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# Nutrition of the Seabass *Lates calcarifer*

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**Abstract.** — *The ability of seabass to wean with dry pelleted feed was demonstrated from as early as the fry stage by the Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER), Tahiti. Dietary protein and lipid requirements of seabass were also investigated from the fry to market-size stages by IFREMER. Results indicated that the seabass fingerlings required 45-50 % protein in diets made with high quality fishmeal. Dietary lipid can be reduced to 6 % without real protein-sparing effect on growth, and fish survival was not affected.*

*The Primary Production Department of Singapore (PPD) studies covered the weaning of seabass from fingerlings stage onwards and the dietary protein requirement of early grow-out fish. Dietary protein requirement of early grow-out seabass was demonstrated to be between 40-50 %, at dietary lipid level of 12 %, using fishmeal protein. Nevertheless fish growth was significantly higher with trashfish feed, but apparent protein retention was significantly better with formulated feed.*

## INTRODUCTION

This research on the nutrition of Seabass was initiated in 1985, thanks to a cooperation between IFREMER and PPD including :

- supply of fry and fingerlings;
- exchange of nutritional data in order to evaluate some nutritional requirements of seabass;
- development of formulations;
- propose conditions of manufacturing such a feed in order to sustain future seabass operations whether in Singapore or in Tahiti.

The objectives of seabass nutrition studies conducted in Tahiti were the estimation of basic protein and lipid requirements of fry and the reduction of the cost by optimization of the formulation and selection of low cost protein sources.

Seabass fry were imported from Singapore (PPD) in 1985 for the first experiment and in 1986 for two other ones; larval rearing was conducted in Tahiti with 15 days old larvae.

Rearing conditions for fish nutrition studies were as follows : 100 litres capacity fiberglass, rectangular tank; water exchange at 10-100 % per hour and sand filtered sea water ; aeration at 8 litres/minute; light with low intensity and black plastic lid covering 3/4 of the tank; temperature between 27 and 29°C; automatic feeder for feed distribution 8 hours per day.

Definition of different terms employed in the study :

— relative growth rate in % per day

$$= \frac{\text{Ln } Wt^2 - \text{Ln } Wt^1}{\text{Number days}} \times 100$$

— conversion ratio $= \frac{\text{Quantity of dry feed}}{\text{Weight gain}}$

— feed efficiency ratio % $= \frac{1}{CR} \times 10$

— protein efficiency ratio % $= \frac{\text{Weight gain (g)}}{\text{Ingested gain (g)}}$

— Energy/protein ratio $= \frac{\text{Energy (kcal)}}{\text{protein (g)}}$

All statistical analysis were done with one way analysis of variance on total weight increase, each month at alpha risk of 5 % and a Newmann - Keuls test.

### Protein requirement

Experimental design selected for protein requirement was a range of 4 protein content : 35, 40, 46 and 55 and a control at 48 %, each treatment in 2 replicates, 39 fry per tank, and an initial weight of 34,7 ê 0,6 g. Feeding levels were fixed at 3 % of body weight. Formulations were given as indicated in Table 1.

### Lipid requirement

Experimental design selected for lipid requirement included 3 levels of lipids at 6, 10 and 14 % and 3 blocks with 2 replicates per treatments,

**Table 1.** Diet Composition for Lates Fingerlings in Protein Requirement study.

| Raw materiel % | A | B | C | D | Control |
|---|---|---|---|---|---|
| Norseamink | 39 | 45 | 55 | 58 | 34 |
| Fish concentrate | | | | | 20 |
| Shrimp meal | 5 | 5 | 5 | 5 | |
| Meat bone meal | | | | | 4 |
| Corn | 44 | 34 | 18 | | |
| Soja | 2 | 3 | 10 | 23 | 10 |
| Whole wheat | | | | | 8 |
| Wheat flour | 5 | 5 | 5 | 5 | |
| Yeast | | | | | 10 |
| Dried whey | | | | | 4 |
| Vitamin Rovimix | | | | | 2 |
| Alfalfa | | | | | 3 |
| Minerals mix | | | | | 1.4 |
| Guaranate | 2 | 2 | 2 | 2 | |
| Capelin oil | 3 | 3 | 5 | 6 | 4 |
| % As fed protein | 34.4 | 39.5 | 46.7 | 54.5 | 48 |
| Fat | 8.3 | 8.9 | 10.5 | 12 | 10.6 |
| Ash | 6.5 | 7.3 | 8.6 | 9.7 | 7.9 |
| crude energy Kcal/kg | 4 600 | 4 700 | 4 900 | 5 100 | 4 900 |

21 fry per tank and initial weights of 20,5 ± 0,5, 25,0 ± 0,6, 30,5 ± 0,8 for blocks 1, 2 and 3 respectively. Feeding levels were fixed up at 3 % body weight. Formulations are given as indicated in Table 2.

