

The Hidden Challenge in Plant-Based Aquafeeds: Antinutritional Factors and Their Management

Nidhi Rathod* and K. H. Vadher

Department of Aquaculture, College of Fisheries Science, Veraval, Gujarat

*Corresponding author

Email address: rathodnidhi55@gmail.com

How to cite this article:

Rathod, N. and Vadher, K. H. (2026). The Hidden Challenge in Plant-Based Aquafeeds: Antinutritional Factors and Their Management. *Agrolife Frontiers*, 1(6), 107-111.

Abstract

Plant-derived feed ingredients are being investigated as sustainable alternative protein sources in aquaculture to lessen reliance on fishmeal. However, these components frequently include antinutritional factors (ANFs) like phytates, tannins, saponins, protease inhibitors, and trypsin inhibitors, which can have a negative impact on fish health overall, growth performance, feed utilization, and nutrient digestibility. ANFs cause mineral shortages and compromised physiological activities in farmed animals by binding with vital nutrients and decreasing nutrient bioavailability. Thus, the development of plant-based aquafeeds that are economical, nutritious, and sustainable depends on the efficient control of ANFs. Numerous processing methods, such as fermentation, germination, soaking, and autoclaving, have been effectively used to lower the concentration of antinutritional chemicals and enhance the nutritional value of feed ingredients obtained from plants.

Keywords: Antinutritional factor (ANFs), Plant-derived nutritional substances, Aquaculture

Introduction

Plant protein sources have been used in the feed industry for a number of reasons, including sustainability, availability, and cost-effectiveness. Plants contain thousands of chemicals that, depending on the situation, might be beneficial or harmful to organisms that consume them. They are utilized fresh and raw, dried, powdered, boiled, fermented, concentrated, and so on. It is fed directly to herbivorous fish and as a supplement or partial replacement for fish meal in fish feed formulations. Plant sources are characterized as alternatives that can be employed in fish feed without affecting its nutritional quality. Plant-based fish feed has disadvantages due to poor protein content and certain anti-nutrients (Mondal and Payra, 2015). Legumes, ferns, and other non-traditional animal feed sources have anti-nutritional properties in both their green and dry stages.

Antinutritional Factors

Antinutritional factors are compounds that disrupt food use, growth, health, and reproduction in animals, either directly or through bio-transformation. Animals are susceptible to antinutritional influences, which have a negative impact on growth and health. Most antinutrients used in fish feed have poor physiological effects, stunted growth, and health difficulties, rather than causing mortality. Hypoglycemia, liver damage, pancreatic hypertrophy, and other pathological illnesses are linked to poor food conversion efficiency. The severity of these symptoms varies based on the amount of antinutrients consumed, animal species, size, age, and other physiological factors (FAO, 2018).

Antinutritional factors can be broadly classified into the following groups:

- (a) Those affecting protein digestion such as protease inhibitors, lectins, tannins etc.
- (b) Those affecting mineral utilization such as phytates, oxalates etc.
- (c) The antivitamin (amthamines, antiriboflavins etc.) that have an impact on vitamin use.
- (d) Other miscellaneous compounds, such as mycotoxins, phytoestrogens, saponins, etc.

Antinutritional factors can also be grouped according to their ability to withstand thermal processing, the most commonly known treatment for destroying them.

- (a) Thermolabile (heat-sensitive): Reduced or inactivated by cooking, extrusion, roasting, or autoclaving. e.g., enzyme inhibitors, Lectins and certain alkaloids.
- (b) Heat-resistant/thermostable: Dose not inactive by typical cooking or feed processing temperatures. e.g., Non-starch polysaccharides, phytic acid, saponins, and tannins.

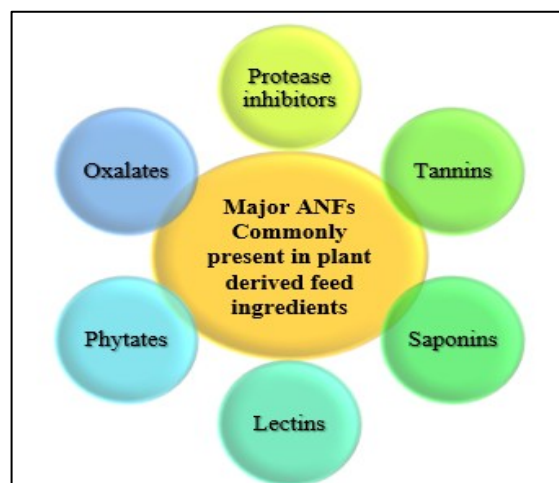
Major ANFs Commonly Present in Plant-Derived Feed Ingredients

Saponin

Saponins are widely distributed in nature, primarily in plants, and are generally regarded as non-volatile, surface-active secondary metabolites. Saponins are sugar-containing steroids or triterpenes. Many plant species, such as groundnuts, lupins, oil seeds, etc., naturally produce them as glycosides or triterpenes that produce foam.

