ABAH BIOFLUX
Animal Biology & Animal Husbandry
International Journal of the Bioflux Society

Opportunities to improve the quality of aquatic products

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Abstract. Today there are significant changes in consumer preferences toward food components, people increasingly heading towards aquatic products, which is more diversified, and especially due to their qualities of outstanding biological value. Given this situation, operators at all stages of production, processing, storage and distribution along the way of production-capitalization, are responsible to ensure that the technological processes and aquatic products meet's the requirements of the law on food quality and safety for human health. This framework encompasses the present work which includes aspects that must be tracked and monitored to ensure that a farm can operate normally and that the products produced to meet the quality and ensure consumers safety.
Key Words: Aquatic products, food safety, improvement, opportunities, fisheries.

Rezumat. Astăzi se constată o schimbare semnificativă a preferinţelor consumatorilor faţă de componentele alimentare, oamenii îndreptându-se tot mai mult spre oferta de produse acvatice, care este tot mai diversificată, urmare a calităţilor acestora şi îndeosebi a valorii biologice deosebite. Ţinând cont de această situaţie, operatorii de la toate nivelele de producţie, procesare, depozitare şi distribuţie aflate pe traseul producere-valorificare, sunt responsabili să se asigure că procesele tehnologice şi produsele acvatice obţinute satisfac cerinţele legii privind calitatea şi siguranţa alimentelor pentru sănătatea omului. În acest context se înscrie şi prezenta lucrare care cuprinde aspectele ce trebuiesc urmărite şi ţinute sub control pentru ca o fermă piscicolă să poată funcţiona normal şi pentru ca produsele obţinute să îndeplinească condiţiile de calitate şi securitate pentru consumatori.
Cuvinte cheie: Produse acvatice, siguranţă alimentară, îmbunătăţire, oportunităţi, ferme piscicole.

Introduction. It is striking today, although we find ourselves entrenched in the century of speed, that information concerning aquatic organisms is quite poor, sporadic and less explicit, whether it relates to marine species or species from the continental waters.

Based on these aspects we consider that it is pertinent to conduct a study to capture the current state of fishery product quality and to try to find new ways to improving them not just as quantity (Bud et al 2009; Crişan & Bud 2013) but as quality as well, from the production unit to the consumer. This study came naturally after some scientific approaches addressed to aquatic environment health studies conducted by Popa & Bud (2010), Popa & Bud (2011), Crişan & Bud (2013), on fish meat quality (Boaru at al 2010), and fish reproduction trait (Bud et al 2009).

In the last 50 years have been achieved particularly important progress in the knowledge of food hazards, and in the field of technological processes that leads to improved food security, however there is still plenty of opportunity to reduce risk or prevent them (Baba & Giurgea 1993).

Today it is increasingly appreciated the beneficial role of aquatic products on human health, through they effect of strengthening the human organism and significant drop of occurrence of cardiovascular disease and lower action on cholesterol and triglycerides (Bud et al 2010; Metaxa 2003).

Material and Method. The research was conducted during 2013 at the Cipău fishery located in Mureş County, and aimed at obtain quality products, safe for consumers and

finding the appropriate measures to increase production on the one hand, and improving quality in terms of highest food safety on the other hand.

Cipău fishery is part of S.C. Pescaliment S.R.L., founded in 1983, having a surface of 102.3 ha, which of 89.64 ha water surface, profiled on the growth of fish material, mainly carps, for consumption and restocking (Buruian & Grama 2005), selling alive and refrigerated fish.

Beside the constantly increase of fish production and improvement of its quality, the farm has in the aims development of sport fishing and ecotourism, given the wealth of flora, fauna and especially avifauna in this area of the unit.

The main species of fish run on the farm are: carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), big head carp (*Aristichthys nobilis*), and crucian carp (*Carassius carassius*).

To highlight the qualitative status of aquatic products from this farm we have fallowed all steps of fish from tank of growth to the table. On the whole trip we were trying to improve every detail of the chain and ensure the quality of the final product (Nicolae 2002).

Results and Discussion. Consumers always has claimed that their disposal food to be safe in terms of health and hygiene so to not cause any disease (Bud & Mireşan 2008).

The quality of aquatic products is determined by the specific quality characteristics and may be adversely affected by numerous factors with a potential risk to human health, among which we can mention: water pollution, high level of permeated organic substances in the aquatic environment, pesticides, heavy metals, food additives, bio-stimulators, various pathogenic vectors, fishing gear, handling of natural toxic materials, fishing system, conveyance, storage areas, primary processing etc (Laslo et al 2008; Şteţca et al 2009).

