AgriCos e-Newsletter
ISSN: 2582-7049
AgriCos e-Newsletter
Open Access Multidisciplinary Monthly Online Magazine
Volume: 03 Issue: 01 January 2022 Article No: 05

Promising Alternative Plant Protein Sources for Replacing Fish Meal in Fish Feed

S Jeyaprakashsabari[1] and S Aanand[2]
[1]MFSc and [2]Assistant professor, Erode Bhavanisagar Centre for Sustainable Aquaculture, TNJFU. Bhavanisagar, Erode, Tamilnadu

SUMMARY

Fish meal is the primary protein source in fish feed for many reasons, such as high protein content, rich amino acid profile, and better nutrient digestibility. The consistent growth of the aquaculture sector has created an ever-increasing demand for fish meal in the market over the past decade. However, the worldwide supply of fish meal has reached stagnation, which implies increasing the cost of feed in aquaculture. Hence, the need to replace fish meal with an alternate protein source to reduce the feed cost in the aquafeed industry. Plant-based protein sources can be opted to substitute fish meal in aquafeed. Although plant-based protein sources contain some anti-nutritional factors, they can cost-effectively replace fish meals with proper treatments.

INTRODUCTION

India is the second-largest fish-producing country in the world. The feed sector plays a dominant role in the growth of the aquaculture industry. According to FAO (2016), world farmed fish production stood at 73.8 million tons in 2014, from 1.6 million tons in 1960. This includes 49.8 million tons of fish, 16.1 million tons of shellfish, 6.9 million tons of crustaceans, and 7.3 million tons of other aquatic animals. The sustainability of aquaculture depends on many factors, and among them, cost-effective feed is one of the crucial factors. Because feed only contributes around 60% of total operating cost in aquaculture. Therefore, the remarkable growth of the aquaculture sector can be sustained only through the development of cheaper aqua feed.

Animal feed market:

The Indian animal feed market was valued at almost ₹403.5 billion in 2020. The animal feed market is expected to grow at a compound annual growth rate (CAGR) of 15% between 2021 and 2026 and reach almost ₹933.3 billion by 2026. The animal feed market in India can be segmented into three groups: poultry, cattle, and aqua.

Aquafeed market:

The global aquafeed market was valued at USD 70 billion in 2016 and is expected to reach USD 155.5 billion by 2022 with a CAGR of 12.5%. The Indian aquaculture feed market was valued at USD 1.20 billion in 2017 and is projected to reach 2.3 billion USD in 2023 with a CAGR of 10.4%. Indian feed mills can produce 2.88 million metric tons of aqua feed per year. The aquafeed market is segmented on the type of feed into two groups: fish feed and crustacean feed. The carp feed ranks first among fish because carps account for 89% of the freshwater feed, and P. vannamei feed dominates the crustacean feed category.

Major Components of Aquafeed:

A fish diet must provide a suitable energy source and be in proper balance concerning Proteins, Lipids, Carbohydrates, Vitamins, and Minerals. Among these components, protein is one of the essential components for all animal tissue. It plays a vital role in determining the growth rate in different life stages of fish. Protein is the major bio-molecule involved in the cell's various physiological functions and is a significant component of any animal feed.

Protein scarcity:

Nowadays, there is a protein scarcity in the aquafeed, which is one of the critical constraining factors blocking the development of the Indian aquafeed industry. Moreover, the aquafeed industry relies heavily on fish meal to meet the protein requirement of farmed species. Globally 20.2 % of total fish catch has been used to produce fish meal, of which the aquafeed industry utilized 60.8 % to produce compound feed for the animals. But due to declining marine capture fisheries, the production rate of fish meal gradually decreased at the rate of 1.7 % annually. Hence, as the demand for fish meal increases, the cost of the fish meal will rise in the market. Higher

demand will lower the quality of the fish meal. Further, the World aquaculture society (WAS) recommends not using fish meal as a protein source in fish feed. All these things make the feed formulators and researchers look for alternative feedstuff which can replace the fish meal as a protein source in aquafeed in a cost-effective way without affecting the growth performance of the animal.

