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Health & Welfare
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Brazilian researchers examine amino acids in Nile tilapia diets



1 November 2010 Dr. Wilson Massamitu Furuya Themis Sakaguti Graciano Luiz Vitor Oliveira Vidal Valéria Rossetto Barriviera Furuya



Threonine supplementation is associated with improved growth, fillet yield



Determination of the dietary amino acid requirements of tilapia allows precise formulation of feed.

The Nile tilapia is one of the most important cultured fish species in Brazil, where tilapia production has changed from traditional culture in earth ponds to more intensive culture in cages. Tilapia culture has played an increasingly important role in the economy of many Brazilian regions over the past two decades. The ongoing study of tilapia nutrition and feeding has been the focus of many research groups, and the importance of amino acids on fish nutrition and feeding is rapidly expanding.

Amino acid source

Plant ingredients such as soy protein derivatives have received increasing attention as potential substitutes for fishmeal protein in tilapia diets. However, plant proteins often show deficiencies in some essential amino acids and several antinutritional factors. When compared to fishmeal, soybean meal has low levels of digestible energy, available phosphorus and digestible methionine, and higher contents of fiber.

Recently, feather meal, blood meal and meat and bone meal have been used to substitute for fishmeal in commercial diets for Nile tilapia in Brazil. The apparent digestibility coefficients of the protein and amino acids of these ingredients are lower than those for soybean meal. The digestibility coefficients of individual amino acids must be considered to establish well-balanced diets that sustain tilapia performance.

Amino acid requirements

Under practical conditions, commercial diet formulation is not easy, as the amino acid compositions of ingredients depend on many factors. Because multiple factors affect amino acid requirements, estimations of the requirements for fish should be based on the ideal amino acid profile. In Brazil, many experiments have been performed with different basal diets and fish of varied ages and genetic lines to determine these profiles.

Lysine is one of the most limiting amino acids in fish nutrition. It is related not only to fish growth, but also to fillet yield. Under typical culture conditions, it is possible that two fish have the same weight, but produce different values of fillet yield. The standard dietary requirement for lysine was determined at 5.5 to 6.0 percent of the dietary protein. Based on information from research in Brazil, methionine is necessary as approximately 60 percent of lysine.

Threonine supplementation is associated with improved tilapia growth and fillet yield, especially in diet formulations based on soybean protein, indicating that threonine is a limiting amino acid in soybean meal when meat production is considered.



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Amino acid patterns

The concept of ideal amino acid patterns has been adopted by the swine and broiler industries, and was initially applied in fish diets in Brazil by the main author in 2000, using DL-methionine and L-lysine as supplemented amino acids.

In Brazil, experiments investigated the responses of fish fed graded dietary inclusions of the essential amino acids lysine, methionine and threonine to determine the ideal amino acids ratios of the assayed amino acids relative to lysine. The methionine and cystine requirement based on the ideal protein concept is approximately 60 percent of lysine, regardless of fish age or weight.

Reducing dietary protein content is important in formulating cost-effective and low-pollution diets, especially when fish are cultured in intensive systems. Fish growth is determined by the first limiting amino acid, and reducing the protein content of fish feeds is one strategy to increase the sustainability of tilapia production. It can reduce feed costs as well as environmental impacts if economical growth can be maintained with less nitrogen input.

Fish health

The development of antibiotic resistance in farm animals has pressured nutritionists to find alternative ways of achieving high production and healthy animals. Nutritional supplements are being considered as a means to improve immune systems and gastrointestinal defense mechanisms against invasive bacteria. Glutamine, arginine and threonine are involved in many maintenance functions and in immunity and gut mucosal repair processes in particular.

The intestine is the first barrier to foodborne antigens and bacteria. The high rate of protein turnover in the gut ensures that damaged tissues are rapidly shed, and large amounts of mucins are secreted to create a barrier to bacterial translocation. Mucosal cells and intraepithelial lymphocytes require glutamine as an energy source and for the synthesis of other non-essential amino acids and nucleotide bases.

The supply of glutamine can become limited during intestine stress. Glutamine supplementation reduces intestine villi atrophy and improves weight gain. The efficacy of dietary glutamine depends on the type and intensity of the challenges that occur in the gut.

Perspectives

The main objective of modern fish production is return on capital. Feed efficiency, uniformity, weight gain, carcass yield and fillet yield are used as performance indicators. Recently, feed cost per kg of weight gain and feed cost per kg of fillet meat produced were introduced as variables to choose the best levels of threonine and protein in Nile tilapia diets, respectively.

The profitability of fish production partially hinges on the ability to formulate economically viable feeds that support efficient growth and healthy fish. Determining the dietary amino acid requirements of tilapia allows precise formulation of feed, because overformulation to meet limiting amino acid requirements is reduced or eliminated. It will be important to develop models that simulate and predict fish performance responses to amino acid supplementation under variable conditions.

(Editor's Note: This article was originally published in the November/December 2010 print edition of the Global Aquaculture Advocate.)

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