A REVIEW ON USE OF PLANT PROTEIN SOURCES IN DIETS FOR FISH FEED FORMULATION

Dr. KAUSIK MONDAL*
PABITRA PAYRA**

*Asst. Professor, Dept. of Zoology, Sidho-Kanho-Birsha University, Purulia, India
**M.Sc. Students, Dept. of Zoology, Sidho-Kanho-Birsha University, Purulia, India

ABSTRACT

Fishmeal and fish oil are the most important raw materials used in the fish feed industry. Fishmeals are more preferable due to its high protein content, good amino acid balance, lack of antinutrients and high palatability. The quest for protein sources alternative to fish meal has been a priority in aquaculture research because of growing concerns on the future availability of fish meal for incorporation in fish diets. The number of feedstuffs with high protein content that can currently be used to replace fishmeals are very limited. Different raw plant feedstuffs were used in fish diet preparation. All these materials have deficiencies in essential amino acids, fatty acids and micro nutrients. The use of plant materials is furthermore limited since they contain growth inhibitors. The optimization of technological treatments to remove anti-nutrients in plant materials could increase their use in fish diets and may reduce dependence on animal by-products.

KEYWORDS: Fish Diets, Fishmeal, Plant Products, Anti-Nutritional Factor.

INTRODUCTION

Due to increasing demand of fishmeal and the huge price hike of the fishmeal, it is necessary to arrange an alternative protein source for fish culture. According to Rumsey (1993), increased use of plant protein supplements in fish feeds can reduce the cost of fish meal. The research has focused on utilizing less expensive and readily available plant protein sources to replace fish meal, without reducing the nutritional quality of the feed (El-Sayed, 1999). The apparent digestibility of protein, energy and individual amino acid are of prime consideration as the basis for feed formulation in fish, with information gained for different raw materials, such as plant product commonly utilized in the feed manufacturing industry. The utilization of nonconventional feedstuffs of plant origin had been limited as a result of the presence of different anti-nutritional factor like: alkaloids, glycosides, oxalic acids, phytates, protease inhibitors, haematoglutinin, saponegin, momosine, cyanoglycosides,
linamarin to mention a few despite their nutrient values and low cost implications (Sogbesan et al. 2006).

Plant oilseeds as well as their by-products mainly constitute the major source of dietary protein in diets of freshwater fish species (Lim and Dominy 1991). Factors limiting the application of these ingredients in fish diets at high levels include low protein content, amino-acid imbalance, and the presence of antinutritional factors (Wee., 1991).

**Plant leaf meal use in fish diet formulation**

Different aquatic and terrestrial macrophytes have been used as supplementary diets in fish culture industry (Bardach et al., 1972). Leaves of several terrestrial plants, grasses and vegetables and aquatic weeds have been reported as feed in fish culture.

**a. Leaf meals prepared from terrestrial plants**

**Mulberry leaf meal**

Mulberry leaf is cheap source of protein of silk worm. The mulberry leaf meal is successfully used in the diet preparation for fishes (Mondal et al. 2012). Cruz and Laudencia (1978) used mulberry leaf meal for Nile tilapia and at 60% inclusion in combination with 40% rice bran, highest weight gain and food conversion ratio was obtained.

**Subabul leaf meal**

The leaves of the tropical legume of ipil-ipil or subabul or simply leucaena (*Leucaena leucocephala*), is a cheap source of protein (Pantastico, 1988). *Leucaena leucocephala*, is a vigorous and drought-resistant leguminous tree whose protein-rich leaves have been widely used in animal diets, particularly for ruminants and poultry in the tropics.

