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Plant Based Ingredients Used in Aquaculture Feed

Rajesh V. Chudasama and Arita M. Rathod
Research Scholar, Department of Aquaculture, College of Fisheries Science, Kamdhenu University, Veraval

SUMMARY

The aquaculture industry requires sufficient edible protein sources for growing organisms faster than any industry. The current scenario of the protein source of feed is fully dependent on forage fishes that burden the marine ecosystem so find out an alternative and sustainable edible protein source to full fill the requirements. In aquaculture farming the main cost is feed so reduces of the price of the ingredients directly affects the farmer's profit level. Plant-based ingredients are one of the major sources that provide sufficient nutrients for aqua feed these ingredients also present some anti-nutritional factors and metabolites that affect the feed quality but in the cooking process, the feed eliminated that factors. The aquaculture feed industry's future is dependent on plant-based ingredients.

INTRODUCTION

The technique of growing aquatic flora and fauna under controlled or semi controlled conditions is known as aquaculture. Nowadays, about half of the fish food consumed worldwide comes from aquaculture. Most of the proteins in current fish feed are derived from fish (fishmeal). It will be crucial to use more raw fishmeal and more plant-based proteins if we want the aquaculture sector to expand and prosper. The nutritional profile of fish feed derived from plant-based proteins should be the same as that of meat protein. In various diet formulas for aquaculture feeds, a variety of plant-based ingredients have been used (Zettl *et al.,* 2019).

The aquaculture industry produces edible proteins effectively and expands more quickly than any other area of the food industry. As a result, it demands a huge amount of fish feed. The fish feed has a direct impact on the cost, potential health benefits, and quality of the fish that is produced. One of the major market drivers for the growing aquaculture business, the cost of aquaculture feed accounts for 40% to 75% of aquaculture production costs (Ansari *et al.,* 2021). Aquaculture based on animal feed contributes significantly to worldwide aquaculture development. As aquaculture production develops to fulfill the demands of the expanding human population, more feed will probably be used in aquaculture. Animals are fed high-protein aquafeeds in aquaculture, which accounts for over 70% of animal output in aquatic environments. Aquafeeds are now dependent on fish meal and fish oil derived from wild-caught forage fish. Alternative protein sources are required because the continued use of forage fish is unsustainable and because an estimated 37.4 million tonnes of aquafeeds would be needed by 2025. For the next 10–20 years, insect meals, byproducts of fisheries and aquaculture, and fish meal have the most potential to provide aquafeeds with the protein they need (Hua *et al.,* 2019). Some of the plant-based ingredients information is below described.

A. Soybean Meal:

Due to its high protein content (40%), good EAA profile, and widespread availability on the worldwide market, soybean (*Glycine max*), the most important oilseed crop in the world, ranks top as a substitute protein source for fish meal. Unprocessed soybean meal has about 30% carbohydrates, including starch, non-starch polysaccharides (e.g. cellulose, hemicellulose, and pectin)., oligosaccharides (such as stachyose and raffinose), and 30-50% protein. Except for cysteine, SBM contains less EAA (mostly lysine, methionine, and threonine), taurine, and tyrosine than FM.

B. Groundnut Oil Cake (GNOC):

Fishmeal can be replaced with groundnut oil cake as an appropriate plant protein source. According to reports, the GNOC has superior binding qualities to soybeans and is quite palatable. The additional benefits of GNOC make it a viable substitute protein source. With a high crude protein concentration of between 40 and 45%, it is the most easily accessible, affordable, and abundant source of dietary plant protein for domestic animals. Although GNC is lacking in some necessary amino acids, mixing it with fishmeal, which is high in methionine and lysine, will help generate a highly nutritious feed and promote better fish growth (Olapade and George, 2019).

C. Cottonseed Oil Cake:

In tropical and subtropical areas, cottonseed oil cake is one of the most widely available sources of plant protein. Due to its wide availability, cheap cost, high protein content (26%-54%, depending on processing methods), and suitable amino acid profile, it is also one of the ideal protein candidates for tilapia in underdeveloped countries. Fish can get their protein from cottonseed oil cake. Cottonseed meal's use in fish farming is limited in addition to the presence of gossypol by the source of fiber and the insufficient availability of lysine, methionine, and cystine. It is best to use a cottonseed meal that has been decorticated. The common carp gained more weight and had higher feed and protein efficiency when fed cottonseed meal compared to groundnut meal, sunflower meal, and maize meal. The acceptable amounts of cottonseed meal are typically low, in the 5- 15% range, especially in salmonids, because it contributes to reducing feed intake, growth, and feed efficiency in fish. However, the actual limit varies depending on the type of fish, cottonseed meal, and gossypol content. Crustaceans can use cottonseed meals as a source of protein, but the amount that may be added is constrained by the gossypol and fiber content. White shrimp is less digestible than soybean meal. Whilst higher levels may be employed, actual integration rates range from 5 to 10% (Li and Robinson, 2006).

D. Lupin Meal:

Included among the lupin sensory evaluation for use in aquaculture diets are whole seed, dehulled seed, and protein concentrates. Lupins are marketed more and more based on their protein content and are principally sold for use in animal feed. Because plant protein meals contain different amounts of anti-nutritional components than fishmeal, they differ in terms of nutrition. During feed extrusion, antinutritional elements can be minimized. Most other grain legumes have a crude protein (CP) level that is lower than that of lupin seeds, which ranges from 31 to 42%. Using lupin meal as a source of plant protein for aquaculture diets makes it easier (Rajeev and Bavith, 2015).

