Online Version ISSN: 1314-412X
Volume 3, Number 3
September 2011

AGRICULTURAL SCIENCE AND TECHNOLOGY

2011

An International Journal Published by Faculty of Agriculture,
Trakia University, Stara Zagora, Bulgaria

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Online Version ISSN: 1314-412X

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Consumption of dissolved oxygen in rainbow trout *(Oncorhynchus mykiss*) cultivated in raceway

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Abstract. *The purpose of the study was to determine the dissolved oxygen consumption of rainbow trout, cultivated in raceway. The consumption analysis is based on a process automatic oxygen measurement system and compares the theoretically calculated amount of food for trout feeding based on the flow and oxygen consumption of the cultivated fish with wise used in the trout nutrition practice - calculation of feed amount according to water temperature and individual fish weight. The average amount of oxygen consumed by the fish in our trial measured in an interval of 1 minute was 0.295 mg.l^{-1}. The comparison between the calculated amount of food by the equation σ = 0.054.Q. (O in-O out) and quantity of food used in feeding of rainbow trout based on water temperature and individual fish weight did not show statistically significant differences.*

Keywords: dissolved oxygen, consumption, rainbow trout, calculation of daily food ration

Introduction

In natural conditions, water is enriched with oxygen directly from the air, by precipitation and from the process of photosynthesis, achieved by green plants. A deficiency of oxygen affects the growth of cultivated hydrobionts and low values of this gas can even lead to their death. Different species have a different sensitivity to oxygen deficiency (Zaikov, 2006). According to Staykov (2001) most of the cultivated hydrobionts needed between 5 and 8 mg.l^{-1} dissolved oxygen.

For many trout species, the exposure to low concentration of dissolved oxygen (5-6 mg.l^{-1}) is a reason for increased mortality among them (Doudoroff and Shumway, 1970, Weithman and Haas, 1984). The concentration of dissolved oxygen is a limiting factor in the cultivation of rainbow trout from the spawning to the preservation of the stocking size of the fish (Rubin, 1998).

For these reasons the elucidation of the mechanisms which have their meaning for lowering or raising the consumption of dissolved oxygen by the fish are being studied (Wang, 2006).

Willoughby (1968) suggests, that the amount of feed given to the fish and the connectivity with their metabolism affects the amount of oxygen consumed by them. Haskell (1959) described the relationship between the amount of oxygen consumed by the fish, the water flow and the quantity of feed.

The aim of the study was to determine the oxygen consumption of rainbow trout reared in raceway based on process measurement of dissolved oxygen in the water and to compare the theoretically calculated amount of fish feed with feeding method used in practice on the basis of the temperature and individual weight of the fish.

Material and methods

The experience was conducted in a Fish farm "Ribena", near the city of Zlatna Panega. The trial period was 25 days during September and October 2009, in a concrete raceway № 1, with water volume 36 m^3. The stocking density of the cultivated rainbow trout was 140 fish per m^3, the total number of experimental fish was 5040 rainbow trouts. The water flow was 40 l.s^{-1} . The average initial weight of the experimental trouts was 21.4 g. Fish were fed by hand six times per day. There were carried out two control catches during the trial period: the first in the middle of the experiment and the second at its end where forty rainbow trouts were weighted and their individual growth (g) was determined. At the end of the trial individual gain (g) and biomass (kg.m^{-3}) of the experimental fish were calculated.

A theoretical amount of feed for cultured fish was used in the following equation (Haskell, 1959 in Wang, 2006):

1) σ = 0.054 Q. (O in-O out)

σ - amount of food per day (lb);

Q - flow (gpm);

O in and O out - the amount of dissolved oxygen (mg.l^{-1}), respectively in the incoming and outgoing water. The data from equation 1 for the amount of feed and water flow were recalculated, respectively in kg and l.s^{-1}.

