Journal of Fisheries International 2 (1): 1-3, 2007


# Changes in Some Growth Parameters of Mirror Carp (*Cyprinus carpio*) Reared with Pekin Duck in a Polyculture System

[1]Ekrem Laçin, [2]Olcay Hisar, [2]Abdulkadir Bayir and [2]Sukriye Aras Hisar
[1]Department of Animal Science, Faculty of Veterinary Medicine, Atatürk University, Erzurum-Turkey
[2]Department of Fisheries Science, Faculty of Agriculture, Atatürk University, 25240, Erzurum-Turkey

**Abstract:** In this study, the effects of polyculture on growth parameters such as weight gain, Glucose-6-Phosphate Dehydrogenase (G6PD) enzyme activities and plasma thyroid hormones levels of mirror carp (*Cyprinus carpio*) were tested during the two month. Monocultures of fish were included as controls. Although, initial values of the growth parameters were not significantly different ($p>0.05$); specific grow rates, plasma levels of $T_3$ hormone, G6PD enzyme activities except $T_4$ rose with time in both treatment and they were also different between the treatments ($p<0.05$). In conclusion, it was determined that a significant effect of polyculture on the growth of mirror carp.

**Key words:** Polyculture, mirror carp, duck, weight gain, G6PD enzyme, thyroid hormones

## INTRODUCTION

The primary goal of rational pond management is to produce fish to maximize economic returns to farmers. Polyculture is commonly practiced in pond which is stocked a mixed of selected species, with complementary or synergistic interactions and different ecological requirements, thereby resulting in maximum fish production (Milstein, 1992). Manures of the species reared together in polyculture can be given an example to complementary interactions. Since, they are assumed a greater role in supplementing nutrient deficiency as well as stimulating plankton production (Jana and Sahu, 1994, Das and Jana, 1996). Thus, pond production is enhanced by inputs of manures supporting a high primary and secondary production in the pond for the benefit of the fish.

It is quite obvious that nutrition plays a significant role in growth regulation. Recent data suggest that hormones and physiological conditions of the individual are also equally important endogenous regulators of growth (Dutta, 1994). For example, thyroid hormones and glucose-6-phosphate dehydrogenase enzyme (D-glucose 6-phosphate: NADP+ oxidoreductase EC 1.1.1.49; G6PD) generating NADPH play important roles in growth and development (Power *et al*., 2001, Gavlik *et al*., 2002, Barroso *et al*., 1999).

Growth is measured in units of length and weight and is best represented as the specific growth rate. However, growth could be measured by using certain other criteria such as hepatosomatic index, RNA:DNA ratio, specific hormone levels and enzyme activities (Dutta, 1994). Therefore, in the present study, it was aimed to determine the effects of polyculture on growth of mirror carp by using weight gain, G6PD enzyme activities and tiroid hormones.

## MATERIALS AND METHODS

The experiment was carried out in 6 earthen ponds (3×2 m, mean water depth 1m) at the Central Laboratory at the Aquarium Fish Rearing Facility of the Department of Fishery Science the Agricultural Faculty at Atatürk University for a period of 60 days. The ponds were free from aquatic vegetation and well-exposed to sunlight. No fertilizer was placed into the ponds. The ponds were randomly divided into two treatments: Three ponds were subject to polyculture application and the remaining three ponds were control without duck (fish monoculture control). They were empty for 4 months and then filled with an aerated dechlorinated tap water with a constant water flow of 1.5 l $min^{-1}$, 9±1°C average water temperature, 9 ppm dissolved oxygen, 7.8 pH and 102 mg as $CaCO_3$ total hardness. They were stocked with mirror carp (mean weight 15±1 g) and pekin duck (mean weight 410±25 g) obtained from the Department of Fisheries Science. A completely randomized design was used to test four stocking combinations. While 40 mirror carp were randomly sorted into 3 earthen ponds, 40 fish and 6 duck were stocked in the other each pond.

**Corresponding Author:** A. Bayir, Department of Fishery Science, Faculty of Agriculture, Atatürk University, 25240, Erzurum-Turkey

Table 1: Changes of growth, plasma thyroid hormones levels and G6PD enzyme activities in mirror carp in monoculture and polyculture treatments (Values are mean ±SD)

| | Period | | |
|---|---|---|---|
| Treatments/Parameters | Initial | First month | Second month |
| *Monoculture* | | | |
| Survival (%) | 100 | 100 | 100 |
| Weight (g) | 15.4±0.2$^{a}$ | 31.8±2.6$^{Ab}$ | 48.4 ±3.3$^{Ac}$ |
| Specific growth | - | 2.4±0.3$^{Aa}$ | 1.9±0.1$^{Ab}$ |
| T3 hormone | 1.3±0.2$^{a}$ | 2.5±0.6$^{Ab}$ | 3.5 ±0.5$^{Ac}$ |
| T4 hormone | 0.3±0.1 | 0.3±0.1 | 0.3±0.1 |
| G6PD enzyme activity | 17.9±1.5$^{a}$ | 24.1±1.7$^{Ab}$ | 28.0 ±2.2$^{Ac}$ |
| *Polyculture* | | | |
| Survival (%) | 100 | 100 | 100 |
| Weight (g) | 15.5±0.2$^{a}$ | 37.6±2.4$^{Bb}$ | 65.1 ±2.7$^{Bc}$ |
| Specific growth | - | 2.9±0.2$^{Ba}$ | 2.4±0.1$^{Bb}$ |
| T3 hormone | 1.4±0.2$^{a}$ | 5.5±0.8$^{Bb}$ | 9.1 ±1.2$^{Bc}$ |
| T4 hormone | 0.3±0.1 | 0.3±0.1 | 0.3±0.1 |
| G6PD enzyme activity | 17.8±0.2$^{a}$ | 27.1±1.6$^{Bb}$ | 32.2±2.4$^{Bc}$ |

