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Aquafeeds

Alternative ingredients for tilapia aquafeeds

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Nutritionists should consider unconventional dietary sources

Fishmeal has traditionally been one of the primary protein sources in tilapia diets.

Tilapias constitute the third-largest group of farmed finfish, surpassed only by carps and salmonids. Their culture is widely practiced in various tropical and subtropical regions of the world. Global production – most of which comes from developing countries – increased from

308,234 metric tons (MT) in 1988 to 972,773 MT in 1998. Cultured tilapia production continues to grow at an annual rate of about 12 percent.

The increasing production of tilapia and other aquaculture species is increasing the demand for fishmeal as a protein source for formulated aquafeeds. A challenge facing tilapia nutritionists is to completely or partially replace fishmeal and similar sources with less-expensive, unconventional protein sources available in developing countries. Several studies have considered various animal and plant products as protein and energy sources for tilapia (Table 1).

Animal protein sources

Fishery byproducts

With the exception of fish silage, little attention has been given to fishery byproducts – including fish protein concentrate and hydrolysates, shrimp meal, krill meal and squid meal – as partial or total protein sources for tilapia. It has been reported that up to 75 percent of dietary fishmeal could be safely replaced with fish silage in tilapia feeds.

Terrestrial animal byproducts

Cottonseed meal performs well as a partial fishmeal replacement in tilapia diets.

Terrestrial animal by-products, including poultry byproduct meal, blood meal, hydrolyzed feather meal, and meat and bone meal have been extensively used as partial or total fishmeal alternatives in tilapia feeds. These sources have high protein contents and good essential amino acid profiles, although they

may be deficient in one or more amino acids. Supplementation of the deficient amino acids and/or maintaining the proper ratio between these by-products would improve the quality of the diet.

Plant protein and energy sources

Oilseed plants

Many oil seed byproducts have been tried as partial or complete substitutes for fishmeal in tilapia feeds. Soybean meal and cottonseed meal are considered the best plant protein sources in terms of protein content and essential amino acid profiles. Several other oil seed byproducts have been tested with varying results (Table 1).

Table 1. Alternative protein and energy sources for tilapia. Levels tested are substitutions of standard dietary protein (mainly fishmeal and soybean meal), or whole diet. Recommended levels are based on biological and/or economic evaluation.

Animal Sources	(%) Tested	(%) Recommended
Shrimp head meal	0-100	15-25
Shrimp meal	0-100	100
Fish silage + Soybean meal (1:1)	0-75	75
Fish offal silage	0-75	75
Poultry by-product meal	50	50
Poultry by-product meal + feather meal	10 -40	40
Meat and bone meal	0-100	50-100
Meat and bone meal + Blood meal	0-100	100
Meat and bone meal + Blood meal (2:3)	0-100	100
Blood meal	0-100	<100
Hydrolyzed feather meal	0-100	30-66
Animal by-products	0-100	100
Chicken offal silage	0-20	20
Oilseed Plant Sources		
Soybean meal +/-Methionine	0-100	100
Soy protein concentrate	0-100	100
Soybean meal + Phosphorus source	0-100	100
Cottonseed meal	0-100	50-100
Cottonseed meal +/- lysine	100	100
Sesame seed meal	0-75	25
Groundnut cake	0-100	25
Rapeseed meal	0-75	15-75
Copra meal	0-50	25-50
Defatted cocoa cake	0-100	20-100
Palm kernel cake	0-100	30-60
Macadamia press cake	0-100	50-100
Roquette seed meal	0-20	13
Aquatic Plant Sources		
Spirulina	0-100	20-40
Azolla pinnata	0-100	<25-40
Hydrodictyon	0-100	20
Eleocharis ochrostachys	20-40	20-30
Potamogeton	25-50	25
Ceratopyhllum demersum	20-50	20-30
Duckweed	0-100	50-100
Water hyacinth	0-100	<25-75
Water hyacinth protein concentrate	0-23	17

Single-Cell Protein Sources		
Pruteen	50-100	50
Eurolysine fodder protein	0-40	<40
Yeast	20-40	40
Grain, Legume, Plant Protein Sources		
Leucaena leaf meal	0-50	<25-100
Cassava leaf meal	20-100	<100
Green gram legume	13-50	25-37
Jack bean meal	0-35	25
Sesbania seed meal	0-35	<10
Alfalfa leaf protein concentrate	15-55	35
Cowpea leaf protein concentrate	0-50	20-30
Corn gluten feed + Soybean meal	100	100
Corn gluten feed	16-49	30-42
Corn distillers' grains	16-49	35-49
Corn co-products	0-100	50
Pito brewery waste	0-100	100
Brewery draff	30	30
Salicornia	0-10	40
Coffee pulp	0-39	13-30
Egyptian clover	4-12	8
Atriplex meal	7-20	7
Black seed meal	0-20	10

Although oil seed proteins are deficient in some amino acids, lack of dietary minerals may be the first limiting factor in plant protein sources. For example, supplementation of soybean meal with dietary phosphorus, and sesame seed meal with dietary zinc, has improved the performance of diets thought to be deficient in essential amino acid requirements for tilapia. It is clear that plant proteins could be supplemented with “cheap” minerals instead of “expensive” essential amino acids, and still produce superior results.

Oil seed byproducts (and other plant sources) contain many endogenous antinutrients, such as protease inhibitor and phytohaemagglutinin in soybean meal, and gossypol in cottonseed meal. Fortunately, most of these antinutrients can be destroyed or inactivated by heating.

Aquatic plants

The use of aquatic plants in tilapia feeds should be carefully evaluated because of the varying, and sometimes conflicting, reported results. Fish species and size, as well as culture conditions, play a major role in determining the inclusion levels of dietary aquatic plants. Among these plants, fresh duckweed seems to be the best protein source for tilapia, due to its high protein content (35 to 45 percent) and balanced amino acid profile.

Grain legumes, other plants

Legumes or cereal plants and by-products have been extensively tested as feed ingredients for tilapia. Various studies have indicated most of these sources could be partially incorporated into tilapia feeds. However, they may contain endogenous antinutrients, high fiber contents, and high phytic acid levels, and should be properly treated and processed.

Single-cell proteins

Single-cell proteins are a group of microorganisms including unicellular algae, fungi, bacteria, cyanobacteria, and yeast. Their production represents a simple, cheap, and effective way of producing natural fish food. Single-cell proteins are currently produced on a commercial scale and used as a protein source for fish.

Economic feasibility

Few studies have considered the economic evaluation of feed inputs for tilapia. Applying cost/benefit analyses, some studies have demonstrated that, despite the fact that most unconventional feed inputs produce lower biological performance than standard diets, the unconventional sources were economically superior. Therefore, it is necessary that both biological and economic evaluations be considered for optimal use of these feed ingredients for tilapia.

Increasing demand for fishmeal in aquaculture feeds challenges nutritionists to identify alternate protein and energy sources. In the case of tilapia, which are mainly produced in developing countries, nutritionists should consider unconventional dietary sources, which are available in the producing regions. Numerous studies have shown the potential of these ingredients in tilapia diets.

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