We implemented a system for automatic monitoring of dissolved oxygen (mg.l^{-1}) for the examination of the consumption of dissolved oxygen in the concrete raceway with rainbow trout, but also to make a comparison between the theoretically calculted amount of feed based on equatation 1 and used in practice way of feeding (on the basis of temperature and individual weight of fish). The consumption of dissolved oxygen in trout cultured in a concrete raceway was determined by the mounted process probes for measuring oxygen concentration in water from the water supply channel (Figure 1) and the water outgoing from the raceway (Figure 2). The principle of determining dissolved oxygen in the water was based on the use of LDO® technology (Hach Lange–US Patent № 6,912,050). In the mounting of the process probes we followed the instructions of the manufacturer (Hach Lange, 2006).

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Figure 1. Mounting of the process probe for dissolved oxygen in the water supply channel

Figure 2. Mounting of the process probe for dissolved oxygen in the water outgoing from fish basin

Visualization of the data and the data storage process were made by controller Sc 1000 (Hach Lange®) (Figure 3). Measurements of dissolved oxygen ($mg.l^{-1}$) were done every minute for the whole trial period resulting in a gain of a solid database consisting of over 80000 measurements from both probes.

The data theoretically obtained and identified in the measurement were processed variationally using ANOVA to determine statistical differences ($P<0.05$).

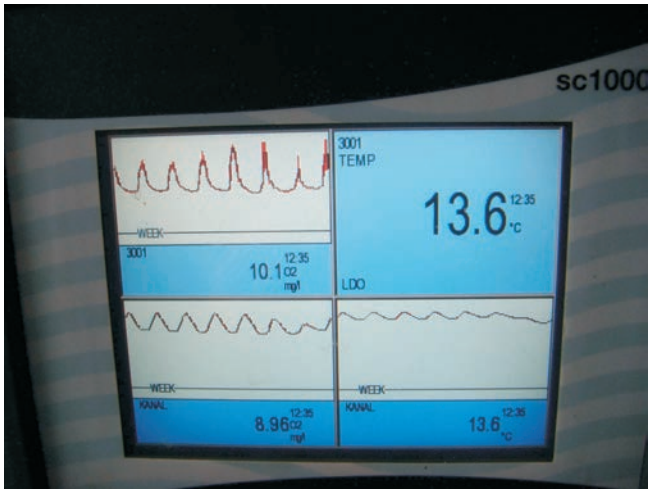

Figure 3. Controller Sc 1000

Results and discussion

The average body weight of experimental rainbow trout at the middle and at the end of the trial was respectively 194% and 289% higher than at the start of the trial (Figure 4). As shown in Figure 5, the total growth of fish was 98.8 kg in the middle and 194.32 kg at the end of the trial. The total biomass of farmed fish in the middle of the trial period has increased by 191%, compared to the amount at the beginning of the experiment and by 276% at the end of trial