In our research we have considered the provisions aimed to apply correct HACCP to fresh fish at Cipău fish farm. Risk analysis for products in this category took into account all the links in the technological flow from the fish production ponds, feeding, harvesting, water quality, biological material selection, density, transport of live or refrigerated fish (Bondoc & Sindrilar 2002). We have considered all the risks and critical control points in getting a quality fresh fish as it is shown in Table 1.

Table 1

The risks and critical control points to obtain fresh fish

Technological stage	*Possible risks*	*Prevention and control*
Live fish in raceways	Contamination with pathogenic bacteria, bio-toxins, parasites and other chemical components in the growth and exploitation ponds	Permanent monitoring of environmental parameters
Fish feeding	Pathogen vector transmission through infested forages	Chemical and bacteriological control of feed
Harvesting and handling	Bacteria evolution and infection from various sources	Control of water and environment temperature, and fishing tools hygiene
Fish refrigeration for temporary storage and transport	The development of different types of bacteria or contamination with several number of pathogens	The continuous monitoring of temperature, and storage and transport conditions
Biological material delivery	Contamination by various pathogens and the possibility of bacterial occurrence	Hygienic handling and continuous monitoring of temperature
Reception at capitalization	Follow the quality of fish on all route and possible changes occurrence at a time	Competent sensorial analysis

Application of HACCP for the fresh fish at the Cipău fish farm considered the next steps:

A. Control and monitoring measures. Monitoring the temperature conditions can be achieved by keeping the fish under continuous surveillance and continuous inspection of ice used to maintain low temperature. In this firm disposable eps polystyrene boxes and ice are used to maintain a constant temperature, for both storage and adequate transport of fish (Buchanan 1995).

Also, appreciation of fish is done at harvest and during transport and delivery to the customer in terms of color, smell, tissue texture and overall appearance, according to applicable (Jurcă 2006) (Figure 1).

Figure 1. Live and refrigerated fish exposed for sale.

B. Temporary construction and retail space. In some situations, the fish is also offered for sale at the farm, at markets or booths, in which case it takes into account all requirements of hygiene and food safety so as to avoid contamination of fish with different pathogenic vectors. In addition of cleaning the transport and storage equipment, it always checked the water temperature and oxygen level, so that the fish do not suffocate (Bărzoi & Apostu 2002).

C. Permanent control of the environmental factors. Given the fish dependence of aquatic environment and its importance on the quality of biological material (Barnabe 1993) at intervals of 30 days water samples were taken and a number of indicators were analyzed in the laboratories of S.C. Compania Aquaserv S.A. Tg. Mureş. The average results of the analysis are shown in Table 2.

According to analyzes, Cipău farm waters fall into the second quality category, between optimal set limits to increase cyprinids. Through the biological activity, self-purification capacity of the water is very intense due to the presence in large quantities of the mezosaprobic forms (Diaconescu 2003), which are vital elements in the food chain of a fish farm pond (Figure 2).

Table 2

The average physical-chemical values of the water from the Cipău fish farm

Parameter	*Unit*	*Optimum values for carp farms*	*Limits for carp*	*Todoran 2013*
Temperature	°C	25.0	15-28	24.0
Transparency	cm	30.0	25-40	25-30
Oxygen	mg/L	6.0	4-8	4-8
Carbon dioxide	mg/L	5.0	2-10	2-3
Hydrogen sulphide	mg/L	-	-	-
pH	-	7.0	5-8	8.3-8.7
Hardness	dH°	8.0	5-12	10-12
Nitrogen	mg/L	1.0	0.5-2.5	0.8-1.1
Ammonia	mg/L	0.6	0.5-1.5	0.4-0.5
Nitrate	mg/L	0.6	0.5-1.5	0.30-0.47
Nitrites	mg/L	0.4	0.1-1	0.001-0.002
Phosphates	mg/L	0.3	0.1-0.5	0.1-0.3
Sulphates	mg/L	7.0	2-30	2-3
Iron	mg/L	1.0	1-4.5	1.1-1.9
Chloride	mg/L	5.0	5-10	5.3-6.2
Magnesium	mg/L	0-40	-	1.8-3.6
Potassium	mg/L	3-4	-	3.1-3.5
Salinity	mg/L	under 1.0	1.5	0.3-0.4
Coliform bacteria	no./100 mL	-	-	0
Escherichia coli	nr/100 mL	-	-	0
Enterococci	nr/100 mL	-	-	0
Colonies no. at 37 °C	UFC/mL	-	-	2228-523

Figure 2. Pond 3 and 4.

D. Hygiene, cleaning and disinfection of ponds and gear. At Cipău farm, fishing is done throughout the year, for both the capitalization of fish for consumption and to transfer fish from one pond to another, but especially in autumn, at the end of the biological cycle, when the fish reach optimal weight for market.

For cleaning of the basins and stopping circulation of pathogens, basins are cleaned annually, after harvest and drainage through drying, freeze and sterilizing with quick lime, whose amount depends on the thickness of the deposited material (Man & Man 2006). Through this procedure pathogens that can contaminate the fish are almost totally destroyed.

