Effect of Temperature and Feeding Frequency on Growth Performances of Roach (*Rutilus rutilus caspicus*)

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**Abstract:** Roach, *Rutilus rutilus caspicus*, belongs to *Cyprinidae* one of the most economically important and valuable telostei in the Caspian Sea. Roach is regarded as a valuable fish species both for angling and commercial food in Iran. Few studies have investigated the effects of temperature on growth despite it is the main determining factor in fish. Temperature namely acts on metabolism and thus influences feed intake. The aim of this study was to investigate the interactive effects of temperature and feeding on roach performances growth. Eighteen groups of 21 fish (1.3 g mean weight) were reared in 18 tanks during 56 days according to a complete design testing 4 temperatures (20, 24, 28 and 32°C) and 3 feeding frequencies (2, 3, 4 times a day to apparent satiation) in duplicate. Feed intake (FI) was recorded throughout the experiment. At the end of the study, fish were weighted for calculation of weight gain (WG) and specific growth rate (SGR). Temperature had an interactive effect on WG and independently influenced SGR, FCR (P<0.05). WG and SGR were the highest at 20°C and 24°C (1.36±0.04g, 1.38±0.06% respectively). The best growth performances (WG) were observed when fish were reared at 24°C and ambient temperature. FCR was the highest at 32°C (2.57±0.08) and 28°C (2.26±0.08). No significant effect was observed on the fish feeding frequency.

**Key words:** Roach, Growth, Temperature, Feeding

**INTRODUCTION**

The Caspian roach (*Rutilus rutilus caspicus*) is a commercially important species in the Caspian Sea [1, 2]. This species is eurytopic, living in rivers, streams, lakes, reservoirs and fresh parts of seas. This species is found in the southeastern part of the Caspian Sea, i.e. in the coastal waters of Iran and Turkmenia [3]. The Caspian roach is a migratory fish which enters the Iranian border river Atrak and other Iranian rivers such as Gharesoo and Gorganrood for spawning. The Caspian roach is also a major food sources for wild Beluga sturgeon populations [3]. Like other Caspian sea fishes (e.g. sturgeons) the species is considered threatened due to overfishing, water pollution and loss of habitat and spawning grounds [4]. However, the Iranian Shilat organization has developed culture methodologies to rear Caspian roach up to market size to reduce pressure on natural Caspian Sea populations [5]. Fish can be classified broadly by their feeding habits into the wellknown classes of detritivores, herbivores, omnivores and carnivores [6]. However, to acertain extent, fish can change their diet in response to nutrient availability by modifying their behavior and metabolism. Some authors have indicated that, independently of their feeding habit, the fish digestive system response correlates closely with diet [7].

In all fish species, growth optimization is of paramount importance for profitability of fish farming activity. Within a given species, numerous factors can influence fish growth, among which the most important are probably temperature and feeding frequency [8]. Temperature regulates metabolic activity and all fish species are characterised by a range of temperature within which growth is maximal [9-11]. The influence of feeding frequency on fish growth has received much attention [12-14]. Increased feeding frequency has been shown to improve the growth of various fish species [15-17]. Two or three feedings a day have been found to be...
sufficient for maximum growth of a number of species such as yellowtail [15], channel catfish [16], grouper *Epinephelus tauvina* [18], as well as sea bass *Dicentrarchus labrax* [19] and rainbow trout [20]. Optimum feeding frequency seems to be dependent on fish size, since fingerlings require a higher number of daily feedings for good growth and survival [21, 22]. Whereas poorly timed or sporadic feeding frequency may lead to increased hunger, intra-specific aggression and increased rate of cannibalism [22]. All these problems result in decreased production efficiency which ultimately increases cost of production [23]. However, optimum feeding frequency and rate vary depending on the fish species, size and rearing system [18]. The optimum feeding frequency for maximum growth of fish is generally affected by fish size and culture conditions [24, 25]. So, with aspect to two or three times feeding per day in farms and existing food forroach (*Rutilus rutilus caspicus*) feeding in Iran it seems essential to specify the best temperature and feeding frequency for reaching the highest rate of growth on Caspian roach (*Rutilus rutilus caspicus*). Considering the ideas mentioned above in this research, the effects of temperature and feeding frequency on the growth performances of roach (*Rutilus rutilus caspicus*) were studied.

