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An overview of different feed ingredients used for aqua-feed formulation

Kouberi Nath

ICAR-Research Complex for Northeastern hill Region, Tripura Centre, LEMBUCHERRA (TRIPURA) INDIA

Email : kouberi914@gmail.com

Introduction : The rapid expanding aquaculture industries demand more feed, which constitutes more than 60% operation cost in production cycle. To gain economic sustainability the feed ingredients should be locally available with low cost. The feed ingredients may be from plant and animal origin. The problem with the ingredients of plant origin is that their nutrient composition, especially amino acid profile varies widely from plant to plant. This creates a restriction in their free usage in feed composition. Plant proteins are deficient in lysine and methionine. Digestibility of plant proteins is also less than fish proteins. Fish meal is the most widely used protein rich feed ingredient in fish feed supplied mostly from marine sector. There are many conventional and unconventional feed ingredients available which needs careful selection based on culture species, cost and availability.

Classification of feed ingredients : Feed ingredients can be classified on the basis of composition, function and source.

Classification on the basis of composition:

On the basis of composition, the ingredients can be classified in followings.

Protein constituents: Ingredients are rich in proteins and are used as per their amino acid profiles. Fish meal, soyabean meals are some of the common ingredients used as the sources of proteins in fish feed.

Lipid constituents: Ingredients like fish oil, coconut oil are used to increase the fatty acid or triacyl-glyceride content of the fish feed.

Carbohydrate constituents: Ingredients such as alginic acid, tapioca flour, are included in the feed as carbohydrate source.

Vitamin constituents: Vitamins are required for effective metabolism of animals as they are indispensable part of many metabolic enzymes. Their deficiency leads to disorders, diseases. Multi-vitamin mix solutions are added to fish feed to provide fish vitamin supplementation

Mineral constituents: Any living organism require minerals for proper functioning of the body. There are about 21 recognized elements which perform essential functions in the body. Minerals provide rigidity to the endoskeleton in finfish and exoskeleton on shellfish. They are required in maintaining acid-base equilibrium and osmotic balance with the environment, they are involved in proper functioning of muscle fibers and neurons, they are involved in endocrine system, they are present as components of red blood cells, enzymes and organic compounds in tissues and cells.

Classification on the basis of function :

On the basis of function, ingredients can be classified as:

Energy supplements : These ingredients have protein > 20% and fibre < 18 %. They are also called protein supplements. Carbohydrates, fats and protein are included in this category.

Non-energy yielding supplements: Ingredients that contain protein < 20% and fibre < 18 %are classified as non-energy yielding supplements. These include vitamins, minerals which have physiological and biochemical roles and are important in deciding efficiency of the diet.

Classification on the basis of source :

Feed ingredients can be of animal or plant origin discussed in details below:

Ingredients of animal origin: Feed forms the most expensive production function in aquaculture.The protein is the most expensive component that determines the cost of feed andfish production. Fish meal, slaughter house waste are widely used to increase the protein composition of fish feed. Fish meal is a very important ingredient as it is rich in lysine and methionine In addition to this, fish processing by-products, processing house waste can be procured cheaply for incorporating into feed. Certain fishing by-catch like Mantis shrimps (*Squilla* sp.) or market value fish like Anchovies can be used to prepare fish meal which can be added as a protein source in feeds.

Ingredients of plant origin : Agriculture forms the primary economic sector of India and this country has a wide variety of vegetative flora hence it would be wise to use plant derivatives in feed preparation for they will be abundantly available throughout the length and breadth of the country unlike fish meal which will be a scarce item in

North-Indian states like Jammu and Kashmir, Himachal Pradesh, Haryana, Punjab and in North-eastern states. As ingredients of plant origin will be available in almost all the seasons and in large quantities, they will be cheaper. Handling such raw materials is easy, their shelf life is more than that of the ingredients from animals. Health and hygiene problem in handling plant derivatives is less which in turn will reduce the cost of feed production.

Rice bran, wheat bran, oil cakes and soya bean meal have been widely used as traditional feed in Indian aquaculture.

There is another general classification of fish feed ingredients, which is as follows:

Dry forages and roughages: Theseinclude hay, straw, hulls and other products with more than 18% crude fiber content. Rice bran and seed coats are of special mention in this category.

Pastures, range plants and forages fed green: This includes ingredients that may be slightly cured on the stem, cut and fed fresh. eg. *Hydrilla*, dried *Azolla*, *Colocasia* leaves etc.

