Global Journal Of Biodiversity Science And Management, 2(1): 50-53, 2012
ISSN 2074-0875

Effect of different feeding levels in rainbow trout, *Oncorhynchus mykiss*, reared in brackish water drained from desert land reservoirs

[1]Ahmad Bitaraf, [1]Nassrin Mashaii, [1]Habib Sarsangi Ali-Abad, [1]Farhad Rajaipour, [1]Mohammad Mohammadi, [2]Majid Askari Hesni & [3]Majid Bitaraf

[1]*Iranian Fisheries Research Organization, Bafgh Fisheries Research Station, P.O. Box 159, Bafgh, Yazd, Iran*
[2]*Islamic Azad University, Maybod Branch, Yazd, Iran*
[3]*Shahid Bahonar University, Department of Biology, Kerman, Iran*

ABSTRACT

This study was aimed to investigate the effect of four levels of feeding, i.e., *ad libitum* to satiation, standard feeding, 10% less and 10% more than that of standard feeding on growth, size, feed conversion rate (FCR) and carcass quality of rainbow trout, *Oncorhynchus mykiss*, with three replicates under the condition of brackish water (salinity 8.5 gL^{-1}) drained from desert land reservoirs during the cold seasons (autumn and winter) in central plateau of Iran. The fish were reared in 12 aerated flow-through fiber glass tanks (2500 l rearing volume, n=150 fish per tank) with the initial mean weight of 44.72±3.42 (±S.E.).The highest significant increases in body weight, gain and size were occurred in ad libitum to satiation feeding group during this experiment (101 days). On the contrary, FCR (1.27±0.24) in this group was statistically lower than that of the other groups. The highest significant increases in percent of moisture, crude protein and ash in carcass were occurred in *ad libitum* to satiation feeding group whereas the crude fat percent was the lowest of all ($P<0.05$).

Key words: feeding level, rainbow trout, brackish water, cold seasons, desert lands

Introduction

In recent years, investigations on different aspects of rainbow trout, *Oncorhynchus mykiss*, rearing in arid zones have been started in Bafgh Fisheries Research Station, located at 31˚37´ N latitude and 55˚ 17´ E longitude, under the condition of brackish water during the cold seasons (autumn and winter) in central plateau of Iran. The fish are mostly produced in earthen ponds but to some extent in fiber glass tanks and concrete ponds also. Since then, the bio technique of rainbow trout culture has been introduced to many earthen ponds with limited water exchange in this region where the considerable amount of underground brackish and saline water reservoirs are available. Properties of meat produced in these systems such as good appearance of skin and flesh, tenderness and a good flavor and aroma along with a rather good growth and feed conversion rate (FCR) would be an indication of proper rearing conditions in this climate that is practiced mostly in earthen ponds that are enriched with considerable amount of live food. It is worthy of mention that the rate of salinity in aforementioned underground reservoirs is so high that made them only usable to fish production, in special rainbow trout in cold seasons.

In respect to 50 percent of cost allocation to feeding (New, 1987) in one hand and the effects of salinity on fish growth and feed consumption in the other hand, this study was aimed to determine the effect of four different levels of feeding with three replicates on growth, size (total body length), FCR and carcass quality of rainbow trout reared under the condition of brackish water drained from desert land reservoirs during the cold seasons.

Materials and Methods

Rainbow trout, *Oncorhynchus mykiss*, at 44.72±3.42g (Mean±S.E.) body weight were obtained from Shirkooh farm at Khatam town, Yazd, Iran. An initial number of 1800 fish were randomly distributed to 12 tanks (2500l rearing volume, n=150 fish per tank) provided aerated flow-through brackish water (salinity 8.5 gL^{-1}, temperature 10-15˚C). There were four groups of feeding comprising *ad libitum* to satiation (T1), standard feeding(T2), 10% less (-10%) than that of standard feeding (T3) and 10% more (+10%) than that of standard feeding (T4) with three replicates in this study.

