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FEED INGREDIENTS AVAILABLE IN INDIA AND THEIR POTENTIAL NUTRITIVE VALUE

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Development of practical feed formulations depend upon information on two major aspects; the nutritional requirements of the animals and the nutritive value of the potential feed ingredients. Once information on these aspects along with other essential parameters, become available for a specific species and size, it should be possible to develop low-cost practical feeds using linear programming. During the past two decades there has been a phenomenal increase in research activities relating to identification of raw materials for formulating feed ingredients both in the developed and developing nations of the World.

As against the highly nutritious practical feeds developed in the developing countries, which can make use of large quantities of feed ingredients of high quality, developing countries have to rely mostly on relatively nutritionally poor quality raw materials.

Information on the raw materials available in different parts of the country and their nutritive value are important for identifying ingredients for incorporation into practical diets of aquatic organisms. While a great deal of information has accumulated on the potential nutritive

value of feed ingredients, information on the biological value for finfish and crustaceans is relatively limited. Based on their composition the raw materials, used for feed compounding are grouped into eight classes (Table 1). Since, protein is the most expensive and most important nutrient in the diet extensive surveys have been made to identify natural protein rich raw materials for practical feed formulations. So far, a large number of conventional ingredients have been identified and their potential nutritive value have been worked out. In view of the shortage of these conventional feed ingredients, as a result of increased demand competition with animal husbandry, in recent years. Considerable emphasis has been laid on identifying new sources.

PROTEIN RICH INGREDIENT SOURCES

The most important protein rich ingredient sources are oil cakes, fish meals, crustacean meals, blood meal, slaughter house waste and poultry wastes, certain unicellular algae etc.

Oil cakes

Soyabean oil cake: Of all the major plant protein sources soybean is considered as the best protein source. Since 1972, soyabean production has risen primarily owing to the high demand for edible oils. In some countries like USA soyabean meal ranks as the most widely used source of supplemental protein for livestock. In recent years soybean oil cake is successfully used as an ingredient in the feeding of finfish. Soybean oil cake has the highest crude protein and energy contents among oil cakes. The energy content will vary with the level of residual oil and percentage fibre in the meal. Lysine, threonine and methionine are the limiting amino acids, with tryptophan and valine limiting under

certain circumstances. With the exception of methionine, the biological availability of amino acids is quite high. But, heat treatment required to inactivate protease inhibitors results in reduced biological availability of both lysine and cystine, and partial destruction of arginine, tryptophan, histidine and serine. About 50 to 70 per cent of the phosphorus in Soyabean cake is present in the form of phytic acid, which is biologically not available. Besides, during processing phytate-protein-mineral complexes form, resulting in decreased availability of Ca, Zn, Cu, Mn, Mo and Fe. Among the vitamins, choline is found in relatively high levels; but niacin, riboflavin pantothenic acid and thiamine are significantly reduced (losses of 10-75%) during heat treatment.

Cotton seed oil cake:

The protein content of cotton seed oil cake varies between 29 and 37 per cent, depending on the amount of hull removed. The content as well as biological availability of lysine, threonine, tryptophan and methionine may be lower than that of soybean oil cake. The energy value is inversely related to its fibre content. It is deficient in calcium, but is a richer source of Mg than is soybean cake. It is a good source of thiamin and of vitamin E. The presence of the polyphenolic pigment gossypol and cyclopropenoic fatty acids adversely affects its nutritional value. However, glandless variety of cotton seed is almost free from gossypol.

Groundnut oil cake: It is most commonly made from the peanut kernels, husks of pods being removed by the process of decortication. Although the crude protein content is almost equal to that of soybean cake, it is lower in lysine, tryptophan, threonine and methionine. It is a good source of Mg, S and K. Vitamins niacin, pantothenic acid and

thiamine are abundant, while choline and vitamin E tend to be deficient.

Sunflower oil cake: The protein quality of sunflower oil cake is regarded to be lower than that of soybean cake, with lysine being especially deficient. Heat treatment during processing severely depresses the availability of aspartic acid, arginine, threonine, leucine, lysine and tryptophan while the content of glutamic acid, serine and ammonia increase (Smith, 1969; Christison, 1980). It is higher in crude fibre than in soybean cake. The fibre content varies depending on the proportion of hulls removed prior to processing the meal. Sunflower oil cake contains relatively higher levels of available calcium. It is a poor source of trace minerals, but is high in sodium and sulphur. B-complex vitamins and carotene are found in relatively greater levels.

Rapeseed oil cake: The composition has been shown to vary depending on the growing conditions. The presence of crucic acid and glucosinolates adversely affects its nutritional value. However, development of rapeseed varieites with lower levels of crucic acid and glucosinolates has been a major breakthrough which allows their inclusion at much higher levels in animal feeds (Clandinin et al., 1978). The available lysine and threonine content is approximately 10 per cent lower than that in Soyabean oil cake (Saver et al., 1981). But it has more methionine and cystine than soybean cake. Crude fibre levels can be as high as 16 per cent. By removing the hulls crude fibre content can be reduced. Phytic acid and fibre reduce the availability of P, Ca, Mg, Zn, Cu, and Mn. In spite of this it is a better source of available Ca, Fe, Mn, P, Mg. and Se than soyabean oil cake. It also contains higher levels of cholins, niacin, riboflavin, folic acid and thiamine but lower levels of pantothenic acid than soyabean cake.

