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The effects of dietary water content on the growth of hatchery-reared turbot (*Scophthalmus maximus* L.) and sole (*Solea solea* (L.))

by

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A dry pelleted diet has several advantages over a moist paste. The dry diet is more easily stored, can be automatically fed, and can be produced over a wide range of particle sizes. Processing the food reduces the chances of transferring parasites and disease to the fish from infected foods. Results are presented here of some preliminary investigations into the suitability of feeding dry diets to juvenile sole and turbot.

TURBOT

A multifactorial experiment was conducted on twelve groups of five turbot. The aim was to investigate the effects of a reduction of the dietary water level on the growth rate and to determine if drying the food altered its nutritional quality. Four dietary water levels, each fed at three rates, were tested. The percentage composition of the diets was as follows:

Composition of diet (%)	Percentage of water			
	75	40	20	0
Trash fish	95	-	-	-
Dry trash fish meal		51.6	68.8	86
Cod liver oil	1.5	3.6	4.8	6
Cellofas binder	3.0	3.6	4.8	6
Vitamin mix	0.5	1.2	1.6	2

On a dry weight basis the diets contained equal proportions of fish, cod liver oil, vitamins and binder, except for the 75 per cent water diet in which the level of binder was slightly increased.

The 75 per cent water diet was based on minced, frozen, whole whiting (*Merlangius merlangus* (L.)). The 40, 20 and 0 per cent water diets were prepared from minced whiting which had been dried in a vacuum oven at 60°C and homogenized to a fine powdered fish meal. The fish meal was

mixed with binder, vitamins, cod liver oil and 50 per cent water and pelleted by extrusion through a die to give a pellet size of 0.6 mm diameter. The pellets were re-dried in a vacuum oven to the required water level. The 75 per cent water diet could not be pelleted and was fed as a paste.

The feeding rate was adjusted so that fish on the different diets received comparable amounts of 'dry matter' equivalent to a feeding rate on the 75 per cent water diet of 2, 4 and 6 per cent respectively of the initial body weight of the fish per day. The fish were weighed at fortnightly intervals over an eight week period and the feeding rates were calculated at the start of each period.

Fish were fed once a day, except that in some cases it was necessary to feed twice a day at the 6 per cent feeding rate level and occasionally at this level some of the food was not eaten. This happened over the full range of dietary water levels. It was concluded that a feeding rate of 6 per cent per day is near the maximum for fish of this size and that the factor limiting food intake is the amount of dry matter in the food, rather than the bulk of the material consumed.

The mean weight of the fish in the various treatments is plotted against time in Figure 1. In all cases the relationships were linear and the regressions have been fitted by eye.

At each feeding rate the slopes of the regressions were of the same order of magnitude and increased with the feeding rate. The slopes also tended to increase with a decrease in the dietary water level, indicating that the food was being used slightly more efficiently and giving a better growth rate on the diets with reduced water levels. This probably reflects the tendency for the moist diets to fragment slightly during the vigorous feeding behaviour shown by turbot.

The results show that vacuum drying the food did not reduce its nutritional quality or acceptability, and that feeding a dry pelleted diet should be a viable proposition for growing turbot. The effects of the long-term feeding of turbot on dry diets is not known. The fish on the 6 per cent feeding rate almost trebled their weight in eight weeks on the dry diet and this would suggest that dry diets will probably not be harmful in the long term.

SOLE

Preliminary experiments were conducted on five groups of 30 fish. Each group was fed on a single food type; diets tested included fresh, frozen, and dried Artemia nauplii, dried fish (Norway pout, Trisopterus

esmarkii Nilsson) and dried Crepidula sp. The dried diets were prepared by homogenizing the food and, in the case of fish, the bones were removed by extrusion through a nylon mesh. On a wet weight basis, a 1.5 per cent cod liver oil, 1.5 per cent cellofas binder and 0.8 per cent vitamin mix was then added, and the food dried in a vacuum oven at 60°C. The dry food was powdered in a micro-hammer mill using a 3 mm mesh plate. The powder was passed through a 500 μm (30 mesh) sieve before feeding. The fresh and frozen Artemia nauplii were fed whole without any further dietary additions. Fish were fed an excess of food twice a day during weekdays and once a day at the weekends. Growth was determined as an increase in length, measured from the tip of the head to the tip of the tail. A subjective estimate of the fullness of the alimentary canal from its colour and state of swelling was made on a three-point scale: 0 = empty, 1 = half full, 2 = full, one hour after feeding on day 27.

