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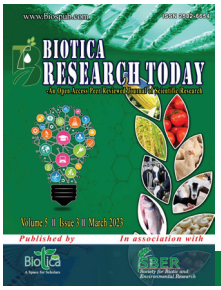

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An Inclusion Level of Plant-Based Ingredients to Make a Balanced Aquafeed

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Abstract

Plant-based ingredients are most widely used to replace (partially or completely) the animal-based ingredients. In general, it contains anti-nutritional factors and low micro-nutrients. So, it has to be treated and enriched with micronutrients. Plant based ingredients should be included at recommended level in the fish diet. Because the over inclusion of plant ingredients leads to an imbalanced feed that cause negative impact on growth and survival of culture species. Hence, the formulator must aware about nutritional requirement of species, ingredients background to formulate and prepare a balanced aquafeed.

Keywords: Balanced feed, Feed formulation, Plant-based feed ingredients, Soyameal

Introduction

Fish meal has been used as a main ingredient in aquafeed industry due to its high nutritional value (protein content and amino acid) and palatability (Cavrois-Rogacki *et al.*, 2022). However, the limited supply and higher price of fish meal paves unsustainable for the feed formulator since it relies on final feed cost (Olsen and Hasan, 2012). To minimize the usage of fish meal in the diet, plant-based proteins can be an alternative due to their nutritional quality and lower cost. Highly nutritious ingredients can entirely or partially replace the fish meal in the formulation of aquafeeds. However, the formulator should know about the maximum inclusion level of plant-based ingredients to make a balanced diet. Obviously, it may varies based on the source of plant, nutritional quality, anti-nutritional factors, most importantly, fish species. This article helps to know about the maximum inclusion level of plant-based ingredients.

Plant-based Ingredients Inclusion Level

An inclusion level of particular ingredients may vary according to the species requirement. Several research has been focused on plant-based ingredients incorporated (alone or blended with animal-based ingredients) diet to various species (Hertrampf and Piedad-Pascual, 2000).

Soybean Meal

Soya meal (SM) has been produced from soya beans after the oil extraction. At present, SM is the most important protein source; partially or completely replace the FM in aquafeed industry. The protein content of SM is varied according the processing where de-hulled SM and fully fatted SM contain 48% and 36% respectively. SM contains trypsin inhibitors which affect the protein digestion through the reduction of pancreatic enzyme activity (trypsin and chymotrypsin). Hence, the recommended level (Table 1) of SM has to be added in the diet preparation.

Maize or Corn Products

Maize is a cereal; derived products are meal, starch and gluten. Among the products, the ground maize or maize meal is a good energy source but low in protein and amino acids (lysine, methionine and tryptophan). In addition, it has rich amount of Vitamin A due to the presence of cryptoxanthin and carotene pigments which act as a precursor for Vitamin A. Maize starch is a good source of polysaccharide and act as binder in the feed preparation. It is used to prepare floating fish feed. The major components of starch are amylopectin and amylose which can be effectively utilized by carp when gelatinized by extrusion. Usually, this carbohydrate source

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Table 1: Recommended inclusion level of soybean meal in the diet

Feeding habit of fish & crustaceans	Starter feed	Grower feed	Finisher feed
Fish			
Carnivores (%)	5	10	15
Herbivores/ omnivores (%)	10	20	30
Crustaceans			
Marine shrimps (%)	3	8	15
Freshwater shrimp (%)	5	10	20

should not be included in higher (not more than 20%) ration in the diet of carnivorous species. Maize gluten meal is the protein portion of the maize kernel and is a by-product of wet milling in the processing of starch. Even though it contains 60% of crude protein should not be added more amount in the aquafeed due to the high level of crude fibre. It is a source of beta carotene and xanthophyll. As per recommended inclusion level of maize meal, starch, gluten meal and maize bran should be included in the aquafeed preparation (Table 2).