**Leaf meals of other terrestrial plants**

There are reports on the use of other plant leaf meals in fish feed formulation. Hajra (1985) successfully evaluated a common land grass, *Cynodon dactylon* as feed for grass carp in terms of protein-calorie supply and growth. The palatability of the grass as a feed is very low because of grasses contain high crude fibre. Viola et al. (1988) observed that 20 and 30% inclusion of tapioca performed well in carps and tilapia. Alfalfa leaf protein concentrate was used in diets for tilapia, *Oreochromis mossambica* (Olvera-Novoa et al., 1990). Manissery et al. (1988) observed that *Cassia tora* leaves could reduce 17% of the feed cost without compromising fish yield and flesh quality compared to the fish meal based control diet in common carp. Ng and Wee (1989) used tuber meal and leaf meal of cassava, or tapioca, *Manihot esculenta* in Nile tilapia diet. Yosif et al. (1994) evaluated dehydrated alfalfa salt
bush (*Atriplex*) leaves in diets for *Oreochromis aureus*. Mondal and Ray (1999) used leafmeal of *Acacia auriculiformis* in formulation of diet for *L. rohita*. Other terrestrial plant sources with potential of inclusion in fish diet formulation, bamboo (Keir et al. 1997), banana (Belewu and Belewu 2005), cassava tubercle (Stevenson and Graham 1983), cassava peels (Devendra 1977), cassava leaves (Du and Preston 2005), maize leaves (Kiruiro et al. 2001), sweet potato leaves (Oduro et al. 2008), barnyard grass (Gohl 1981). Generally, among the crops leaves, mulberry showed the highest protein content combined with the lowest Neutral detergent fibre content (Dongmeza et al. 2009). Some of the plant (cassava and mulberry) leaves analysed in this study had high protein content (Dongmeza et al. 2009).

### Leaf meals of aquatic plants

Aquatic plants or weeds have been shown to contain substantial amounts of protein and minerals (Ray and Das, 1994). These weeds, which otherwise remain unutilized, and often makes the water body unsuitable for fish culture, may be converted into valuable fish flesh through their incorporation as a dietstuff in aquadiets.

**Water hyacinth leaf meal**


**Duckweed leaf meal**

The duckweeds (family Lemnaceae) are free-floating, self-propagating plants with a worldwide distribution (Culley *et al*., 1981). Hajra and Tripathi (1985) reported high nutritive value of the duckweed *Spirodela polyrhiza* feed for grass carp in terms of protein-calorie supply and growth when fed in fresh condition. Das and Ray (1989) determined the suitability of dried duckweed, *Lemna polyrhiza* as a feed ingredient for *Labeo rohita* fingerlings. Mbagwu *et al*. (1990) studied the growth and survival of *Sarotherodon galilaeus* fingerlings fed a test diet containing 10% duckweed *Lemna paucicostata*, and observed mean weight gain to be higher than in fish fed the control diet with 40% protein.
Leaf meals from other aquatic plants

Very common aquatic weeds *Eichhornia crassipes*, *Pistia stratiotes*, *Hydrilla verticillata* and *Nymphoides cristatum* are used in feed formulation of rohu, *Labeo rohita* fingerlings (Ray and Das, 1994). Ray and Das (1992) evaluated the growth performance of rohu fingerlings fed on composted water lettuce, *Salvinia cuculata* incorporated diets in laboratory conditions. The results indicated the possibilities of incorporation of composted *Salvinia* leaf meal in supplementary diets for the Indian major carp, substituting the conventional diet up to 20% level. Protein digestibility was highest (94.0%) from *Eichhornia crassipes*, followed by *Lemna polyrhiza* and *Nymphoides cristatum*. Digestibility of lipid from *Nymphoides cristatum* and *Lemna polyrhiza* was higher, whereas, digestibility of carbohydrates was found to be highest in *Eichhornia crassipes*. Ray and Das (1995) evaluated the suitability of dried aquatic weed *Pistia stratiotes* leaf meal as a diet stuff in pelleted feed for *Labeo rohita* fingerlings and their results indicated the possibility of including *Pistia stratiotes* leaf meal in pelleted feed up to 45% level for the Indian major carp. Patnaik *et al.* (1991) evaluated the potentiality of two aquatic weeds, *Ottelia alismoides* and *Nymphoides indicum* as a protein source in supplementary diets for Indian major carp fry, and reported positive results up to 50% level of incorporation. *Azolla pinnata* has been screened as a possible protein source for fish (Micha *et al*., 1988). Antinutritional Factors of plant ingredients