The diet consisted of commercially available GFT1 and GRT2 pellets (CHINEH Co., Karaj, Tehran, Iran). The fish were hand-fed *ad libitum* to satiation in group T1 and in other groups at the above-mentioned three controlled levels based onto the size (total body length) and water temperature three times daily at 8, 12 and 16 o'clock (Guillaume *et al*., 1999). The fish were initially fed with GFT1 (dimension 3.5mm, dry matter 89%,

Correspondence Author: Ahmad Bitaraf, Agriculture and Natural Resources Research Center, P.O. Box 89165-571, Yazd, Iran.
Tel: +98 351 7212414, Fax: +98 351 7222261, E-mail: bitaraf_ah@yahoo.com

crude protein 38% and fat 13.5%) up to the weight of 93g and then gradually within three days, replaced with GFT2 (dimension 4.5 mm, dry matter 89%, crude protein 36% and fat 14%).

In the days 15, 30, 45, 58, 87 and 101 from the beginning of the experiment, started after a period of 15 days adaptation, the average body weights of 50 fish and the individual sizes of 20 fish were measured by means of a digital scale (accuracy: ±0.01g) and a biometry board (accuracy: ±0.1cm) respectively in samples randomly caught from each tank.

At the end of the trial, three samples of ground emptied head-cut carcasses of 10 fish, randomly taken for each group, were sent to the laboratory in order to measure moisture, crude protein, crude fat and ash percent in triplicate according to the AOAC (1975) methods. The analyses were carried out in the provincial laboratory of livestock feed analysis affiliated to Agriculture Organization of Yazd province. The dissolved oxygen, nitrite, ammonium measured periodically were in the range of 5.2-6.6, 0.01-0.02 and 0.08-0.20 mgL^{-1} respectively.

Statistical analysis was based on a completely random experimental design by using a SPSS statistical package version 19 and the data were analyzed by the analysis of variance (ANOVA). When F-value indicated significance ($P<0.05$), means were compared using Duncan's multiple test range.

Results:

The analysis of variance showed significant differences for body weight, gain, size (total body length) and FCR (the average cumulative feed intake in g/the average cumulative gain in g) in different groups of feeding ($P<0.05$) in the end of the experiment where the highest value of final body weight, gain, size and the lowest one of FCR found in T1, *ad libitum* to satiation group (Table 1).

Table 1: Means (±S.E.) of body weight, gain, size (total body length) and FCR in different groups

	Parameters				
Feeding groups	Initial weight (g)	Final weight (g)	Gain (g)	Size (cm)	FCR
ad libitum to satiation	43.85±3.42	218.40±4.19 ^{a}	174.17±4.38 ^{a}	25.2±0.3 ^{a}	1.27±0.24 ^{a}
standard	44.88±3.42	122.54±3.42 ^{c}	77.67±3.49 ^{c}	21.7±0.3 ^{c}	1.70±0.20 ^{c}
-10% standard	46.08±3.42	118.54±3.42 ^{c}	72.46±3.49 ^{c}	21.7±0.3 ^{c}	1.69±0.20 ^{c}
+10%standard	44.06±3.42	133.29±3.42 ^{b}	89.23±3.49 ^{b}	22.5±0.3 ^{b}	1.60±0.20 ^{b}

Means±S.E. in the same column with different lower case letters are significantly different based on Duncan's multiple range test ($P<0.05$).

Among controlled feeding groups, i.e., T2, T3 and T4 the highest averages for body weight, gain, size and the lowest one for FCR were found in T4 group based on Duncan's test. During different biometry, FCR in T1 group was in a rather same level, not fluctuating like those in controlled feeding groups of T2, T3 and T4 (Figure 1).

