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Growth of Rainbow Trout (*Oncorhynchus mykiss*, W. 1792) in Net Cages in Almus Dam Lake (Tokat)

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Abstract: The growth performance of Rainbow trout, *Oncorhynchus mykiss,* (initial weight 100 g) were tried in net cages in Almus Dam Lake in Tokat. Rainbow trout were tried in net cages with 4 kg m^{-3} stocking rearing density with four replicates. Rainbow trout were fed adlibitum with pellet feed numbered 4. Investigation was continued 106 days between August and November, 2003. At the end of the trial live weight increment was computed as 165,91 g and also specific growth rate 0,915, condition factor 1,550 and food conversion rate 1,63 were determined.

Key words: Rainbow trout, stocking density, growth, cage, breeding

INTRODUCTION

Aquaculture in Turkey has gained acceleration in the last decade as parallel to rapid changes in fishery technology and economic development.

Especially fishermen prefer cultivating trout in the net cages established in the natural lakes and dams. Instead of making high cost investment in the land, establishment of net cages system supported by modern mechanization and with low cost shows a profitable farm type. No doubt that, fishermen prefers cultivation of trout due to no marketing risk, having high feed conversion ability and as a result reaching marketing weight in a short period.

It could be said that the most important economical factor in fish cultivation is their rearing density (Papoutsoglou *et al*., 1980). And also knowing the growth performance is essential to make more profitable fish production. It is known that some factors such as amount of water, water temperature and its optimal limits, oxygen content of water, ingredients of feed and feeding regime, size and healthiness of fish effect the fish yield in cultivation.

In intensive fish culture, stocking density, i.e., the number of individuals per volume of water is one of the main factors determining the final biomass harvested (Boujard *et al*., 2002).

Some studies have described the effect of density on the metabolic routine expenditure of farmed rainbow trout (Lenfrançois *et al*., 2001), effect of stocking density on the growth of rainbow trout (Sayili *et al*., 2006) and impact of stocking density on the welfare of rainbow trout (North *et al*., 2006).

Fish breeding parameters are very important in net cage production. The ideal feeding rate, feeding frequency, the size of cages, determining harvesting size of fish are the important factors of commercial fish producing. And knowing growth performance of fish in cages is essential for having commercial fish breeding. And also the welfare of farmed fish is a subject of growing public, commercial and governmental concern Therefore the aim of this study was the analyse the growth performance of rainbow trout reared in net cages in Almus Dam Lake with low stocking density (4 kg m^{-3} at harvesting) ratio from the technical point of view.

MATERIALS AND METHODS

The study conducted in the net cages system of GOP University, Almus Fisheries Collage in Almus Dam Lake, which is 36 km far from Tokat province, Turkey. One thousand rainbow trout having average 100 g initial weight were reared in net cages having 2.5×2.5×2.5 m dimensions (15 625 m^3) with nets of knotless nylon mesh of 18 mm. Pellet feed numbered 4 (containing 35% protein) were used for breeding trout. Feeds were taken from a private feed plant.

Experiment lasted for 106 days (from August 4, to November 16, 2003). The fish were reared at ambient water

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Table 1: Average and total weight of fish at the beginning of experiment

Expected stocking density at harvesting	Replicate (R)	No. of fish	Average fish weight (g)	Total fish weight stored at net cages (kg)
4 (kg m^{-3})	I	250	101.12±0.58	25.28
	II	250	101.18±0.62	25.30
	III	250	101.36±0.63	25.34
	IV	250	101.69±0.66	25.42
		Average	101.34±0.042	25.34

temperatures (varying between 17.6 and 19.8°C) under natural summer-autumn season. Rainbow trout were reared at net cages as 4 kg m^{-3} at harvesting with four replicates. The experiment plan used in the study is given in Table 1. From each group 50 fish were sampled and their live weights were measured each 15 days period (Sumbuloglu and Sumbuloglu, 1998). Their growths were observed in 7 different periods. Electronic scale (CAS Digital) was used to weight the fish in 0.001 g sensitiveness.

Commercial trout feed was fed to satiation by hand two times a day in the trail. The reaction of the fish to feed was controlled and this process continued up to lessening of their respond to feeding. Died fish were removed cages, counted and recorded. Supplementary fish having same properties with died fish was added to experiment in order to reduce negative effects of lack of fish (Holm *et al*., 2005).

