Alliance
(https://www.aquaculturealliance.org)

Global Aquaculture Advocate ™

Aquafeeds

Lipid nutrition of farmed tilapia

Saturday, 1 October 2005

By Wing-Keong Ng, Ph.D.

Omega-3 and omega-6 fatty acids essential for optimal growth

White hybrid tilapia grew equally well from stocking to marketable size when fed diets based on fish oil, soybean oil, or palm oil.

In the production of tilapia feeds, manufacturers are constantly faced with the need to reduce feed costs to match fluctuating and at times low farm prices of tilapia. Since fish feeds can account for 45 to 85 percent of tilapia farm prices, there is a great need to understand the optimum nutrient requirements of tilapia and reduce feed costs by using locally available or alternative feed ingredients.

Optimum dietary lipid levels

Lipids are important sources of metabolic energy and essential fatty acids. These precursors of hormones and prostaglandins aid in the absorption of fat-soluble vitamins and act as building blocks of cellular and membrane structures. Lipids such as fish oil and squid liver oil are commonly used to coat extruded feed pellets to improve the palatability and appearance of the feed.

Commercial tilapia feeds manufactured in Asia currently contain about 5 percent dietary oils, mostly fish oils, which meet the minimum requirement of dietary lipids in most culture systems. However, the optimum dietary lipid level for various tilapia species has been reported as 10 to 15 percent, depending on the dietary ingredients used.

Improved protein utilization efficiency has been reported in tilapia fed graded levels of dietary oil up to 15 percent. A recent study showed that the addition of at least 1.5 percent phospholipids in the form of phosphatidylcholine was beneficial in the diets of tilapia fingerlings.

Recent technological advances in aquafeed manufacturing have permitted oil inclusion levels up to 50 percent to produce energy-dense diets. With the availability of such technology and the increasing environmental challenges facing intensive aquaculture, it may be time for aquafeed manufacturers to further invest in feed equipment that allows higher inclusion levels of dietary lipids in commercial tilapia feeds. This could benefit both fish farmers (in terms of increased fish growth rates) and the environment (reduced nutrient loss).

Essential fatty acid requirements

It is a long-held belief that tilapia, like other warm water fish, are more inclined to require greater amounts of omega-6 fatty acids than omega-3 fatty acids for maximum growth. To date, however, research on the fatty acid requirements of tilapia has produced contradictory results.

Earlier research work reported no enhancement in growth when linolenic acid (18:3 omega-3) or omega-3 highly unsaturated fatty acids (HUFAs) were supplemented in tilapia diets. Other researchers observed that high levels of omega-3 polyunsaturated fatty acids (PUFAs) depressed the growth of tilapia. In the 1980s, the fatty acid requirement for Nile tilapia was reported as 0.5 percent 18:2 omega 6, and that for *Tilapia zillii* was about 1 percent for 18:2 omega 6 or 20:4 omega 6.

More recently, researchers reported that both omega-3 and omega-6 fatty acids are essential for the maximal growth of hybrid tilapia. Even though tilapia can synthesize the physiologically more important C20 and C22 HUFA from 18:2 omega-6 and 18:3 omega-3, the elongation and desaturation of these essential C18 fatty acids to their HUFA end products has been reported insufficient to supply the needed amounts, and dietary supplementation with preformed HUFA may be necessary.

Based on fatty acid requirements determined for other fish species, it is recommended that until further research data is available, a provision of 0.5-1.0 percent of both omega-3 and omega-6 PUFAs should be included in the commercial feeds of farmed tilapia.

Alternative lipid sources

The stagnation in global fish oil production, coupled with increased demand for its use in aquaculture feeds, has greatly increased prices for marine fish oil. Therefore, in order to sustain the rapid growth of the tilapia industry, many countries where tilapia is farmed will have to partially or totally replace fish oil with cheaper and sustainable sources of dietary lipids.

Various studies have shown that tilapia fed diets supplemented with catfish oil, soybean oil, sunflower oil, linseed oil, or various palm oil products showed comparable growth and feed utilization efficiency compared to fish fed a fish oil-based diet.

Fillet fatty acid profiles are known to be markedly influenced by the dietary fatty acid compositions of the dietary oils used. In tilapia feeds, vegetable oils lacking in eicosapentaenoic acid (EPA) and docahexaenoic acid (DHA) decrease the concentrations of these beneficial omega-3 HUFAs in fish fillets destined for human consumers. EPA and DHA decrease the risks of degenerative diseases like cardiovascular diseases and cancer.