The mean lengths of fish plotted against time are shown in Figure 2. The relationship is linear in each case and the regression lines have been fitted by eye. The best growth rate was on fresh Artemia (0.67 mm/day) followed by frozen Artemia (0.44 mm/day). Growth on the dry diets was poorer; on Crepidula and fish the growth rate was 0.18 mm/day, and on dry Artemia only 0.07 mm/day. The subjective estimates of gut fullness were:

Fresh Artemia	2.0
Frozen Artemia	2.0
Dried Artemia	0.86
Dried fish	1.10
Dried Crepidula	1.36

These results suggest that poorer growth on the dried diets was in part due to a reduced feeding rate. Other possible factors include (a) the inability of the fish to digest the dry diets, (b) an upset in water balance due to reduced dietary water intake, (c) leaching of nutrients from the food prior to consumption.

The fact that soles of this size will feed and grow on powdered diets is encouraging. This provides an opportunity to assess the importance of the factors already mentioned and others such as the feeding rate, particle size, taste and texture on the growth rates of the fish. The eventual aim is to develop a prepared diet for commercial use.

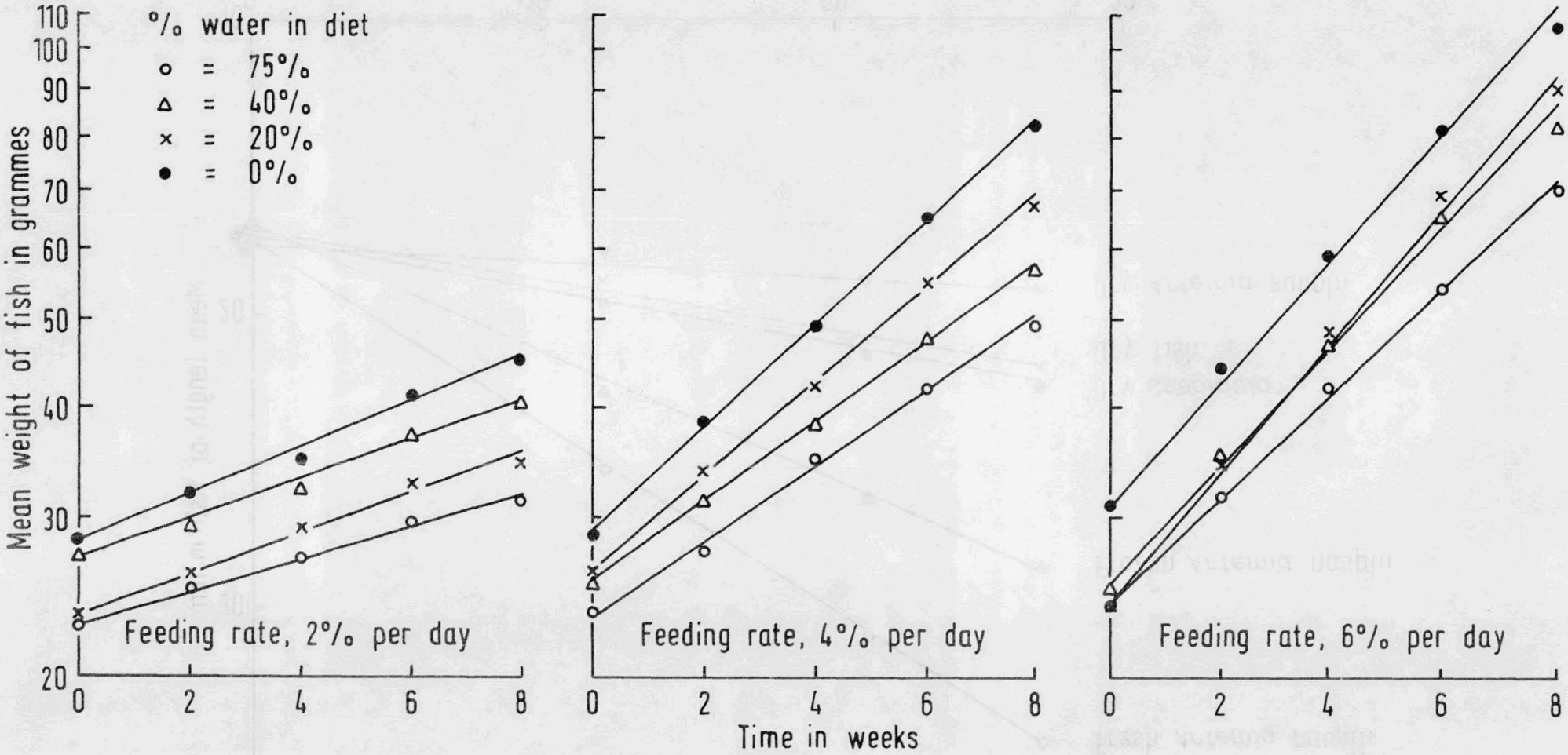

Figure 1 The influence of the feeding rate and dietary water level on the growth of turbot. The feeding rate was adjusted so that the fish received amounts of 'dry' matter equivalent to feeding rates of 2, 4 and 6 per cent respectively of the initial body weight per day on the 75 per cent water diet.