Investigation for new protein sources:

Due to the protein scarcity in the aquafeed, the feed formulators have been investigating various protein sources. Plant-based protein sources are economically feasible feedstuff to replace fish meal in the aquafeed. These plant protein sources can either be a conventional protein source or a non-conventional protein source.

Conventional plant sources:

Groundnut oil cake:

It is one of the most critical protein ingredients with 40% and 7% protein and fat content. It has a pleasant flavour, is highly palatable, and has better binding properties than soybean meal. But it is deficient in specific essential amino acids such as methionine and lysine. It is the most economical protein ingredient among the various plant protein sources with easy availability. Its' global production status stood at 43.2 million tons during 2017-18.

Soya bean meal:

Soya bean meal is the by-product of soybean oil extraction, used as an essential protein source in animal feed. Soya bean meal is graded into two categories based on the protein content: De-hulled type and with hull or parts of hull type with 47-49% and <47% crude protein content, respectively. At the same time, it has some anti-nutritional factors such as trypsin inhibitors, Haemaglutinins, and methionine deficiency. Several processes exist in the production of soya bean meal, such as mechanical extraction method with >3% oil content and solvent extraction method with <2% oil content. Soya bean meal's global production status stood at 337.9 million tons during 2017-18.

Cottonseed meal:

Cottonseed meal is the by-product of oil extraction from cotton seeds with a protein content of 49%. It is widely used as animal feed as well as organic fertilizers. The cottonseed meal's global production status is 43.4 million tons (2017-18). India, China, and the USA are the major cotton-producing countries globally. Though it has many merits, it contains gossypol, a major anti-nutritional factor affecting animals' performance.

Sunflower seed meal:

The protein content of the sunflower seed meal varies from 28% for the hulled seed meal to 42% for the de-hulled seed meal. Besides being used as fish feed, it can also feed pigs and poultry under certain conditions. Sulfur-containing amino acids and methionine were rich than other protein sources but low in lysine content. Global Production status was 49.7 million tons (2017-18).

Non-Conventional plant sources:

Corn gluten meal:

Corn gluten meal used as livestock feed contains about 65% crude protein. It is a source of protein, energy, and pigments. But one of the drawbacks of this meal is its low lysine content. Corn gluten meal is occasionally confused with corn gluten feed, a mixture of bran, steep liquor, and maize germ oil from the milling process with a low crude protein content of 22%. Globally 1.07 million metric tons of corn gluten meal is produced every year.

Wheat gluten meal:

Wheat gluten meal is a protein-rich ingredient with a crude protein content of 79.8% and fat content of 1.6%. It is mainly composed of two proteins, namely Gliadins and Glutenins. Besides a protein source, it can also

be a binding ingredient in animal feed. Low in lysine, but it contains more sulfur amino acids and is also high in glutamine, which improves gut health and modulates the immune system in the animal. Globally 766.5 million tons of wheat gluten meal is being produced every year.

Rapeseed meal:

Rapeseed meal, widely used to feed all classes of livestock, including the fishes, contains a crude protein content of 40%. But rapeseed oil has a poor reputation due to the presence of erucic acid, which gives a bitter taste and causes health problems in live stocks. Also, it contains anti-nutritional factors such as glucosinolates and tannins, which are detrimental to animal performance. The leading producer of rapeseed meals is the European Union, China, Canada, and India. 75.6 million tons of rapeseed meal was produced worldwide during 2017-18.

Canola meal:

Canola meal ranks second in the global production of protein feedstuff from oilcakes and meals. In 2019, the global production of canola meal stood at 27.4 million tons. Canola is the name given to genetically selected rapeseed varieties produced by *Brassica napus* and *Brassica campestris* species with a crude protein content of 38%. It also contains anti-nutritional factors such as glucosinolates and erucic acid but is comparatively lower than rapeseed meals. The presence of high levels of several constituents common to all oilseed protein products, and some components unique to canola/rapeseed meals (e.g., glucosinolates), prevents the full expression of this high quality of canola protein.