Live weight increment and amount of feed consumption were determined in the trail. The performances of the fish were evaluated using following parameters:

- Absolute Growth (AG) and Absolute Growth Ratio (AGR) (Busacker *et al*., 1990):

$$AG = Y_2 - Y_1$$
$$AGR = (Y_2 - Y_1) / (t_2 - t_1)$$

Where;
Y_1 = Initial live weight
Y_2 = Final live weight
t_1 = Starting date (time) of experiment
t_2 = Finishing date (time) of experiment

- Relative Growth (%RG) and Relative Growth Ratio (%RGR) (Busacker *et al*., 1990):

$$RG = [(Y_2 - Y_1) / Y_1] * 100$$
$$RGR = [(Y_2 - Y_1) / (Y_1 * (t_2 - t_1))] * 100$$

Where;
Y_1 = Initial live weight
Y_2 = Final live weight
$t_2 - t_1$ = Period of experiment

- Specific Growth Rate (%SGR) (Jackson, 1988):

$$SGR = [(\ln W_2 - \ln W_1) / (t_2 - t_1)] * 100$$

Where;
W_1 = Initial mean live weight
W_2 = Final mean live weight
$t_2 - t_1$ = Period of experiment

- Feed Conversion Ratio (FCR) (Okumus *et al*., 1999, 2001):

$$FCR = FC / (A_2 - A_1)$$

Where;
FC = Feed consumption
A_1 = Total weight at the beginning of the period
A_2 = Total weight at the end of the period

One-way analysis of variance (ANOVA) was used to test for differences. There were four parallel groups in the trial. But there were no significant differences between the parallel (replication) groups ($p>0.05$). Therefore, replicates were accepted as one group (n = 200). All data analysis and statistical testing were carried out using SPSS (8.0).

RESULTS AND DISCUSSION

Live weight growth: During the experiment, mean live weight of rainbow trout reached to 267.25±0.741 g (Table 2).

Absolute growth and absolute growth ratio: Both absolute growth and absolute growth ratio calculated from live weight. The highest absolute growth was obtained at the first period of the trial (28.89 g). At the end of the experiment, general absolute growth value was achieved as 165.91 g. On the other hand, general absolute growth ratio (daily live weight gain) was determined as 1.57 g in the trial. There was no significant difference between groups in each period ($p>0.05$).

In a study carried out by Atay *et al*. (1980), rainbow trout (initial live weight 75 g) reared in irrigation channels were stocked at densities of 160, 240, 320 and 400 fish m^{-3} by feeding a 36.35% protein feed gained 1.79, 1.80, 1.71

Table 2: Growth parameters of the fish

Periods	Stock density (kg m^{-3})	Parameters: Live weight	Absolute growth	Absolute growth ratio	Relative growth	Relative growth ratio	Specific growth rate	Feed conversion ratio	Feed consumption per fish (g)
1st	4	101.34±0.364	28.89	1.81	28.51	1.78	1.568	1.34	38.71
2nd	4	130.23±0.476	23.91	1.59	18.36	1.22	1.124	1.48	35.39
3rd	4	154.14±0.710	13.28	0.89	8.62	0.57	0.551	1.57	20.85
4th	4	167.42±0.641	13.32	0.89	7.96	0.53	0.510	1.61	21.45
5th	4	180.74±0.963	25.42	1.69	14.06	0.94	0.877	1.73	43.98
6th	4	206.16±1.104	22.76	1.52	11.04	0.74	0.698	1.79	40.74
7th	4	228.92±1.748	28.33	2.56	16.74	1.12	1.032	1.86	71.29
General	4	267.25±0.741	165.91	1.57	163.72	1.54	0.915	1.63	272.41

and 1.50 g live weight, respectively. Lanari *et al.* (1993) stated that rainbow trout had 1.55, 1.66, 1.82 g live weight increment via feeding fish with feed having 36, 39, 43% protein in dry matter. Saygun (1998) explained that at three stocking densities (120, 160 and 200 fish m^{-3}) total live weight increment at the end of the trail were calculated as 211.665, 215.938 and 191.385 g and daily absolute live weight increment were determined 1.53±0.03, 1.56±0.08 and 1.38±0.04 g, respectively. Okumus *et al.* (1999) reported that single and mixed species of rainbow trout had 0.83 and 0.99 g daily live weight gain, respectively in the trail lasted 217 days. In a study carried out by Karatas and Toğlaci (1999), rainbow trout (initial live weight 50 g) reared in net cages in Almus Dam Lake were stocked at density of 120 fish m^{-3} by feeding a 45.00% protein feed gained 1.31 g live weight.