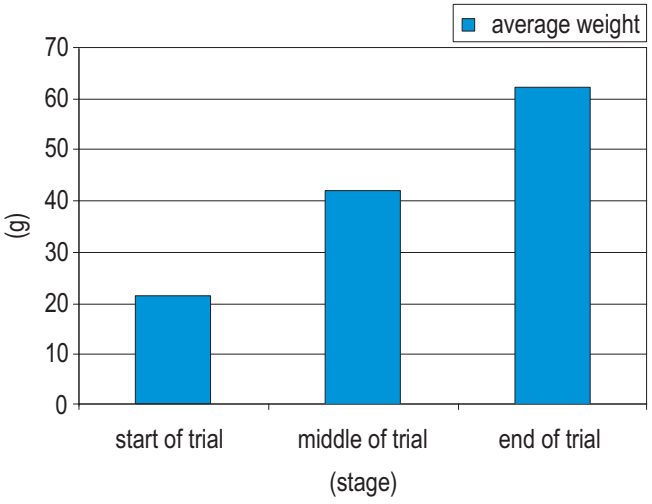

Figure 4. Weight of cultivated rainbow trout

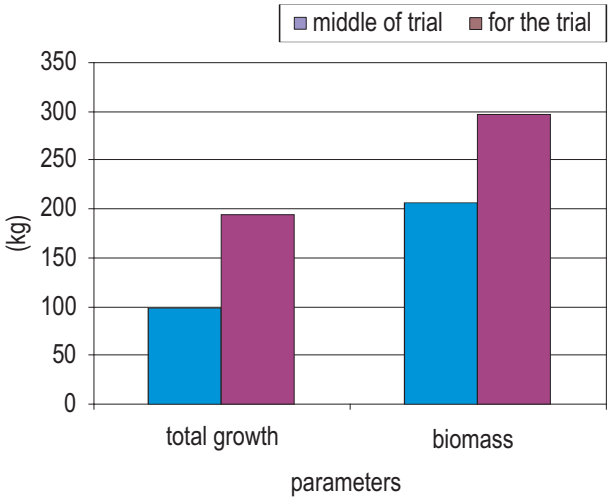

Figure 5. Total growth and biomass of cultivated fish

The average temperature throughout the trial period in the water supply channel was 14.8°C and the dissolved oxygen was at 8.25 mg.l^{-1}. The water temperature in outgoing water from the trout's raceway was 14.9°C and the dissolved oxygen 7.96 mg.l^{-1} for the trial period. According to Todorov (1989) dissolved oxygen in trout farms should not be less than 7 mg.l^{-1}. As shown in Figures 6 and 7, throughout the trial period the daily amount of dissolved oxygen was lower in outgoing water by approximately 4% than the quantity of oxygen in incoming water, because of the consumption of oxygen in fish breathing and other biological processes in the raceway. Independently of the decreasing amount of oxygen concentration, the intensity of trout growth was not affected, because differences in oxygen concentration in incoming and outgoing water up to 2 mg.l^{-1} are permissible in trout cultivation technology. On the basis of the measured oxygen in the water it is clear that the used stocking density of farmed trout was low and it could be increased up to 40%.

The average amount of oxygen consumed for the entire trial period in the raceway was 0.295 mg.l^{-1}. As can be seen on the graphs on Figure 8, at the end of the trial the average weight of farmed fish increased and led to a slight increase in oxygen consumption by the fish.

