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Aquafeeds

# Increased density improves grouper feeding response, growth

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White grouper (*Epinephelus aeneus)* is a Mediterranean fish species that, like many Asian groupers, is a very promising candidate for intensive aquaculture because of its high market value, excellent taste and rapid growth. Under domestication at the National Centre for Mariculture in Eilat, Israel, white grouper has been successfully reproduced in captivity, and a formulated feed had been developed for its culture.

One of the major steps in this development is to define the potential of the fish for growth under optimal conditions and how this growth is affected by the quality and quantity of the feed the fish eat. In addition, other factors that influence growth, such as feeding behavior and water temperature, should be determined.

As part of the research in these areas, a growth trial using hatchery-reared grouper was carried out by the author to study the effects of stocking density on feed intake and subsequent growth.

**Study setup**

Duplicate groups of white grouper with initial weights of 5.2 g were reared for 63 days at stocking densities of 20, 40, 60, 80 and 100 fish/200-L tanks. The average water temperature was 23.3° C, and salinity was 40 ppt. Feed was formulated mainly from fishmeal and fish oil and steam pelleted to a size of 1.6 mm (Table 1).

Provided that optimum water quality parameters are maintained, white grouper can be a suitable candidate for intensive farming systems.

| INGREDIENT CONTENT | |
|---|---|
| Fishmeal (g/kg) | 740 |
| Corn starch (g/kg) | 200 |
| Fish oil (g/kg) | 50 |
| Vitamin mix (g/kg) | 10 |
| ANALYSIS (AS FED) | |
| Dry matter (g/kg) | 919 |
| Crude protein (g/kg) | 498 |
| Crude lipid (g/kg) | 119 |
| Ash (g/kg) | 114 |

| INGREDIENT CONTENT | |
|---|---|
| Gross energy (MJ/kg) | 19.95 |

The grouper were fed manually twice a day to apparent satiation, and feed intake was recorded daily. Feeding ceased once pellets were found remaining on the bottoms of the tank for more than a minute.

Special attention was also paid to maintain water quality parameters with increasing biomass via increased water flow and sufficient aeration. The tanks were also cleaned daily of any waste products.

**Results**

At the end of the trial, the fish grown at the highest density reached a final weight of 50.5 g, compared to 25.5 g for fish kept at the lowest density. This corresponded to stocking densities of 25.2 kg/$m^3$ and 2.5 kg/$m^3$, respectively. The improved growth was obviously due to higher daily feed intake, which increased gradually from 2.7 to 3.5 percent of biomass for fish kept at the low and high densities, respectively (Table 2). Concurrent with the higher feed intake and greater body weights, the lipid content and thus energy content of the grouper gradually increased, as well (Table 3).

| Number of Fish in 200L | Final Weight (g) | Stocking Density (kg/m3) | Feed Intake (%/biomass/day) | Feed Conversion Ratio |
|---|---|---|---|---|
| 20 | 25.52 | 2.5 | 2.68 | 0.95 |
| 40 | 34.62 | 6.9 | 2.90 | 0.80 |
| 60 | 43.24 | 13.0 | 3.06 | 0.80 |
| 80 | 45.59 | 18,2 | 3.17 | 0.77 |
| 100 | 50.46 | 25.2 | 3.48 | 0.77 |

The improved feed intake and subsequent growth performance of the grouper probably reflected a behavioral response to increased crowding in the tanks. At higher fish densities, there might be a disruption of feeding hierarchies among the fish. It is also possible there was some kind of feeding reinforcement among the fish, similar to the feeding frenzies seen in larger groups of fish.

| No. of Fish in 200L | Dry Matter (g/kg) | Protein (g/kg) | Lipid (g/kg) | Ash (g/kg) | Energy (MJ/kg) |
|---|---|---|---|---|---|
| Initial | 240 | 164 | 33 | 39 | 5.078 |
| 20 | 257 | 167 | 50 | 41 | 5.703 |
| 40 | 274 | 178 | 58 | 43 | 6.120 |
| 60 | 274 | 173 | 61 | 41 | 6.189 |
| 80 | 268 | 170 | 59 | 41 | 6.097 |
| 100 | 270 | 169 | 64 | 39 | 6.218 |

As shown in Figure 1, with increasing stocking densities, feed intake increased, and consequently growth improved. This response was almost linear over the range of stocking densities tested and did not reach an apparent maximum. These results were in contrast to the general perception, where crowding negatively influences growth performance.

### Water quality

Apart from varied responses to increased stocking density among species, the effect of deteriorating water quality associated with higher density might be one of the reasons for suboptimal growth performance for several fish species described in the literature, rather than the stocking density, per se.

Flow-through and cage culture production systems are commonly subject to large fluctuations in water quality. However, in intensive recirculation systems, where water quality parameters are controlled and maintained, it is possible to evaluate the possible effects of stocking density separately from those of other water quality issues.

Another interesting aspect in this study was the improved feed-conversion ratio (FCR) achieved with the increased feed intake. FCR improved with increasing stocking densities from 0.95 down to 0.77 (Table 2). This was contrary to the common belief that fish fed to maximum voluntary intake will display a deteriorating FCR.

The reason for the better FCR was that, relatively speaking, the maintenance requirement of the faster-growing fish represented a smaller proportion of the overall requirement. The opposite is also true – with the higher maintenance demand in relation to weight gain of the slower-growing fish, the FCR will worsen.

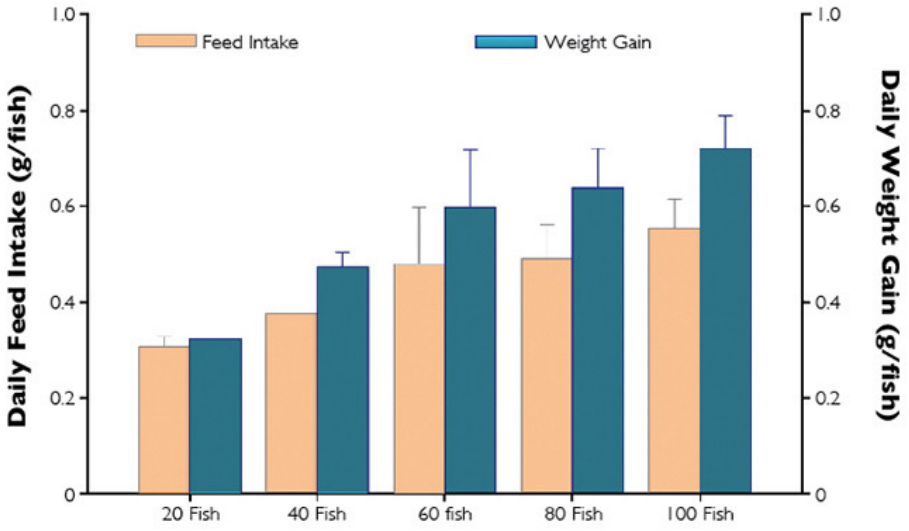


**Figure 1.** Effects of stocking density on voluntary feed intake and subsequent weight gain in white grouper.

Figure 1

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