Relative growth and relative growth ratio: Relative growth values ranged between 7.96 and 28.51% in the study. And relative growth ratio values were between 0.53 and 1.78%. At the end of the trial general relative growth and relative growth ratio values were 163.72 and 1.54%, respectively. Holm *et al.* (2005) reported that growth rate increased with increased feed availability (high frequency of feeding) was especially important when densities were extremely high.

Specific growth rate: Specific growth rates were ranged between 0.510 and 1.568% in the trial (Table 2). At the end of the experiment, general specific growth rates were found to be 0.915%. The result of this study is parallel to the findings of Okumus *et al.* (1999) because specific growth rates (%/day) were 0.95±0.24 for single species rainbow trout and 1.01±0.33 for mixed species rainbow trout.

Feed conversion ratio and feed consumption: Feed conversion ratio is one of the criteria affecting the production cost and the profitability of rainbow trout rearing (Logan and Johnston, 1992; Klontz, 1990). The highest feed conversion ratio belongs to 7th period (1.86) of the study and in general, feed conversion ratio was found to be 1.63. In addition the total amount of feed consumption per fish was calculated as 272.41 g and live weight increment gained from 1 g feed was 0.609 g in the study.

In a study carried out by Holm *et al.* (2005), the effect of fish density and feeding regimes on individual growth rate and mortality in rainbow trout and they stated that mean individual growth rate, irrespective of feeding regime, was highest in the lowest density and lowest in the highest density.

For the rainbow trout fed with three types of feed containing 36, 39 and 43% protein feed conversion ratio was 1.31, 1.27 and 1.17, respectively (Lanari *et al.*, 1993). In another study, feed conversion ratio was determined as 1.57±0.08 (Rad and Koksal, 2001). Okumus *et al.* (1999) found that single and mixed species of rainbow trout have 1.81±0.54 and 1.55±0.32 feed conversion ratio, respectively.

Mortality rate: Survival was high during the experiment (97.1%). It was determined that the general mortality rate was 2.90% and number of died fish were totally 29. These losses were probably related to the handling of the fish during transfer and sampling.

The results of the many studies carried out in different region and conditions show that increasing stocking density has a negative effect on the growth of fish, mortality rate, feed conversion ratio (Christiansen *et al.*, 1991; Jorgensen *et al.*, 1993; Berg *et al.*, 1996; Kayim, 2002; Holm *et al.*, 2005). On the other hand, as reported by Brown *et al.* (1992), keeping fish in a stocking density lower than a certain density has increased competition and aggressive behaviour among fish. This situation affects the growth of fish in negative away.

To sum up, the study demonstrated that 4 kg m^{-3} stocking density is recommendable for fishermen technical reasons point of view.

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REFERENCES

Atay, D., M.S. Celikkale and I. Erkoyuncu, 1980. A research on the cultivation of trout in channels. Paper Presented at The Scientific and Technical Research Council of Turkey Scientific Congress, Ankara, Turkey (In Turkish).

Berg, A.J., T. Sighold, A. Seland and A. Danielsberg, 1996. Effect of stocking density, oxygen level, light regime and swimming velocity on the incidence of sexual maturation in atlantic salmon (*Salmo salar*). Aquaculture, 143: 43-49.

Boujard, T., L. Labbe and B. Auperin, 2002. Feeding behaviour, energy expenditure and growth of rainbow trout in relation to stocking density and food accessibility. Aquacul. Res., 33: 1233-1242.

Brown, G.E., J.A. Brown and R.K. Srivastakz, 1992. The effect of stocking density on the behaviour of arctic chair (*Salvelmus alphinus* L.). J. Fish Biol., 41: 955-963.

Busacker, G.P., I.R. Adelman and E.M. Goolish, 1990. Growth. In: Methods for Fish Biology. Schreck, C.B. and P.B. Moyle (Eds.), American Fisheries Society, USA., pp: 363-387.