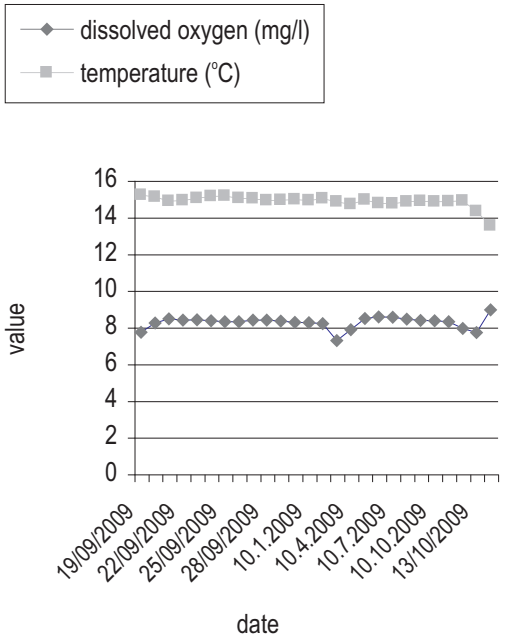

Figure 6. Dissolved oxygen and temperature of incoming water

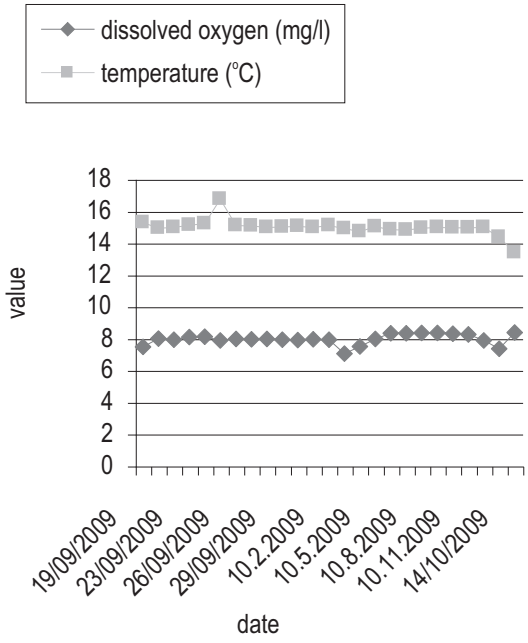

Figure 7. Dissolved oxygen and temperature of outcoming water

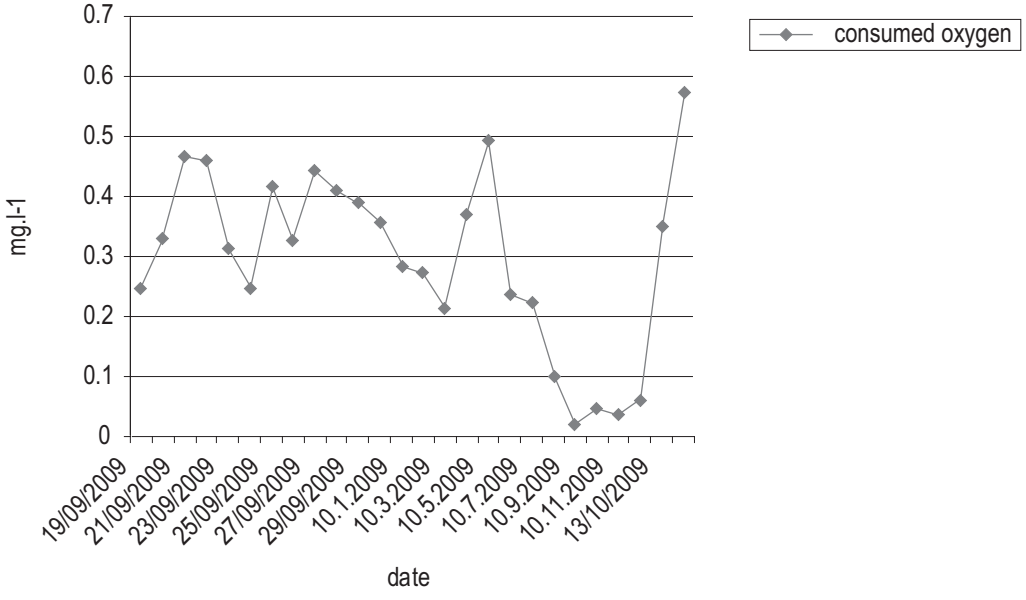

Figure 8: Oxygen consumed by rainbow trout in raceway

Table 1. Comparison between theoretically calculated amount of food and practically fed feed

Feed per day	Mean ± SEM	p
Theoretically calculated amount of food (kg per day)	5.156 ± 2.00	ns
Fed amount of food (on the basis of temperature and individual weight of rainbow trout) (kg per day)	4.417 ± 4.87	ns

The theoretically calculated amount of feed in daily ration for a stocking density of rainbow trout in the amount of 140 fish per m^3 was on an average of 5.1 kg per day. In the calculation of the daily food ration by the method used in rainbow trout cultivation practice (based on daily temperature and average individual weight of fish) the result was 4.4 kg per day, which is by 13% lower than the theoretically calculated amount of feed, but without statistically significant difference (Table 1).

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The manuscript should be structured as follows: Title, Names of authors and affiliation address, Abstract, List of keywords, Introduction, Material and methods, Results, Discussion, Conclusion, Acknowledgements (if any), References, Tables, Figures.

The title needs to be as concise and informative about the nature of research. It should be written with small letter /bold, 14/ without any abbreviations.

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Penkov D, 2008. Estimation of metabolic energy and true digestibility of amino acids of some feeds in experiments with muscus duck (Carina moshata, L). Thesis for DSc. Agrarian University, Plovdiv, 314 pp.

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AGRICULTURAL SCIENCE AND TECHNOLOGY

Volume 3, Number 3
September 2011

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