Silages : This category of feed ingredients are reduced in size and then preserved by reducing their pH. The silage are added to the feed, not fed directly. Grasses, slaughter house waste, fish, grains, roots, tubers etc are generally preserved in this form.

Energy feeds: This includes ingredients with protein content below 20% and fibre content less than 18% (on dry weight basis). eg. Vitamins and minerals mix.

Protein supplements: This includes ingredients containing protein level above 20% (on dry weight basis). eg. oil cakes, soyabean meal etc.

– Mineral supplements

– Vitamin supplements

– Additives : The ingredients in this category are added in feed to make it more efficient by enhancing its pelletability, palatability, attractiveness. These are antibiotics, coloring materials, flavors, hormones, medicines, binders etc.

Conventional feed ingredients : Aquaculture tends to utilize locally available inputs as feed ingredients. In India, agricultural by-products and waste are abundantly available to use them in aquaculture. These conventional inputs have used to provide fish mainly for proteins and energy supplements. These inputs have successfullysupplemented feed with some nutrient value and producing fish slightly above the natural carrying capacity of the water bodies.

Some of the conventionally used feed ingredients are discussed below:

Rice bran : This is the most popular ingredient for practical diets in fin-fishes especially for carps. It contains crude protein 10-12%, crude fiber 12-18%, total lipid 7-12% and ash 8-12%. It is a good source of energy and B group vitamins. Deoiled rice bran is better in terms of nutritional profile and protected from rancidity.

Wheat flour and wheat bran : This is a good source of energy having crude protein 10-14%, crude fiber 12-18%, ash 6-18%. It is a good source of phosphorous, potassium, magnesium and zinc.Amongst vitamins, niacin, pantothenic acid and biotin are in good amounts. For prawn feeds, ground whole wheat flour is widely used. Inclusion of this in feeds foments gelatinization hence improving the feed stability.

Corn gluten: It contains crude protein 20-30%. The arginine and lysine levels are low, but goodsource of iron, zinc, niacin and vitamin E.

Sorghum and millet : Crude protein 8-12%; poor profile of amino acids, minerals and vitamins; can be used as an energy source.

Oil cakes and meal: In India oil cakes have been widely used as feed ingredients based upon the type of oil seeds in various regions. Some important ones are:

Soyabean oil cake : Among the plant sources soyabean oil cake is considered as the best source of protein, in terms of its protein content and amino acid profile. The energy content varies with the deoiling extent and process which will have an effect on the fibre content of the meal. Despite its high protein content, it lacks in methionine, lysine and threonine levels.

It also contains protease inhibitors, urease enzyme, haemagglutinins and glycosides like saponin. All these antinutritional factors can be destroyed by heat treatment.

Levels of incorporation in feeds for tilapia, carps, channel catfish is as high as 50%, sea bass, grouper, trout 10-20%, prawns upto 40%.

Cotton seed oil cake : Protein content varies from 29-42% depending upon the amount of hull removed. The content as well as availability of lysine, threonine, and methionine is lower than in soyabean oil meal. It is a good source of thiamine and vitamin E. Presence of phenolic pigment gossypol and cyclo-propanoic fatty acids adversely affect the nutritional value of cotton seed oil cake.

Groundnut oil cake: Crude protein ranges from 35-42%. It is lower in lysine, tryptophan, threonine and methionine in soyabean meal cake. It is a good source of magnesium, sulphur and potassium. Good source of vitamins, niacin, pantothenic acid, thiamine, while choline and vitamin E

levels are low. Highly prone to fungal growth and mycotoxin (aflatoxin) in humid conditions.

Sunflower oil cake: Highly deficient in lysine. Methionine and cystine higher than soyabean. Vitamin B and carotenoids found in good quantities.

Mustard oil cake: It used in carp diets. Non detoxified cakes contain erucic acid, glucosinolates.

Some other oil seed cakes are safflower oil cake, rapeseed oil cake, gingelly oil cake, linseed oil cake.

Cereal products: Ground broken rice, wheat, sorghum, millets and maize can be used considering their cost, availability and carbohydrate content.

Root crop: Tapioca, sugar beet, molasses and meals from potatoes have been used. Hydrocyanic acid content should be checked in the tapioca before use.

Conclusion : Careful selection of feed ingredients as per nutritional requirements of fish made a balanced diet to fulfill the good health of fish in intensive fish culture. The local availability, cost, nutrient composition and ability of fish to assimilate the nutrients from prepared diet ultimately determine the economic viability of aquaculture practice.

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