Feeds and feeding of seabass in hatchery, nursery and grow out system using formulated feeds

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The requirement of nutrients varies throughout the life cycle of an individual. At early stages, the requirement of nutrients is comparatively high which declines with age. Also the requirements depend upon the feeding habits that change accordingly to the morphology of digestive system. Considerable effort has been made in Australia, Thailand, Philippines and more recently Israel, in defining the nutritional requirements of seabass in order to improve production (Boonyaratpalin and Williams, 2001). Feeds and feeding are the critical factors that determine the economic viability of commercial aquaculture of the species concerned and this topic assumes much more significance in a carnivore species like seabass. Based on the nutritional requirements we know that this fish requires a high protein high energy diet. Further, being a predatory carnivore in nature, weaning them to formulated feed is the critical factor which influences the success of grow out culture of seabass. Understanding the nutritional requirements of the candidate species is the first and essential pre- requisite for the development of cost effective, efficient and eco friendly feeds.

Feeding of larvae in hatchery and nursery

Larvae of finfish and shellfish are generally fed with live food organisms (phytoplankton or zooplankton or both) in the initial phase. Investigations revealed that the developing larvae do not have the full complement of digestive system developed. The larvae of seabass are no exception to this. Studies conducted at CIBA on the metabolic changes and nutrient turn-over in developing seabass larvae revealed that the growing larvae require the essential amino acids leucine and lysine at higher levels in the larval diets (Syama Dayal *et al.*, 2003). Being carnivorous, seabass larvae are fed with zooplankton such as rotifers for the first two weeks post hatch (PH) and then switched over to brine shrimp (*Artemia*) nauplii. The size of the rotifers plays an important role in the successful rearing of the larvae. Super small size rotifers are preferred for feeding seabass larvae. Since, Artemia is an expensive live-food, its replacement by prepared diets has assumed significance in the hatchery and nursery rearing of fish larvae. In this context, formulated micro particulate and microencapsulated diets have been successfully used for feeding the growing fish larvae.

Compounded micro diets for seabass larvae

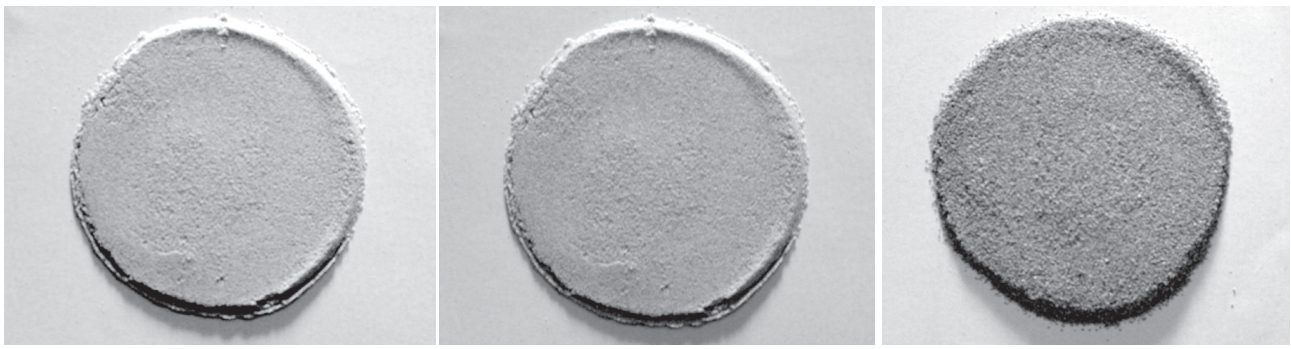
Physical aspects

Size

Diet must be prepared as microparticles, whose size must be adapted to the size of the larval mouth. As an example, size of the microparticulated diets used for seabass larval

experiments was 50 to 125 ←m at first feeding, then 125-200 ←m from Day 14 to Day 25, then 200-400 ←m to Day 40 (Cahu and Zambonino Infante, 1994). The size of commercial microparticles used in hatchery for seabass or sea bream weaning, used from Day 40, is generally 400 to 600 ←m. Accurate size of the microparticles is essential and must be well calibrated to minimize waste. Particularly, small microparticles (less than 50 ←m diameter) cannot be easily detected by larvae, whereas large ones are difficult to ingest and may even promote a blockage of the digestive valve (Walford *et al.*, 1991). The composition of microparticles must be homogenous; hence, ingredients must be incorporated as very fine meal. The size of the meal particles must be much smaller than the size of the final dietary microparticle. Diet, such as fish meal, must be ground and sieved before being included in microparticles. Concerted efforts made by CIBA scientist lead to the development of micro diets for seabass larvae and the different micro diets used for larval rearing are given below.

