The JSFS 85th Anniversary-Commemorative International Symposium
"Fisheries Science for Future Generations"
Symposium Proceedings, No. 09004

Original article

Growth performance of adult yellowtail *Seriola quinqueradiata* fed extruded low-fish meal diet in commercial aquaculture; potential for cost reduction

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Keywords: Yellowtail; Low-fish meal diet; Commercial aquaculture; Extruded pellet; Cost reduction.

Received: 12 July 2017 / Accepted: 5 September 2017

Introduction

Fish meal is the most important material in fish diets in Japanese aquaculture and is contained at a level of over 50%. In Japan, over 90% of the fish meal used in fish diets for aquaculture is imported. Recently the world price of fish meal has dramatically increased due to reduced production caused by fishery regulation in South America and the increased worldwide demand for cultured fish. The increasing fish meal price threatens the viability of production of Japanese aquaculture farmers. Therefore, a low-fish meal diet is strongly required.

Another consideration is food palatability, as fish readily ingest high-fish meal (≥ 50%) diets, but not low-fish meal (<35%) diets. Fish farmers believe that fish do not digest and grow efficiently on low-fish meal diets, so they don't want to use low-fish meal diets. Since low-fish meal diets have usually been developed by research institutes using small scale net-cages and have not been tested in a commercial aquaculture field, such diets are not readily accepted by farmers and not widely used in aquaculture.

We already studied a low-fish meal (20%) test diet for red seabream in the field and obtained good results [1]. Using the same procedure, we tried to evaluate 30% fish meal diets for yellowtail in the field in order to develop inexpensive diets and optimize their utilization in relation to the physical conditions in the net cage.

Materials and methods

Experimental diets and processing
The control diet (C-FM) contained 50% fish meal. In the first year, a commercial diet was used for the control diet. In the second year, in order to examine the potential for cost reduction, the composition of the control diet was designed and pelletized.

For the low-fish meal diet, fish meal was replaced with commercially available plant (P-LFM) and animal (A-LFM) materials. In the first year, P-LFM was used for the test diet. Soy protein concentrate, defatted soy bean meal, and corn gluten meal were used for plant materials. In the second year, A-LFM was used for the test diet. Mainly, chicken meal was used. Taurine was added to the low-fish meal diets at 0.5%.

It is known that yellowtail become less responsive to a diet as the amount of dietary fish meal is reduced [2,3]. Therefore, a skipjack peptide (SP) was used as supplements to maintain the palatability of the non-fish meal diet [4]. The SP was concentrated from the cooking water of skipjack tuna. An enzyme solution was added to the low-fish meal diets to improve digestibility and absorption. The SP and an enzyme solution were sprayed onto the diets after being formed into pellets by using an extruder.

All the experimental diets were processed using a double-screw extruder at the Kagoshima plant of Marubeni Nisshin Feed Co., Ltd.

Feeding experiment at commercial farms
One year old yellowtails in two commercial farms (A and B) in Azuma-Cho Fishery Cooperative, Kagoshima Prefecture were used in the experiments. Each farm provided two net cages, one each for the control diet group and the test diet group. Feeding was conducted to satiation three times a week for six months in 10 m × 10 m net cages each containing ca. 4000 fish.

Body weight and fork length of 20-25 live fish taken at random from every group were measured monthly and blood tests also conducted. At the end of

the experiment, Daily feed intake, Growth of weight, Feed efficiency, and Feed efficiency cost were calculated.

Feeding experiment using small net cages

Cost reduction was further examined using four small net cages (5m × 5m × 5m, 150 fish each) in the second year. One was for the control diet and the other three were fed low-fish meal diets. One experimental (low-fish meal) diet cage was switched to the high-fish meal diet in November and in another cage switched in December and in the last cage the experimental diet was continued.

Results

Feeding experiment of P-LFM at commercial farms

In the first year, the experimental diet was designed using plant ingredients (P-LFM) as a partial replacement. Experimental fish growth was comparative to control fish. Growth performance and feed efficiency (C-FM; 2.99, P-LFM; 2.83) were similar (Fig. 1).

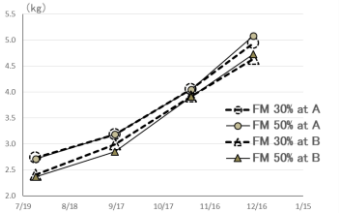

Fig. 1. Growth curves of yellowtail fed the 30% fish meal diet with plant ingredients (P-LFM: ○, △) and 50% fish meal diet (C-FM: ●, ▲) in the two farms (A, B).

Feeding experiment of A-LMF at commercial farms

In the second year, the experimental diet was designed using animal ingredients (A-LFM). Control diet (C-FM) was also designed in order to calculate the cost reduction effect in feeding experiment. As a result, the raw material cost of the A-LFM was about 90% of those of C-FM. When the weight approached 6 kg, fish growth rate markedly reduced. Growth performance and feed efficiency of the experimental diet were slightly inferior to the control (Fig. 2).

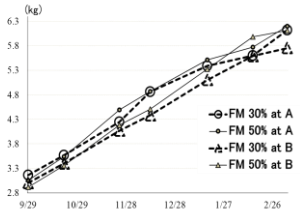

Fig. 2. Growth curves of yellowtail fed the 30% fish meal diet with animal ingredients (A-LFM: ○, △) and 50% fish meal diet (C-FM: ●, ▲) in the two farms (A, B).

Feeding experiment for cost effective method using small net cages

Feed efficiencies were 2.51 in the control; 2.41 in November switched cage; 2.36 in December switched cage, and 2.60 in continued cage. Feeding efficiency cost based on the control as 100%, was 83.5% in November switched cage, 86.2% in December switched cage, and 92.8% in continued cage. Therefore, the switching method is considered effective for cost reduction (Fig. 3).

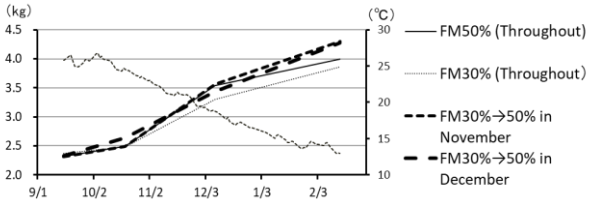

Fig. 3. Growth curves of yellowtail fed the experimental diets of 30% fish meal diet with plant ingredients (A-LFM) and 50% fish meal diet (C-FM). Two groups of the A-LFM were switched to C-FM in November and December, respectively.

Discussion

To develop low-cost and practicable low-fish meal diets for adult yellowtail until harvestable size, feeding experiments were conducted in practical scale cultures. The experimental diets were designed to have more total protein and total calories than control diets, since growth and feed efficiency decrease continuously with the decreasing fish meal content. Taurine was also used to prevent green liver syndrome [5-8].

There were no differences between experimental and control diet groups in feeding, disease, blood properties, and meat quality using instrumental analyses. In addition, since both diets of P-LFM and A-LFM showed similar performance, a capability was shown that there is potential to use various ingredients for low-fish meal diet with for consideration of price-level changes.

On the other hand, to develop an effective utilization method of low-fish meal diets, a way to alter diets with the seasons was studied. The cost reduction was seen in the case of using low-fish meal diet in summer and then switching to the control diet after autumn.

Acknowledgements

This work was supported by commissioned research project to sustain aquaculture production from the Fishery Agency, Ministry of Agriculture, Forestry and Fisheries of Japan.

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