International Council for the Exploration of the Sea

C.M. 1974/E:17
Fisheries Improvement Committee
Ref. Demersal Fish (N) Committee

# The effects of dietary fat and protein levels on the growth and food conversion of hatchery-reared turbot (Scophthalmus maximus L.)

by

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A multifactorial experiment was conducted to assess the effects of various levels of dietary lipids, proteins and feeding rates on the growth and conversion efficiency of hatchery-reared 0-group turbot (Scophthalmus maximus L.). The fish were all of the same age and had been subjected to similar conditions up to the start of the experiment (Alderson and Bromley, 1973).

Four diets of the following composition were tested:

| Composition | Diet A | B | C | D |
|---|---|---|---|---|
| Minced trash fish (%) | 95 | 92 | 89 | 86 |
| Additional fat (%) | 0 | 3 | 6 | 9 |
| Binder, Cellofas (%) | 5 | 5 | 5 | 5 |
| Estimated k cal/g wet weight | 1.14 | 1.37 | 1.61 | 1.84 |
| Estimated protein g/g wet weight | 0.171 | 0.166 | 0.160 | 0.150 |

The minced trash fish consisted of small whole gadoids, mainly Norway pout (Trisopterus esmarkii Nilsson). The additional fat was a mixture of

50% by weight of cod liver oil and corn oil. Almost 1% natural fat was present in the minced trash fish, bringing the total level of fat in the diets to 1, 4, 7 and 10% of wet weight respectively. The binder consisted of sodium carboxymethyl cellulose, which is considered undigestible and was not included in the estimated energy equivalent of the food.

Each diet was fed at four levels giving a total of sixteen treatments. Each treatment was tested on a group of five fish of approximately 2.5g. The temperature was held between 17 and 18$^{\circ}$C, with a light cycle of 12 hour light, 12 hour dark. The weights of the fish were recorded at ten-day intervals over a period of 30 days. A number of control fish and the fish at the end of the experiment were analysed for fat, protein and energy content. The analyses have not yet been completed and the following results are based on preliminary findings.

The corresponding feeding rates on the four diets were isocalorific and were based on the weight of the fish at the start of each ten-day period. They were recalculated per unit of mean weight of the fish over the ten-day period and amounted to approximately 25, 50, 100 and 150 cal/g/day respectively. The growth rates were calculated as the increase in weight per gramme of fish per day (g/g/day) over each ten-day period. The efficiency of energy conversion was calculated as the increase in energy content of the fish divided by the energy content of the food, and the protein conversion efficiency was the increase in protein content of the fish divided by the weight of protein in the food consumed over each ten-day period. The results of the three consecutive periods were combined to give mean estimates of all of the above measurements for each treatment.

The results are represented graphically in Figure 1. Figure 1A shows the relationship between the growth rate and the energy consumed. Over most of the range of feeding the growth rate was best on the diets containing 4% and 1% fat, and at the highest feeding rate, which was approaching the maximum rate of intake for fish of this size, the growth rate was slightly better on the 1% fat diet than on the 4% fat diet.

The relation between energy conversion efficiency and the feeding rate can be seen in Figure 1B. The energy conversion efficiency increased to a maximum at a feeding rate of approximately 100 cal/g/day, after which there was a general decline in efficiency. At the optimal feeding rate of 100 cal/g/day, the energy conversion efficiency was greatest on the 4% fat diet and became progressively smaller in the diets containing 1, 7 and 10% fat respectively.

The relation between protein conversion efficiency and the feeding rate (Figure 1C) shows a somewhat different picture. Protein conversion efficiency at each fat level increased to a maximum at a feeding rate of approximately 100 cal/g/day and thereafter declined. However, the relationships for the 4, 7 and 10% fat diets were very similar, and all three gave better protein conversion efficiency than the 1% fat diet.

The results lead to a number of conclusions. Most efficient conversion of both protein and energy occurred at a feeding rate of approximately 100 cal/g/day for all of the diets tested. At this rate of feeding the growth rate and the energy and protein conversion were all best on the 4% fat diet. The respective values for each food type at a feeding rate of 100 cal/g/day were as follows:

| Factor tested | Percentage fat | | | |
|---|---|---|---|---|
| | 1 | 4 | 7 | 10 |
| Energy conversion efficiency | 0.36 | 0.40 | 0.30 | 0.26 |
| Protein conversion efficiency | 0.36 | 0.46 | 0.45 | 0.45 |
| Growth rate (g/g/day) | 0.030 | 0.034 | 0.025 | 0.021 |

The results suggest that at a level of 4% fat in the diet the metabolism of fat shows maximal protein-sparing capacity. At levels below 4% fat an increasing amount of protein is metabolized, leading to a reduction of the protein available for growth and consequently to a reduction of protein conversion efficiency. Above a level of 4% fat the conversion of food protein into fish protein is already proceeding at a maximum, and the extra fat metabolism is simply wasted.