Micro diets developed at CIBA for seabass larvae



MD-200 *MD-300* *MD-400*

Manufacturing techniques

Nutrient leaching is one of the problems in developing suitable diets for fish larvae. Particles must be water-stable, palatable and digestible. Diets used for late weaning (after Day 40) in the hatchery can be crumbled, prepared by grinding and sieving pellets, but diets of smaller size must be prepared in microbound, microcoated, or microencapsulated form. In microbound diets, the powdered ingredients are microbound with a water stable matrix such as agar, carrageenan or calcium alginate or by a protein such as casein or zein. Microencapsulated diets are prepared with a cross-linking agent. Microencapsulation produces regular shape and water stable microparticles, but the microcapsules can be difficult to digest. The ability of larvae to break microcapsules depends on the thickness of the capsule coating.

Buyoancy of the diet

Dietary microparticles must be distributed in large excess. Indeed, early stage larvae have a limited movement and microparticles must be caught during their fall in the water column. Good results can be obtained with low density microcapsules (400-600 g/L), sinking at about 25 cm/h average.

Visual and chemical stimuli of the diet

Light intensity, color of microparticles and tank are essential for ingestion. Some pigments, such as asthaxanthin, have been incorporated in microparticles, more for improving the visibility of the particle by larvae than for their nutritional value. Free amino acids, such alanine, glycine and arginine and the compound betaine, have been identified as efficient chemical stimulator for microdiet in gilthead sea bream larvae (Kolkovski *et al.*, 1997).

Thus, larval feed development largely depends on:

- Selection of nutrient specific to the species
- Nutritional balance of formulation

- Retention of nutritional components
- Homogeneity of particles
- Particle size and distribution
- Density of particles
- Water solubility
- Storage stability
- Packing requirements

Apart from providing a balanced diet, the other problem related to larval rearing is the weaning of larvae. Some of the larvae tend to grow faster naturally than the other in the stock, which have to be segregated time to time for higher survival ability and production. These fast growing ones are not necessarily due to nutritionally imbalanced feed but could be due to number of other factors that the hatchery operator usually faces.

Practical feeding of micro diets in sea bass larval rearing

Weaning

The age at which weaning is carried out varies considerably depending on the larval size and rearing method employed. The use of micro diets in larvae is essentially preceded by weaning them to formulated diets. The weaning of larvae can be carried out in following ways:

1. By having a intermediate feeding phase using frozen or freeze dried zooplankton
2. Using simultaneous distribution of live prey and dried feed. It can be started at an early stage.
3. Co-feeding but shortening the live prey co feeding to one or two days. This results in better size homogeneity
4. Starving the larvae and then introducing the micro diets. This method can only be practiced in larvae which are in good health

Micro diets distribution

The major bottleneck associated with micro diets feeding are over feeding of larvae and pollution of the environment. The food particles must be made available in large number around the larvae. Small particles float initially and then fall to the bottom. The larvae are not interested in diet that are floating or lying at the bottom of the tank but fed on those particles that pass by their vicinity. Feeding frequencies and feeding period has to be extended as the larvae are very sensitive to starvation. However, they can not ingest their daily ration in two to three meals as the resting time in the digestive tract of larvae are very short compared to juveniles. These features of larvae necessitate continuous and excess feeding. Thus, it is essential to use feeders in larval rearing of seabass using micro diets.

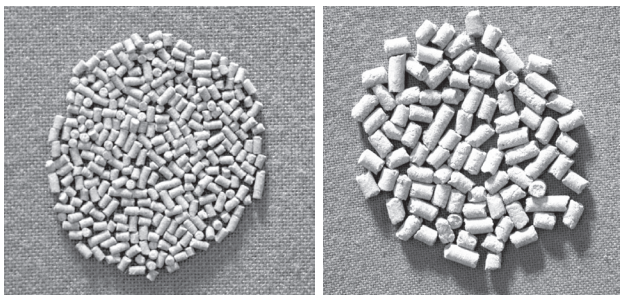
Feeds and feeding of seabass in grow-out culture

In some of the East Asian countries and also in India, seabass is cultured in grow-out ponds using low value fish (trash fish) and tilapias in fresh condition. Since, procurement and storage of these feed-fish is not only laborious but also quite expensive. Hence, formulated feeds are essential for the propagation of large-scale farming of seabass.

