Oral recombinant bovine somatotropin improves growth performance in rainbow trout (*Oncorhynchus mykiss*)

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Abstract

The aim of this research was to evaluate the effects of oral recombinant bovine somatotropin (RBS) 1% on growth performance of rainbow trout (*Oncorhynchus mykiss*). 600 rainbow trout weighing 46±1 grams were randomly allotted in two groups including: 1) the control group and 2) RBS treated group, each in three replicates. The fish were hand-fed with commercial pellets. The fish received 200g RBS 1% per 100kg BW. The administration method of RBS-mixed feed to fish was once a week for 4 consecutive weeks, totally 8 times for 12 weeks of rearing periods. At the end of each rearing periods (on day 28, 56, 84) the means of some of growth characteristics were calculated in the control and RBS treated groups. The obtained results in this research demonstrated that there were no significant differences between appearance growth characteristics in the control and RBS treated groups on days 28 and 56 of rearing periods ($p > 0.05$). However, there were significant differences between means of whole body weight ($p < 0.05$), weight gain ($p < 0.05$), average daily growth ($p < 0.05$), total length ($p < 0.001$), and average daily length ($p<0.05$) of the control and RBS treated groups on day 84 of rearing period. In the same period, there was greater 11.2% comparative growth rate in RBS treated group than the control group. Generally, the obtained data showed that oral administration of RBS 1% can produce a significant increase in the growth rate of rainbow trout weighing 46±1 grams on day 84 of rearing period.

Keywords: Oral recombinant bovine somatotropin, Growth performance, Rainbow trout, *Oncorhynchus mykiss*

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Introduction

Optimizing growth rates and body composition are important issues in the aquaculture industry. Maximizing growth and minimizing costs by improving feed conversion are desirable goals in the commercial production of many species of fish. One of the effective techniques to increase production level is elevated growth rate by decreasing rearing period of marketing. The produce of fish using of recombinant growth hormone is a practice method to elevate growth rate. Accordingly, the effects of oral recombinant bovine somatotropin (RBS; Eltosil®) manufacture of LG life sciences evaluated on growth performance of rainbow trout (*Oncorhynchus mykiss*) weighing 46±1 grams. Numerous studies have suggested that exogenous and endogenous growth hormone promotes growth of many species teleosts (Leedom et al., 2002; McLean et al., 2003; Biga et al., 2004; Simpson et al., 2004; Biga et al., 2005). It has been reported that ovine somatotropin improved growth rates and whole body protein accretion in rainbow trout (Foster et al., 1991). Recombinant bovine somatotropin has increased growth rate approximately 40% in very young (1.4-3.0 g) rainbow trout (Schulte et al., 1989). Also, recombinant bovine somatotropin enhanced rate of gain and feed conversion efficiency in juvenile Coho salmon (*Oncorhynchus kisutch*) (Down et al., 1988; 1989). Long-acting recombinant porcine somatotropin implants accelerated growth (37 to 83%) and reduced carcass fat (30 to 55%) of juvenile Coho salmon (McLean et al., 1990; McLean et al., 1992). Growth hormone (GH) stimulates tissue growth by increasing DNA synthesis and rate of cell multiplication and differentiation. GH acts both directly and indirectly via insuline-like growth factor (IGF-1) or somatomedin C (Biga et al., 2005; Yada, 2007). GH injections have been found to increase growth rate, appetite and competitive ability (Johansson & Björnsson, 1994; Jönsson et al., 1996). The aim of this research was to evaluate the effects of oral recombinant bovine somatotropin 1% on growth performance of rainbow trout (*Oncorhynchus mykiss*) weighing 46±1 grams.

Materials and methods

In this research, 600 rainbow trout (*Oncorhynchus mykiss*) fry mean weight of each fish 46±1 grams were randomly allotted in two groups including: 1) the control group and 2) recombinant bovine somatotropin (RBS) treated group, each in three replicates. These fish were randomly divided in six 2,000 liter round concrete ponds with a continuous water flow of 5 liter per minute. Ponds were supplied with well water (temp. range: 15±1; O_2: 7.2±0.2 mg l^{-1}; pH= 8±0.3). The fish were hand-fed four times daily with commercial pellets (Cheeneh Company, Table 1) at the beginning of experiments and reached twice daily during continuous growth. The fish received 200g RBS 1% (Eltosil®) per 100kg BW. RBS added the morning feed amounts which calculated on both total fish weight in each replicates of RBS group and water temperature. After, the prepared morning feed were completely mixed with RBS without water addition. Finally, the RBS-mixed were gently mixed with water spray until the sticky feeling disappeared (RBS possesses gelatin-like

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material that it adhesives to feed when water adds to feed). The administration method of RBS-mixed feed to fish was once a week for four consecutive weeks at the first and third rearing periods, totally eight times for twelve weeks (four times for four weeks in the first rearing period; withdrawal for four weeks; and again four times for four weeks in the third rearing period).

