterminal, with thick lips. The carp has four mustaches, and on the trunk and tail are pairs of fins (two ventral and two pectoral) and non-pairs (dorsal, anal and codal, which have two equal lobes). He lives up to 30 years, sometimes even more (3). Once the spring comes, carp starts looking for food when the water reaches 10-12°C. Then, his appetite increases proportionally with the heating of the water, but only until 28-30°C, when it will feed less intensely. In the autumn, when the water cools, the carp consumes less and less food, so that at a temperature of 7-8°C it stops eating, and at 5-6°C it stops moving and enters in hibernation. In winter, he loses weight between 5 and 10%. Carp reaches sexual maturity at the age of 3 years, males being more precocious compared to females. For reproduction, the most suitable are the 5-8 year old females, which deposit between 600,000 and 800,000 eggs. At 18-20°C the reproduction takes place, and in 3-4 days after fertilization the carp larvae appears (1). Carp breeding in ponds is made in semi-intensive system, the supply being simple (carp from a single age category) and in polyculture with peaceful species. Carp growth occurs from the age of 1 year, when it has an average body mass of about 50 g/piece, until two years when it registers an average body mass of 500 g/piece.

Siberian sturgeon

Acipenser baeri is one of the most common species of fish available to buyers, because it reproduces easier than other species, grows rapidly and has few health problems. Siberian sturgeon has grey-brown skin, but the ventral is whitish, sometimes with grey spots. The muzzle is long and pointed with a white tip (Fig. 2). In the wild it can grow to a length of 2 m and weigh up to 200 kg. In ponds, it can have a length of 1 m and about 10 kg. The growth rate depends on the quality of the feeding process. Sturgeons should be fed throughout the year, needing the equivalent of 2-3% of their body weight, of good quality foods per day in summer, respectively less in winter. A healthy sturgeon diet should contain a high level of animal protein, namely at least 40% protein and 15% or more, oil. A small percentage of protein can be obtained from soy, but most must be from fish meal or other animal sources.

Fig. 2. Siberian sturgeon on the ice layer

The most common sturgeon health problems are nutrition related and/or the oxygen content of the water (7, 8, 16).

Sturgeon

Acipenser gueldenstaedtii is a benthic marine fish that lives in the Black Sea and the Caspian Sea and migrates for reproduction in the rivers that flow into them. In Romania, it is encountered along the coast, in the Danube from the entry into the country until the discharge and occasionally, in the water of Lake Razelem (7-10). As dimensions, it can reach 2.3 m and 110 kg in the wild, and 1.25 m and 15 kg, in ponds (16). The body is thick near the head and narrow towards the tail, covered with dorsal, lateral and ventral

shields (Fig. 3). The muzzle is rounded, wide and short with the mention that the male is slightly longer. The mustaches are not fringed and are located closer to the tip of the muzzle than to the mouth. The upper lip is split in the middle and the lower one is uninterrupted. The colour is variable: the dorsal side and the flanks up to the side shields in some specimens are black-gray, and in other specimens green-dirty to dark green. The abdomen is whitish (8). It develops very fast, does not tolerate well the low oxygen or temperatures above 25°C, additional oxygenation in the summer months being essential. Due to its growth rate, it must be fed with good quality food, because it suffers from malnutrition very quickly. Same as the Siberian sturgeon, it needs a large amount of animal protein, respectively a percentage of foods of 2-3% of its body weight for 1 day of the warm season and something less for 1 day of the cold season (16).

Fig. 3. Sturgeon on the ice layer

RESULTS AND DISCUSSIONS

Results and discussions on monitoring the environmental parameters of the fish sales area

Presentation forms of fishery products for food use are fresh products, prepared products, processed products and canned fish. In the retail store of the study unit, the fish is offered for sale both in live form and in refrigerated or frozen form.

Monitoring the parameters for live fish

The fish sold in the living state have characteristic movements of vitality, both in the aquarium in which it is exposed (Fig. 4), and especially after the removal from the water. The fish are kept in specially built aquariums, with clear water, without foreign smells, and which do not contain other substances that may endanger the health of the consumer. The volume of water in the aquarium must be correlated considering the quantity and species of fish in it.

In order to maintain the oxygen concentration, the aquarium water is periodically renewed with fresh water. Aquariums are cleaned and disinfected after each use (7).

