ISBN 1793 -0561

JULY/AUGUST2017

Volume 13 Number 4

AQUA CULTURE

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MCI (P) 013/10/2016 PPS1699/08/2013(022974)

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Enhancement of production performance and fish quality of red drum

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What are the optimal digestible protein/digestible energy ratios for growth and fish quality of red drum (*Sciaenops ocellatus*) juveniles and adults up to market size in a recirculated aquaculture system?

Tropical fish generally grow much faster than temperate species and a harvest size of more than 1.5 kg can be obtained in 15-18 months. Therefore, the optimal composition of diets to support these high growth rates is likely to be very different from the traditional marine fish feeds used for temperate species. The need is for feeds capable of supporting high production performance during the whole grow-out period, from 30 g to 300 g for plate size fish, and up to 2.5 kg for fillet size cultured under high temperature conditions without affecting flesh quality. Moreover, little is known on the effects of different feeds on the quality and health of the large fish harvested.

In the case of the red drum, a few nutritional studies have been carried out in order to evaluate the dietary requirements of the species and its tolerance to terrestrial feedstuffs as replacement of fish meal-based proteins. However, most published studies have been done on small-size fish over a short period of time and thus did not cover the whole grow-out period.

The objectives of this two-year experiment were to determine optimal digestible protein/digestible energy ratios for growth, feed conversion ratio (FCR) and fish quality of red drum juveniles and adults up to market size. We formulated, produced and field tested the production performances of 3 diets for grow-out operations of red drum. In phase 1, from 30 g juvenile (88 day post hatch-DPH) to 300g (±200 DPH) for plate size fish and in phase 2, from 300g to 2 kg (± 500 DPH) for fillet size fish. We stress that this study is designed to focus on maximum feed intake rather than cost-effective feed management.

Further to this, we then investigated trace heavy metals bioaccumulation in fish tissues (muscle and liver) and performed sensory analysis to determine the effects of feed formulations on the organoleptic characteristics of farmed red drum (sensory profiles and hedonic testing).

Treatment diets

Three diets were formulated with the same raw materials (steam dried fish meal 65% protein, high HUFA fish oil, soybean meal, full fat soya, corn gluten, wheat, soy lecithin, vitamin and mineral premixes) and similar composition except for the % crude protein and % crude lipid levels, which varied from 48/12 (diet A) to 48/15.5 (diet B) and 44/15.5 (diet C).

Phase 1

During the first phase of the experiment fish were grown from 30g to plate size (300g) in closed recirculating systems. Red drum juveniles originating from the same spawning event from domesticated broodstock were randomly distributed to nine tanks of 2 m^3 capacity, each stocked with 104 fish (there were 3 replicates per test diet). Feeding was done continuously and at maximal feeding rate for all treatments. After 102 days of culture, the fish fed diet A reached an average weight of 262 ± 7.26 g, fish fed diet B reached an average 248 ± 7.00 g and for fish fed diet C, 226 ± 13.74 g. Diet A outperformed the other diets in terms of growth with average specific growth rate (SGR) of 4.51% for diet A, 4.45% for diet B and 3.83% for diet C. FCRs were 1.26 for diet A, 1.34 for diet B and 1.55 for diet C.

Phase 2

For the second phase of the experiment, 36 fish from each treatment in phase 1 were pooled and grown in a closed recirculating system comprising six tanks of 2m^3 until fish from the fastest-growing treatment reached fillet size (2.2 kg). After 542 days of culture, fish fed on diet A reached 2.265 ± 0.438 kg in comparison to 2.025 ± 0.452 kg for fish fed on diet B and 1.263 ± 0.419 kg for fish fed diet C. The average SGRs during the second phase were 0.59% for diet A, 0.63% for diet B and 0.60% for diet C. FCRs were 1.58 for diet A, 1.42 for diet B and 1.68 for diet C.

In both phases, the rearing conditions were:

- Photoperiod (illumination): 24/24h through phase 1; 16/24h during phase 2.
- Feeding frequency: during illumination period.
- Rationing similar to the tank that has the highest feed intake.
- 2 automatic feeders per tank + manual feeding.
- 1 airlift per tank.

Bioaccumulation of heavy metals

To get a clear picture of heavy metal bio-accumulation in large size cultured fish, the levels were measured in fish tissues (liver and flesh) and in the feed.

Additionally, liver condition and hepatosomatic index were evaluated per treatment and the bio-accumulation of five heavy metals (lead, cadmium, arsenic, mercury, and fluoride ions) were monitored in both liver and flesh tissues at the end of each growout phase. Generally, very low heavy metal bioaccumulation was observed in both flesh and liver with values often under the limit of detection.

Sensory evaluation

Finally, fillets from the different treatments were subjected to evaluation of their organoleptic characteristics by a panel of sensory experts. Organoleptic analyses were carried out at the sensory analysis laboratory of IFREMER in Nantes, France. The results revealed that the diet influenced the sensory characteristics of red drum flesh, mainly texture, some smell criteria and global intensity. In fact, differences between diets were significant. Texture might be correlated to size difference and growth rate of fish. Fillets from fish fed diet A obtained the best scores and were most appreciated in the organoleptic evaluation by consumers who had never been exposed to sensory evaluation and also by trained panelists.

Furthermore, in the hedonic tests, consumers showed a significant preference for fish fed diet A over those fed diet C, mainly because of its better texture and taste. The more discerning consumers referred to a “lack of taste” or “savourless” for fish fed diet C as well as “dry, dense and soggy” for texture of fish fed diet C. On the contrary, they showed a great appreciation for fish fed diet A.

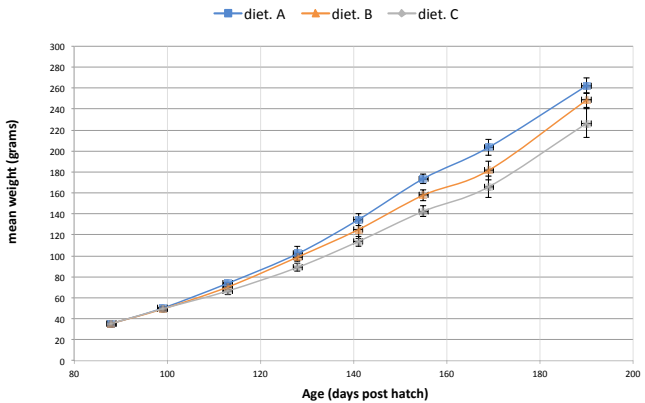

Figure 1. Growth performance (mean weight gain) during phase 1 – plate size grow-out phase (30-300 g)

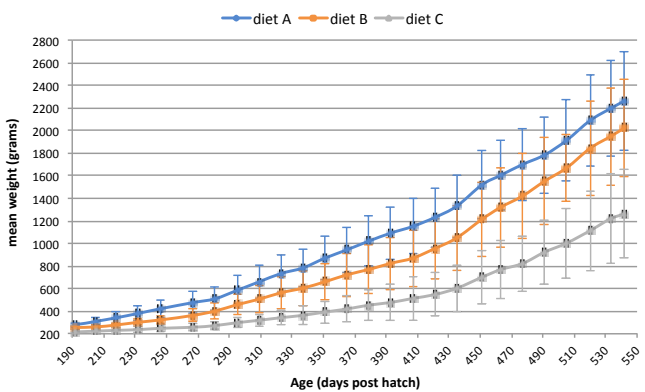

Figure 2. Growth performance (mean weight gain) during phase 2 – Fillet size grow-out phase (300 g -2 kg)

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