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ORIGINAL PAPER

Antinutritional Factors: Harmful or Beneficial For Aquaculture

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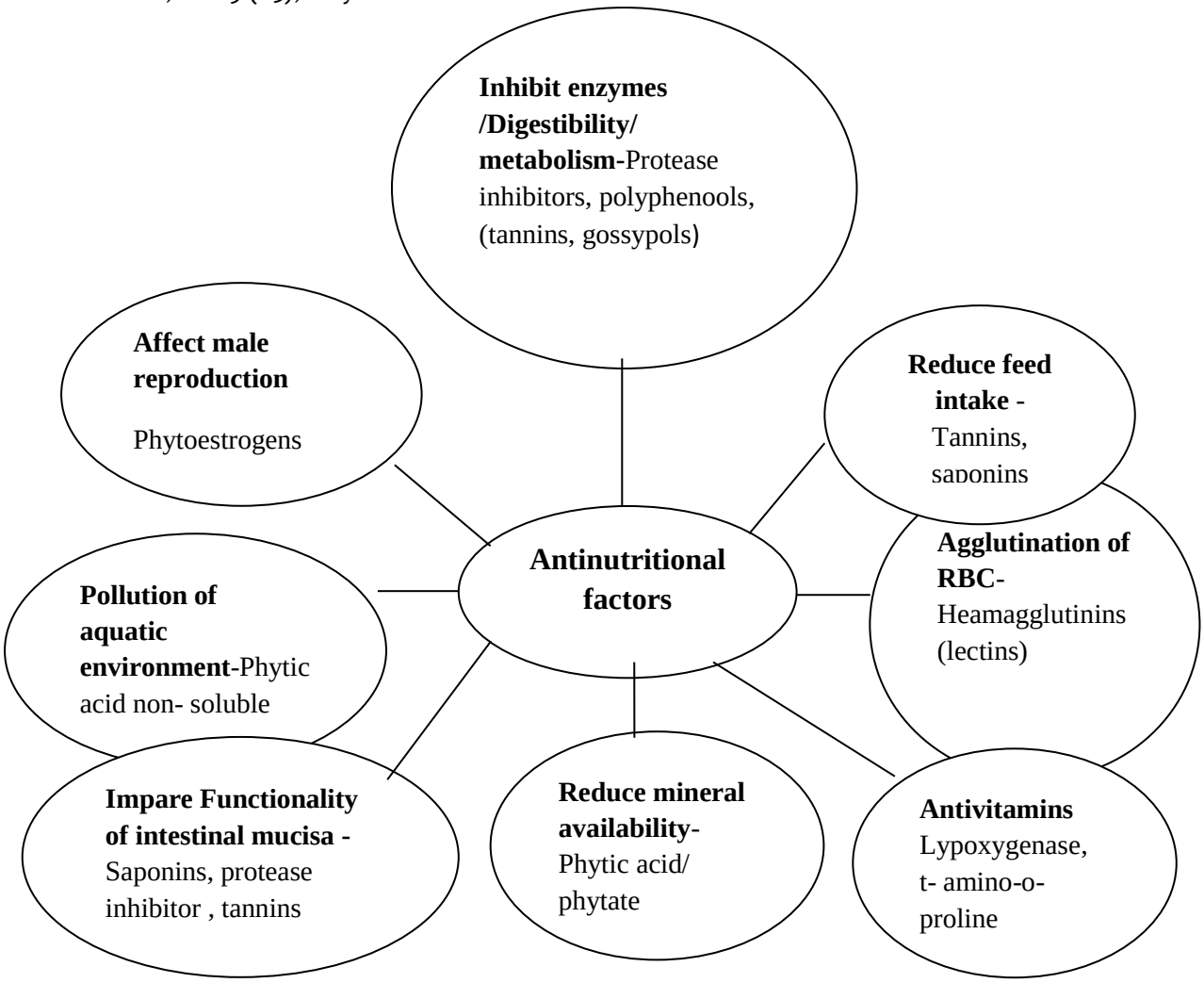
INRTODUCTION

Substances which either by themselves or through their metabolic products, interfere with food utilization. Antinutrients are plant compounds that reduce the body's ability to absorb essential nutrients. Affect the health and production of animals. Aquaculture is fastest growing sector so the demand of aquafeed is very high and use of animal protein in aquafeed is not economically viable. So it is important to use plant based protein resources in aquafeed. Antinutritional factors are the main hurdle in using plant based feed resources but proper elimination strategies for removing antinutritonal factors can make easy to use plant based nutrients in aquafeed.