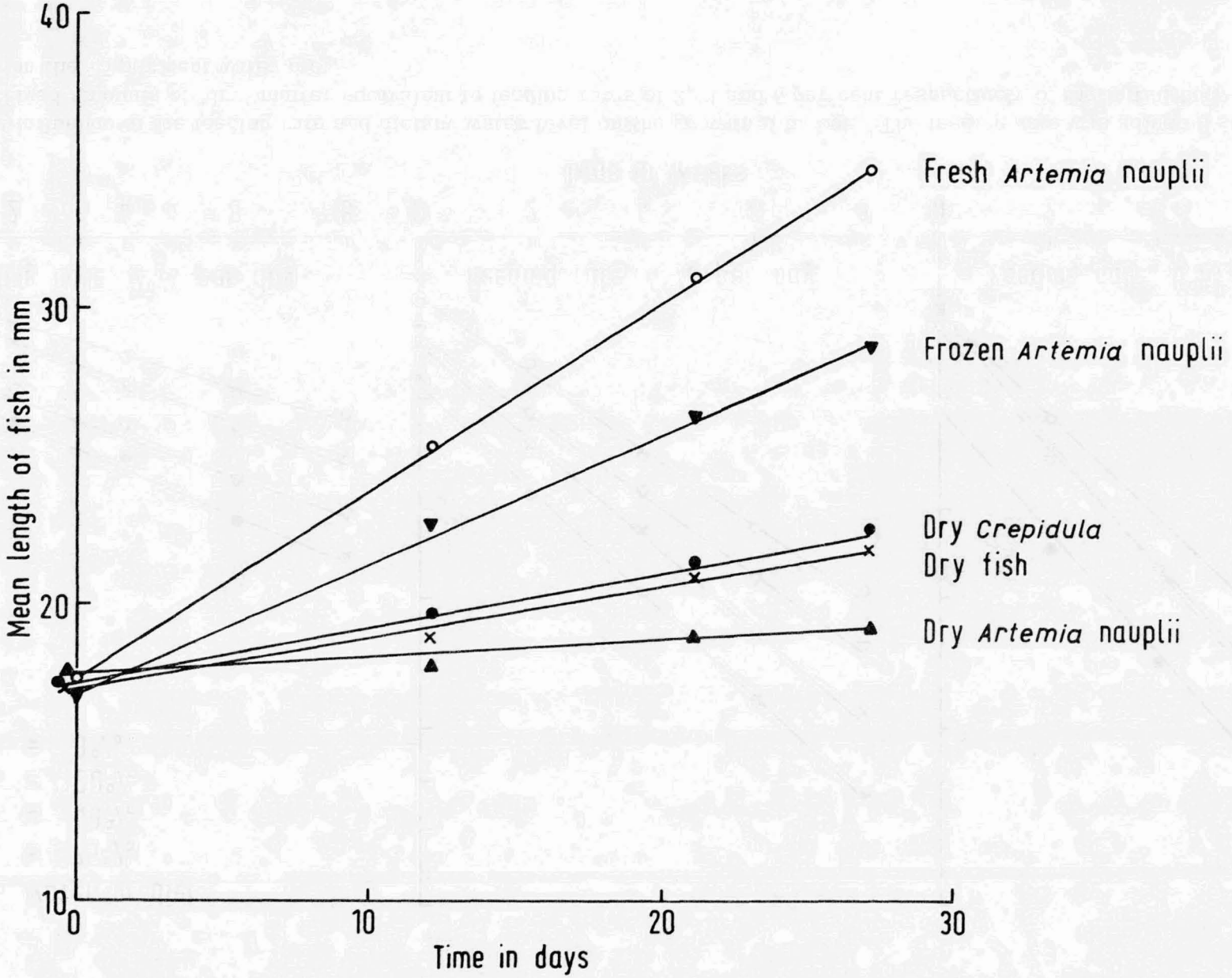

Figure 2 The growth in length of soles fed on fresh, frozen and dried diets.