MARINE FISH NUTRITION

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Marine fish nutrition is unique in the sense that their nutritional requirements are highest grossly compared to any livestock. Ruminants have a protein requirement of approximately 15% in the compounded cattle feed and poultry feed varies from 20-22%. For pigs it varies from 24-26%. The same in aquatic animals varies from 25 – 40%. Marine fish is known to require not only high protein in their feeds but also fat to the tune of 10% in the tropics. Since shrimp and quality marine fish fetches high price in the market, with such costly inputs these enterprises are proven to be viable financially.

Fish nutrition like any other nutrition including human nutrition encompasses the major macro nutrients which are protein, fat and carbohydrate which includes fibre also. Generally fish cannot tolerate fibre content of more than 4% in its feeds because they are also monogastric (single stomached) animals. Exceptions like grass carp and rabbit fish are there to name which can handle more fibrous feed. Fish in nature has limited access to carbohydrate and utilizes protein to meet its energy requirement. That is why their protein requirements are higher compared to terrestrial livestock. Micronutrients like vitamins and minerals are also very vital in fish nutrition also. In general fat soluble

vitamins like A, D and K are available to them through the fat they consume. They can be stored because fat is stored by all animals including fish. Water soluble vitamins are not so. Day-to-day requirement has to be obtained through feed and excess gets discarded through urine. In nature as fish lives in aquatic medium water soluble vitamins are obtained by them from the water where the microbes present synthesize almost all water soluble vitamins (B-complex). The only difficulty noticed is in the case of vitamin C which may fall short of the requirements in culture conditions. This is overcome by supplementing the feed apart from the dietary allowances through inclusion of vitamin and mineral premixes with a water stable form of vitamin – C (ascorbyl polyphosphate APP) available commercially.

The fish needs to be fed only when we culture them by restricting the water volume and increasing their number per unit area (stocking density). Feeding fish with fish is not appreciated now because it is pointed out that low value fish is a source of nutrition for human beings. Using it to feed fish which costs more deprives the section of the society which cannot afford to buy high quality fish costing higher.

In such a situation, if we examine evolution of fish feeding, it started with feeding by broadcasting feed material, mainly agro-industrial by-products like oil cakes, brans and grains. Further refinement happened when they were mixed and fed, which is the beginning of compounded supplementary feeding. All this involved feed wastage. To overcome this, farmers in Andhra Pradesh started hanging gunny bags containing feed material with perforations in the pond water so that wastage of feed can be minimized has wide acceptance.

The next development in fish feeding is the use of compounded feed pellets which began with a cold pellet. Better acceptance and digestibility was acquired through a steam cooked pellet and now most of the shrimp feeds available commercially are steamed pellets and crumbles.

Most crustaceans including shrimp and lobsters prefer a

sinking pellet which can be produced using kitchen utensils at farm site. Feeds produced closer to farm sites are called farm made feeds and simple formulations with locally available raw material will be very cost effective as shown below.

Ingredients	Parts (%)
An animal/ marine protein source Fish, shrimp, clam, poultry by product meal	30%
A vegetable protein source Soy, ground nut oil cake, cotton seed oil cake	30
A starch source Wheat flour, tapioca flour, maida	30
Oil Fish oil if available or a mixture of vegetable oils with fish oil	5
Mineral mixture	3
Vitamin mixture	2

The starchy ingredient (wheat or any other flour) when gelatinized with water becomes sticky. The remaining ingredients can be mixed with water to obtain a dough stiff enough to be pelletized. This pellet can be sun dried or oven dried to reduce its moisture content below 10% and stored and used. This is the simplest method of producing aquatic feed. Instead of a hand pelletizer if a motorized pelletizer is used the process gets mechanized gradually.

Having stated a simple method to produce feeds, it is appropriate to have knowledge of the feed stuff than can be used for making feeds. In today's world we need not carry information physically. It is available from a website www.feedipedia.org which is a very comprehensive database of all feed materials from where we can make out whether we can use the material we have as a fish feed ingredient.

Knowledge of the feed ingredients at your disposal is the

initial step in scientific feed compounding, unlike resorting to an empirical mixture given above. After narrowing down the material to be used in making the feed, the next step knowing the nutritional requirements of fish. The most scientifically authentic information will be available in NRC (2011) and a summary of what is available there for some marine fish in which our interest lies is shown below.

Item	Asian seabass Latesclcarifer	Cobia Rachycentron-canadum	Grouper Epinephelus spp.
Protein %	38	38	42
Digestible energy (kcal/g diet)	4200	4000	4000

formulation the 'Excel' way Tips to farmers/farm managers. Fishing Chimes, 23 (5). pp. 17-23.