Phytates

Phytates or phytic acids occur naturally in the plant kingdom. Phytic acid is a secondary compound that is typically present in all plant-based meals and naturally concentrates in plant seeds, particularly in legumes, peanuts, cereals, and oilseeds.



Tannins

Tannins are secondary chemicals found in plant leaves, fruits, and bark. Tannins generate reversible and irreversible tannin-protein complexes between their hydroxyl group and the carbonyl group of proteins, reducing protein digestibility and critical amino acid levels. Tannins interact with proteins, inactivating digestive enzymes and reducing protein digestibility.

Protease inhibitors

These chemicals can inhibit enzymes from performing proteolytic functions. They can be found in all plants, but are particularly common in legumes such as soybeans. These inhibitors attach to digestive enzymes such as chymotrypsin and trypsin, rendering them partially or completely inert.

Lectins or Hemagglutinins

These are proteins that have a high affinity for sugar molecules. The name refers to the agglutination of red blood corpuscles (RBCs). Hemagglutinins can be found in seeds of higher plants. They continue to be present in Plant saps and tubers. Lectins reduce nutrition absorption from the gut or alimentary canal. These chemicals can cause internal hemorrhages. They also reduce growth.

Oxalates

Oxalates in feed ingredients can prevent fish from absorbing certain nutrients. For example, certain critical minerals, such as calcium, which is required for bone formation, a number of metabolic activities, and the cofactor requirements of multiple enzymes, have low bioavailability.

Strategies Used to Reduce ANFs Levels in Plant-Derived Feed Ingredients

Various traditional and technical processes, including soaking, milling, roasting, boiling, germination, and fermentation, have been used to reduce anti-nutritional components in food. This article discusses processing methods for reducing phytate, tannin, and saponin concentrations in foods.

Milling

Milling is the most traditional process for separating the bran layer from the grains. This is the process of grinding grains into flour. Milling eliminates anti-nutrients from grain bran, including phytic acid, lectins, and tannins.

Soaking

In this procedure, plant materials are soaked in water to remove water-soluble ANFs (tannins, phytates) that diffuse into the medium. Soaking increased phytase activity, reduced grain phytate content, decreased phytochemicals, and drained water-soluble vitamins and minerals from grains and legumes. Soaking improves nutritional availability and digestion. It is a simple, low-cost pre-treatment procedure with variable effectiveness.



Soaking

Heat treatments

heat treatment reduces ANFs in plant feed ingredients by inactivating heat labile ANFs such as protease inhibitors and lectins by unfolding the protein structure. It includes boiling, autoclaving, pressure cooking, extrusion cooking, and toasting. Cooking or boiling at 100 °C for 60 minutes was enough to inactivate over 90% of the trypsin inhibitor activity in food.



Cooking/Boiling

Autoclave for 30 minutes at 125 °C and 15 lb pressure to remove thermolabile inhibitory compounds (saponins, terpenoids, alkaloids).

Germination

In this approach, whole grams are soaked overnight and then knotted in a loose cotton cloth after being removed from the water. Seed germination activates phytase, which degrades phytate and reduces phytic acid concentration in the sample. Germination alters the nutritional content, biochemical properties, and physical characteristics of foods. This approach is widely used to reduce the anti-nutritional content of cereals



Germination

Fermentation

Fermentation is a microbial process in which microorganisms (bacteria, fungus, or yeast) create enzymes that convert ANFs to non-toxic, edible forms. Furthermore, this improves nutrient availability, feed efficiency, and promotes fish growth and health.

Conclusion

Plant-based feed ingredients are essential for sustainable aquaculture, however antinutritional factors may significantly affect nutrient uptake, growth performance, and fish health. A detailed understanding of their mechanisms and species-specific impacts, together with

appropriate mitigation techniques, enables the creation of nutritionally efficient, cost-effective, and environmentally sustainable aquaculture feed.

References

- FAO. (2018). Anti-nutritional factors within feed ingredients. Rome: Aquaculture Feed and Fertilizer Resources Information System, Food and Agriculture Organizations of the United Nations [http://www.fao.org/fishery/affris/feed-resources-database.anti-nutritional-factors-within-feed ingredients/en/](http://www.fao.org/fishery/affris/feed-resources-database.anti-nutritional-factors-within-feed-ingredients/en/).
- Mondal, K., & Payra, P. (2015). A review on use of plant protein sources in diets for fish feed formulation. *Journal of International Academic Research for Multidisciplinary*, 3(5), 257-264.

