A study on growth parameters, blood factors and proximate composition of rainbow trout (*Oncorhynchus mykiss*) cultured in underground brackish and freshwater

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Abstract

In this research, growth rate, blood parameters and proximate composition of rainbow trout (*Oncorhynchus mykiss*) cultured in brackish and freshwater were evaluated. Two treatments (brackish and freshwater) in 3 replications were investigated. Six 1.5 m³ fiberglass tanks were used for this experiment, containing 180 rainbow trout specimens with average weight of 47.2±0.1g. Feeding rate in treatments was about 3% of body weight based on water temperature and fish biomass. Total length and weight of fish were measured in 15 days intervals. After 135 days of culture period, some fish samples were transferred to the Lab. Blood were directly collected from the heart. Muscle composition was analyzed for proximate composition. The results showed that the body weight of samples in brackish water was increased significantly after 45 days of culture period. Blood factors including WBC, RBC, Hb, Hct, MCV, MCH, MCHC, lymphocyte, thrombocyte and concentration of K^+ ions in fish cultured in brackish water showed a significant increase ($P<0.05$). Muscle composition analysis showed a significant increasing ($p<0.05$) in fat and dry matter in freshwater treatment, while moisture was significantly higher in brackish water ($P<0.01$)

Keywords: Rainbow trout, brackish water, freshwater, blood factors, proximate composition, growth

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Introduction

Some benefits of rainbow trout aquaculture in Iran are considered as rapid growth, delicious meat, enough knowledge about reproduction and breeding, availability of fry in all seasons, proper marketing and no interaction puberty age with the growing period (Alizadeh, 2004). Considering the restriction of freshwater, the underground brackish water has been highlighted as an alternative way for fish production. Because of salinity affects on the food gain by fish, brackish water fishes have higher growth in these media, as they consumed food more than fishes in freshwater (Falahati, 2002). Water salinity can affect on some blood factors such as morphology and dimensions of red blood cells (Raiati, 1999). Altinok and Grizzle (2001) showed that the best salinity grade for the growth of rainbow trout is 9 g/L. Rassmussn (2000) expressed the best salinity for rainbow trout growth in his research between 15 to 18 g/L. Rainbow trout with average weight of 30 g reared in 18 g/L water salinity showed the best growth efficiency (Turker and Hargreaves, 2003). The effect of different energy levels of diet on the growth indices and carcass composition of rainbow trout (*O. mykiss*) grown in brackish water were investigated by Nafisi (1991). He reported that increasing energy levels in the diet significantly increased the growth indices. Alizadeh (2004) also found about 30% increase in rainbow trout production in brackish recycled water in concrete ponds.

In the present study, some growth parameters include weight, length and some blood factors including red blood cells count, hemoglobin, hematocrit, red blood cell indices (MCV, MCH, MCHC), white blood cells count, concentration of serum sodium and potassium ions, and proximate composition of muscle of rainbow trout reared in brackish and freshwater were compared.

Materials and methods:

This study was conducted in an agriculture farm located in Isfahan province in the center of Iran. For this purpose six 1.5 m^3 tanks were prepared. The underground brackish and freshwater was pumped from two different wells, were stored in a reservoir tanks, and then were transferred separately to fiberglass tanks by pipe. EC and pH of freshwater were 4.3ms and 7.1, respectively. These parameters for underground brackish water were 14.1ms and 7.0. In order to provide the same environmental conditions for treatments, the tanks were located in controllable space. Thirty rainbow trout juveniles were introduced to each tank after adaptation in new conditions. Temperature, salinity, pH, dissolved oxygen, and EC were daily recorded. Fish feeding was performed 3 times per day. Measuring of weight and length of 10 specimens from each tank was done randomly every 15 days. At the end of 135 days of culture period, live samples, taken randomly from treatments, were transferred to the Biology Laboratory Department of Isfahan University. Clove powder was used for anesthesia of fish during transition and sampling period. Fish weight and length were measured, and then blood samples were taken from the heart by sterile heparinized syringe. Considering to size, about

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3-4^{cc} blood was taken from every fish (Korcock et al., 1988). Blood factors including RBC and WBC were counted through prepared spread blood and Neo bar lam. Hemoglobin was measured by spectrophotometer and micro hematocrit method was used for hematocrit measurment (Raiati, 1999). MCH, MCV were calculated through computational formulas (Raiati, 1999). The flame photometer was used for serum Na^+ and K^+ measurement. Percentage of crude protein, total fat and moisture were measured by micro Kjeldahl, Soxhlet and Oven methods, respectively. Minerals were determined by heating the samples in furnace and dry matter content by burning on the flame under the hood. (AOAC, 1990).