Item	White shrimp Litopenaeus-vannamei	Tiger shrimp Penaues monodon	Spiny lobsters*
Protein %	30	34	47-53
Digestible energy (kcal/g diet)	3000	3000	-Not available

*Smith et al. (2003)

Nutrient requirements of marine fish (modified from NRC, 2011)

The requirements reported being the above, we can find commercial products (mostly imported) with more than 40% protein and 10% fat. These products are imported because, as of now, the marine fish culture or mariculture has not become a fully commercial activity in India

Coming to formulation of feed per se, it is the technique of finding out how much of each ingredient should be mixed to obtain the right mixture of nutrients to meet the optimum nutritional requirements of the fish cultured. From a simple

scenario of mixing two ingredients and arriving at the required nutrient density in the mixture, it becomes more and more complicated when more than two ingredients are used with a variety of supplements and additives. The solutions are arrived at using mathematical calculations. With the extensive use of computers calculations can be done in Excel spread sheets as well as using linear programming tool-box in MS Excel known a Solver. Apart from the above, several software and data bases are available for use. For more information please read Vijayagopal (2003).

Technologies used in fish feed production are steam pelleting and extrusion. As mentioned earlier steamed pellets are suitable only for shrimp and lobsters (crustaceans) because sinking pellets can be only produced. Extrusion came into food industry from rubber and plastic industry, for the production of, ready to eat (RTE) snacks and cereal products like corn flakes and noodles. Aquatic feed production resorted to extrusion technology for the production of floating and slow sinking feed pellets depending upon the feeding habit of the fish. These properties are imparted to the feed pellet in extrusion by passing the feed mixture through a heated barrel in which one or two screws rotate and push the feed through dies. During this process gelling of both protein and carbohydrates takes place. With the puffing of starch as in popcorn and due to formation of air pockets in the pellet makes it float. By regulating the time, temperature and material composition, other properties like slow sinking and fully sinking pellets can be also produced through extrusion. It will not be out of place to mention here that extrusion is costlier than steam pelletization mainly because the initial investment in an extruder will be ten times more than a steam plelletizer.

Most of the cultured fin fish including the Indian major carps (IMC's) prefer floating pellets. Another major advantage of using floating pellets to feed fish is that, feed wastage can be minimized to such an extent that the higher price paid for procurement of floating pellets can be offset by the cost effectiveness attained by minimising feed wastage. This is possible mainly by observing feeding carefully and stopping feeding as soon as the fish stops

feeding.

Feeding rate and feeding frequencies are other activities in fish culture requiring attention in the feeding management. The

Seabass

Size (mm)	Fish weight (g)	Feeding rate % body weight per day	Feeding frequency Meals per day
2.0	5 – 20	6 – 12	3 – 4
3.5	20 – 100	4 – 6	2 – 3
5.0	100 – 250	2 – 4	2 – 3
9.0	› 250	1 – 2	1 – 2

Cobia

Size (mm)	Fish weight (g)	Feeding rate % body weight per day	Feeding frequency Meals per day
2.0	15 - 100	5 - 10	3 - 4
3.5	100 - 350	4 - 5	2 - 3
5.0	350 - 750	3 - 4	1 - 2
9.0	› 750	1 - 3	1 - 2

indicative feeding Tables below for sebass and cobia illustrate that.

The thumb rule here is, generally adult vertebrates consume 2-3% of their body weight of dry matter (excluding the water content). As evident in the Table above, during early stages of growth the consumption rates would be higher and then stabilizes at 2-3% of the body weight. This quantity fed in divided portions over a period of 24 hours constitutes the feed ration technically.

Seed and feed are the most expensive inputs in aquaculture. Investment in seed stock has to be safeguarded using careful management of the stock and maximising survival of the stock

through good water management and prevention of diseases. In open systems like sea cages, thus site selection becomes extremely important. Feed being the recurring expenditure as well as the major input has to be sourced or produced without compromising quality. Careful storage of feed and its application based on knowledge of scientific feeding practices leads to maximization growth of fish and profits thereby.

Suggested reading

1. National Research Council (NRC). Nutrient requirements of fish and shrimp.Washington DC, USA: National Academy Press; 2011.
2. Smith, D.M.,Williams, K.C., Irvin, S., Barclay, M., Tabrett, S., 2003. Development of a pelleted feed for juvenile tropical spiny lobster (Panulirusornatus): response to dietary protein and lipid. Aquaculture Nutrition 9, 231–237.
3. Vijayagopal, P. (2003) Blending of ingredients in aquafeed

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