10.7251/AGSY13031039S

THE INFLUENCE OF DIFFERENT INTENSITIES OF FEEDING ON THE GROWTH OF JUVENILE RAINBOW TROUT (*ONCORHYNCHUS MYKISS* WAL.)

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Abstract

The paper presents the results of the research influence of different intensities of feeding on the growth of juvenile rainbow trout (*Oncorhynchus mykiss* Wal.) with an average initial weight and body length (±SD) 2.71±0.87 g - 6.30±0.72 cm, 2.55±0.75 g - 6.18±0.58 cm and 2.66±0.82 g – 6.32±0.60 cm. The experiment is realized in the laboratory of Fisheries, Faculty of Agriculture in Banja Luka. The experimental rainbow trout fingerlings divided into three groups; feeding every day ($EXPG_C$), a group without feeding on sunday ($EXPG_{Sun}$) and the group without feeding on wednesdays and sundays ($EXPG_{Wed-Sun}$). After 42 days of average weight and body length (±SD) was in $EXPG_C$ 9.93±3.85 g - 9.60±1.26 cm, $EXPG_{Sun}$ 8.95±2.82 g - 9.29±0.95 cm and $EXPG_{Wed-Sun}$ 7.96±2.79 g - 8.97±1:00 cm. Significant differences ($P<0.05$), average body weight were found between the experimental group $EXPG_C$ and $EXPG_{Wed-Sun}$. Specific growth ratio (SGR) and thermal-unit growth coefficient (TGC) have a tendency to decrease in proportion food intake, and feed conversion ratio (FCR) has the reverse trend, with the lowest $EXPG_{Wed-Sun}$, followed $EXPG_{Sun}$ and $EXPG_C$.

Key words: rainbow trout, feeding intensity, growth

Introduction

Feeding farmed rainbow trout, one of the most important coldwater fish that is cultivated in a number of countries in the world, occupies a significant place in technology and growing participation in the cost of production.

Salmonid fish species inhabit the clean and clear water, so it is grown in conditions necessary to ensure an adequate supply fish farms of first-class water quality (Mitrovic-Tutundžic and Brkovic-Popovic, 1994, Kahrimanovic et al., 2013, Savic et al., 2013 a, b).

Intensification of cultivation salmonid fish, which included rainbow trout (*Oncorhynchus mykiss* Wal.), natural food has lost its significance due to the large number of individuals per unit of production volume, and nutrition using pelleted and extruded food that provides all the needs of farmed fish (Markovic and Mitrovic-Tutundžic, 2003).

The importance of continued research feeding farmed rainbow trout is large, given that the share of food expenditures in total production costs by 50 to 60%. The continuous development of food is important and in order to achieve optimal growth characteristics that are directly affected by environmental conditions, quality and health status of young rainbow trout, food quality and food technology

The aim of this study was to analyze the effects of feeding different intensity on the growth of juvenile rainbow trout (*Oncorhynchus mykiss* Wal.).

Materials and methods

The experiment was carried out for a period of 42 days (22.2.2013.-06.4.2013.) in experimental polygon at Faculty of Agriculture Banja Luka. Rainbow trout is the populated in the 55 l aquarium with 42 fish in each experimental group.

Water temperature (^oC), content of dissolved oxygen (mg/l) and water oxygen saturation (%) were analyzed by digital oxy-meter Oxi 330i/SET 2b20-0011 WTW, and the pH value of a digital pH-meter pH 330i/SET WTW 2A20-1011 (Germany), every day before feeding.

During the experimental period were followed characteristic growth of body mass (the scale Denver DL-501 payload 0.5 kg) and body length (ichtyo-meter). Useful volume of water in aquarium was 55 l/aquarium with a constant flow of fresh water in all aquariums independently.

In the experiment was used extruded trout feed with 52% crude protein, 20% crude fat and 19,6 MJ/kg digestible energy, and fish were fed twice daily, at 9 and 15 o'clock.

