

Non-conventional feed ingredients used in aqua-diet formulation

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Introduction : Non-conventional feed resources refer to all those feed ingredients that are not traditionally used in animal feeding and are not normally used in commercially produced rations for livestock. The non-conventional feed resources are characteristics by a) They are end products of production and consumption that not have been used, recycled or salvaged. b) They are mainly organic and can be in solid, slurry or liquid form. c) Their economic value is often less than the cost of their collection and transformation for use and consequently they are discharged as wastes.

The different types of non-conventional ingredients available in India are discussed below:

Fisheries by-products: Waste from fish processing industries have found a good use in formulating fish feed. These can be procured from the processing industries in bulk and used immediately after short storage time or can be preserved by ensilage for future use.

Fish meal : This is perhaps the most abundant animal protein source commercially produced and marketed in several countries. The protein content of fish meal is 60-75%, fat 4-20% and the ash content depends on the processing level. The fish meal industry is sustaining the world's largest single fish species, Peruvian Anchovy (*Engraulis ringens*). The best fish meals are manufactured by steam cooking.

Fish soluble : This is the water remaining after the oil is removed from the liquid pressed out during the manufacture of fish meal. The condensed and dried fish soluble serve as an attractant in aqua feed. It is high in B group vitamin and contains an unidentified growth factor.

Fish silage : It is prepared from trash fish, waste fish head, viscera prawn waste small crabs by acids at pH 4. The liquefaction process prevents bacterial decomposition. Biological fish silage is prepared by introducing lactic acid bacteria into ground fish carbohydrate mixture. The lactic acid bacteria produce the acid necessary to preserve the fish. The liquid product can be used as an ingredient in fish feeds.

Crustacean meals : Meals obtained from small prawns, prawn heads, mantis shrimp, crabs and krill are important ingredient for prawn feeds. Fresh crustacean meals are good attractants for prawn. Crude protein level varies between 30-50% depending upon size and species. Ash content ranges from 25-40% and chitin is as high as 16%. It is good source of cholesterol, carotenoid pigments, chitin, calcium, iron, manganese, choline, niacin, pantothenic acid and cyanocobalamin. Fresh material should be used always. In prawn feeds inclusion rates range from 5-15% and meals from small prawns upto 25%.

Meat meal and bone meal : These are dried mammalian tissue exclusive of hair, hooves, horns, hide trimmings, manure and stomach content. Protein content is about 51% for meat meal and 50% for meat and bone meal. Fat is about 9.1-9.7% in both. Meat has phosphorus content less than 4.4% while it is above 4.4% in meat and bone meal. Calcium content of meat and bone meal is 8.8-12% and in meat meal is less 3%. Both have ash content of 27-31%.

Blood meal : It is a dry product made from clean fresh animal blood, exclusive of all extraneous matter. It can be prepared by spray drying, flash drying and conventional drying. Its protein content is 85%, lysine is 9-11% with lysine over 80%.

Feather meal : It is made from poultry feathers, hydrolyzed under pressure with Calcium hydroxide $\text{Ca}(\text{OH})_2$ and dried. Its protein content is 80-85% and not less than 75% of protein must be digestible by the pepsin digesting method. Its use in fish feed is restricted due to its poor digestibility by fish.

Milk by-products : Dried whey, dried whey products, casein and dried skim milk. Dried whey is obtained when lactose has been removed. Protein content is relatively low (13-17%), yet are classified a protein supplements. Dried skim milk forms a part of larval diet as its digestibility is high and has good amino acid profile. It has about 34% protein. Casein is the residue obtained by acid or rennet coagulation of defatted milk. It has 80% protein.

Gelatin: It is obtained by partial hydrolysis of collagen from animal skin, tendons and ligaments. It is hard and brittle when solid but dissolve in hot water and forms gel when cooled. It contains 88-92% protein and have no tryptophan. Gelatin used as protein source and binding agent.

Silkworm pupae: It used in feeds at low level as it contains high levels of chitin, and the lipid is prone to rancidity. Solvent extraction of lipids may improve the quality.