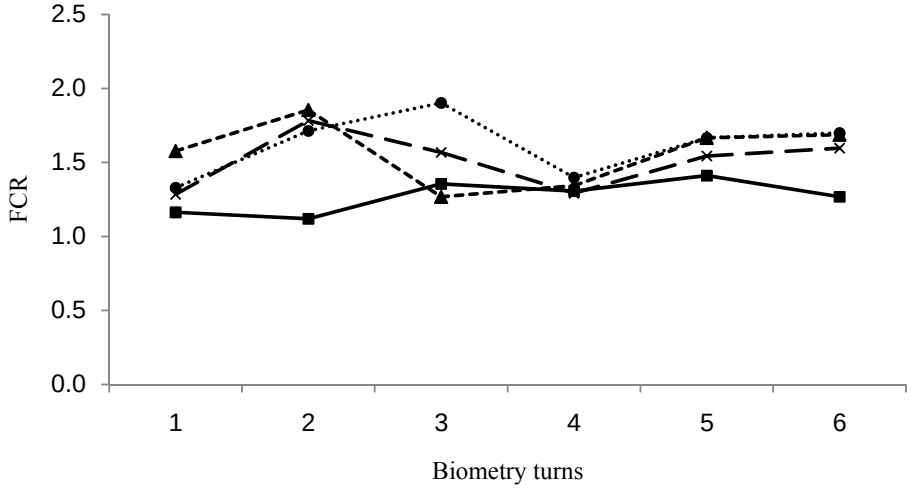

Fig. 1: FCR measured in different feeding groups (■, T1: ad libitum to satiation; ●, T2: standard; ▲, T3: -10% standard; ×, T4: +10% standard) during the experiment.

At the end of the trial, the carcass samples were analyzed and the moisture, crude protein and ash percent were statistically lower in group T1 but the fat percent in this group was the highest of all ($P<0.05$). Based on Duncan's test, the averages for moisture, crude protein and ash percent were not significantly different ($P>0.05$) among controlled feeding groups, i.e., T2, T3 and T4 in this study (Table 2).

Glob. J. Biodivers. Sci. Manag., 2(1): 50-53, 2012

Table 2: Means (±S.E.) of chemical analysis of fish carcasses in different groups

Feeding groups	Chemical analysis			
	Moisture (%)	Crude protein (%)	Crude fat (%)	Ash (%)
ad libitum to satiation	67.55±0.03 [a]	55.95±0.25 [a]	36.80±1.20 [a]	6.57±0.25 [a]
standard	72.11±0.09 [b]	62.41±0.44 [b]	24.87±0.09 [b c]	10.67±0.12 [b]
-10%standard	72.33±0.07 [b]	62.32±0.45 [b]	26.73±0.99 [b]	10.40±0.34 [b]
+10%standard	72.39±0.13 [b]	62.12±0.41 [b]	23.60±0.36 [c]	10.88±0.20 [b]

Means±S.E. in the same column with different lower case letters are significantly different based on Duncan's multiple range test (P<0.05).

Discussion:

Many factors affect the nutrient requirements of fish which is related either to the animal such as species, size (total body length) and physiological status or to the environment such as temperature, salinity and dissolved oxygen content but among them the size of fish and the water temperature are important to balance rations in practice (Guillaume *et al*., 1999). A review of literature concerning feed formulation and nutrient requirements of trout shows that feeding tables are basically prepared based on water temperature and fish size for the fish cultured in fresh water (NRC, 1981; Guillaume *et al*., 1999 and Stead & Laird, 2002). Aquatic nutrient requirements in saline water are different from those in fresh water particularly for energy, minerals and some amino acids like arginine which is itself a consequence of animal adaptation to these environments, in special for osmotic pressure regulation. In this condition, firstly it is recommended to use the feeding tables as a guide and secondly feed is provided *ad libitum* that let fish itself regulate feed consumption in order to fulfill its requirements (Stead & Laird, 2002).