Table 1- Cheeneh Feed composition

Feed composition	Plate Size (3.5 mm)	Plate Size (4.5 mm)
crude protein	38	36
(min)	13.5	14
crude fat (min)	11	11
ash	3.5	3.5
fiber (max)	1.1	1
phosphor (min)		

The aim of this research was to evaluate the effects of oral recombinant bovine somatotropin 1% on growth performance in rainbow trout (*Oncorhynchus mykiss*) weighing 46±1 grams. Accordingly, to calculate growth factors, fish were weighed weekly and their body lengths were measured every other week. At the end of each rearing period (on days 28, 56, 84) the means of whole body weight (WBW), weight gain (WG), average daily growth (ADG), total length (TL), average daily length (ADL) in control and RBS groups were calculated. Also, specific growth rate (SGR), condition factor (CF), food conversion rate (FCR), and the percentage of survival ratio (SR) in the control and RBS groups were calculated. Moreover, at the end of the rearing period (on day 84), comparative growth rate (CGR), the means of WBW, WG, TL, ADL and FCR in the control and RBS groups were calculated according to following formula (Samantaray and Mohanty, 1997):

Weight Gain (WG): (treatment weight gain group – control weight gain group)/ control weight gain group × 100

Specific Growth Rate (SGR): (L_n final weight – L_n initial weight)/ rearing periods (day) ×100

Feed Conversion Rate (FCR): feed intake/weight gain×100

Condition Factor (CF): final weight/ $(\text{length})^3 \times 100$

Comparative Growth Rate (CGR): (treatment weight gain group – control weight gain group)/ rearing period (day)

Statistical Analysis

The data were analyzed using the SPSS program. A comparison between the mean of two groups was carried out by Student's *t* test. The results were expressed as means ± SEM. The differences were considered significant when $p< 0.05$.

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Results

The results of oral RBS effects on growth characteristics in rainbow trout weighing 46±1 grams have been demonstrated in tables 2-6. The obtained results in this research demonstrated that there were no significant differences between growth characteristics in the control and RBS treated groups on day 28 or 56 of rearing periods (p> 0.05, tables 2-6).

Table 2: The effect of oral recombinant bovine somatotropin (RBS) 1% on growth factors of rainbow trout weighing 46±1 grams in different rearing periods

Characteristics	Control group	RBS group	p value
Initial weight (g)	45.28±0.2	47.56±0.2	> 0.05
Day 28			
Final weight (g)	70.53±2.3	75.00±2.3	> 0.05
Average daily gain (g)	0.90±0.03	0.97±0.03	> 0.05
Weight gain/food (g)	0.79±0.01	0.81±0.01	> 0.05
Day 56			
Final weight (g)	103.56±1.7	111.32±1.7	> 0.05
Average daily gain (g)	1.04±0.04	1.14±0.04	> 0.05
Weight gain/food (g)	0.72±0.02	0.74±0.02	> 0.05
Day 84			
Final weight (g)	147.08±3.5	158.73±3.5	< 0.05*
Average daily gain (g)	1.21±0.05	1.32±0.05	< 0.05*
Weight gain/food (g)	0.68±0.03	0.69±0.03	> 0.05

The asterisks indicate the differences are significant between growth factors in two groups

Table 3: The effect of oral recombinant bovine somatotropin (RBS) 1% on whole body weight (WBW), weight gain (WG), and feed conversion rate (FCR) factors of rainbow trout weighing 46±1 grams

Rearing periods	Group	WBW	WG	FCR
Day 84				
	Control	147.08±3.5[a]	101.80±3.58[a]	1.48±0.08[a]
	RBS	158.73±3.5[b]	111.17±3.5[b]	1.45±0.08[a]

Different superscript words indicate the differences are significant between the control and the RBS groups

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Table 4: The effect of oral recombinant bovine somatotropin (RBS) 1% on specific growth rate (SGR), feed conversion rate (FCR), condition factor (CF), and total length (TL) of rainbow trout weighing 46±1 grams in different rearing periods

Rearing period	Group	SGR (%)	FCR (%)	CF (%)	TL (cm)
Day 28					
	Control	1.50±0.14	1.26±0.02	1.08±0.03	18.7±0.16
	RBS	1.63±0.14	1.25±0.02	1.11±0.03	18.9±0.16
Day 56					
	Control	1.48±0.10	1.49±0.04	1.09±0.05	21.15±0.12
	RBS	1.52±0.10	1.43±0.04	1.13±0.05	21.45±0.12
Day 84					
	Control	1.40±0.13	1.60±0.08	1.19±0.06	23.10 ± 0.20^{a}
	RBS	1.43±0.13	1.58±0.08	1.16±0	23.09 ± 0.20^{b}