Chicken eggs: The chicken eggs contain 46% crude protein without shell have level of lipid 43% content. Ash contributes to 4%. It is a good source of amino acids,

Table: Selected non-conventional feedstuffs of potential value to aquaculture

Ingredient	Description	Nutritional value	Existing preparation method
<i>Azolla</i>	An aquatic fern with symbiotic association with blue-green algae <i>Anabaena</i> spp.	CP- 24-30%; 2.1 kg N; 1.05 kg P ₂ O ₅ ; 1.75 kg K ₂ O; oxalate content-0.2; CP-19%; CF-13%	Fed dried or fed directly to animals
Bakery waste	Consist primarily of stale bakery products and other bakery wastes	Higher in fat and may contain a considerable amount of salt	Fed directly
Banana leaf meal, fruit rejects	By-product of banana cultivation and processing	leaf meal: CP-13.66%; CF-25.25%; fruit rejects with peelings: 3364 kcal/kg	Dried and ground
Brewer's dried grains	Rich in protein and high in fiber but is deficient in some amino acids	CP-23%; EE-6.5%; CF-16.1%	Fed in wet or dried form
Cassava leaf meal (yellow variety)	Rich in protein	CP- 22.3%; CF-8.4%; Ca- 1.42%; P- 0.58%	Dried and ground
Chicken manure	High in proteins, minerals and vitamins from spilled feeds	protein - 8-10%; Ca- 3.7-12.5%; P-1.6-2.6%;	Dried and used as feed ingredient
Coco (<i>Cocos nucifera</i>) residue	locally known as "sapal",	DM-89.65%; CP-7.56%; EE-11.18%; CF 17.77%; Ash- 2.9%; NFE-57.39%; gross energy-5554 kcal/kg	Dried; made into mash or pellet
Earthworm meal	Higher protein content	CP- 64% (dry); CP-60%; Ca-0.56; Lysine-2.65%; Methionine-0.75%; Cystine-1.74%; P- 0.825	Dried or dehydrated, following blanching
Elephant yam/sweet yam (<i>Amorphophallus campanulatus</i>)	Herbaceous plant, usually grows up to 2 1/2 m tall with a life cycle between 4-6 years	Starch but low in protein, vitamins and minerals; gross energy-3,308 kcal/kg	Soft boiling to gelatinizing the starch
<i>Colocasia esculenta</i>	Root crop which is an excellent source of carbohydrates, vitamins and minerals	Vit. A and C, Ca and P present in leaves and petioles; gross energy- 850 kcal/kg	Cooked to remove the itchy crystals (raphides), dried and ground
Housefly (<i>Musca domestica</i>) maggots' meal	Larvae of common housefly	DM-7%; CP-55-60%; ash-11%; NFE-2%; EE-20; Ca- 0.74; P-1.81	Dried and ground
Rice middling's	By-product obtained in the milling process of rice	DM-85-85%; CP- 8-10%; EE-1-2.6%; CF-1.1-3%; NFE-66-75%	Used directly as feed ingredient
Rice polishing	By-product of rice obtained in the milling	CP-11.8%; EE- 13.2%	Used directly as feed ingredient
Sweet potato (<i>Ipomea batatas</i>) meal	Rich in carbohydrates and carotene; extremely low in proteins and minerals	Moisture- 85%; CP- 2- 3.5%; gross energy-3316 kcal/kg	Sliced or chopped into pieces, dried and then ground

CP-crude protein, CF-crude fibre; EE-ether extract/crude fat, NFE-nitrogen-free extract, Ca- Calcium, P-Phosphorus

pantothenic acid, cyanocobalamine, riboflavin, iron and zinc. Particularly beneficial in hatcheries and nurseries.

Concentrates: A concentrate is usually described as a feed or feed mixture which supplies primary nutrients (protein, carbohydrate and fat) at higher level but contains less than 18% crude fiber with low moisture and total ammonia nitrogen over 60% on air dry basis.

Miscellaneous ingredients: Fruit processing waste from citrus fruits can be incorporated in the diets which act as a source of carotenoids and vitamins.

Single cell protein: This term single cell protein (SCP) applies to a wide range of products of microbial origin. The microbes may be algae (*Spirulina maxima*, *Scenedesmus obliquus*, *Chlorella vulgaris*), fungal or bacterial origin resulting from fermentation process. Yeast and breweries, sewage, processing waste, wood pulp operation, and petroleum cracking products are some of the substrates which are harmful to the environment but can be utilized to produce single cell protein. Yeast, *Spirulina* are some of the examples of SCP having lot of potential in the fish feed manufacture. *Spirulina* has crude protein level of 55-65% with good levels of essential amino

acids, calcium and phosphorus.

Azolla as feed ingredient: The utilization of aquatic plants having high food value are also used to supplement fish feed at low cost. Azolla, which grows in association with the blue green algae *Anabaena azollae*, is the most promising as the easy of cultivation, productivity and nutritive value. Azolla contains 20-25.5% protein, 3.1% fat, 34.9% carbohydrate, 8.5-11.7% cellulose and also have essential aminoacids. Grass carp and common carp consume fresh azolla and recorded high growth rate.

Conclusion : The non-conventional feed ingredients are mainly by products of other industries. Therefore, incorporation of the non-conventional ingredients in aquafeed may reduce the cost of feed. The animal wastes are also rich in protein and essential amino acid. The attention need only collection and simple processing of waste and blend it into feed.

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