Results

The average of body weight and total length frequencies of fish in each tank at 15 days intervals was shown in Table 1. One way Analysis variance showed there was no significant difference between mean weight of fish in experimented treatments during early 45 days of culture period ($p>0.05$), while it was increased significantly ($p<0.05$) in brackish water.

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Table1. Average weight and length of rainbow trout in brackish water and freshwater treatments

Days of culture	Mean BW (g) in brackish water	Mean BW (g) in freshwater	mean TL(cm) in brackish water	mean TL(cm) in freshwater
1th day	47±0.12	47.2±0.1	162±1	162±1.0
15th days	54.7±1.0	54.6±0.5	164±1	164±1.5
30th days	62.3±0.1	63.5±0.5	174±1	175±1.0
45th days	77.8±0.2	82.5±0.5	185±0.5	186±0.5
60th days	102.3±2.0	111.8±1.7	206±1	211±1.0
75th days	138.8±1.2	157.0± 3.0	226±1	238±2.0
90th days	176.1±1.7	179.0±2.6	247±2	268±2.0
105th days	202.0± 2.1	242.3±2.5	263±3	272±2.0
120th days	259.6±1.5	282.3±4.0	271±2	282±2.5
135th days	296.1±1.1	336.0± 2.5	290±2	302±2.0

Average percentages of parameters including RBC, WBC , MCV, MCH , MCHC , Hb , Hct, lymphocytes and thrombocytes in brackish water treatment were higher than freshwater, significantly ($p<0.05$). However two experimental groups showed no significant difference ($p>0.01$) in average percentages of neutrophils, monocytes, and eosinophils. Concentration of plasma Na^+ in brackish water was lower than freshwater while mean concentration of K+ ion in freshwater (15.46±1.50) was significantly higher (8.53 ±1.16) than brackish water ($p<0.01$).

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Table 2. Measured blood indices of rainbow trout in brackish water and freshwater treatments

Blood parameters	Mean±SD	
	Freshwater	Brackish water
WBC	11029±2003	17651±913
RBC	1374000±134840	1790600±93070
Hemoglobin (%)	7.02±0.61	12.94±0.86
Hematocrit (%)	36.26±1.37	45.61±301
MCV(%)	239.17±20.16	256.59±21.15
MCH(%)	52.66±5.04	72.54±6.72
MCHC(%)	19.42±1.75	28.96±2.92
No. Lymphocyte	81.25±5.76	89.65±3.96
No. Monocyte	1.5±1.05	1.8±1.05
No. Neutrophil	7.4±2.21	7.8±1.28
No. Eosinophil	0.50±0.51	0.55±0.51
No.Thrombocytes	16108±1790.2	20265.5±1034.8
Na^+(mg/l)	161±2.97	160±4.09
K^+(mg/l)	8.53±1.16	15.46±1.50

Proximate analysis of carcass was shown in Table 3. According to the results, the amounts of total fat and dry matter were significantly lower in freshwater treatment ($p<0.05$), while crude protein (20.56%) and minerals (1.64%) were the same in both groups without any significant difference ($p>0.05$). Moisture in the brackish water treatment was higher significantly than freshwater ($p<0.01$)

Table 3. Average proximate composition of carcass in experimented treatments

Proximate composition	Mean (%)	
	Freshwater	Brackish water
Crude protein	20.56±0.67	20.47±0.88
Total fat	2.67±0.85	1.66±0.29
minerals	1.64±0.91	1.64±0.95
Dry matter	23.77±0.78	22.78±0.66

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Discussion

Rainbow trout (*O. mykiss*) is a sensitive fish to fluctuate some environmental factors such as pH, oxygen, temperature, density and water salinity (Askarian and Koosha, 2006). Higher body weight in brackish water treatment (after early 45 days of culture can be mostly related on more energy absorption by fish (Falahati, 2002). Maintaining of fish in different salinities may lead to shift in food consumption (Partridge and Jenkins, 2002). According to studies, better growth of fish in brackish water through more absorption of ingested food, is controlled by their central nervous system and different hormones (Askarian and Koosha, 2006).