Case study:

Plant-based protein sources can partially or fully replace fish meals if certain dietary recommended conditions are provided (Daniel, 2018). For example, grass carp *(Ctenopharyngodon idella)* fed with cotton seed meal, sunflower seed meal, and cornmeal at 75% inclusion level in their diet provides good nitrogen utilization without any adverse effect in growth performance (Koprucu and Sertel, 2012). Similarly, common carp *(Cyprinus carpio)* showed no negative impact on the growth and feeding performances when fed with 50% de-fatted rubber seed meal (Suprayudi et al., 2015). Besides finfish, 25% inclusion of mixed corn gluten meal, rapeseed meal, sorghum, and wheat gluten in the diet of black tiger shrimp *(Penaeus monodon)* did not negatively impact the growth performance (Richard et al., 2011). Further research findings reveal that 100% inclusion of plant protein source in the diet of Nile tilapia *(Oreochromis niloticus)* (Liti et al., 2006) and plant protein concentrate in the diet of rainbow trout *(Oncorhynchus mykiss)* (Zhang et al., 2012) had no adverse effect on growth performance. Further, Cotton Seed Cake up to 30%, and Sunflower seed meal up to 50% can replace ground nut oil cake in Rohu feed without any adverse effects (Dharmakar, 2021).

CONCLUSION

The present article highlights the various available plant protein sources utilized as animal feed ingredients. However, careful selection based on availability, processing procedure, performance on the species selected, etc., needs to be analyzed before deciding on the component for feed preparation. Earlier research findings and current trends in research will help find a sustainable way to overcome dependence on the fish meal in the production of aquafeed. All these together will pave the way for "fish-free feed to the fishes" in the future.

REFERENCES

FAO., 2006. The state of world fisheries and aquaculture. Report of the fisheries and aquaculture department, Rome, Italy.

Daniel, N., 2018. A review on replacing fish meal in aquafeeds using plant protein sources. International Journal of Fisheries and Aquatic Studies, *6*(2), pp.164-179.

Dharmakar Padala. 2021. Assessment of solid-state fermented meals of cottonseed, sunflower seed, and dried brewery waste on the growth and survival of Rohu (Labeo rohita) in nursery phase'. TNJFU. Ph. D Thesis 2021. (Unpublished)

Koprucu, K., and Sertel, E., 2012. The effects of less-expensive plant protein sources replaced with soybean meal in the juvenile diet of grass carp (*Ctenopharyngodon idella*): growth, nutrient utilization, and body composition. Aquaculture international. 20(3):399-412.

Suprayudi, MA., Inara, C., Ekasari, J., Priyoutomo, N., Haga, Y., and Takeuchi, T., 2015. Preliminary nutritional evaluation of rubber seed and defatted rubber seed meals as plant protein sources for common carp *Cyprinus carpio* L. juvenile diet. Aquaculture research. 46(12):2972- 2981.

Richard, L., Surget, A., Rigolet, V., Kaushik, SJ., and Geurden, I., 2011. Availability of essential amino acids, nutrient utilisation and growth in juvenile black tiger shrimp, *Penaeus monodon*, following fishmeal replacement by plant protein. Aquaculture. 322:109-16.

Liti, DM., Waidbacher, H., Straif, M., Mbaluka, RK., Munguti, JM., and Kyenze, MM., 2006. Effects of partial and complete replacement of freshwater shrimp meal (*Caridinea niloticus* Roux) with a mixture of plant protein sources on growth performance of Nile tilapia (*Oreochromis niloticus* L.) in fertilized ponds. Aquaculture Research. 37(5):477-483.

Zhang, Y., Oerland, M., Shearer, KD., Sorensen, M., Mydland, LT., and Storebakken, T., 2012. Optimizing plant protein combinations in fish meal-free diets for rainbow trout (*Oncorhynchus mykiss*) by a mixture model. Aquaculture. 360:25-36.