Fig. 4. Fish intended for sale

Following the determinations made in 2017, in July, August, September, October, November and December, the average value of the aquarium water temperature was 13.16°C, the maximum value being recorded in July, and the minimum value December.

The pH of the water recorded values ranging from 6.9 to 7.3, with an average of those 6 months of 7.1. Aquarium water oxygen recorded a maximum value of 10.5 mg/l in November and a minimum value of 10.0 mg/l in October (Fig. 5).

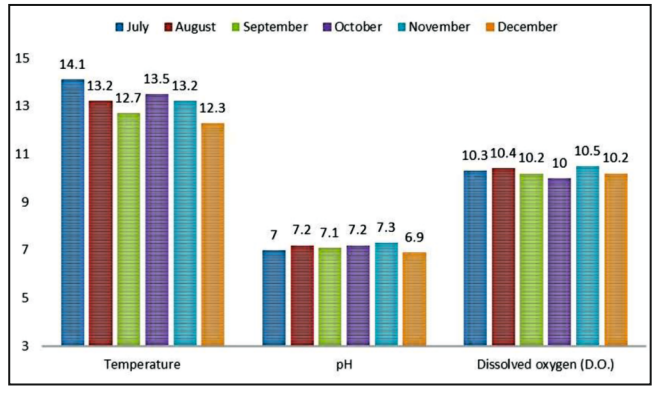

Fig. 5. Aquarium water temperature, pH and oxygen values recorded in 2017

In 2018, the temperature, pH and oxygen of the aquarium water were monitored monthly. The average value of the temperature recorded within the 12 months of the year was 12.4°C, the minimum value of 11.1°C recorded in December and the maximum value of 13.4°C recorded in June. The pH of the aquarium water recorded a minimum value of 6.9 in May and a maximum value of 7.4 in October.

The maximum value of oxygen in the aquarium was 10.5 mg/l, recorded in May (Table 1).

Following the determinations made in 2019, in January, February, March, April and May, the average value of the aquarium water temperature was 12.88°C, the maximum value being recorded in May, and the minimum value in January. The pH of the water recorded values ranging from 6.9 to 7.4, with an average of those 5 months of 7.2. The water oxygen from the aquarium registered the maximum value of 10.6 mg/l in January and the minimum value of 9.2 mg /l in March, the values being correlated with those ob-

Table 1

Water temperature, pH and oxygen values in the aquarium. Living condition for carp and sturgeon (2018)

No.	Date of fishing and introduction to the aquarium	Water temperature in the aquarium	pH of aquarium water	Dissolved oxygen (D.O)
1.	8 January 2018	11.3°C	7.1	10.2 mg/l
2.	12 February 2018	11.4°C	7.2	10.1 mg/l
3.	12 March 2018	12.9°C	7.3	10.1 mg/l
4.	10 April 2018	12.5°C	7.2	10.2 mg/l
5.	15 May 2018	13.1°C	6.9	10.5 mg/l
6.	11 June 2018	13.4°C	7.1	10.1 mg/l
7.	09 July 2018	12.6°C	7.2	10.2 mg/l
8.	13 August 2018	12.8°C	7.3	10.4 mg/l
9.	10 September 2018	13.2°C	7.2	10.1 mg/l
10.	15 October 2018	12.2°C	7.4	10.3 mg/l
11.	12 November 2018	12.4°C	7.1	10.2 mg/l
12.	10 December 2018	11.1°C	7.3	10.3 mg/l

tained in similar months of previous years (Fig. 6).

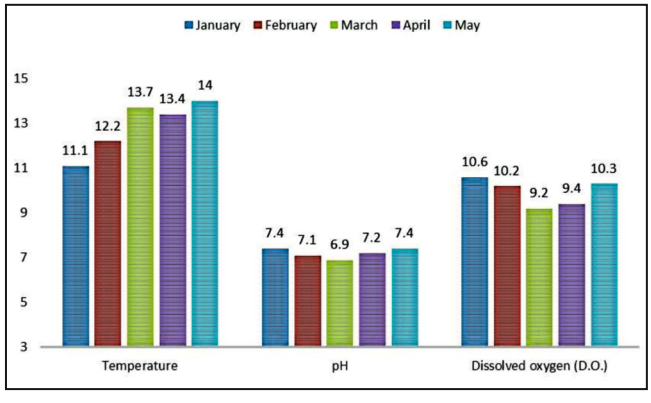

Fig. 6. Aquarium water temperature, pH and oxygen values recorded in 2019

Comparing the results obtained in the present study regarding the pH value, with the results obtained by Warish et al. (2017), it is found that close results were obtained, which fall within the reference range of 6.6-8.5.

