

PRINCIPLES OF FISH WELFARE ASSESSMENT IN FARM REARING CONDITIONS

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Abstract: For several decades fish welfare has been subject of many researches, and the interest for this subject is connected with the fact that fish can feel pain and suffering. In addition to this stressors' mechanisms of action and their consequences are similar in mammals and fish. Assessment of welfare for farmed fish is based on the same principles as for terrestrial farm animals. However, special methods of collecting data are needed due to morphological characteristics of fish and properties of their environment. In the world and in our country, researches of different ways of fish welfare assessment are being conducted, especially based on non-invasive techniques such as monitoring of behaviour. In this paper a review of basic principles and methods used in assessment of farmed fish welfare is given.

Key words: welfare assessment, farm conditions, fish.

Introduction

Welfare of farmed fish has attracted a special attention of experts in recent years, which has resulted in notable changes within the aquaculture industry (Berrill et al., 2010). These changes are connected to increased demand for safe fish meat and fish products, and they are related to intensified production, feeding methodology, housing conditions of fish and selective breeding, as described in the paper by Spasić et al. (2010). Specific aspects regarding fish welfare and food safety can be found in the paper by Relić et al. (2010a).

Researches in area of welfare are driven by the facts that fish can feel pain, fear, and suffering, the same as other vertebrates (Ashley and Sneddon, 2008; Braithwaite and Boulcott, 2008; Vučinić and Radisavljević, 2009), and they respond in a similar way to stress (Wendelaar Bonga, 1997). In farm rearing

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conditions the inappropriate water quality, inadequate stocking density, food that quantitatively or qualitatively are not suitable concerning physiological needs, and handling (catching, transferring to different environment, transport). A long-term exposure to these stressors can negatively affect fish health and productivity, therefore their welfare too.

Considering that mechanism of stress reaction and its effects on fish body are similar for fish and terrestrial mammals, assessment of welfare is conveyed in a similar way and is based on determining the degree of fulfilment of basic needs of the organism (Lembo and Zupa, 2010). The concept of animal welfare is based on respecting the 'five freedoms' (Poli, 2009): freedom from hunger and thirst, freedom from discomfort, freedom from pain, injury or disease, freedom to express normal behaviour, freedom from fear and distress. To achieve these freedoms environment plays a great role. According to Broom (1986) welfare of animal can be defined as the level of adaptability to the environment. The level of welfare is assessed based upon measurable indicators. During welfare assessment, measured values are compared to the ones which are considered as optimal for specific species and category of animals in certain breeding conditions. For Atlantic salmon specific standards for farm rearing exist (RSPCA, 2007). Considering other commercial species more data about fish reacting on different stimulus and in different environmental conditions are needed.

In this paper a review of basic principles of welfare assessment is given, as well as methods applied for collection of data needed for assessment.

Environmental conditions in welfare assessment

The basic needs of an organism include adequate physical and chemical properties of its environment. Environmental conditions affect fish more compared to mammals and other terrestrial animals. Fish need water with appropriate oxygen content, without harmful substances, and environment has to enable their protection from extreme temperatures, normal osmoregulation and enough space for activities. Besides that, fish needs include social interactions, absence of predators, quantitatively and qualitatively specific diets in order to maintain good health. Inadequate housing, excessive stocking density and failures in conveying some technological and hygienic measures can contribute to deterioration of the water quality, which can cause health problems and death of fish. In systems which are equipped with continuous water inflow and appropriate filters for its treatment it is possible to provide less variations of environmental conditions (Verreth and Eding, 2009; Relić et al., 2010c).

Water quality parameters are unavoidable in fish welfare assessment, considering its influence on health condition, productivity and fish behaviour, described in papers by Svobodova et al. (1993), MacIntyre (2008), Relić et al. (2009), and Dulić et al. (2010). The influence of certain parameters on different

species and categories of fish is not the same, but in most of the cases it is indispensable to determine water temperature, concentration of dissolved oxygen, as well as the amount of free ammonia, e.g. nitrogen compounds which are toxic for fish. The level of fish welfare in one environment is considered satisfactory if the values of these water quality parameters do not deviate from optimal. Their rapid changes are especially unfavourable. Otherwise, fish health is threatened, and therefore their welfare. For this reason, water quality parameters can be used to determine the risk assessment for welfare of fish, which is described in papers by EFSA (2008), Relić et al. (2010b, c).

In the risk assessment, beside values of measured parameters, their influence on an individual (especially in terms of causing death) and duration of adverse effects is taken into consideration. This evaluation system is good for comparison of housing conditions of the same category and species of fish, in several rearing facilities of the same type or in the same facility in different time periods. In this way the breeder has possibility of continual monitoring and assessment of housing conditions, particularly during application of some preventive measures described in papers of Sadler and Goodwin (2007), Radenković-Damnjanović and Relić (2008), Relić et al. (2008) and Osman et al. (2009).