## Reference

ALDERSON, R. and P. J. BROMLEY. 1973. A method for rearing larvae of the turbot, Scophthalmus maximus L. to metamorphosis. ICES C.M. 1973/E:20.

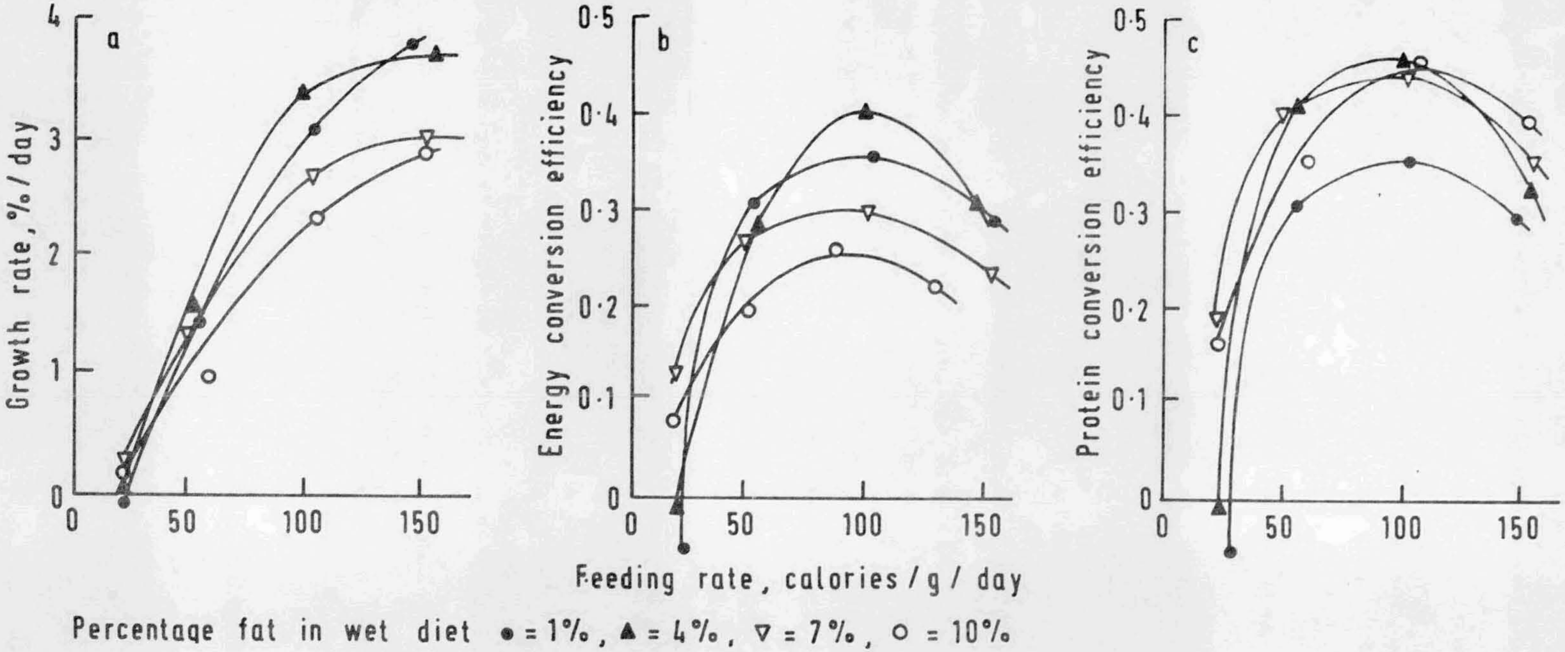


Figure 1 Relationships between (a) the relative growth rate and the relative feeding rate, (b) the energy conversion efficiency and the relative feeding rate, (c) the protein conversion efficiency and the relative feeding rate, all in energy equivalents.