Safflower oil cake: Safflower oil cake is relatively high in crude fibre. The protein is lower in amino acid content than soybean oil cake. It is a good source of Ca, P, Fe. Vitamin content is somewhat superior to soybean cake, but it contains very little vitamin B_6.

Gingelly oil cake: The hull of the gingelly seeds accounts for 15-20 per cent of the whole seed, which contains high levels of oxalic and phytic acids. These acids impart a bitter taste to the oil cake and complexes with calcium and other minerals, rendering them nutritionally unavailable. Dehulled, expeller processed oil cake is high in methionine, cystine and tryptophan, but low in lysine. The presence of phytic acids reduces the availability of Zn, Ca, Mg and Fe. Has high levels of niacin and pyridoxine.

Linseed oil cake: Is relatively high in fibre content due to the mucilage coating in the hull. The mucilage contains a water dispersible carbohydrate which has low digestibility. Besides, linseed oil cake has lower protein and an inferior amino acid profile compared with soybean cake. Lysine and methionine levels are very low. The presence of pyridoxine antagonist linatine leads to pyridoxine deficiency.

Coconut oil cake: This has relatively low protein (average 24.6%) and high crude fibre (average 14.5%) contents. Deficient in methionine and cystine. Rich in potassium and Iron. Niacin and choline are found in good levels.

PROTEIN SOURCES OF ANIMAL ORIGIN

Blood meal: One of the richest source of protein, containing 75-85% crude protein. It is a very good source of essential amino acids, histidine, lysine, phenylalaine and valine but poor source of arginine, methionine and cystine. The

amino acid leucine is found in very high levels compared with isoleucine. It is a poor source of calcium and phosphorus and most of the minerals. But is a rich source of Iron containing as high as 2784 mg/kg dry matter. Niacin and cyanocobalamin are the two vitamins found in relatively good levels.

Chicken eggs (without shells): Has about 46% crude protein and 43% ether extract and 4% ash. Iron and zinc are found in good quantities. Good source of all the essential amino acids pantothenic acid, cyanocobalamin and riboflavin levels are high.

Crab meal: Contains about 30 to 40% protein depending upon the size and species. It is a rich source of chitin. Ash content is very high. Arginine is found in high levels. Very rich source of choline, niacin, pantothenic acid, and cyanocobalamin. High in calcium, iron and manganese levels.

Fish meal: Depending upon the species crude protein varies from 50 to 75%. Ash content from 17 to 30%. Calcium content varies from 2.2 to 7%; phosphorus from 1.9 to 3.8%; rich source of iron, copper and zinc. Rich source of choline, biotin, pantothenic acid, niacin, cyanocobalamin. Good source of all the essential amino acids.

Poultry byproduct meal (with viscera, afeet and heads): Crude protein levels range from 50 to 60%. Good source of all the essential amino acids, calcium, phosphorus, iron and zinc, choline, niacin, pantothenic acid, riboflavin and cyanocobalamin.

Poultry feather meal (hydrolysed): Has high protein content crude protein levels range from 78 to 85%. It is a rich source of sulphur (1.5-1.6) but poor source of most of the minerals, though phosphorus content is higher than calcium.

Niacin and cyanocobalamin are found in relatively good levels. Contains low levels of histidine, lysine and tryptophan.

Shrimp wastes: Crude protein varies from 30 to 40%. Chitinous material is found to be in levels as high as 16%. Ash content ranges from 25% to 40%. Is a rich source of calcium. Has a very high content of choline.

NUTRITIVE VALUE OF OTHER INGREDIENTS

Alfalfa: Crude protein 13-17%; crude fibre 25-30%. Good source of calcium, potassium, iron, manganese and zinc; choline, biotin, niacin, pantothenic acid, riboflavin and vitamin E contents are high.

Spirulina (New source of protein): Contains 55 to 65% protein with good levels of most of the essential amino acids.

Corn gluten: Contains about 25 to 30% protein. Contains low levels of arginine but high levels of leucine. Good source of iron and zinc, niacin and vitamin E.

Molasses (dehydrated): Crude protein 8 to 10%, ash 10-16% and fiber 6-10%. Contains high levels of potassium, copper, iron and manganese.

Rice bran: Crude protein 10-12%; crude fiber 12 to 18% or more depending on the level of husk; ether extract 7 to 12% and ash 8 to 12%. Rich source of energy, phosphorus, potassium, magnesium, iron, manganese, biotin, niacin, pantothenic acid thiamin and vitamin E.

Sorghum: Energy feed; crude protein 8 to 12% poor profile of minerals. Rich source of niacin and pantothenic acid.

Wheat bran: Energy feed; crude protein 10 to 14%; crude fibre 12 to 18%; ash 6-8%; good source of phosphorus; potassium, manganese and zinc; niacin, pantothenic acid and biotin contents are high.

Yeast brewers: Crude protein 40-45; ash 6-9%. Good source of phosphorus; potassium and iron. Richest source of biotin, choline, niacin, folic acid, pantothenic acid, pyridoxine, riboflavin and thiamin.

Tapioca chips: Rich source of carbohydrate. Presence of hydrocyanic acid should be monitored.

NON-CONVENTIONAL INGREDIENTS

Silkworm pupae
Insect larvae
Fish silage
Zooplankton
Molluscs

Recycled wastes to produce:

- yeast
- phytoplankton
- bacteria
- algae
- higher plants.

Single cell proteins
- bacteria
- yeast
- algae

leaf protein
vegetable silage
Aquatic plants
Marshland plants
Sea grasses

The utilization of the above products needs extensive research in terms of nutritive value, cost of production etc.