Christiansen, J.S., Y.S. Svendsen and M. Jobling, 1991. The combined effects of stocking density and sustained exercises on the behaviour, food intake and growth of juvenile arctic charr (*Salvelinus alpinus* L.). Can. J. Zool., 70: 115-122.

Conte, F.S., 2004. Stress and the welfare of cultured fish. Applied Anim. Behav. Sci., 86: 205-223.

Holm, J.C., T. Refstie and S. Bo, 2005. The effect of fish density on feeding regimes on individual growth rate and mortalityin rainbow trout (*Oncorhynchus mykiss*). Aquaculture, 89: 201-398.

Jackson, A., 1988. Growth, Nutrition and Feeding. In: Salmon and Trout Farming. Laird, L. and T. Needham (Eds.), Ellis Horwood Books, pp: 202-216.

Jorgensen, E.H., J.S. Christiansen and M. Jobling, 1993. Effect of stocking density on food intake, growth performance and oxygen consumption in arctic charr (*Salvelinus alpinus* L.). Aquaculture, 110: 191-204.

Karataş, M. and A.I. Toğlaci, 1999. A study on rearing of rainbow trout in net cages in Almus Dam Lake. Tr. J. Vet. Anim. Sci., 23: 257-260.

Kayim, M., 2002. The effects of different stocking densities on growth and food conversion rate of rainbow trout (*Oncorhynchus mykiss*, W. 1972) in Almus dam lake (Tokat). Ege University Graduate School of Natural and Applied Sciences, Ph.D Thesis, Izmir, Turkey (In Turkish).

Klontz, G.W., 1990. Rainbow Trout Production on the Family-owned Farm. University of Idaho, USA.

Lanari, D., E. Aqura and R. Ballestrazzi, 1993. Effect of protein level in high energy feeds on effluent water quality and performance and digestibility rainbow trout (*Oncorhynchus mykiss*). Aquaculture, 28: 127-141.

Lenfrançois, C., G. Claireaux, C. Mercier and J. Aubin, 2001. Effect of density on the routine metabolic expenditure of farmed rainbow trout (*Oncorhynchus mykiss*). Aquaculture, 195: 269-277.

Logan, S.H. and W.E. Johnston, 1992. Economics of commercial trout production. Aquaculture, 100: 25-46.

North, B.P., J.F. Turnbull, T. Ellis, M.J. Porter, H. Migaud, J. Bron and N.R. Bromage, 2006. The impact of stocking density on the welfare of rainbow trout (*Oncorhynchus mykiss*). Aquaculture, 255: 466-479.

Okumus, I., M.S. Celikkale, I.Z. Kurtoglu and N. Bascinar, 1999. Growth performance, food intake and feed conversion ratios in rainbow (*Onchorynchus mykiss*) and brook trout (*Salvelinus fontinalis*) reared as a single and mixed species. Turkish J. V. Anim. Sci., 23: 123-130 (In Turkish).

Okumus, I., A. Degirmenci, N. Bascinar and M.S. Celikkale, 2001. Comparative performance, approximate biochemical composition and consumer preference of albino and normally varieties of rainbow trout (*Oncorhynchus mykiss*). Turkish J. Fish. Aquatic Sci., 1: 23-28.

Papoutsoglou, S.E., E.G. Papaparaskeva-Papoutsoglou and M.N. Alexis, 1980. Rainbow trout growth and production in relation to water volume unit. Reprint from Thalassographica, 3: 43-52.

Rad, F. and G. Koksal, 2001. Structural and bio-technical aspects of rainbow trout (*Oncorhynchus mykiss*) farms in Turkey. Turkish J. Vet. Anim. Sci., 25: 567-575 (In Turkish).

Saygun, S., 1998. Effects of different stocking densities on growth and food conversion rate of rainbow trout (*Oncorhynchus mykiss*) reared in cages in the Bafra-Derbent dam lake. Ondokuzmayis University Graduate School of Natural and Applied Sciences, M.Sc Thesis, Samsun, Turkey (In Turkish).

Sayili, M., M. Kayim and H. Akça, 2006. Economic analysis of rainbow trout stocked with two different density ratios. Ind. Vet. J., 83: 758-761.

Sumbuloglu, K. and V. Sumbuloğlu, 1998. Bio-statistic. Published by Hatiboglu, Ankara, Turkey (In Turkish).