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Aquafeeds

Broodstock nutrition: Effects of nutrient levels

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Aquaculture should follow the lead of the more advanced poultry industry

Both live and pelleted foods are effective, but live food products can introduce unwanted pathogens to broodstock.

There is limited information available concerning the optimal dietary nutrient requirements of broodstock for most of the world's farmed finfish and crustacean species. This is due to the relatively recent history of the commercial aquaculture sector – less than two decades in most cases – and the difficulty and high cost of conducting such studies.

Requirements vary depending on species size, developmental status, sex, gonad/egg maturation process, and in relation to the specific nutrient requirements for producing either muscle, sperm, or eggs. Here we provide some guidelines regarding broodstock nutrition and, in particular, finfish broodstock nutrition.

Nutrient levels in broodstock feeds can affect gonadal maturation, fecundity, fertilization, embryo development, and larval quality.

Gonadal maturation

Food restriction has a negative effect on spawning success in several fish species, including goldfish (*Carassius auratus*), European sea bass (*Dicentrachus labrax*), and male Atlantic salmon (*Salmo salar*). For example, in sea bass, after six months of feeding broodstock with a half food ration, growth rates decreased and spawning time was delayed. Eggs and newly hatched larvae were smaller than those obtained from animals fed full rations.

Fecundity

Dietary nutrient levels have a significant effect on fecundity; the total number of eggs produced within each spawn per female or per unit female body weight. These nutrients include lipids, essential fatty acids, essential amino acids, and vitamins (including vitamin E and ascorbic acid).

Fertilization

Dietary nutrient level also has a marked effect on fertility. For example, there is a positive correlation between dietary eicosapentaenoic acid (EPA) and arachidonic acid (AA) levels and fertilization rates in gilthead sea bream broodstock. There is also a positive effect when supplemental dietary vitamins are used, including vitamins E and C and carotenoids.

Embryo development

Several nutrients, including proteins, essential fatty acids, vitamins and carotenoids can significantly affect embryo development by improving egg morphology and hatching rates. A well-balanced, essential amino acid profile can improve vitellogenin synthesis. High dietary omega-3 HUFA levels improve the percentage of morphologically normal eggs, and improve egg quality and viability. Carotenoids improve egg quality, larval survival and development.

Larval quality

Several studies have shown the effect of broodstock nutrition on seed or larval quality. For example, increasing dietary lipid levels in broodstock diets can result in the production of large newly hatched lavae with an increased survival rate.

Increasing essential fatty acids (particularly DHA) can significantly enhance the weight of some fish larvae and their resistance to osmotic shock. It can also improve the percentage of live larvae after yolk reabsorption, with survival and swim bladder inflation being improved when fish oil replaced soybean oil in broodstock diets. However, excessive levels of dietary omega-3 HUFA levels (over 2 percent) can cause yolk sac hypertrophy and decreased larval survival in larvae of some species.

Effect of duration of feeding

In some fish species such as gilthead sea bream and red sea bream, egg composition is readily affected by diet within a few weeks of feeding. In these continuous spawners with short vitellogenetic periods, it is possible to improve spawning quality by modifying the nutritional quality of broodstock diets, even during the spawning season.

Simlarly, it is possible to improve egg quality and hatching rates of some species by feeding broodstock with appropriate fatty acid profiles during the vitellogenetic period. In batch spawners with up to six months of vitellogenesis, such as in salmonids, broodstock must be fed a good-quality diet for several months before the spawning season to improve their reproductive performance.

Use of valuable ingredients

Cuttlefish and squid meal may contain nutritional components essential for successful spawning in some species. This beneficial effect has been related to the high content of essential fatty acids in cuttlefish. However, the high dietary value of cuttlefish meal may be mainly due to the fat-insoluble fraction of the meal.

Feeding broodstock with the fatinsoluble fraction of squid meal can result in improvements in the total number of eggs produced and the percentages of viable and fertilized eggs. Squid meal protein, as the major component of fat-insoluble fraction, is believed to be the reason for the beneficial effect on egg quality.

Another important feed ingredient is raw krill, which has distinct quality-enhancing effects compared with fishmeal. For example, viable offspring production in red sea bream was more than doubled in terms of the percentage of buoyant eggs, total hatch, and normal larvae, when krill was included within broodstock feeds.

Broodstock diets and practices

For most cultured fish species the commercially available, so-called “broodstock diets” are just larger-sized “grow-out” diets. In practice, farmers improve the nutrition of their broodstocks by feeding them solely on fresh food, or fresh combined with commercial diets. The most common fresh foods include squid, cuttlefish, mussels, krill and small crustaceans.

In addition to the fact that using fresh food does not assure the optimum nutrition of the broodstock, this practice also enhances the risk of disease outbreaks in the parents by potentially introducing pathogens – including endo- and ectoparasites, viruses and other pathogens – through unprocessed fresh food items.

Improving quality

The nutritional quality of formulated feeds can be effectively improved. For example, the elevation of dietary omega-3 HUFA levels to 2 percent, together with an increase in α-tocopherol content to 250 milligrams per kilogram and the inclusion of squid meal instead of fishmeal, was found to increase larval production three-fold compared to animals fed commercial rations. This approach improves larval quality in terms of growth, survival, and swim bladder inflation, as well.

Conclusion

Adequate information on the nutrient requirements of broodstock fish is limited to a few species. Certain nutrients, like balanced amino acids, essential fatty acids, vitamins E and C, and carotenoids, are particularly important in broodstock nutrition. Nutrient requirements during reproduction are higher than those of juveniles, but excesses or imbalances can also be detrimental for reproduction. The relevance of many other nutrients – vitamin A, vitamin B6, folic acid and others – has not been established within broodstock feeds and merits future research. The aquaculture industry should follow the lead of the more advanced poultry industry and begin formulating broodstock and sex-specific rations.

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