Different superscript words indicate the differences are significant between the control and the RBS groups

Table 5: The effect of oral recombinant bovine somatotropin (RBS) 1% on total length (TL) and average daily length (ADL) factors of rainbow trout weighing 46±1 grams

Characteristics	Control group	RBS group	p value
Mean of Initial Length (cm)	16.70±0.20	16.31±0.20	> 0.05
Mean of Final Length (cm)	23.10 ± 0.10^{a}	23.90 ± 0.10^{b}	< 0.0001
Mean of Daily Length (mm)	0.76 ± 0.01^{a}	0.90 ± 0.02^{b}	< 0.05

Different superscript words indicate the differences are significant between the control and the RBS groups

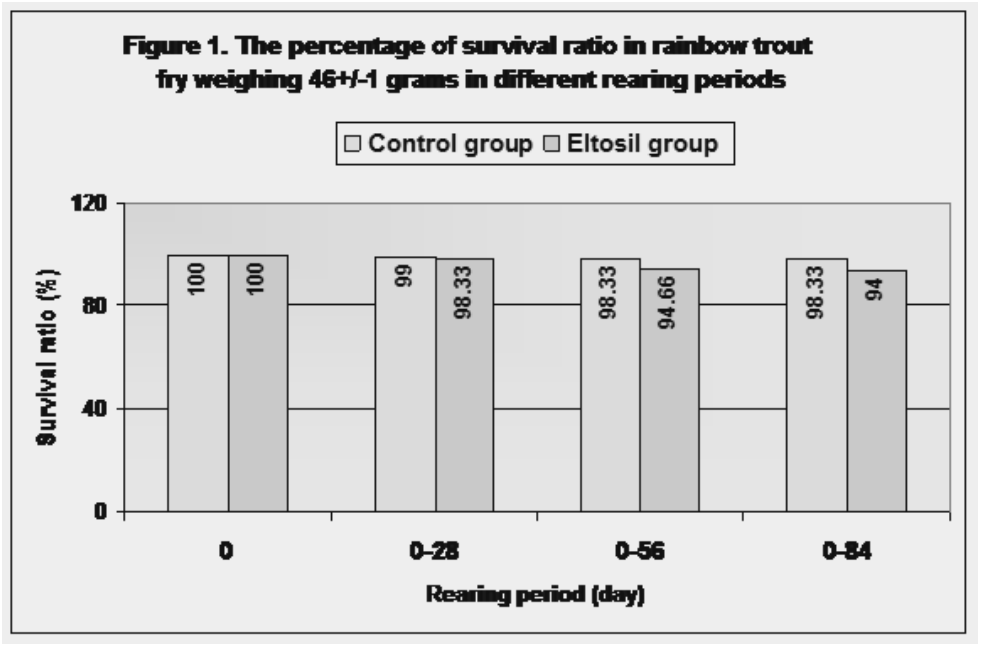
Table 6: The effect of oral recombinant bovine somatotropin (RBS) 1% on the percentage of comparative growth rate (CGR) of rainbow trout weighing 46±1 grams

Saving period (week)	Comparative growth rate (CGR) (%)	Experiment group		Control group		Rearing period (day)	species
		Finial body weight (g)	Initial body weight (g)	Finial body weight (g)	Initial body weight (g)		
1	11.15	158.73	47.56	147.08	45.28	84	Rainbow trout (*O. mykiss*)

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However, there were significant differences between means of growth characteristics in WBW ($p< 0.05$, table 3), WG ($p< 0.05$, table 3), TL ($p< 0.001$, table 5), and ADL ($p< 0.05$, table 5) of the control and RBS treated groups on day 84. In the same period, there was greater 11.2% comparative growth rate (CGR) in RBS treated group than the control group (table 6). There were no significant differences between SGR, FCR and CF. The percentage of survival ratio (SR) has been demonstrated in figure 1. There were no significant differences between the percentage of SR of the control and RBS treated groups in anyone rearing periods ($p> 0.05$, figure 1).



Discussion

The present research demonstrated that oral recombinant bovine somatotropin 1% (RBS; Eltosil®) had no effect on growth factors of rainbow trout (*O. mykiss*) weighing 46±1 grams on day 28 or 56 rearing periods ($p> 0.05$). However, the RBS increased some of growth factors on day 84. Oral RBS increased WBW, WG, ADG, TL, ADL, and CGR on day 84. The results showed that oral administration of RBS 1% improved and increased some of growth factors in rainbow trout weighing 46±1 grams. Somatotropin treatment has repeatedly been shown to increase ADG in rainbow trout in a many studies (Down et al., 1988; Foster et al., 1991; Markert et al., 1977; Gill et al., 1985; Agellon et al., 1988). The results of our study indicated that ADG in the RBS group was 9.1% more than the control group on day 84 that this result is consistent with the results of above mention studies.