The average pH value recorded in the present study during the 3 years of study is 7.1, while in the study conducted by Warish et al. (2017), the average pH value is 6.7 (18).

Monitoring the parameters for chilled fish

The whole or portioned fish, in refrigerated condition is presented in the retail store on an ice layer with a thickness of about 4 cm (Fig. 7), the pieces being distributed on a single line. The ice layer temperature is permanently maintained between 2°C and 4°C.

Similar results regarding temperature were found in the studies conducted by Sandor et al. (2011), however, better results were obtained in this study, most likely by optimizing the ice layer (13).

Fig. 7. Ice layer measurement

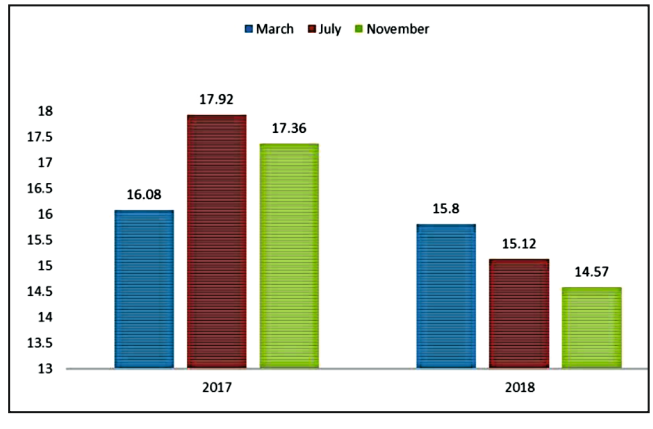

Fig. 8. Total volatile basic nitrogen values, 2017-2018

Monitoring the parameters for frozen fish

Frozen fishery products are stored at a temperature of at least -18°C, but during transport this value varies by ±2°C. In most cases, fishery products weighing more than 3 kg are frozen individually, and the smaller ones are frozen in the form of blocks.

Results and discussions regarding the determination of total volatile basic nitrogen from fish samples

According to Fig. 8, compared to 2017 when the value of total volatile basic nitrogen was in the range 16.08-17.92 mg/100g, in 2018 there was a decrease of its value, by 1.96 mg/100g. The values of volatile basic nitrogen decreased most likely due to the increase of the initial ice layer thickness, from 4 cm to 5 cm. All registered values are in accordance with Regulation (EC) No. 2074/2005 establishing the limit values of total volatile basic nitrogen (5).

CONCLUSIONS

From the research carried out, it was found that the organoleptic characteristics were respected, the analysed products did not show non-conformities in relation to their appearance, consistency, colour or odour, during their validity period. Regarding the temperature of the water in the aquarium with the fish destined for sale in living state, it was between the values of 11.1°C and 14.1°C, not exceeding the values established by the organization within the documentation of the food quality and safety management system. The results of the determination of the pH of the aquarium water, during the 3 years of study, varied between the values of 6.9 and 7.4, and following the assessments of the oxygen content of the aquarium water, it was found that it was within the range of 9.2 and 10.6 mg/l.

Regarding the monitoring of fish preserved by refrigeration, it was concluded that it has a temperature on the ice layer between 2°C and 4°C, and the thickness of the ice layer was during the study period around 4 cm. As a result of the studies conducted, it was decided to increase the ice layer from 4 cm to 5 cm, which resulted in a decrease of the total volatile basic nitrogen, registering an average value of 15.16 mg/100g in 2018, a lower value, compared to the average value of 2017 of 17.12 mg/100g.

It is recommended to respect the technological parameters of preparation for the sale of fish intended for human consumption, as this is an important factor for maintaining the quality and freshness of fish sold through specialized units.