Although plant proteins (PP) are cost effective, their use is limited by deficiencies in essential amino acids and minerals, and the presence of antinutritional factors (ANFs) and complex carbohydrates (Vielma *et al.* 2003). The term anti-nutritional factors (ANFs) encompasses a variety of compounds, including protease inhibitor, phyto-oestrogens, lectins, goitrogens, antivitamins, phytates, saponins, various oligosaccharides and antigenic proteins (Alarcon *et al.* 1999). The ANFs may be heat labile (lectins and protease inhibitors) or heat stable (e.g. tannins, oligosaccharides, saponins, phyto-oestrogen, phytate and alkaloids) (Melcion and van der Pole 1993). The deleterious effects of ANFs include feed intake and nutrient bioavailability, and depressed growth (Alarcon *et al.* 1999). The presence of antinutritional factors within plant feedstuffs restricts their use in animal feeds (Tacon 1990). In the present section attempts have been made to review two major anti-nutritional factor: tannin and phytic acid.
Tannins:

Tannin is a polyphenolic compounds but in contrast to gossypol on hydrolysis they yield sugar residues, phenolcarboxylic acids, and condensed tannins (Mueller-Harvey and McAllan 1992). Tannins inhibit protease activity and form indigestible complexes with dietary protein (Krogdahal 1989). There are reports on growth retardation and digestive enzyme inhibition in fish by tannins (Bairagi et al. 2002).

Phytic acid:

Phytic acid naturally found throughout the plant kingdom. Phytic acid is a strong chelator, forming protein and mineral-phytic acid complexes and resultant is reduced protein and mineral bioavailability (Papatryphon et al. 1999). Phytic acid chelate the metal ions such as calcium, magnesium, zinc, copper, iron, and molybdenum to form insoluble complexes ions are not readily absorbed from the gastrointestinal tract (Hendricks and Bailey 1989). High levels of purified phytic acid have a negative effect on fish and shrimp, including rainbow trout, *Onchorhynchus mykiss* (Spinelli et al. 1983), tilapia, *Oreochromis aureus* (McClain and Gatlin 1988), common carp, *Cyprinus carpio* (Hossain and Jauncey 1989). Phytates also reduce availability of amino acids (Reddy et al. 1989).

Removal of Antinutritional Factors

Heat treatment, solvent extraction, enzymatic degradation and soaking are some of the common techniques to reduce, remove or inactivate ANFs (Anderson and Wolf 1995). Processing plant materials through a simple and cheap method like fermentation might considerably decrease the antinutritional factors and crude fibre content thereby increasing the plant’s nutritional values (Bairagi et al. 2002). Processing plant materials through a simple and cheap method like fermentation might considerably decrease the antinutritional factors and crude fibre content thereby increasing the plants’ nutritional values. The process of fermentation or composting is widely employed in fish diet formulation to decrease the antinutritional factors and crude fibre content of plant diet stuff (Bairagi et al. 2002). Bairagi et al. (2002) observed that fermentation of *Lemna* leaf meal resulted in a significant decrease in the levels of crude fibre and antinutritional factors, tannin and phytic acid, whereas, there was increase in the levels of free amino acids and fatty acids. As per Mukhopadhyay and Ray (2005) the anti-nutritional factor (phytic acid from linseed meal) could be reduced below detection limit by fermentation with lactic acid bacteria, *Lactobacillus acidophilus*. 
Fermentation of the oilseed meal resulted in reduction of the tannin content from 2.45 to 1.32 percentage.

Conclusion

Plant products contain huge amount protein, different amino acid and fatty acids which are not available in animal protein. Some common processing techniques frequently used for recycling of plant products are fermentation, composting, hydrolysis, enzymatic degradation and drying. Through this technique anti-nutritional factors can be neutralize. Plant products contain less amount of phosphate and nitrogen than animal protein, therefore, the chances of eutrification of pond could be minimize. Fish production cost will be minimized through the using the plant product.

References