The sanitizing of the fishing utensils is performed after their preliminary cleaning from silt and vegetation, then drying them having undergone a boil for 30 minutes. Between two harvests the fishing nets are disinfected with a formaldehyde solution for 30 minutes and then rinsed with clean water. Feeding and fishing boats and washed with 3 % sodium hydroxide solution, then dried and painted with waterproof oil paint.

Current fishing utensils (nets, ceels, barrels, sorting tables, etc.) are disinfected with 3 % sodium hydroxide solution and any suspicious odor is removed (Laslo 1996; Bara & Laslo 1997).

Overalls, boots, aprons, gowns, caps and gloves are washed with water and soap or various detergents, boiled and disinfected after each fishing, sortation or stored action, etc.

E. Hygiene of the transport equipment. After capture, the fish is washed to remove mud or debris from the body and gill cavities. After harvesting fish is sort by species and weight classes and placed in transport equipment which first have been cleaned, and then transported to the place of destination based on their economic value (Table 3).

Table 3

The economic importance of fish sold at the Cipău fish farm

Family	*Species*	*Economic importance*	*Meat chemical composition*
Cyprinidae	*Cyprinus carpio* (carp)	Carp are sold by weight variable from 1.5 to 3.5 kg. Carp has a 62-65 % yield of the slaughter, which of: 50 % meat, 4.2 % tegument, 16.8 % head, 3.2 % fins, 4.6 % scales, 8.5 % bones, and 12.7 % viscera.	73.0 % water, 27.0 % dry mater, 17.1 % protein, 6.8 % fat, 1.2 % mineral salts, 3.10 % non-nitrogenous substances
Cyprinidae	*Carassius carassius* (crucian carp)	Crucian carp are sold by weights between 350 and 800 g. Slaughter yield 50 %, which of: 40 % meat, 4.0 % tegument, 4.2 % head; 4.0 % scales, 12.6 % bones, and 14.2 % viscera.	76.5 % water, 23.5 % dry mater, 15.5 % protein, 2.5 % fat, 1.9 % mineral salts, 3.6 % non-nitrogenous substances
Cyprinidae	*Hypophtalmichthys molitrix* (silver carp)	Silver carp are sold by weights between 1.5 and 4.5 kg. Slaughter yield is over 55 %: 48-50 % meat, 22 % head; 7.9 % bones, and 4 % tegument.	72.0 % water, 28.0 % dry mater. 18,5 % protein, 7,0 % fat, 2,0 % mineral salts, and 3,2% non-nitrogenous substances
Percidae	*Sander lucioperca* (zander)	The most valuable and desired species. Sold at weights of 1.5-5.0 kg. Slaughter yield over 55 %: 55-58 % meat, 14-16 % head, 3-4 % tegument, 2-3 % scales, 7-8 % bones, 10 % viscera.	77.6 % water, 22.4 % dry matter, 19 % Protein, 2.0 % fat, 1.1 % mineral salts, 0,6 % non-nitrogenous substances

Water temperature during transport is maintained at 8 - 10 °C, and oxygen is not allowed to fall below 7 mg O_2/L values.

When isothermal box are used, chilled fish is placed in alternate layers of ice flakes (Figure 3).

Figure 3. Exposure of refrigerated carp on ice flakes.

After usage, the isothermal box is washed and disinfected, so there is no possibility of contamination (Laslo 1996; Rotaru 2003).

Regardless of the used transport equipment, it is previously cleaned and disinfected, as well as after transport, according to existing veterinary laws. Fish transport equipment/vehicles are not used for any other purposes and are sanitized after each course, regardless of traveled distance (Bud et al 2007).

F. Preventive therapeutic measures applied at Cipău fish farm. To prevent possible pathology occurrence on the farm the following preventive measures are taken.

Wintering ponds are allowed to dry after drainage, the bottom of the basin is leveled, cleaned from the crop residues and then disinfected with lime, using between 50 and 200 kg lime per hectare, after that is incorporated into the soil and allowed to dry until fall. During summer 2 - 3 plowings are performed to destroy potential vegetation appeared. 7 - 10 days before placing the fish for wintering, ponds are flooded and washed 2 - 3 times and then filled to the optimum level for hibernation.

At the transfer of the biological material from a pool to another or at installation, fish are going through a 5 % salt bath for parasites removal.

Monitoring of fish ponds is performed every 14 - 15 day, at the control fishing, to record the development and welfare of the fish.

The oxygen concentration, pH, and temperature are checked daily, and appropriate measures are taken for the fish to can exhibit their biological potential and to maintain a healthy condition (Mossel 1989).