CHARACTERISTICS

Secondary Products of metabolism, found in virtually all plants to some degree, common in tropical forages, bitter in taste, colored (pigmented), poisonous, antinutritive and immunosuppressive.



Antinutritional compounds their effects and their tolerance limit for Indian major Carps

Compounds	Plant Sources	Effects	Tolerance limit for carps
Phytate	Soybean, Jatropha kernel meal, pea seed meal, cottonseed meal, sesame meal	Reduces the absorption of minerals from a meal (Fe,Zn.Mg,Ca).	0.5%
Tannins	Tea, coffee, betal nuts	Polyphenols that may impair the digestion of various nutrients.	0.5% - 1.13%
Lectins	Found in all feed plants especially in seed, legumes and grains	Interfere with the absorption of nutrients	0.3%-1.1

Protease inhibitors	Soyabean seed, Jatropa kernel meal, lupin seed meal, pea seed meal, sunflower oil cake	They interfere with protein digestion by inhibiting digestive enzymes	0.37%-1.4%
Calcium oxalate	Vegetables, such as spinach	The calcium bound to oxalate is poorly absorbed	NA
Saponins	Soybean seed, Jatropha kernel meal, pea seed meal, lupin seed meal,pea seed meal, sunflower oil cake, alfalfa leaf meal	Bloat ,Haemolysis , GIT erosion, Inhibit enzyme action	0.8%-1.3%
Lipase Inhibitors	Apples, white mulberry, Asian ginseng, Cassia mimosoides (Japanees tea)	Interfere with enzymes,like Pancreatic lipase,that catalyze the hydrolysis of some lipids, including fats.	0.3%-1.5%
Alkaloids	Cocaine, Nicotine, Caffeine, Lupin seed meal	Bloat ,Haemolysis , GIT erosion, Inhibit enzyme action	0.8%-1.3%
Glycosides	Linseed, sorghum, soybean, clover etc	Toxicity results from aglycone release during enzymatic degradation	NA

ELIMINATION TECHNIQUES FOR ANTINUTRITIONAL FACTORS

Dehulling

In dehulling, the seed were dried, deformed in a single-roll dehuller, separated into kernels and hull fractions using an electromagnetic separator. Most effective in removal of tannins (89-92%) and phytic acid (52%-60%). Dehulling improve the palatbility and taste of chickpea, pigeon-peaand lentiland. Reduce polyphenols or tannins, mostly present in the seed coat of pulses. Pre-treatments using infrared heating or soaking and drying the seeds prior to mechanical dehulling did improve dehulling efficiencies.

Cooking

Cooking under pressure includes the food material are autoclaved for 30 min. at 125^{0}C and 15lb pressure. Thermo labile anti nutritional factors such as cyanogenic glycosides, saponins and alkaloids could be eliminated by autoclaving. Lectins can be removed by aqueous heat treatment (100 ^{o}C for 10 min) or autoclaving.

Extrusion coocking

This process takes place within the extruder where the product produces its own friction and heat due to its own friction and heat due to the pressure generated (10-12

bar). This process can induce both protein denaturation and starch gelatinization, complete inactivation of haemagglutinins

Irradiation

Food irradiation is a physical process involving an energy-input, which does not induce radioactivity in foods. The amount of energy input is called the radiation absorbed dose, and is measured in Grays (1 Gy=1 J/kg). It is similar in nature to the use of heat via either thermal (infrared) or microwave energies. Radiation doses of 5, 15, 30 and 60 kGy reduced urease activity in soybeans so that the residual enzyme caused pH to fall by 1.45, 0.35, 0.27 and 0.24 pH units, respectively.

Oligosaccharides : Irradiation of green grams at 2.5 kGy reduced the level of oligosaccharides by 20%, including a 50% reduction of stachyose and raffinose, the two most gas-forming sugars.

Phytate The maximum reduction in phytate levels (90 to 96% reduction) that occurred during germination of samples dosed at 0.20 kGy

Phytohaemagglutin When soybean was subjected to a radiation dose of 10 kGy, the phytohaemagglutinating activity was reduced by 50%.