**Table 2.** Lipid requirements of *Lates calcarifer* observed in a preliminary study.

| Raw materials % | A | DIETS<br>B | C |
|---|---|---|---|
| Norseamink | 34 | 34 | 34 |
| Fish concentrate | 20 | 20 | 20 |
| Meat bone meal | 4 | 4 | 4 |
| Soja concentrate | 9.6 | 9.6 | 9.6 |
| Whole wheat | 12 | 8 | 4 |
| Yeast | 10 | 10 | 10 |
| Dried whey | 4 | 4 | 4 |
| Vitamins | 2 | 2 | 2 |
| Alfalfa | 3 | 3 | 3 |
| Minerals | 1.4 | 1.4 | 1.4 |
| Capelin oil | | 4 | 8 |
| Crude protein (1) | 56.4 | 57.5 | 55.5 |
| Fat (1) | 6.8 | 10.6 | 14 |
| Carbohydrates (1) | 20 | 15 | 14 |
| Ash (1) | 9 | 9 | 9 |
| Crude energy Kcal/Kg | 4.7 | 4.9 | 5.1 |

(1) % as fed.

## RESULTS

### *Protein requirement*

Summary results on the comparison of five protein levels in compounded diets for sea bass fry during a 3 months experiment are given as indicated in Table 3.

Significant growth differences correlated with protein levels appeared as early as the first month of experiment. Optimum protein level was around 50 % as showed by conversion and feed efficiency ratio values. Importance of protein source quality with a mixture of fish meal and fish protein concentrated was demonstrated by best results obtained with the control. At a constant digestible energy protein ratio of 7,5 Kcal/g of protein, there were a slight accumulation of body lipids when protein content of the diet was superior to 40 %.

**Table 3.** Results of survival, weight gain, food conversion ratio (FCR) and food efficiency ratio (FER), comparing 5 protein levels in compounded diet for Seabass.

| Diet | Crude Protein % | Survival % | Total Weight Gain (g) | Relative Growth Rate (%/day) | FCR | FER |
|---|---|---|---|---|---|---|
| A | 34 | 100 | 77 | 1.3 | 1.8 | 1.8 |
| B | 40 | 97 | 100 | 1.5 | 1.5 | 1.8 |
| C | 46 | 100 | 120 | 1.6 | 1.4 | 1.6 |
| D | 54 | 99 | 124 | 1.7 | 1.4 | 1.4 |
| E | 48 | 99 | 138 | 1.8 | 1.3 | 1.8 |

Seabass fish appeared as a strictly carnivorous species with an optimum protein level around 50 %. No further improvement of growth was observed even with a protein level higher than 50 %.. Protein quality appeared as an important factor to be considered to enhance fish growth.

Body analysis results are indicated in Table 4.

**Table 4.** Summary of body analysis results on seabass fry fed at five different protein levels in the compounded diet during a 3 months experiment.

| | Diets | Crude (1) Protein % | Fat (1) % | Ash (1) % |
|---|---|---|---|---|
| INITIAL | A.E. | 14.2 | 3.1 | 3.7 |
| | A | 16.2 | 3.5 | 4.3 |
| | B | 16.3 | 4.1 | 4.2 |
| | C | 16.5 | 5.0 | 3.9 |
| | D | 16.4 | 6 | 3.9 |
| | E | 16.3 | 6.1 | 3.8 |

(1) % of live fish.

## Lipid requirement

Weight gains, relative growth rate and food conversion ratio results on the comparison of 3 fat levels in the diet are indicated in Table 5.

**Table 5.** Growth results on the comparison of 3 fat levels in dry feeds for seabass fry during 120 days experiments.

**Total weight gain in grams.**

| | % LIPID IN DIETS | | |
|---|---|---|---|
| | 6 | 10 | 14 |
| Block 1 « 20 g » | 114 | 93 | 140 |
| Block 2 « 25 g » | 94 | 125 | 81 |
| Block 3 « 30 g » | 161 | 121 | 110 |
| mean | 123 | 113 | 100 |

**Results**

**Mean relative growth rate (%/day).**

| % lipid in diet | %/day |
|---|---|
| 6 | 1.4 |
| 10 | 1.3 |
| 14 | 1.2 |

**Mean foood conversion ratio.**

| % lipid in diet | FCR |
|---|---|
| 6 | 1.7 :1 |
| 10 | 1.7 :1 |
| 14 | 1.8 :1 |

Fat body analysis (Table 6) did not show lipid accumulation at high fat level in the diet for 20 g average weight fish and a slight increase with other fish sizes.

