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Short communication

Effect of feed portion size on growth of rainbow trout, *Oncorhynchus mykiss* (Walbaum), reared at different temperatures

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Abstract

Groups of 125 rainbow trout, *Oncorhynchus mykiss* (Walbaum) were fed identical daily feed rations using various portion sizes (0.23–4.29 pellets fish^{-1} portion^{-1}). The procedure was repeated for rearing temperatures of 5 °C, 10 °C, and 15 °C. Throughout the study, growth rates and feed conversion ratios (FCR) were best when a portion size of 0.52 pellets per fish was used. As temperature increased, good growth rates and FCR were observed over a broader range of portion sizes (0.52–3.11 pellets per fish) than previously seen at 5 °C, indicating a high level of plasticity in the trout's ability to adjust to different portion sizes at higher temperatures. This study suggests that the temperature of the water should be considered when feed portion sizes are decided upon as the rate at which trout are able to catch pellets appears to be influenced by temperature.

Keywords: Portion size; Feeding intensity; Feed management; *Oncorhynchus mykiss*; Rainbow trout; Temperature

Fish farmers strive to minimise feed loss to improve farm profitability and reduce environmental impacts. Models are available for calculating daily feed ration (Alanärä et al., 2001) but the farmer must still face the problem of how to deliver the feed so that the fish can utilise it in an optimal way. Feeding schedules may vary in number of feed portions per day, the time between portions and the size of each portion. Alanärä et al. (2001) described a meal as the amount of food consumed in a single feeding bout, usually with a duration of between 30 min and 2 h. A meal can be made up of one to many "feed portions". The size and temporal spacing of these portions will affect the meal length and/or the feeding intensity of the daily ration. As these definitions are interrelated, a change in one parameter in the schedule will affect each of the other parameters. Selection of a feeding schedule should be based upon knowledge of the behaviour of the fish being farmed, and especially the feeding rate of the fish at different temperatures.

The purpose of this experiment was to examine the effect of differently sized feed portions on growth rate (thermal unit growth coefficient, TGC) and feed conversion ratio (FCR) in groups of rainbow trout (*Oncorhynchus mykiss* (Walbaum)) held at different temperatures. FCR and TGC (modified from Cho, 1992) were calculated according to the following formulae:

$$\mathrm{FCR} = \frac{(F)}{(G)}$$

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$$\mathrm{TGC} = \left[\frac{\left(W_D^{\frac{1}{3}} - W_0^{\frac{1}{3}} \right)}{\left(\sum_{i=1}^{D} Ti \right)} \right] * 1000$$

where, F is the amount of feed delivered to a group (g) and G is the biomass gain of that group (g), W_D is the fish weight (g) after a period of time (D), W_0 is the initial weight (g), and T is the mean daily temperature (°C).

Six groups of 125 fish with a mean weight (±S.D.) of 65.8±16.5 g were stocked in 1 m^3 tanks supplied with 5 °C water, and allowed to acclimate for one week. Nets were stretched 10 cm above the tank bottom to prevent bottom feeding. Daily feed rations were calculated using a model outlined by Alanärä et al. (2001). This gave daily rations of 0.62%, 1.22% and 1.75% body weight per day at 5, 10 and 15 °C, respectively. All tanks received the same daily rations and the effect of portion size was tested during 25 days at each of the 3 temperatures. Feed was delivered using automatic, timer-controlled feeders during one meal per day starting at lights on in the morning. The average sizes of the different feed portions were as follows; 0.2, 0.5, 1.9, 2.8, 3.1 and 4.3 pellets per fish per portion, with time periods between each portion measuring 3, 5, 10, 15, 20, and 30 min, respectively. This period was kept constant at all temperatures. To keep the number of pellets per fish in each portion constant, the number of portions per day and meal length increased with temperature. The same feed was used throughout the study (GEP 576; Aller Aqua, Christiansfeld, Denmark: Protein (45%), Fat (28%), NFE (13%), Ash (6%), Fibre (1%), Gross Energy (24.1 MJ kg^{-1}); mean pellet weight (0.03 g).