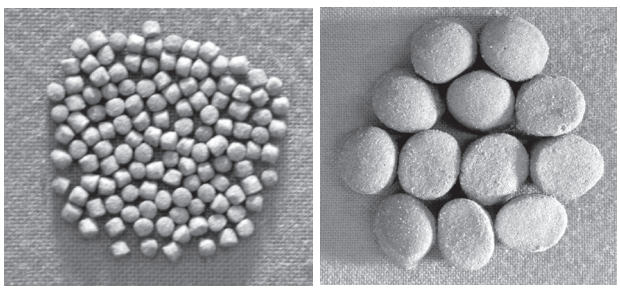
Asian seabass is cultured in Australia and Thailand using formulated feeds (Boonyaratpalin, 1991). As in the case of other carnivorous species, feed formulations for seabass utilize marine fish resources (for meeting protein requirement) and fish oils along with plant protein sources. The animal ingredients are kept above 60% of the formulation to get protein levels in the range of 45-52%. Experiments conducted at Muttukadu field laboratory of CIBA had shown that feeds with substantial fishmeal component (30-40%) only have good acceptability for seabass. Higher the proportions of fishmeal better the acceptability. The texture and size of the feed affects acceptability of the feed. If the flavour and texture of the

feed are not to the liking of the fish, it spits out the feed soon after ingesting. The use of animal protein sources such as fishmeal is inevitable in order to keep higher protein levels in the feed. However, plant ingredients such soybean meal and other oil seed residues may be utilized in the feed formulations. Marine fish oils should be included in the feed formulations as a source of polyunsaturated fatty acids (PUFA). Studies conducted at CIBA revealed that the amino acid, glutamic acid, is a useful feed attractant for seabass.

Seabass feeds on moving prey; hence the physical design of the feed plays a very important role. The fish readily accepts soft semi-moist feeds with appropriate size to swallow vis-à-vis the size of the fish. The lower lip of the fish is curved slightly upward, which pose disadvantage while biting the feed. Floating and slow sinking pellet feeds are more suited for feeding seabass. Such feeds are generally processed in extruders.



Sinking feeds for seabass



Floating feeds for seabass

Extruder technology

The basic components in an extruder are a barrel fitted with a die plate and a screw shaft conveyer, which is connected to a high-speed motor. The feed mixture is fed into an extruder by proper arrangement of water/ steam injection facility. The extruder operates at high pressure (14 98 kg/cm^2) and steam (Pressure 5 7 kg/cm^2) injection. Depending upon the characteristics of the feed mixture and moisture content, the pressure develops before the material passes through the die. Because of this the temperature rises and the material is forced through the die and the pressure suddenly drops. The temperature of the material rises to 110 130^{o}C for a short spell of time and cooks the food, gelatinizing the starch present in the feed mixture. This imparts good binding and water stability to the resultant pellets. However, the pellets expand as they come out of the die due to sudden drop of pressure and air gaps develop inside the pellet, which makes them float or sink very slowly. This is an excellent process for producing floating pellets for finfish culture. By adjusting the pressure in the barrel and moisture in the feed, it is possible to prepare sinking pellets by extruder. The new generation extruders are made with twin screw barrel arrangement, which are more versatile for feed manufacture. The size of the pellet diameter ranges from 0.5 mm to 8.0 mm.

The characteristics of extruder pellets are

- Reduction in pellet disintegration and loss in water.
- Increases starch digestibility due to good cooking
- Can be worked with higher moisture and oil (fish oil) levels in the feed.
- Extruder pellets float or sink slowly.
- Making charges for extruder pellets are higher due to high cost of extruders

At CIBA, formulated feeds developed as floating and sinking pellets were successfully tested in grow-out ponds and the fish growth was found to be 500 g in six months.

The fish should be fed at the rate of 10% of their body weight to start with. After four to six weeks the feeding rate may be reduced to 8%. As the fish grow in size the feeding rate should be gradually reduced to 5%, 3% and

finally 2%. The total biomass in the pond should be periodically estimated by suitable means (by caste netting) for adjusting the feed. The entire quantity of feed in a day should not be given at one time but divided and fed 3-4 times a day.

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