Other indicators used for fish welfare assessment

In fish welfare assessment, beside water quality, numerous parameters which indicate state of fish organism or post-mortem changes on carcass are used, if the assessment is conducted during slaughter. According to Huntingford and Kadri (2008), the level of welfare of individuals may indicate the physical condition of the animals (incidence of injuries and diseases, functioning of the immune system, food conversion, growth rate, reproduction), physiological condition (concentration of certain metabolites and hormones in the blood and body fluids, biochemical changes in the brain, expression of certain genes) or behaviour of individuals (behavioural signs of stress/fear, the appearance of stereotype behaviour, natural forms of behaviour). In researches, the values of parameters which are changed when organism is exposed to stress are mostly evaluated. These include level of lysozyme, glucose and cortisol in blood, as quoted in papers of Ardó et al. (2009) and Hristov et al. (2009), as well as values of parameters which indicate the immunological status of individuals (e.g. amount of total immunoglobulin, respiratory burst activity of leukocytes, ability of phagocytosis, hematocrite, leukocrite, etc.).

Despite the use of anesthetics, handling during blood sampling induces acute stress in fish. Therefore, a part of the research in fish welfare is directed to finding non-invasive methods for gathering needed data, such as measuring levels of fish metabolites in the water (Ruane and Komen, 2003).

One of the ways to reduce stress to the least possible value is to apply the cannula directly into the blood vessel, most often in dorsal aorta of the fish, as described in paper by Omlin and Weber (2010). Tashjian and Hung (2005) cite data on application of this technique in salmon, carp, tuna, catfish, tilapia and other fish species. Some authors describe technique of tube application in oral cavity, esophagus or intestine of fish in order to distribute specific amounts of specific substances in gastrointestinal tract. In this way, these substances reach targeted organs in different controlled intervals, and with minimal possibility of vomiting, disturbing and stressing of fish. Similar to that, catheterisation of fish is used to study kidney and bladder functions.

Mentioned methods give detailed information about physiological changes of fish in different environmental conditions and the impact of different stimuli. However, in praxis estimation of the welfare levels is mostly conducted on the basis of fish weight and growth rate, fins and gills conditions, changes on eyes and body surface (injuries, loss of scales, presence of parasites, skeletal deformities), as well as on fish behaviour (Avizienius, 2009).

Behaviour monitoring is the simplest way of getting data, therefore for farm animals this method is very often applied. In welfare assessment, based on behavioural indicators, it is important to register the behaviour which deviates from the usual behaviour characteristic for species and rearing conditions. Research results in area of fish behaviour can be found in paper by Cerutti and Levin (2006).

In the area of social interactions among fish it is concluded that some species have only one partner for life time, which they recognise based on look and smell. Moreover, fish have ability to learn, express aggression through certain rituals, as well as to communicate amongst themselves indicating presence of danger. Regarding adaptive behaviour and learning, fish show specific abilities for orientation in space, adjustment to certain situations and timed actions, as well as different sorts of adaptive behaviour based on Pavlov reflex. For example, fish in captivity get used to getting food every day at the same time, also they get used to the person distributing food. This can be manifested by resurfacing and coming close, expecting meal, or running away and moving to the deeper water if unknown person approaches (Köhler, 1976; Malyukova et al., 1983).

Research of fish behaviour in group has started by monitoring the fish migration in open waters (rivers, lakes, seas), for which from the middle of last century telemetry has been used (Trefethen, 1956). This technique has significantly developed in the past decades, and the usage of satellite systems (GIS-geographic information systems, GPSs-global positioning systems) is often included (Rogers and Bergersen, 1996). Fish have to be marked with radio or ultrasound transmitters which transmit signal of certain range, or specialised devices which react to temperature change (Schulz and Berg, 1992) or pressure

(Baldwin et al., 2002). Some authors have monitored the heartbeats in telemetric research (Lucas et al., 1992, 1993) and frequency of tail movement (Johnstone et al., 1992), in order to determine energy capacity of the fish, oxygen usage, swimming speed and other activities.

In the laboratory conditions, monitoring of the fish behaviour usually is conducted in special glass tanks or aquariums, and in significantly smaller number of fish than in outdoor water. Behaviour is registered with different types of cameras and data is being processed in specific computer programs. For this purpose fish also can be equipped with transmitters, which makes easier to get data needed for physiological, health and other parameters at individual level. For example, Suter and Huntingford (2002) have got data about differences in sclera colour with young salmon, depending on their group status as well as on expressing of dominance and aggressive behaviour.