Note: Different superscripts (a, b) are used to show significant differences between parameters within each group. Capitals (A, B) are used to indicate significant differences between the two groups

The commercial pellet diets with 40 and 22 % protein, 10.5 and 2.7 % fat, 95 and 94 % dry matter, 11.4 and 6.6% ash was used to feed the fish and duck during the study, respectively. Feeding times were centered in the middle of the light period of day.

Every four weeks, the 5 fish were captured, anesthetized in MS-222 (200 mg $L^{-1}$) and individually weighted. Growth was expressed as Specific Growth Rate (SGR) calculated as: [ln(final weight)-ln(initial weight)]/culture period (day)x100. Following the weighted processing, blood samples were obtained from the caudal vasculature of each carp with a heparinized syringe and then fish were died with over dose of MS-222. The blood samples were kept on ice for up to 30 min until the plasma was separated by centrifugation. Plasma samples were stored at -80°C until analysis. The plasma $T_3$ and $T_4$ concentrations were determined by an enzyme immunoassay using a commercial serozyme kit from Roche following a literature procedure (Varghese *et al*., 2001).

After this procedure, the remaining erythrocyte pellet was washed with 0.16 M KCl three times and the supernatant was discarded. One volume of erythrocyte pellet was hemolyzed in five volumes of ice-water and G6PD activities were determined. The enzymatic activity was measured by Beutler's, (1971) method. One enzyme unit was defined as the enzyme amount reducing 1 μmol $NADP^{+}$ per minute. Protein was quantified at 595 nm according to Bradford's (1976) method, with bovine serum albumin as standard.

Results are presented as means±standard deviation and all data were subjected to a one-way analysis of variance followed by Duncan's multiple-range test to determine significant differences among the regimes at the 0.05 level.

## RESULTS AND DISCUSSION

Changes in parameters related to growth of fish presented in Table 1.

Growth rate in different fish species has been shown to be influenced considerably by various factors such as feed, dietary regime, feeding competition and frequency. Of these, the feed is the most important (Milsten, 1992, Holm and Refstie, 1990) and considered to control the variations in the circulating levels of thyroid hormones (Larsen *et al* ., 2001) and G6PD enzyme activity (Barroso *et al*., 1999).

In the present study, it was determined that polyculture positively effected the growth parameters of carp. As seen in Table 1, whereas there was no significant difference in individual weights of carp between monoculture and polyculture treatments at initial, weights at the other experimental periods differed markedly ($p<0.05$). Specific growth rates, plasma levels of $T_3$ hormone and G6PD enzyme activities rose with time in both treatment and they were also different between the treatments. However, there were no significant variations in survival and plasma level of $T_4$ hormone during the experimental period.

From the our results, it was assumed that the higher growth rates might be derived from polyculture than from monoculture as a result of natural feeds produced by duck manure in the ponds. Since, similar amount of feed was given to fish stocked in each treatment group.

It is well known in the aquacultural efforts that pond production is enhanced by inputs of manures supporting a high primary and secondary production in the pond for the benefit of the fish (Ayyappan *et al*., 1990, Riise and Rose, 1997). The role of manures and/or commercial fertilizers in increasing the fish production has been emphasized in many studies (Schroeder *et al*., 1990, Milsten, *et al*., 1995) and fertilizer value of different organic manure (pig, cow, chicken and green manure) has been investigated(Sharma and Olah, 1986, Zhu, *et al*., 1990) . In Israel, maximum fish yield was about 20, 30 and 40 kg/ha/day with chicken, cattle and duck manure, respectively (Bhakta *et al*.,2004).

Our results also showed that polyculture stimulated plasma $T_3$ levels and G6PD enzyme activity without affecting $T_4$. To this behavior, that $T_4$ has few direct actions in biological systems could cause. Since, $T_4$ is considered to act principally as a precursor for triodothyronine ($T_3$), the biologically active form of the hormone (Smith, 1982) and has lower affinity than $T_3$ for the nuclear receptor (Mc Cormick *et al*., 1987). Increasing the G6PD enzyme activities m ight be related to cell and body growth in fish. In support of this, it was reported that the regulatory mechanisms of G6PD enzyme respond to changes in fish growth (Barroso *et al*., 1999).

## CONCLUSION

In this study, a polyculture system utilizing also animal wastes practiced. From the results, it was observed that increase in growth parameters of fish attributable to polyculture was high compared to monoculture and understood that it was possible to enhance the fish production in water ponds like this treatment. Therefore, the sustainability issues of this novel technology needs to be carefully assessed during the design and planning of aquacultural developmental efforts.

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