Macloal (2002) reported that rainbow trout cultured in 15 ppt water salinity consume more amounts of food than lower salinity and fresh water. Salinity can affect on fish through changes in the osmotic regulation and the amount of energy required for growth (Macloal, 2002). Red blood cells of rainbow trout had slight changes in the brackish water (Vosyliene et al., 1993). In the present study, the number of red blood cells significantly increased in brackish water that it is in agreement with the report of Randall and Perry (1992), which showed that by increasing of salinity, the number of red blood cell was increased. According to Maccarthy and Strenson (1973) hematological factors including red blood cells, hemoglobin and hematocrit were changed due to changes in water salinity, in which was in agreement with this research. It was also reported that change of MCV, MCH, MCHC in rainbow trout is due to physiological factors and environmental changes (Salonius and Iwama, 1993).

According to the results, activity of immunity system of brackish cultured fish was higher, because of more amounts of white cells and lymphocyte in brackish water group. Physiological factors such as stress, life cycle, swim and also some environmental factors like temperature, oxygen, photoperiod, season, food, poisons and especially the salinity of water can be affected the hematocrit level (Raiati, 1999). In this study, the mean of MCHC, MCV, MCH, HCT, RBC, Hb in freshwater treatment was confirmed with Beiraghdar (2008) results, so these factors increased significantly in brackish water group. Muscle protein in brackish water treatment was lower than freshwater but did not show any significant difference ($p>0.05$). Final weight increasing of fish cultured in brackish water, might be resulted from osmotic adjustment mechanism that needs more energy (Tsintsadze, 1991). Protein resources showed that inadequate energy in rainbow trout diet can decrease the protein content of body (Alizadeh, 2004). The diets containing more fat and less protein, lead to increase of protein absorption in rainbow trout (Takeuchi et al., 1978). Therefore, these diets in rainbow trout increase the protein efficiency. Significant reduction of total fat in brackish water treatment was similar to the results of other researchers such as Steffens (1994) and Gouveia (1992). Increase in metabolic activity in brackish water group may be resulted from reduction in the percentage of fat in these fish.
Also it was found that brackish water affects on blood factors, proximate composition of

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carcass and growth factors. The results also stressed the importance of brackish water resources for fish production.

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مطالعه پارامتر های رشد، فاکتورهای خونی و ارزش های غذایی ماهی قزل آلا *Oncorhyncus mykiss* در آب لب‌شور و شیرین

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چکیده:

در این تحقیق،رشد، فاکتورهای خونی وارزشهای غذایی ماهیان قزل آلا در آب لب شور و شیرین مورد بررسی قرار گرفت. تعداد ۱۸۰ عدد بچه ماهی قزل آلا با وزن ۰/۱ ± ۴۷/۱ گرم در ۶ حوضچه پلی اتیلنی با ظرفیت ۱/۵ مترمکعب آب رها سازی گردید. برای این ۲ تیمار هر یک ۳ تکرار در نظر گرفته شد و در طول دوره آزمایش سعی شد کلیه شرایط ثابت نگهداشته شود. غذادهی در طول دوره پرورش به میزان یکسان برای هر تکرار و با توجه به درجه حرارت آب و بیوماس ماهیها صورت گرفت.

هر ۱۵ روز یکباراز هر دو تیمار مراحل زیست سنجی ماهیان انجام شد. پس از گذشت ۱۲۶ روز ماهیان به صورت زنده به آزمایشگاه انتقال و پس از بیومتری وزن و طول ،ماهیها بیهوش شدند و خونگیری مستقیم از قلب انجام گردید، فاکتورهای خونی موردنظر اندازه گیری شد و همچنین آنالیز ماهیچه آنها صورت پذیرفت. نتایج نشان داد رشد ماهیان در آب لب شور بعد از مرحله سوم بیومتری افزایش معنی داری نسبت به تیمار دیگر نشان داد.

فاکتورهای خونی WBC, RBC, Hb,Hct,MCV,MCH,MCHC,Lymp,Throm و یون پتاسیم در ماهیان آب لب شور افزایش معنی داری نسبت به آب شیرین نشان داد($P < ۰/۰۵$).

آنالیز شیمیایی ماهیچه نشان داد میزان چربی و ماده خشک به طور معنی داری در ماهیهای آب لب شیرین بیشتر بود ($P <۰/۰۵$). میزان رطوبت در ماهیهای آب لب شور نسبت به آب شیرین بیشتر بود و اختلاف معنی داری نشان داد. ($P < ۰/۰۱$).

کلمات کلیدی: قزل آلا، آب لب شور، آب شیرین، فاکتورهای خونی، آنالیز شیمیایی، رشد.

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