REFERENCES

1. *Albu I., Tăpăloagă P.R., Tăpăloagă D., Neagu I., Petcu C.D., Bacila V.,* (2014), Researches regarding the artificial reproduction technology in carp (*Cyprinus carpio*) in a private farm in south-eastern Romania. J Biotechnol, 185(Supp):S44-S44.
2. *Britton R.J., Orsi M.L.,* (2012), Non-native fish in aquaculture and sport fishing in Brazil: economic benefits versus risks to fish diversity in the upper River Paraná Basin. Rev Fish Biol Fisher, 22(3):555-565
3. *Bud I., Diaconescu Ș.,* (2010), Raising carp and other fish species [in Romanian], (Ed.) Ceres, Bucharest, Romania, pp. 1-436
4. *Ciobotaru E.,* (2013), Veterinary forensic medicine [in Romanian], (Ed.)Ceres, Bucharest, Romania, pp.1-240
5. Commission Regulation (EC) No 2074/2005 of 5 December 2005 laying down implementing measures for certain products under Regulation (EC) No 853/2004 of the European Parliament and of the Council and for the organisation of official controls under Regulation (EC) No 854/2004 of the European Parliament and of the Council and Regulation (EC) No 882/2004 of the European Parliament and of the Council, derogating from Regulation (EC) No 852/2004 of the European Parliament and of the Council and amending Regulations (EC) No 853/2004 and (EC) No 854/2004.
6. *Gjedrem T., Robinson N., Rye M.,* (2012), The importance of selective breeding in aquaculture to meet future demands for animal protein: A review. Aquaculture, 350–353:117-129
7. *Mitrănescu E.,* (2010), Water quality as sturgeons' welfare indicators in a farm from the center of the country. Jurnal Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 67(1).
8. *Mitrănescu E., Furnaris F.,* (2010), Fish welfare on farms, during transport and in cutting units – Guide [in Romanian],(Ed.)Printech,Bucharest,Romania,pp.1-122
9. *Mitrănescu E., Furnaris F., Tudor L., Mitrănescu D., Rotaru E., Oraseanu A.*, (2009b), Water quality as fish welfare indicator in Potoci fish farm. Jurnal Scientific Works - University of Agronomical Sciences and Veterinary Medicine, Bucharest Series C, 55(1):161-165
10. *Mitrănescu E., Furnaris F., Tudor L., Rotaru E., Simion V., Mitrănescu D., Dragomir F.A.*, (2009a), Researches regarding water quality as an indicator of fish welfare in two farms from the southern area of the country. Jurnal Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 66(1):248-252
11. *Petcu C. D.*, (2006), HACCP-Food safety guarantor, (Ed.) Idea Design, Bucharest, Romania
12. *Petcu C., Savu C., Neagu I., Tăpăloagă D., Manta C.,* (2008). Features of some preliminary programmes in a fish processins unit, Simposium Progress and Perspectives in Veterinary Medicine Iasi, Veterinary Medicine Series, 51(10)-II:483-489
13. *Sándor J. Zs., Papp Gy. Zs., Csengeri I., Jeney Zs.,* (2011), Fish meat quality and safety (review). Tehnologija mesa, 52(1):97-105
14. *Savu C., Petcu C.D., Tudor L., Nicolaescu M., Butean V.,* (2007). General hygiene requirements and implementation of the HACCP principles for guaranteeing food safety [in Romanian], (Ed.) Proema, Baia Mare, Romania, pp. 1-128.
15. *Tăpăloagă D.*, (2008). Animal production systems [in Romanian], (Ed.) Vox, Bucharest, Romania, pp. 1-436
16. *Terry W., Graham Q.,* (2007), Siberian sturgeon (*Acipenser baerii*), Available at: http://www.sturgeonweb.co.uk/siberian-sturgeon-acipenser-baerii
17. *Tittensor D.P., Eddy T.D., Lotze H.K., Galbraith E.D., Cheung W., Barange M., Blanchard J.L., Bopp L., Bryndum-Buchholz A., Buchner M., Bulman C., Carozza D.A., Christensen V., Coll M., Dunne J.P., Fernandes J.A.,* (2018), A protocol for the intercomparison of marine fishery and ecosystem models: Fish-MIP v1.0. Geosci Model Dev, 11(4):1421-1442
18. *Warish K., Abdul V., Adil M., Najib H.,* (2017). Water quality requirements and management strategies for fish farming (a case study of ponds around Gurgaron canal Nuh Plwal). IJTSRD, 2(1):388-393.