A recent study in the Fish Nutrition Laboratory of Universiti Sains Malaysia in Penang showed a marked decrease in omega-3 HUFAs in fish fed 100 percent added soybean oil or crude palm oil (Fig. 1). Reductions in omega-3 HUFAs in the fillets of tilapia fed diets with palm oil blended with fish oil or linseed oil were not as drastic.

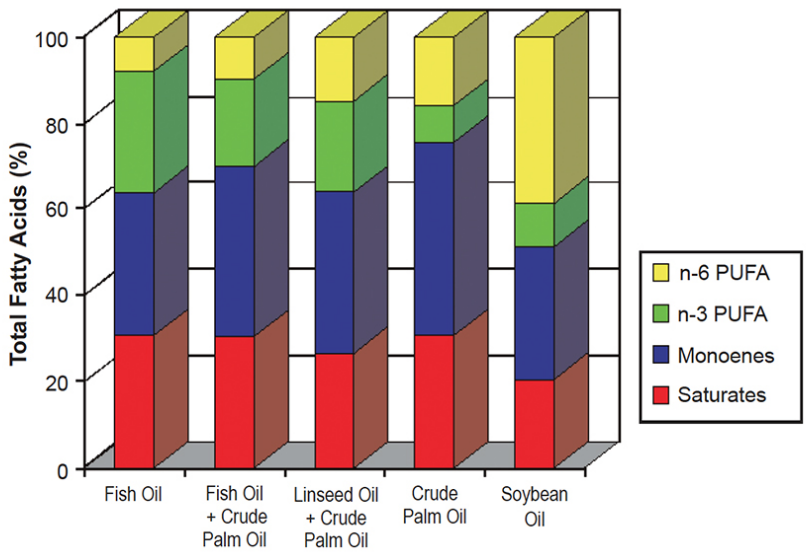

Fig. 1: Tilapia fillet fatty acid composition in fish fed diets with added oils for five months.

In addition to finding an appropriate blend of fish and vegetable oil in tilapia diets, another feeding strategy used to normalize the flesh levels of beneficial omega-3 HUFAs is to revert to a fish oil-based diet at an appropriate time before harvest. This feeding strategy allows the use of higher levels of vegetable oils for the major part of the grow-out phase, thus providing cost savings without significantly altering the health benefits of the resultant fish fillets.

Positive feed traits

The relative ease with which the fatty acid composition of tilapia fillets can be manipulated by altering the fatty acid composition of their diets is a positive aspect of farmed tilapia on which feed manufacturers can capitalize. Good fish oil substitutes should limit the deposition of undesirable fatty acids such as 18:2 omega-6 in fish fillets. In this respect, vegetable oils such as linseed oil, which is rich in 18:3 omega-3, and palm oil, rich in monoenes, are superior alternatives for replacing fish oils in tilapia feeds.

Recent studies at the Universiti Sains Malaysia showed that when tilapia were fed palm oil or soybean oil in their diets, potent natural antioxidants such as tocotrienols and tocopherols were deposited in their fillets. Other than imparting antioxidant properties to the tilapia fillets, thereby prolonging shelf life and seafood freshness, the deposition of tocotrienols also adds value to the product, especially if eaten raw as sushi or sashimi.

The potential health benefits of tocotrienols in humans include the prevention of cardiovascular diseases and cancer. These nutritionally enhanced tilapia fillets could therefore be marketed as especially healthy foods.

Broodstock lipid nutrition

Tilapia broodstock nutrition is becoming increasingly important as the demand for quality fry exceeds supply in some countries. Very little is currently known about the lipid nutrition of tilapia broodstock.

Nile tilapia broodfish fed diets supplemented with 5 percent cod liver oil have been reported to show significantly lower reproductive performance when compared to broodfish fed soybean, coconut, or corn oil. However, a more recent study reported that the spawning performance of tilapia was not affected by dietary oil source.

Researchers at the Universiti Sains Malaysia observed high accumulations of dietary palm carotenoids and vitamin E in the ovaries of hybrid tilapia fed crude palm oil-supplemented diets. Several feeding trials are currently being conducted to further learn the roles of dietary lipids and their minor components in the reproductive performance of tilapia.

(Editor's Note: This article was originally published in the October 2005 print edition of the Global Aquaculture Advocate.*)*

Author

WING-KEONG NG, PH.D.

Fish Nutrition Laboratory
School of Biological Sciences
Universiti Sains Malaysia
Penang 11800 Malaysia

wkng@usm.my (mailto:wkng@usm.my)