Trout treated with RBS consumed 6.95% more feed and consumed it more aggressively than did trout untreated. Feed intake may be influenced by a variety of factors, including environmental salinity (Kayes, 1977), temperature (Brett et al., 1969), individual species' body and viscera size (Paloheimo & Dickie, 1966), and rate of digestion (Windell, 1967), all of which may contribute to the variability of the response in feed consumption to growth hormone therapy. The results reported by

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Agellon et al., (1988), noted that trout treated with recombinant salmon somatotropin (50 and 500 µg/l) consumed more feed and consumed it more aggressively than did untreated fish. However, Markert et al. (1977) observed no treatment effect of bovine somatotropin on average daily feed intake of yearling Coho salmon injected once weekly, although voluntary feed intake was numerically higher in treated fish. It has been suggested that recombinant bovine somatotropin improves the efficiency of feeding utilization in fish (Kayes, 1978); it may therefore cause a reduction in intake. Also, It has been reported that injection of recombinant growth hormone (Posilac®) (30, 60, 120 µg/g^{-1} BW per 3 weeks) did not increase feed intake in both Norris and NWAC103 strains of channel catfish (Peterson et al., 2004). Silverstein et al. (2000) and Wilson et al. (1988) reported a 16% and 69% increase in feed consumption, respectively, in recombinant bovine growth hormone- injected catfish. It has been suggested that recombinant bovine growth hormone might enhance fish growth by stimulating appetite and improving feed and protein conversion (Donaldson et al., 1979; Markert et al., 1977; Matty, 1986). And also, it has been suggested, GH might stimulate food intake indirectly through metabolic changes that feedback on hypothalamic centers regulating energy balance (Silverstein et al., 1999). The research with recombinant bovine somatotropin has shown that it is effective in improving feed efficiency and increasing carcass protein while decreasing carcass fat (Dalke et al., 1992; Moseley et al., 1992) and average daily gain (Dalke et al., 1992), in finishing cattle.

Other obtained results in the present study were increase in mean of total body length (TL) and average daily body length (ADL) of rainbow trout group treated with the RBS. At the end of day 84, the mean of TL in RBS treated group was 3.46% more than the control group ($p< 0.0001$). Moreover, the mean of ADL in RBS group was 18.42% more than the control group ($p< 0.05$). These results suggest that RBS increased linear growth of rainbow trout. These results are consistent with the results of studies made by Garber et al. (1995), who showed recombinant bovine somatotrop (Posilac®) (20 µg/g BW) increased the mean of TL 5.7% and the mean of ADL 15% in rainbow trout of two years old, and also Peterson et al. (2004), who showed injection of recombinant bovine somatotropin (Posilac®) increased total body length in two strains of catfish. Although in our study carcass protein and fat content did not study, nevertheless significant increase of TL and ADL might suggest that obtained increase weight in the fish of treated with the RBS is in a result of linear growth of body, no increase in carcass fat content.

The RBS induced no increase in specific growth rate (SGR). It has been shown that injection of recombinant bovine somatotrop (Posilac®) in Norris and NWAC103 strains of catfish had no effect in SGR on days 21 and 42, but it caused increase in SGR in both strains fish on day 63 (Peterson et al., 2004).

In our study, the RBS had no effect on feed conversion rate (FCR). It has been indicated that rbGH had no effect in improving FCR Norris catfish on days 21, 42, and 63; but it improved FCR in NWAC103 strain on day 63 (Peterson et al., 2004). The observed overall increases in growth without a difference in FCR or food consumption may be explained by an

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increase in the utilization of nutrients that regulate energy balance and thus growth. In contrast, Wilson et al. (1988) reported improves in FCR by rbGH.

There was no significant difference in condition factor (CF) between the control and the RBS treated groups. This result is consistent with the obtained result of the research of Peterson et al. (2004). While Wilson et al. (1988) observed an increase in CF in catfish receiving rbGH.

Considering the obtained results in this research, it is suggested that the period of administration was more effective than the RBS concentration to improve and increase growth rate. Therefore, it is possible that long-term application of the RBS (for 9-12 months) may reduce 1-2 months of rearing period in rainbow trout; if so, it will be more economic profit in aquacultures.

The positive effects of oral recombinant bovine somatotropin 1% on some of growth factors including whole body weight, weight gain, average daily weight, comparative growth rate, total body length and average daily length indicated that the oral RBS can produce a significant increase in the growth rate of rainbow trout weighing 46±1 grams on day 84 of rearing period.

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