Table 2: Recommended inclusion level of Maize/ Corn derived product

Maize products	Carni-vores	Herbivores/ omnivores	Marine shrimp	Freshwater prawn
Maize grain meal (%)	20	35	25	25
Maize starch (%)	15	35	15	15
Maize gluten meal (%)	15	20	15	15
Maize bran (%)	5	20	-	15

Rice By-Products

Rice by-products encompassed rice bran (RB), broken rice (BR) and rice flour (BR). RB contains the bran layer together with the germ of the rice kernel; it is being used as a conventional energy source in the aquaculture industry due to easy availability and cheaper. Usually, the crude protein content of RB varies based on defatting or not, for example, de-oiled rice bran (DORB) contains 15.1% CP and 1.7% CL; whereas RB contains 9% CP and 7.4% Cl. RB is mostly used for herbivorous and omnivorous than carnivorous fish diet. While preparation of compound diet, it should be added at minimum due to poor pelletizing ability. Broken Rice results from the milling and polishing of rice. It is a useful component of aquaculture feed and often used by small scale farms in on-farm made feeds. The pelletizing ability of broken rice is better than of rice bran. It can be used as an energy source in diets (Table 3).

Table 3: Recommended inclusion level of rice derived product

Feeding habit	Rice bran (%)	Broken rice (%)
Carnivorous	15	10
Omnivore	35	50
Herbivores	35	60
Crustaceans	10	20

Coconut Meal

It is a by-product of the mature nut (fruit) of the coconut tree. A coconut encompasses of 13% meal, 62% oil, and 25% shells. It contains more than 20% protein. Generally, the herbivorous and omnivorous fish diet can be incorporated with 5-15% of coconut meal, whereas 5-10% can be incorporated in the carnivorous fish diet.

Cotton-Seed Meal

It is a byproduct of cotton-seed. For example, about 160 kg cotton-seed can be obtained during the production of 100 kg of cotton fibre. In fishes it can be incorporated at 5-15%, whereas in 5-10% can be incorporated in the crustacean's diet.

Ground-Nut Oil Cake (GNOC)

It is produced from the ground nuts after the extraction of the oil from the ground-nut. It contains 40% crude protein and 1.06% of sulphur amino acids. About 10-15%, 5-10% and 5-8% of GNOC can be incorporated in the diet of herbivorous/ omnivorous, carnivorous fish and crustaceans, respectively.

Mustard Meal

Mustard meal and mustard cake are the byproduct of mustard. It contains 40% of crude protein content. It can be included at the rates of 5-10% in the fish diet.

Sunflower Meal

Sunflower meal is the residue of oil extraction from sunflower seeds. It contains 25% and 50% of crude protein content (method of extraction decides the protein level). It is deficient in lysine, but methionine and arginine are higher than in soybean meal. About 10% can be incorporated in the diet of carnivorous fish whereas herbivorous/ omnivorous fish diet may be blended with 20%.

Wheat and Wheat By-Products

Wheat contains 10-16% of crude protein. Wheat bran is the fibrous coating under the husk which contains most of the vitamins and protein of the wheat grain. Wheat gluten is a by-product in the manufacture of starch from wheat. It is a water insoluble protein complex. It is limited with lysine, threonine and valine. In general, wheat feedstuffs are deficient in Vitamin A and D but are a good source of Vitamin B1 and other B-complex vitamins. The inclusion level of wheat by-products is given in table 4.

Table 4: Recommended inclusion level of wheat by product

Wheat by-products	Fish feed	Crustacean feed
Wheat bran (%)	2-5	2-5
Wheat flour (%)	10-15	5-25
Wheat gluten (%)	2-5	5-10

Water Hyacinth

It contains 10-12% of crude protein. It is incorporated in the herbivorous and omnivorous diet at the rate of 5-10% only because it has low protein and high fibre content (Naseem *et al*., 2021). The nutritive value can be increased through the solid-state fermentation of water hyacinth with probiotic bacteria or any carbon sources. Then it can be utilized as cost-effective feed ingredient in the diet of herbivorous and omnivorous fish.

Conclusion

Plant-based ingredients can be incorporated at above said level to avoid the problems associated with the diet. Otherwise, those ingredients may be enriched with other nutritive media or micronutrients and it has to be testified with desired species for the maximum inclusion level in the diet.

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