By increasing the level of feeding at the present study, the body weight and gain were increased and the highest significant body weight and gain occurred in T1, *ad libitum* group (P<0.05). Coordinately, FCR was improved and the lowest significant value (P<0.05) was observed in this group (Table 1). The findings of the present study for the aforementioned parameters are confirmed by the Stead & Laird (2002) that recommend feed rainbow trout *ad libitum* in waters other than fresh water. Macleod (1977) in a study in rainbow trout, *Salmo gairdneri* R., acclimatized to experimental salinities showed that food intake was increased significantly (P<0.05) in salinities 15.0 and 28.0 gL^{-1} in comparison to that of fresh water but with further increase, at salinity of 32.0 gL^{-1}, feed intake was significantly decreased (P<0.01). There was a tendency for feed conversion efficiency to improve by increasing salinity in this study. The above-mentioned results of this study for feed conversion efficiency and food intake coordinates with those ones obtained at the present study for body weight increase and FCR. Storenbakken & Austreng (1987) in a study on rainbow trout, *Salmo gairdneri* R., cultured in fresh water, investigated the effects of six different feeding levels, i.e., 0.125, .250, 0.500, 1.000 (level 1.000 based on expected maximum growth depending on fish size and water temperature), 2.000 and 4.000 on growth, feed Intake, protein digestibility, body composition, and feed conversion. It was shown that both growth and feed conversion efficiency were increased up to the level of 1.000 significantly but with further increase in feeding level, feed conversion efficiency decreased while there was an increase in growth only. The improving trend of body weight, gain and FCR by increasing feeding level in the present study have a coordination with the findings of this study up to the feeding level of 1.000. Ash, fat and moisture percents of fish carcasses were increased significantly (P<0.01) in this study by increasing the feeding level in groups 2.000 and 4.000 whereas at the present study, there was a significant increase in fat percent only in T1, *ad libitum* group, and the percents of ash and moisture were decreased significantly comparing with the feeding levels of T2 and T3 groups (Table 2). By increasing the feeding level at the present study, protein percent of carcass was also decreased significantly (P<0.05) in T1 group, but no significant difference was reported by Storenbakken & Austreng (1987) in this regard. In a study performed by Mambrini *et al*. (2005) on brown trout, *Salmo trutta*, the growth rate was increased significantly (P<0.05) in fish fed *ad libitum* comparing to that of restricted fed animals (75% *ad libitum*) that is comparable to the results obtained at the present study for T1, *ad libitum* to satiation group, (P<0.05). The feed efficiency (FE= $[(W_f-W_i)\times(\text{distributed feed-feed waste})^{-1}]$) was not significantly different in two groups (1.4 on the average), but contrary to this, FCR was significantly decreased in *ad libitum* to satiation group, T1, at the present study (P<0.05, average=1.27). Azevedo *et al*. (1998) carried out a study to determine the effect of feeding level and water temperature on growth and feed efficiency (wet weight gain/dry feed) of rainbow trout *Oncorhynchus mykiss*. The results showed a significant decline in weight gains for restricted feeding groups (P<0.05) compared to that of near-satiation group of fish, regardless of water temperature. Near-satiation group showed the highest feed intake and weight gain rate that is comparable to the results of present study but FE, contrary to FCR obtained in present study, was not significantly different among groups. Two strains of rainbow trout, *Oncorhynchus mykiss*, were used in other study performed by Valente *et al*. (1998) and the possible interaction between genotype, the dietary composition and feeding level on utilization efficiency and voluntary feed intake was investigated. The results showed a significant difference for weight gain between fast growing and slow growing strains that fed to satiation (P<0.05); however, in restricted fed groups (2% BW)

no difference was observed between two strains. Feed gain ratio **(**FGR=feed intake(g dry matter)/weight gain(g)**)** was declined significantly ($P<0.05$) in groups of fish fed restricted level that is contrary to the increasing trend of FCR by decreasing feeding level at the present study (Figure 1). Van Ham *et al*. (2003) in a study on, *Scophthalmus maximus*, reported a significant increase ($P<0.05$) in final weight of group fed to satiation vs. restricted levels of 35 and 65% to satiation and a simultaneous increase in feed conversion efficiency (FCE=k growth/k DM feed) of group fed to satiation level vs. 35%. The fish was reared in salinity 34.5±0.2g gL^{-1} (±S.E.). The fat, ash and moisture content of whole body composition increased in fish fed to satiation significantly ($P<0.05$) in comparison with fish fed restricted regime (35% to satiation) that is comparable to the results obtained for fish carcass analysis at the present study, but contrary to it, Van Ham *et al*. (2003) reported no significant difference in protein content.