Conversion ratio, feed efficiency and protein efficiency ratio were stable. Total weight increase fluctuated in a range of 100 to 120 g over 4 months but classification of diets versus growth was not strictly correlated with fat level. Survival and growth of sea bass fry were not significantly

**Table 6.** Body fat analysis of 3 sizes of seabass fry fed at 3 fat levels in the diet during a 4 months experiment, in % of fresh fish.

| % fat in diet | Block 1 | Block 2 | Block 3 |
|---|---|---|---|
| 6 | 2.9 | 2.1 | 2.9 |
| 10 | 2.9 | 3.1 | 3.4 |
| 14 | 2.9 | 3.7 | 4.4 |

**Table 7.** Seabass experimental diet used at PPD. Singapore.

| | % |
|---|---|
| Singapore fish meal | 17 |
| Norseamink | 36 |
| Dried mussel meal | 4 |
| Dried meal | 2 |
| Squid meal | 4 |
| Meat bone meal | 6 |
| Soya bean meal | 5.5 |
| Whole wheat | 3 |
| Vitamin mixture | 1 |
| Mineral mixture | 5 |
| Alpha starch | 10 |
| Cod liver oil | 4.4 |
| Crude protein (%) | 48 |
| Crude fat (%) | 13 |
| Ashes (%) | 15 |
| Calcium | 2.8 |
| Phosphorus | 2.4 |
| DE Kcal/kg | 3 522 |
| DE/P mg Kcal | 136 |

**Table 8.** Dietary protein requirement of seabass. Results obtained at PPD (Wong and Chou, 1988).

| Diet with Protein Level (%) | Growth Rate g/fish/day | FCR | Survival % |
|---|---|---|---|
| CP 30 | 0.3 | 2.0 | 90 |
| CP 35 | 0.5 | 1.5 | 90 |
| CP 40 | 0.6 | 1.3 | 95 |
| Trash fish (control) | 1.0 | 1.2 | 90 |

N.B. 1.6 g average initial weight of fish.

affected when fed at 3 fat levels in the diet. Preliminary conclusions on lipid requirements related to 6 % fat level brought in by capelin oil in the diet which seems sufficient to bring in energy and fatty acids to sea bass fry. Fat level higher than 6 % did not improve growth nor reduce food consumption although the digestible energy/protein ratio was.

## CONCLUSION

From our results and in accordance with literature on Seabass nutrition, Chou (1984), Wong et *al* (1988), protein and lipid levels in formulated feeds should be around 50 and 6 % respectively for fish ranging from 20 to 200 g mean weight. These percentages should be confirmed for larger sized fish up to the commercial mean weight (500-600 g). Utilization of low cost protein sources is to be considered as large scale aquaculture development of this species is expected. More fundamental research is needed to specify essential amino acids and fatty acids requirements to improve and optimize feed formulations.

Feed formulation is guided towards a substitution of fish meal by soya meal in a way to reduce the cost of feed. Meanwhile it was shown that pelleted feed versus extruded feed was proved identical in terms of growth and survival rate.

Least cost formulation is already possible with a minimum of nutritional constrainsts and a right selection of quality ingredients.Extruded or pelleted feeds can sustain growth of *Lates* from 20 g up to 650 g after 180 days in floating cages at a density of 60 fry/square metre with a FCR of 1.4 to 1.0 : 1 (Fuchs, 1986).

At PPD in Singapore, similar formulations (Table 7) are achieved in order to replace trash fish by cheap extruded or pelleted feeds and similar studies are carried out on protein (Table 8) and lipid requirements of seabass. Such studies would help to sustain a reasonable cost of feed in order to convince local farmers to use pelleted feeds instead of trash fish.. Inclusion of local fish meal is necessary for economical reasons ; utilization of local mussel meal represents a good potential protein source for part of *Lates* feed. The future of pelleted feed relies entirely on a performant but economical formulation of the feed to get a chance to compete with large use of trash fish by farmers in Singapore.

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