Mass and body length were determined on a sample of 42 fish/exp group. On the basis of absolute indicators of mass and body length were calculated condition factor, specific growth rates and thermal-unit growth coefficient. Condition factor (CF) was calculated according to the formula: $CF = (BW/L^3) \times 100$, where CF - condition factor; BW – body weight (g): L - length of fish (mm). A specific growth rate was calculated according to the formula: SGR = ((ln FBW - ln IBW) / D) * 100, where FBW - final body weight (g), IBW - initial body weight (g), ln - natural logarithm; D-days. Thermal-unit growth coefficient is calculated according to the formula: $TGC = [FBW^{1/3} – IBW^{1/3}]/\Sigma [TxD] \times 100$, where TGC-thermal-unit growth coefficient; FBW - final body weight (g), IBW - initial body weight (g), T - temperature (°C), D - days. Feed conversion ratio (FCR) was calculated according to the formula: FCR = F/G, where the F-food consumption, G-realized weight gain.

Statistical analysis of the data included descriptive statistics (mean value, standard deviation and coefficient of variation), a simple analysis of variance and t - test (Microsoft Office Excel 2003: Statistical Analysis - ANOVA).

Results and discussion

During the experimental period, daily water quality was analyzed on the basic parameters of the physical and chemical characteristics of water (water temperature, dissolved oxygen content in water saturation of water with oxygen and pH) are important for fish farming (Table 1).

The results of most of the analyzed physical and chemical characteristics of water shown in table 1 indicate on the optimal values for the cultivation of young rainbow trout. The exception is the saturation of water with oxygen, which is in all aquariums averaged less than 90% (from 85.43 to 87.77%).

Although during the experiment, compared to the optimal (90-100%), showed a slightly lower water oxygen saturation, were recorded good growth characteristics in all analyzed treatments. Generally, the variation of the analyzed characteristics of water in all treatments does not indicate significant differences between treatments as suggested by the coefficient of variation for each analyzed trait.

Consequently, we can say that the quality of water in all treatments was similar with the exception of water saturation as indicated.

Table 1 Results of the analysis of physical and chemical properties of water throughout the experimental period (water temperature, dissolved oxygen, oxygen saturation of water and pH value)

	Water temperature, ^{o}C			Dissolved oxygen (O_2), mg/l			Oxygen saturation of water (O_2), %			pH		
Treatmans	Mean values±SD	min-max	CV	Mean values±SD	min-max	CV	Mean values±SD	min-max	CV	Mean values±SD	min-max	CV
$EXPG_C$	12.88±0.34	12.2-13.8	2.64	9.09±0.30	8.53-9.61	3.29	87.77±2.86	82.1-91.8	3.26	7.39±0.15	7.14-7.92	2.08
$EXPG_{Sun}$	12.88±0.29	12.3-13.3	2.22	8.81±0.32	8.38-9.80	3.57	85.43±2.75	80.2-93.8	3.22	7.25±0.10	7.07-7.58	1.44
$EXPG_{Wed-Sun}$	12.87±0.31	12.3-13.4	2.41	8.91±0.32	8.31-9.68	3.59	86.27±2.60	81.3-92.6	3.02	7.28±0.09	7.05-7.49	1.25

In the table 2 are shown the growth characteristics of juvenile rainbow trout (*Oncorhynchus mykiss* Wal.) from three treatmans with different feeding intensity.

Table 2. Growth parameters of experimental groups rainbow trout

	Parameter	Treatmans - Experimental group (n = 42)		
		$EXPG_{Control}$	$EXPG_{Sun}$	$EXPG_{Wed-Sun}$
Initial				
	W±SD (g)	2.71 ± 0.87^{ns}	2.55 ± 0.75^{ns}	2.66 ± 0.82^{ns}
	CV_W	31.95	29.48	30.92
	L±SD (cm)	6.30 ± 0.72^{ns}	6.18 ± 0.58^{ns}	6.32 ± 0.60^{ns}
	CV_L	11.39	9.45	9.57
	CF	1.084	1.080	1.054
	Feeding days	41	36	31
Final				
	W±SD (g)	$9.93\pm3.85^{*}$	8.95 ± 2.82^{ns}	$7.96\pm2.79^{*}$
	CV_W	38.8	31.48	35.02
	L±SD (cm)	9.60±1.26	9.29±0.95	8.97±1.00
	CV_L	13.18	10.27	11.17
	WG (g)	7.22	6.40	5.30
	LG (cm)	3.29	3.11	2.65
	Survival (%)	95.24	95.24	100.00
	FCR	0.64	0.63	0.61
	CF	1.122	1.116	1.103
	SGR	3.092	2.989	2.610
	TGC	0.144	0.135	0.116