Assessment of fish welfare in practice

Welfare assessment has great importance for experts in different fields (biologists, veterinarians, ethologists etc.) as well as for breeders. Fish welfare in farm rearing conditions is for many years the major part or main goal of many research projects in the field of aquaculture. These investigations are aimed at finding suitable ways of obtaining and processing data that indicate the level of fish welfare.

The fact is that none of the indicators presented in this article, if viewed separately, is sufficient to determine the level of fish welfare or suffering. The best is to use as many as possible different scientific and practical methods, and to base the conclusion on the most significant results concerning the data collected (Poli, 2009). Therefore, in assessing of welfare, the results of behavioural studies are combined with the results of physical and physiological parameters examination, as well as data on the quality of the fish environment. Such welfare assessment was applied for the salmon cage rearing system (Turnbull et al., 2005).

Atlantic salmon (*Salmo salar* L.) represents one of the most studied cultured species of fish, which resulted in development of system of assessment called 'Welfaremeter' (Anonymus, 2010). This system has undergone series of tests on commercial salmon farms with cage system of breeding, and it is still being improved. It consists of measuring devices placed in the centre of the cage, receptor devices placed on specific distance from the farm, database, and special computer program for processing data, and appropriate internet page. Measuring devices register temperature, amount of oxygen, salinity, fluorescence, and turbidity of the water every half meter to the bottom. Data are shown on internal internet page, and via mobile network (GPRS) transferred to the database. These data are further analysed in special programme, which enables the assessment of

environment conditions in the cage as very good, good or potentially harmful for fish. Welfare index is assessed by programme from 0 (very low level of welfare) up to 100 (excellent level of welfare). This index is based on modelling of metabolic processes (e.g. ability of salmon to extract needed oxygen quantity from the water) and factors which affect the sensitivity of salmon to stress and changes in environment. In this way breeders can use index of welfare when they plan specific technological procedures (such as time of food distribution or amount of food), and decide when certain procedures should be conducted (e.g. cleaning of the cage).

Other cultivated fish species are also subject of research on improving method of the welfare level assessment, as it can be found in the work of van de Nieuwegiessen et al. (2008). In Serbia, researches related to the assessment of the welfare of carp (*Cyprinus carpio* L.) are conducted at the Centre of Applied Hydrobiology and Fisheries at the Faculty of Agriculture in Belgrade, University of Belgrade (Hristov, 2009; Relić et al., 2010c). In these researches, the welfare assessment is integrated with current experiments. The effect of certain factors to which the fish are exposed is examined (for example, high stocking density or handling). Special attention is paid to rearing conditions. The influence of the factors that could adversely affect the welfare of carp is reduced to a minimum. For example, indoor tanks are interconnected in system with recirculation of water (Recirculation Aquaculture System, RAS), where incessant purification and refreshing of the water is provided. Control of conditions in the ponds and tanks is carried out by continuous online monitoring of physical and chemical properties of the water. As indicators of welfare, growth rate and health status of fish are regularly monitored, and depending on the needs of research some blood parameters are also measured. In this way, fish in the Centre are treated in accordance with the provisions of the welfare legislation (Anonymus, 2009).

Conclusion

Assessment of fish welfare level, as well as for other farm animals, is based on data about measurable indicators. Unique system of welfare assessment has not been defined yet. One of the reasons for that is the way of data collecting, which in fish is mostly dependant on very expensive equipment, it causes additional stress or requires sacrificing of individuals. Therefore in the last decades in the world, research is focused on the improvement of methods for data collection, as well as finding out an efficient way of the assessment of fish welfare in different rearing conditions. Considering differences which exist amongst reared species, lack of data concerning particular species, regulations and standards in the area of fish welfare there are not only large possibilities but also great needs for further research in this area.

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PRINCIPI PROCENE DOBROBITI RIBA U FARMSKIM
USLOVIMA GAJENJA

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R e z i m e

Dobrobit riba je već nekoliko decenija predmet brojnih istraživanja, a zainteresovanost za ovu temu povezana je sa činjenicom da ribe mogu da osećaju bol i patnju. Osim toga, mehanizmi i posledice delovanja stresora kod riba vrlo su slični onima kod sisara. Procena nivoa dobrobiti kod farmski uzgajanih riba zasniva se na istim principima kao kod kopnenih farmskih životinja. Međutim, voda kao životna sredina riba i njihove morfološke specifičnosti zahtevaju posebne metode prikupljanja podataka. U svetu i kod nas se istražuju različiti načini procene dobrobiti riba, naročito oni koji se zasnivaju na neinvazivnim postupcima, kao što je praćenje ponašanja. U ovom radu dat je prikaz osnovnih principa i metoda koji se koriste u proceni dobrobiti farmski gajenih riba.

Ključne reči: procena dobrobiti, farmski uslovi, ribe.

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