There was a problem with the feeding units for groups of fish fed a portion size of 2.8 pellets per fish at 10 °C and a portion size of 4.3 pellets per fish at 15 °C. The feeders had delivered feed sporadically over a period of time and it was difficult to determine the size of the feed portions accurately. These groups were therefore removed from the analysis.

There was a significant correlation between feed portion size and TGC at 5 °C (linear regression, $p=0.026$; $r_p=-0.92$) but no correlation was detected at 10 °C or 15 °C. FCR increased significantly with increasing portion size at 5 °C ($p=0.011$; $r_p=0.96$) and were nearly significant at 10 °C ($p=0.068$; $r_p=0.85$). AT 15 °C, no significant correlation was seen between portion size and FCR ($p=0.730$; $r_p=0.40$). At each temperature, the group fed at 0.5 pellets × $fish^{-1}$ × $portion^{-1}$ showed the highest rate of growth while maintaining a good FCR (Fig. 1).

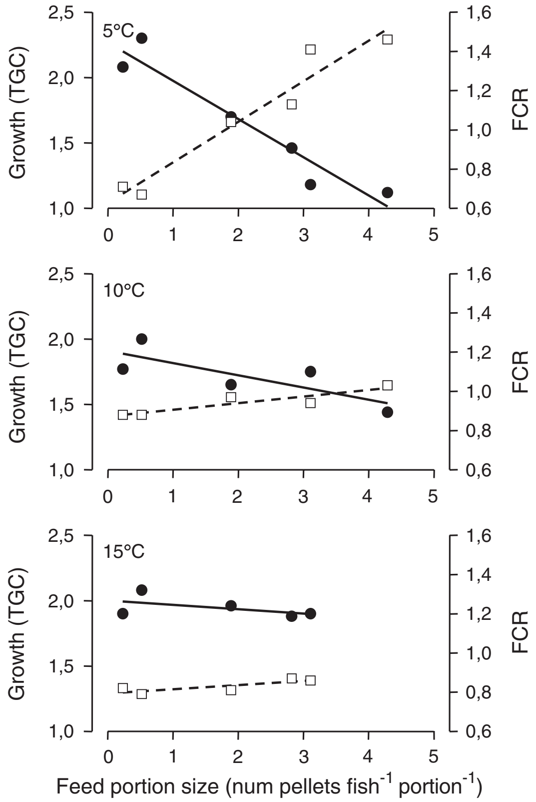

Fig. 1. Relationship between mean feed portion size and TGC (filled circles and solid line) and FCR (open squares and hatched line) for groups of rainbow trout held at 5 °C, 10 °C and 15 °C. Please note that groups of fish fed a portion size of 2.8 pellets per fish at 10 °C and a portion size of 4.3 pellets per fish at 15 °C are excluded from the study due to malfunctioned feeders.

This study shows that portion size affects the growth rate of rainbow trout held at different temperatures. At 5 °C, large portions resulted in poor growth and increased amounts of feed waste. When temperatures were increased fish became more active and caught a larger proportion of the pellets in larger portion sizes as reflected by improvements in growth and FCR. The positive result in terms of growth performance with increasing portion size at 10 °C and 15 °C would be expected, since, like other ectothermic animals, fish become sluggish at low temperatures. This is in agreement with studies on feeding and changes in swimming activity at different temperatures (Elliott, 1975; Rimmer et al., 1985; Cunjak, 1988; Fraser et al., 1993; Fraser et al., 1995; Graham et al., 1996).

Throughout the study, growth rates and feed conversion ratios (FCR) were best when a portion size of 0.52 pellets per fish was used. However, increasing temperatures increase the energy and feed demand of fish, and without a corresponding change in feed portion size, the fish-farmer is forced to feed the fish essentially throughout the entire day. In addition, reduced time required to deliver the daily ration is beneficial from a practical viewpoint. Commercial farms using a food barge, for example, would benefit from reduced feeding time at every cage. Thus, a better strategy would be to feed fish using feed portions that change in size with changes in temperature, large at high temperatures and small at low temperatures, thereby keeping meal length relatively constant over temperatures.

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