**MATERIALS AND METHODS**

**Experimental Design:** A batch of 420 roach fingerlings (1.3±0.4 g) was provided by Center Breeding and Culture Sijual. After one week of acclimation in laboratory facilities, fish were divided into 18 groups of 21 fish each and transferred into 120-L rectangular tanks after individual weighting. Four temperatures (20, 24, 28 and 32°C) and three feeding frequencies (2, 3 or 4 times a day to apparent satiation) were tested in duplicate. Photoperiod was set at 12L:12D. Fish were fed by hand to satiation. Total amount of given food was evaluated daily. Experiment lasted 56 days. Water quality was monitored twice a week. pH and dissolved oxygen were maintained above 7.5 and 7 mg L\(^{-1}\) respectively. N-NH\(_4\)\(^+\) and N- NO\(_3\)\(^-\) concentrations remained below 1 mg L\(^{-1}\).

**Variables and Statistics**

**The Following Parameters Were Calculated:**

Weight Gain (WG, g) = Final weight (W\(_f\)) - Initial weight (W\(_i\))

Specific Growth Rate (SGR, % d\(^{-1}\)) = 100\(\times\)Ln (W\(_f\)/W\(_i\))/Experiment duration.

Coefficient conversion (FCR) = \(F/(W_f - W_i)\)

Variables were analysed following a design of two-way ANOVA. Following ANOVA, significant differences between means were detected with the LSD test. The minimum levels of significance were set at P<0.05 for both ANOVA and mean comparisons. All data are expressed as means± standard error of the mean (S.E.M.). After analysis of the results, an optimal feeding rate was estimated for each temperature tested, according to the feeding regime giving both the highest growth and feed efficiency.

**RESULTS**

All data recorded and calculated at the end of the experiment according to temperature and feeding frequency are presented in Table 1. First of all, temperature interacted on fish weight gain and SGR (Table 1). It was not also influenced by feeding frequency (Table 3). As a result, optimal feeding rates (expressed in percent of fish biomass per day) that maximized growth under our laboratory conditions were found to be 1.38% at 20°C, 1.22% at 24°C, 0.95% at 28°C and 0.78% at 32°C, taking 1.36, 1.22, 1.02 and 0.90 g for W\(_56\).

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Frequency</th>
<th>SGR (%)</th>
<th>FCR</th>
<th>WG(gr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>2</td>
<td>1.3±0.11</td>
<td>1.82±0.46</td>
<td>1.3±0.33</td>
</tr>
<tr>
<td>20</td>
<td>3</td>
<td>1.38±0.02</td>
<td>1.69±0.26</td>
<td>1.36±0.02</td>
</tr>
<tr>
<td>20</td>
<td>4</td>
<td>1.46±0.10</td>
<td>1.61±0.11</td>
<td>1.43±0.09</td>
</tr>
<tr>
<td>24</td>
<td>2</td>
<td>1.05±0.10</td>
<td>2.1±0.13</td>
<td>1.11±0.07</td>
</tr>
<tr>
<td>24</td>
<td>3</td>
<td>1.33±0.01</td>
<td>1.75±0.01</td>
<td>1.32±0.01</td>
</tr>
<tr>
<td>24</td>
<td>4</td>
<td>1.27±0.005</td>
<td>1.82±0.01</td>
<td>1.26±0.007</td>
</tr>
<tr>
<td>28</td>
<td>2</td>
<td>1.01±0.1</td>
<td>2.1±0.16</td>
<td>1.05±0.07</td>
</tr>
<tr>
<td>28</td>
<td>3</td>
<td>0.95±0.1</td>
<td>2.27±0.15</td>
<td>1.02±0.07</td>
</tr>
<tr>
<td>28</td>
<td>4</td>
<td>0.91±0.15</td>
<td>2.33±0.24</td>
<td>0.99±0.10</td>
</tr>
<tr>
<td>32</td>
<td>2</td>
<td>0.67±0.15</td>
<td>2.78±0.3</td>
<td>0.85±0.09</td>
</tr>
<tr>
<td>32</td>
<td>3</td>
<td>0.95±0.02</td>
<td>2.26±0.03</td>
<td>1.02±0.01</td>
</tr>
<tr>
<td>32</td>
<td>4</td>
<td>0.73±0.12</td>
<td>2.66±0.26</td>
<td>0.87±0.08</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temperature</th>
<th>SGR (%)</th>
<th>FCR</th>
<th>WG(gr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20(n=6)</td>
<td>1.38±0.06 a</td>
<td>1.71±0.08 c</td>
<td>1.36±0.04 a</td>
</tr>
<tr>
<td>24(n=6)</td>
<td>1.22±0.06 a</td>
<td>1.89±0.08 c</td>
<td>1.22±0.04 a</td>
</tr>
<tr>
<td>28(n=6)</td>
<td>0.95±0.06 b</td>
<td>2.26±0.08 b</td>
<td>1.02±0.04 b</td>
</tr>
<tr>
<td>32(n=6)</td>
<td>0.78±0.06 b</td>
<td>2.57±0.08 a</td>
<td>0.90±0.04 b</td>
</tr>
</tbody>
</table>