E. Sunflower Cake (SFC):

A by-product of the production of sunflower oil is sunflower cake (SFC), which is the protein-rich byproduct that is left in the residual form of seeds after the oil has been extracted. The amount of crude protein in SFC ranges from 27.8 to 37.4%, depending on the processing and seed quality. SFC has the potential to replace sources of animal and plant protein like fishmeal and soybean meal in part because of its competitive nutritional value and reasonably low cost. Sunflower oil cake, which is comparable to soy cake in terms of feeding, is crucial in rumen diets due to its high methionine concentration. It has a lot of fiber, and the well-structured raw fiber is beneficial to animals' diets. Because of the relatively high concentration of polyunsaturated fatty acids (PUFA), which might result in an undesirable soft fat consistency in the flesh if the amount is too high, its usage in the finishing phase must be avoided (Hossain *et al.*, 2018).

F. Macroalgae:

Seaweeds usually referred to as macroalgae, are marine plants that are widely employed in food production and other related businesses. With improvements in the identification and cultivation of many seaweed species, their production has increased over the years. Due to their nutritional content and bioactive substances that are good for human nutrition and health, seaweeds have been investigated as food over the years. According to this theory, seaweeds can also be utilized as an ingredient in aqua feeds, particularly as they are a good source of omega-3 and can thus replace fish oil, whose availability has been declining. According to studies, around 50% of the total fatty acids in seaweeds are polyunsaturated fatty acids, which are crucial for fish nutrition. Seaweeds are a good source of protein, minerals, and vitamins in addition to polyunsaturated fatty acids. Compared to certain higher plant-based protein crops, such as soya beans, they are also notable for containing high quantities of protein that are rich in all the essential amino acids (Saleh, 2020). Fish feed formulations have included a variety of macro- and microalgae species to check their nutritional content, and many are advantageous: Tilapia or Korean rockfish were given *Chlorella*, *Scenedesmus*, *Undaria*, *Ascophyllum*, *Porphyra*, *Spirulina*, or *Ulva*, European seabass were given *Gracilaria* or *Ulva*, Striped Mullet were given *Ulva*, Gilthead Sea Bream was given *Pterocladia* or *Ulva*, and Atlantic cod were given a mixture of *Nannochloropsis* and *Isochrysis*. However, it has rarely been able to identify the nutritional components that are responsible for these positive effects, either because this was not attempted or because the study's design was partial (Henry, 2012).

G. Wheat Bran:

The germ, endosperm, aleurone layer, and pericarp are the different tissues that makeup wheat bran. Bioactive substances, micronutrients, and phytochemicals are abundant in wheat bran. These substances are found in bran fractions in higher concentrations. Wheat bran (WB) is a by-product of rolling and milling wheat grain. Pericarp, aleurone, and testa tissue make up the bulk of WB. The following is a list of the distribution of the components in WB: On a dry matter basis, the composition is as follows: 55–60% non-starch carbs, 14–25% starch, 13–18% protein, 3-8% minerals, and 3-4% fat (Katileviciute *et al.*, 2019).

H. Rice Bran:

Fish feed usually contains rice bran. While it works well in nurseries, significant rice-fish culture typically does not require it. Farmers should probably use less once fish have reached the farm if they had to pay for it. Some farmers use rice husks in their farming practices, and some fish species actively consume them. Essential fatty acids are particularly abundant in rice bran, which contains 18–23% oil. Moreover, it contains a lot of dietary fiber, vitamins B and E, and trace amounts of iron, potassium, calcium, chlorine, magnesium, and manganese (saturated fatty acids range from 16.59 to 21%, while monounsaturated and polyunsaturated fatty acids range from 39.82% to 49.95%) (Alauddin *et al.*, 2019).

I. Tapioca Starch:

The percentage of fish feed that floats and its hardness can both be improved by using tapioca starch as a binding agent. The gelatinized starch can increase the hardness of fish feed, decrease permeability, and promote interparticle interaction between particles (Sumardiono and Siqhny, 2019).

Table 1. Aquaculture feed ingredients and their advantages and disadvantages

Ingredient	Advantage	Disadvantage
Soybean meal (SBM)	Cheap protein and oil source	Lack of methionine, lysine, and PUFA
Wheat	High starch content	Low proteins
Peas/lupins	High digestible proteins	Lysine and methionine are limited, presence of antinutrients quinolizidine alkaloids
Cottonseed meal (CSM)	Cheap protein and oil source	Gossypol might have a toxic effect
Microalgae	Easy to digest, balanced essential amino acids, PUFA, contains pigments, vitamins, and minerals	High cultivation and processing cost

Adapted from Ansari *et al.*, 2021

CONCLUSION

If any Industry they are growing animals under controlled condition feed and feed formulation is a very important thing in that sector like aquaculture because its fully dependent on the growth rate of the cultured species or organisms. In feed formulation, an essential part is the ingredients involved to prepare a balanced diet of requirement. In aquaculture feed, the major protein source of the protein ingredient is fish meal it is high price and depended on the forage fish to make pressure on the marine ecosystem. Plant-based ingredients as above described are given sustainability and reduced the cost of feed preparation. Plant-based ingredients contend various types of antinutritional factor but it is eliminated by extruding or pre-treatment like hitting the ingredients. The future of the aqua feed industry is fully dependent on plant-based sources of nutrients.

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