Not at least, we can mention that fish health can be improved against some pathogen agents, which can cause morbidity once the water parameters are changed, by adding natural additives to their food, as sea-buckthorn (*Hippophae rhamnoides*) (Csép et al 2010).

G. Biosecurity, prevention and therapeutic measures at Cipău fish farm. Biosecurity involves a package of technical-organizational and sanitary measures which must be applied in a farm to prevent the introduction and spread of pathogens (Cătoi 2003). Biosecurity is particularly beneficial because it ensures maintaining the health of aquatic organisms, allows externalization of their productive potential, guaranteeing hygiene, protect consumer health and prevent environmental pollution with pathogens (Lester et al 1997; Luning et al 2002).

In order to meet biosecurity measures, Cipău farm envisaged an action plan that is strictly complied and includes among others:

- very strict security measures on the farm perimeter to prevent entering of the foreign persons or animals and circulating pathogens;
- permanent monitoring of the aquatic medium: physical, chemical and biological;
- disease occurrence and dissemination prevention by zoo-economic measures such as parasites control, disinfection, quarantine etc.;
- basins drainage after each biological cycle and destroying undesired biological agents by the action of ultraviolet and lime;
- fish are going through a salt bath after any type of manipulation to destroy external parasites;
- selling as live fish as the most convenient option regarding fish quality (freshness);
- insurance of an optimum temperature, dissolved oxygen content, providing an optimum density, so at the pools, as well as during transportation.

H. Permanent algae control. When the algae are growing in normal conditions, they are extremely beneficial for both, fish and other aquatic organisms, serving directly or indirectly as food to aquatic organisms and help water oxygenation. When the algae are multiplying excessively, produce the so-called "water bloom" phenomenon, which can lead to a specific "trophic impact" that can cause death of fish and other aquatic organisms.

At the Cipău fish farm, algae monitoring is permanent and in a case of excessive development, control is performed by using copper sulphate (Vass & Bud 2010) and peroxide, noting that in recent years there not have been such phenomenon, due to the special attention given to the management of organic fertilizers.

I. Quality fish production and opportunities for improvement. The main pursuit of the farm management was to provide for consumer throughout the year fresh and high quality fish, and the attribute of the fish to join the quality level set by international standards.

In order to respond as quick as possible to consumer demands and claims the following points were considered:

- the most wanted species at a time (carp, grass carp, silver carp, bighead carp, crucian carp);
- preferred weight by consumer (carp 1.5 - 2.5 kg, crucian carp 0.4 - 0.5 kg);
- to contain a moderate percentage of fat (not exceed a rate of 7 – 8 %);
- to consider the way of selling (most of the production was sold as live fish).

J. Fish protection from microbiological contamination. After the fish removal from the water and his death, the protective mucus loses his protective attributes, it remains adherent to the substrate, but it is a veritable culture medium for many microbes (Nicolescu 2002).

Accelerated growth of microorganisms is possible due to the disappearance of the functional immunological barriers that were present at the live fish, and also due to the inactivation in time of the biostatic substances of mucus and bacteriolitic enzymes (Oancea 1996).

To prevent spoilage of fish and to limit microbiological contamination at Cipău fish farm has been applied a series of measures, among which:

- fish manipulation from harvest to delivery does not exceed the time of 2 - 4 hours for the refrigerated or live fish;
- storage and transport temperature is assured in the limits of 8 - 10 °C by using ice blocks, which represent 20 % of the total volume of water and fish;
- fish to be harvested is no longer feed in the last 48 hours to prevent the overgrowth of enzymes and alteration of the refrigerated meat;
- at fish handling prevention measures are taken to preserve intact the mucus layer and integrity of scales;
- ill specimens and with wounded surface of the body are removed that can be easily infected with microorganisms and are unsightly, leading to disservice for the fishery unit.

Conclusions. Our findings reveal opportunities for improving the quality of fish in a carp fish farm from Mures County, by applying modern and effective measures which also lead to the increase of food safety.

Based on research conducted in line with farm management, we managed to keep under control and to improve significantly the processes of growth, feeding, harvesting, handling and transportation, implementing an effective food safety management based on the most modern principles and to sell fish at the highest quality standards.

By applying the HACCP method for the circuit of fishery products have assured the consumer that he benefit quality fish products in optimal health conditions and food hygiene.

Improving the quality of fishery products and their traceability will lead in the future to a significant growth in the consumption volume of fish and other aquatic organisms.

A major goal is the awareness of all those working in fisheries in compliance with hygiene and control contamination of fishery products in all stages of the technological process from the production farm to fork.

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Received: 28 September 2013. Accepted: 01 November 2013. Published online: 13 November 2013.
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How to cite this article:
Todoran L., Bud I., 2013 Opportunities to improve the quality of aquatic products. ABAH Bioflux 5(2):156-164.