Data are expressed as mean±S.E.M. Different letters indicate significant difference (P<0.05).
Weight gain was the lowest at 32°C whatever the feeding regime tested, ranging from 0.87 to 1.02g and the highest at 20°C (1.36±0.04gr). SGR was reduced significantly with water temperature, from 1.38% d⁻¹ at 20°C to 0.78% d⁻¹ at 32°C. Feed efficiency (FCR) also significantly increased with water temperature, the highest at 32°C (2.57±0.08) and 28°C (2.26±0.08) (Table 2).

SGR of fish fed by feeding frequency did not differ significantly between groups (Table 3).

**DISCUSSION**

First of all, weight gain, SGR were higher in fish held at 20°C and 24°C than in fish held at 28°C or 32°C. Roach acclimatized to 20°C and can survive water at 33°C. Under natural conditions, therefore, roach should be the most susceptible to a sharp rise in temperature when they are already living near their ultimate upper lethal temperature, but it is difficult to correlate fish kills in nature with temperature, because temperature effects are complicated by the effects of temperature-dependent factors [26]. Nevertheless, some authors have reported that optimal temperature may decrease with fish weight in some species like African catfish (*Clarias gariepinus*), carp (*Cyprinus carpio*), Atlantic cod (*Gadus morhua*), or Atlantic halibut (*Hippoglossus hippoglossus*), [27-30], the results of this study is not the same.

Feeding frequency is an important aspect for the survival and growth of fish at the early stage [31]. Change in some factors like feeding frequency, feeding technique, or fish density may cause some changes in different fish species body weight [31]. Our research results showed that the feeding frequency and growth rate are different in different species. Research results showed SGR of fish fed by feeding frequency did not differ significantly between groups. Although results of other researchers showed that increasing feeding frequency causes feed acceptance increase and fish growth in many cases [32], Study results on young cat fish by Murai and Andrews (1976), have shown that more feeding frequency is needed for growth increase. Similarly, Mollah and Tan (1982) and Charles *et al* (1984), have reported that increasing feeding frequency in (*Clarias macrocephalus*) and (*Cyprinus carpio*) will cause an increase in growth, the results of this study is not the same. Comparison of other studies show none of the results were not consistent with the results of this study was that increased feeding frequency varies in different fish. Also, the survey results showed that increasing of feeding frequency there isn’t effect on growth roach. Booth *et al* (2008), noted that 1 to 4 feeding frequency per day may have the best function for increasing growth in Salmonidae and Australian snapper, the results of this study is not the same. The highest growth in the low frequency of feeding occurs [19]. Study conclusions have shown that one-time feeding will be enough for the normal growth of Micropogonias furnieri [33], Korean rock fish [34], yellow tail flounder [25], the results of this study is the same.

However, we are aware that other factors that were not taken into account in this study might interact with temperature, especially feed composition or photoperiod. However, Gardeur *et al.* (2007), have pointed out the fact that temperature and photoperiod play a more important role than feeding frequency in the determination of Eurasian perch growth. It was shown that rearing roach juvenile at 20°C, clearly enhances growth and no significant effect was observed on the fish feeding frequency. In addition, roach on growing requires more information about the effects of other major factors like photoperiod.

**REFERENCES**


Table 3: Effect of feeding frequency on SGR, W G(gr) and FCR

<table>
<thead>
<tr>
<th>Feeding frequency</th>
<th>SGR (%)</th>
<th>FCR</th>
<th>W G(gr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2(n=6)</td>
<td>1.00±0.05 a</td>
<td>2.22±0.07 a</td>
<td>1.07±0.04 a</td>
</tr>
<tr>
<td>3(n=6)</td>
<td>1.15±0.05 a</td>
<td>1.99±0.07 a</td>
<td>1.18±0.04 a</td>
</tr>
<tr>
<td>4(n=6)</td>
<td>1.09±0.05 a</td>
<td>2.11±0.07 a</td>
<td>1.14±0.04 a</td>
</tr>
</tbody>
</table>

Data are expressed as mean±S.E.M. Different letters indicate significant difference (P<0.05).