α-amylase inhibitor : Its activity in the defatted seed flour of Moringa peregrina was decreased by 44 and 48% upon treatment with 7.0 and 10.0 kGy, respectively

Microwave cooking

In this process heat is given to foods by passing microwave radiation through it .Microwave ovens use frequencies 2.45 GHz and a wavelenght is 12.2 centimeteres for 10 minutes to eliminate trypsin inhibitors and haemagglutinating activity in food.

Soaking

Soaking could be one of the process to remove soluble antinutritional factors in whichseeds were soaked in water at 22^0C for 18 hour. Soaking has been found to decrease phytate, protease inhibitors, lectins, tannins and calcium oxalate.12-hour soak reduced the phytate content of peas by up to 9% . Soaking pigeon peas for 6-18 hours decreased lectins by 38-50%, tannins by 13-25% and protease inhibitors by 28-30% .leafy vegetables can also be soaked to reduce some of their calcium oxalate.

Sprouting

Soak the seed overnight, rins with water in morning and then every 12 hours for 3-4 days Store upside down in a glass jar with a cloth over top, expose the fresh sprouts to sunlight before using . Sprouting has been shown to reduce phytate by 37-81% in various types of grains and legumes. There also seems to be a slight decrease in lectins and protease inhibitors during sprouting

Fermentation

Fermentation of grains and legumes leads to a significant reduction in phytate and lectins. Fungi base fermentation-Several species of Aspergillus have been used ex.-

A.oryzae, A. Usamii, A.niger , Rhizopus oligoporus. Fermentation with Aspergilli almost completely eliminates phytate. Bacteria based fermentation- Bacillus species like B.subtilis , Lactobacillus plantarum used for fementation of soyabean .Yeast like Saccharomyces cereviseae also used for fermentation. Fermenting pre-soaked brown beans for 48 hours caused an 88% reduction in phytate. Fermentation increase free amino acid content, crude protein content in soyabean. It degrades phytate, trypsin inhibitors and oligosaccharides.

Enzyme treatment

Enzymes provide additional powerful tools that can inactivate anti-nutritional factors and enhance the nutritional value of plant-based protein in feeds. They provide a natural way to transform complex feed components into absorbable nutrients. Addition of enzymes in feed can improve nutrient utilization, thereby reducing feed cost and the excretion of nutrients into the environment. Phytase enzyme releases phosphorus and bound minerals and amino acids from phytate, paving the way for maximum utilization of nutrients.

Phytase added to diets improves protein and amino acid digestibility in fishes. Phytase can improve the metabolic energy of feeds by breaking down the phytate-lipid complex. Non-starch polysaccharides reduce the growth performance of aquatic animals. Tannase (tannin-acyl-hydrolase), catalyzes the hydrolysis of ester bond in tannic acid. Because fish lack intestinal enzymes for degradation of non-starch polysaccharides, supplementation of degrading enzymes in the diet will result in better feed utilization

Combination of Methods

The most effective way to reduce antinutrients in plant foods is to combine several different elimination strategies. Combining methods may even degrade some of the antinutrients completely. Soaking, sprouting and lactic acid fermentation decreased the phytate in quinoa by 98% . Sprouting and lactic acid fermentation of corn and sorghum degraded phytate almost completely.In addition, soaking and boiling pigeon peas led to a 98-100% reduction in lectins, tannins and protease inhibitors .

BENEFICIAL EFFECTS OF ANTINUTRITIONL FACTORS

Compound	**Beneficial effects**
Protease inhibitors	Anticarcinogenic
Amylase inhibitors	Potentially therapeutic in diabetes
Lectins	Help in obesity treatment
Phytate	Hypocholesterolaemic effect

Oxalates	Anticarcinogenic
Tannins	Lowers the risk of hormone related cancer
Saponins	Hypocholesterolaemic effect

CONCLUSION

The expansion of global aquaculture production is increasing the demand for aqua feed. Fishmeal is a main critical protein source in aquafeed production .The increasing cost of fishmeal has encouraged feed manufacturer to look for cheaper protein sources. So plant based protein sources are used because these are cheap as compared to fishmeal The removal of antinutritional factors is very essential before using them as feed.