BASIC NUTRITIONAL RESEARCH-WHAT DOES IT MEAN FOR THE FARMER?

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Introduction

In most aquaculture operations today, the cost of food accounts for one-half of the production of fish. This means that small savings in the cost of food can make aquaculture enterprises profitable. However, the costs of food cannot be compromised with decreased amounts of essential nutrients, nutrients availability, or unbalanced composition of nutrients. The requirements for optimum growth, survival and health of animals set the limits of "economic" diet formulation.

The nutrient requirements are determined (in most cases) for aquatic species in the grow-out phase and with respect to nutrient concentrations in the diet, rather than in the daily recommended allowance. With this in mind, intake for maximum growth of larval and juvenile fish, that have significantly elevated metabolic rates, will require higher nutrient concentrations than older (larger) fish.

Dietary Requirement

Fish require three macronutrients, proteins, fats and carbohydrates, along with many substances and elements classified as micronutrients. Some nutrients are called indispensable (essential) because they are not synthesized in the body, whereas others are interchangeable as energy sources.

In general proteins do not impose metabolic blocks in fish, because these animals excrete ammonia as their final catabolic product in protein metabolism. Therefore, utilization of proteins in fish is extremely efficient and they can afford "high return rates of free amino acid pools" to protein synthesis (Cowey and Luquet, 1983). The high levels of free amino acids in body fluids of fish result in regulatory mechanisms which frequently incapacitate the utilization of dietary free amino acids. Consequently, similarly to some carnivorous mammals (kittens) fish are probably susceptible to amino acid "toxicity."

There is some evidence to conclude that the requirements of essential amino acids reported for various fish species are in reasonable agreement (National Research Council, 1993). However, differences frequently in the range of 25-35% among single amino acids, as well as discrepancy in estimation by various investigators (arginine example in salmonids) suggest that much work need to be done. Some examples of African tilapias with the active urea cycle pathway, would suggest that these species would not require dietary arginine, as most mammals.

At present, the protein requirement values for all fish range from 35 to 55%. This is synonymous with high protein quality found, at least in part, in fish meal or semi-purified protein sources.

Recent evidence by Norwegian researchers indicated that lipid levels of 25-30% in salmon diets have a beneficial effect on growth and reduction of dietary protein needs. Fish, in common with other vertebrates, have no capability for synthesizing polyunsaturated fatty acids (18 and longer carbon chains). There are also dramatic differences among fish, for instance freshwater pike (*Esox lucius*) are incapable of elongating and desaturating linoleate and linolenate (18 carbon unsaturates) (Henderson et al. 1995).

Vitamin requirements differ in respect to the systematic position of fish; for instance Chondrostei (sturgeon and paddlefish) do not require dietary vitamin C, in direct contrast to all (in the author's opinion) bony fishes (Teleostei). Dietary supplements of some vitamins in fish species with intestinal bacterial flora have proven to be inessential (folate in common carp; cobalamine in catfish and tilapia). However, there is a universal agreement that larval fish diets need to be supplemented with all vitamins.

Missing Information

There is a major gap in our understanding of "native" and "denaturated" protein utilization in fish intestine during ontogeny. The partitioning of activity of pancreatic and/or brush border enzymes in the process of absorption/digestion in larval fish is not understood. This may be a primary reason for our inability to raise larval fish of many species. In conclusion, a new dimension to our understanding of protein and amino acid composition of dietary protein is required.

How much "is enough but not too much" (Diamond, 1991) in respect to concentration of single nutrient and possible interactions? An example with vitamin A (Dedi et al. 1995) is probably the first in the series of side effects due to active molecules. The vitamin A hypervitaminosis in larval diet of hatchery-reared Japanese flounder resulted in growth depression and high incidence of bone deformity.

The role of nutrition, vitamins deficiencies in particular, on gene expression, in case of folate deficiency leading to DNA strand breaks (chromosomal breakage) in vivo, may prove decisive in resistance to infectious diseases, stress and cancer in fish.

Recommendations

There are limitations in identifying nutrient requirement for "new" aquatic species of interest to aquaculture. An analogy can be made based on "warm-water" or "cold-water" biology (ontogeny) of the species. A less successful approach would be to tune requirements to feeding habits of fish (Dabrowski, 1993).

References

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