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Improved digestibility and growth in selected families of rainbow trout (*Oncorhynchus mykiss*)

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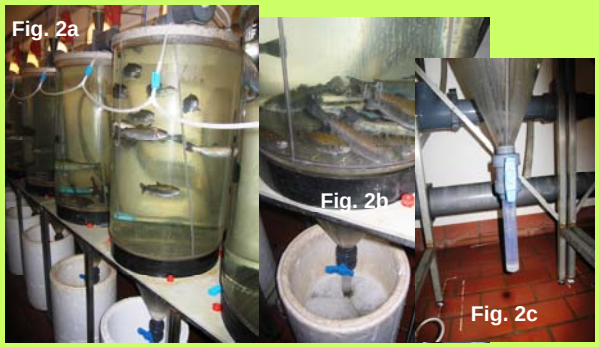
Introduction

Selective breeding and efficient fish feed development has been the main factors in the success of rainbow trout production. The aim of this study was to investigate whether improved growth and protein retention efficiency was associated with improved digestibility of main dietary nutrients using 4 families of rainbow trout (*Oncorhynchus mykiss*).

Materials and Methods

The experimental fish were full-siblings of 4 selected families (A, B, C and D) of rainbow trout (*Oncorhynchus mykiss*) from a brood stock that had already undergone selective breeding for several generations. The experimental facility for the growth study had 12 tanks and was based on recirculation technology with mechanical and biological filtration and oxygenation of the water (Fig. 1). During the growth experiment the fish were fed *ad libitum* for 7 hours on every week day.

The digestibility of dietary nutrients was studied in a flow-through system consisting of 12 tanks with a conical bottom with a ball valve at the outlet (Fig. 2a). At this outlet a columnar glass, submerged in ice-water, was mounted for collecting the faeces (Fig. 2b/2c).



Results

Table 1 shows, that family C had a significantly higher growth rate expressed by the Thermal Growth Coefficient (TGC) than all other families, and TGC of family D was significantly higher than that of family A and B, respectively. A similar pattern was shown for the feed conversion ratio (FCR), where family C showed a significantly better feed utilization than family A, while families A, C and D performed significantly better than family B. In the two fastest growing families C and D, the protein digestibility was significantly higher than in the slower growing family B, while the lipid digestibility was significantly higher in family C compared to family A.

Table 1. The digestibility of dietary nutrients protein, lipid, NFE and dry matter expressed as the apparent digestibility $D_a = (I - F)/I$, where I was the amount of nutrient ingested and F the content of nutrient in the faeces. The fish growth was expressed by the Thermal Growth Coefficient, TGC = $(W_2^{0.333} - W_1^{0.333}) \cdot (\text{degree days})^{-1} \cdot 1000$, where W_2 and W_1 was the final and the initial fish weight, respectively and the degree days were the sum of °C values for each day of the experiment (Cho, 1992, Aquaculture 100, 107-123). Feed Conversion Ratio, FCR = g feed · g weight increase^{-1}. Protein Retention Efficiency, PRE (%) = $(P_2 - P_1)/P_{Ing} * 100$ %, where P_2 and P_1 was the final and initial protein content of the fish, respectively and $P_{Ing.}$ was the protein intake during the experiment. Mean values are shown ± S.D. Letter differences depict statistical differences with the levels of significance: * P < 0.05, ** P < 0.01, *** P <0.001.

Family	Digestibility (%)				TGC	FCR	PRE (%)
	Protein	Lipid	NFE	DM			
A	91.1 ± 0.7 cd	91.4 ± 0.8 d	78.0 ± 1.4	85.1 ± 0.8 cd	2.89 ± 0.04e**	0.92 ± 0.002 d	39.1 ± 0.49 a
B	90.2 ± 0.5 d	91.9 ± 1.2 cd	77.0 ± 2.7	84.5 ± 0.8 d	2.58 ± 0.02 f***	1.00 ± 0.006 e***	35.0 ± 0.75 b***
C	92.2 ± 0.6 c**	93.7 ± 0.7 c*	78.8 ± 2.4	86.6 ± 0.9 c*	3.15 ± 0.02 c	0.90 ± 0.015 c*	38.5 ± 0.49 a
D	92.0 ± 1.1c*	92.5 ± 0.7cd	77.8 ± 2.9	85.8 ± 1.2 cd	3.02 ± 0.05 d*	0.90 ± 0.007 cd	40.0 ± 0.57 a

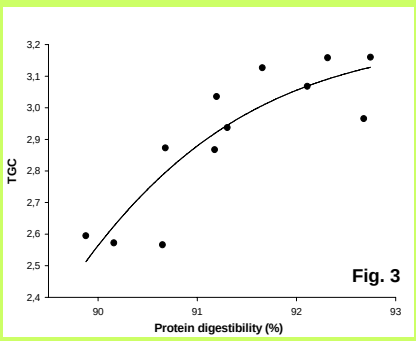


Fig. 3 shows a significant correlation between protein digestibility and the Thermal Growth Coefficient (TGC), ($R^2 = 0.77$, $P < 0.01$).

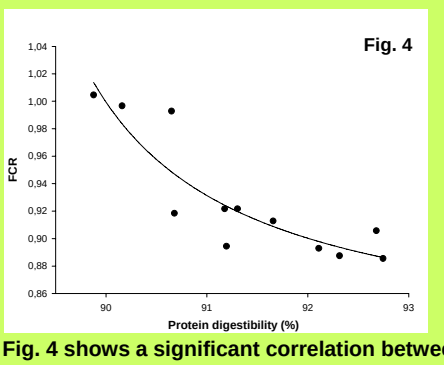


Fig. 4 shows a significant correlation between protein digestibility and feed conversion ratio (FCR), ($R^2 = 0.80$, $P < 0.001$). Accordingly, a strong linear correlation between TGC and FCR was found ($R^2 = 0.92$, $P < 0.001$).

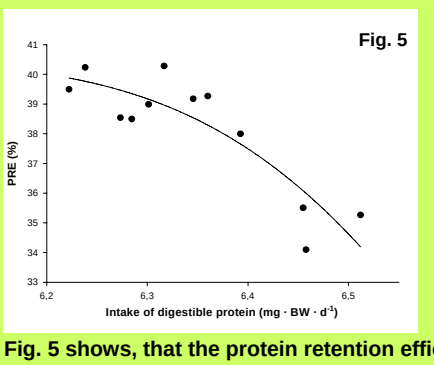


Fig. 5 shows, that the protein retention efficiency (PRE) decreased when exceeding an intake of about 6.1 mg digestible protein · g BW $^{-1}$ day $^{-1}$, ($R^2 = 0.77$, $P < 0.01$).

Discussion and Conclusion

The results indicated a direct relationship between improved growth, feed utilization and improved digestibility of dietary nutrients in rainbow trout (Fig. 3 and 4). However, despite the advantageous protein digestibility upon fish growth, analysis of the protein retention efficiency (PRE) showed that "excess" nitrogen was excreted and did consequently not contribute to protein deposition in the fish above a protein intake of about 6.1 mg digestible protein · g BW $^{-1}$ · day $^{-1}$ (cf. fig. 5).

The results indicated a close relationship between protein digestibility, growth and feed conversion ratio in the four rainbow trout families. They emphasize the importance of selective breeding as a tool to improve the digestibility, growth and feed conversion efficiency and consequently an improvement of the sustainability of rainbow trout farming.