W – body weight (g); CV_W – coefficient variation of body weight; L– body lenght (cm); CV_L – coefficient variation of body lenght; WG - weight gain (g); LG - length gain (cm); FCR – feed conversion ratio; FE – feed efficiency; CF - condition factor; SGR – specific growth ratio; TGC – thermal-unit growth coefficient. ^{ns}not significantly; $^{*}p<0.05$

Beginning weight and body length of young rainbow trout in all treatments was similar (no statistically significant difference), with the coefficients of variation of body weight significantly expressed. At the end of the experiment was statistically significant difference in mean of body weight ($p < 0.05$) between treatments $EXPG_{Control}$ and $EXPG_{Wed-Sun}$, and there was no statistically significant differences in mean values body length in any combination. Increase of body weight expressed are high coefficients of variation and of the body weight, particularly in treatments between which significant difference in ($EXPG_{Control}$ and $EXPG_{Wed-Sun}$). Coefficients of variation of body length at the beginning and the end of the experiment were similar. The coefficient of condition at the end of the experiment compared to the initial is increasing at all treatments, indicating that although the treatment $EXPG_{Sun}$ fish is not fed one day during the week, and in the treatment of $EXPG_{Wed-Sun}$ fish is not fed 2 days during the week, and the ratio of growth of the body length is increasing in the required limits when it comes to condition.

Specific growth ratio (SGR) and thermal-unit growth coefficient (TGC) have a tendency to decrease in proportion food intake, and feed conversion ratio (FCR) has the reverse trend, with the lowest $EXPG_{Wed-Sun}$, followed $EXPG_{Sun}$ and $EXPG_{Control}$. In the experimental group $EXPG_{Wed-Sun}$, in which the fish is not fed twice per week, the lowest FCR and the best utilization of food, but the increase in body mass is proportional nutrition.

The found FCR (0.64; 0.63 and 0.61) agree with the results Choobkar (2008), which states that the FCR of rainbow trout average weight of about 10 g at different feeding frequencies (4, 6 and 8 times) 0.61 ; 0.51 and 0.52, while the SGR identified in this study was significantly lower (3.092; 2.989; 2.610) compared to the results of the aforementioned authors (3.78; 4.19, 4.12). Also, CF in the according to the intensity of feeding decreased the of $EXPG_{Control}$ to $EXPG_{Wed-Sun}$ group and agrees to the Choobkar (2008), which states that the CF at different frequency of feeding ranges from 1.05 to 1.24 and allegations Karabulut et al (2010) to CF in water temperatures of 9 and 15°C and different feeding around 1.7 and similar results Uysal and Alpbaz (2002) and Savic et al. (2012).

Reducing the number of feeding days FCR is lower according Choobkar (2008) and contrary to the allegations Guzel and Arvas (2011), who argued that the control group had the lowest FCR, and the reduction in the number of feeding days FCR is increasing, while the CF in rainbow trout average weight of about 10 g significantly higher (1.32 to 1.38) compared to the results presented in this paper.

Mortality during the experimental period was 4.76% (2 individuals) in the treatment of $EXPG_{Control}$, treatment $EXPG_{Wed-Sun}$ also was 4.76% (2 individuals) was similar to the Karabulut et al. (2010), while in treatment $EXPG_{Wed-Sun}$ no mortality.

Conclusion

The growth patterns of young rainbow trout (*Oncorhynchus mykiss* Wal) CF, SGR and TGC agree feeding intensity, the highest growth indicators were found in the experimental group $EXPG_{Control}$, and lowest in $EXPG_{Wed-Sun}$. Also, in the experimental group $EXPG_{Control}$ were recorded the highest coefficients of variation, particularly of body weight. At the same time, the lowest FCR is in the experimental group $EXPG_{Wed-Sun}$ which indicates a longer retention of food in the digestive tract and a higher degree of utilization of nutrients. Although marked differences in average mean weight and body length in all three treatments was statistically significant mean difference in average body weight only between the treatments $EXPG_{Control}$ and $EXPG_{Wed-Sun}$, while the other combinations are not the significant differences.

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