Work performed by other authors confirms the effects of salinity on growth and metabolic activities of rainbow trout in different stages of life. In this regard, Nadir Başçınar (2010) reported best growth performance in larvae of rainbow trout, *Oncorhynchus mykiss*, in 4 gL^{-1} salinity that it may be due to energy recruitment for activities such as water regulation and ion transfer**.** Krumschnabel & Lackner (1993) in other study reported marked decrease in blood glucose level of rainbow trout, *Oncorhynchus mykiss*, in alevin stage when exposed to different stimuli like salinity that it could be a result of increase in energy requirements. This energy is used for osmotic pressure regulation that is followed by an improvement in growth due to the metabolic activity enhancement.

Conclusion:

According to the results of the present study, it seems that an *ad libitum* to satiation regime would be the best feeding practice for the rainbow trout production in fish culture of desert lands under the condition of brackish water in cold seasons because of a rather improved FCR and a higher weight gain in a rather shorter time. However, further investigations are needed to draw firm conclusions for trout production in earth ponds of arid zones under the condition of brackish water enriched with live foods.

References

AOAC, 1975. Official Methods of Analysis of the Association of Official Analytical Chemists, 12th ed, Association of official analytical chemists, WA, DC, USA. pp: 1094.

Azevedo, P.A., C. Young Cho, S. Leeson and D.P. Bureau, 1998. Effects of Feeding Level and Water Temperature on Growth, Nutrient and Energy Utilization and Waste Outputs of Rainbow Trout (*Oncorhynchus mykiss*). Aquatic living resources, 11: 227-238.

Başçınar, N., 2010. Effect of Low Salinity on Yolk Sac Absorption and Alevin Wet Weight of Rainbow Trout Larvae (*Oncorhynchus mykiss*). The Israeli Journal of Aquaculture – Bamidgeh, 62(2): 116-121.

Guillaume, J., S. Kaushik, P. Bergot and R. Metailler, 1999. Nutrition and Feeding of Fish and Crustaceans. 1st ed. Springer, UK. pp: 408.

Krumschnabel, G. and R. Lackner, 1993. Stress Response in Rainbow Trout (*O.mykiss*) Alevins. Comparative Biochemistry and Physiology, 104: 777-783.

MacLeod, M.G., 1977. Effects of Salinity on Food Intake, Absorption and Conversion in the Rainbow Trout *Salmo gairdneri*. Marine Biology, 43: 93-102.

Mambrini, M., L. Labbe and F. Randriamanantsoa, 2005. Response of Growth-Selected Brown Trout (*Salmo trutta*) to Challenging Feeding Conditions. Aquaculture, 252: 429-440.

New, M.B., 1987. Feed and Feeding of Fish and Shrimp, a Manual on the Preparation and Presentation of Compound Feeds for Shrimp and Fish in Aquaculture. FAO Field Document ADCP/REP/87/26. FAO, Rome, Italy. pp: 275.

NRC, 1981. Nutrition Requirements of Coldwater Fishes, 1st ed. National Academy press, WA, DC, USA. pp: 63.

Stead, S.M. and L.M. Laird, 2002. Handbook of Salmon Farming, 1st ed. Springer, UK. pp: 502.

Steffens, W., 1989. Principles of Fish Nutrition, 1st ed. ELLIS HORWOOD LIMITED, England. pp: 384. (In German, Translated by Hemmings, B.D., 1989)

Storenbakken, T. and E. Austreng, 1986. Ration Level for Salmonids II. Growth, Feed Intake, Protein Digestibility, Body Composition, Feed Conversion in Rainbow Trout Weighing 0.5-1.0 Kg. Aquaculture, 60: 207-221.

Valente, L.M.P., B. Fauconneau and E.F.S. Gomes, 1998. Voluntary Feed Intake, Feed and Nutrient Utilization in Slow and Fast Growing Rainbow Trout Strains. Aquatic Living resources, 11: 93-99.

Van Ham, E.H., M.H.G. Berntssen, A.K. Imsland, A.C. Papoura, S.O. Wendelaar Boga and S.O. Stafansson, 2003. The Influence of Temperature and Ration on Growth, Feed Conversion, Body Composition and Nutrient Retention of Juvenile Turbot (*Scophthalmus maximus*). Aquaculture, 217: 547-558.