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Fish feed ingredients and additives – Classification, composition and anti-nutritional factors

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Introduction

Ingredients are the basic raw materials of fish feeds. No single feed ingredient is nutritionally complete and can supply the nutrients and energy required for growth of fish. Therefore, a mixture of ingredients in a carefully formulated feed can provide balanced levels of nutrients and energy for optimum growth performance.

Classification of feed ingredients

1. Based on source (Table 1)

The ingredients are classified as plant source and animal source based on their source of origin. Animal protein sources are generally considered to be superior because of their balanced amino acid profile.

2. Nutritional value

Based on nutritional value, ingredients are classified as protein rich and energy rich. Feed ingredients in which the crude protein content is 20% or more and with less than 20% crude fibre are considered as protein rich, while energy rich ingredients contain less than 20% crude protein and less than 20% crude fibre. Examples of protein rich ingredients include fish meal, shrimp meal, clam meal, squid meal, meat and bone meal, fish solubles, blood meal, poultry by-product meal, hydrolysed feather meal, soybean meal, cotton seed meal, ground nut oil cake, distillers dried grains with solubles, sunflower meal, canola meal etc. Energy rich ingredients include cereals such as corn, rice and wheat products, plant and animal fats and oils. Every ingredient source may have different nutritional value, therefore they should be

analysed for nutritional composition and if needed modify the feed formulations.

Table 1. Proximate composition (on % dry matter basis) and approximate price of common fish feed ingredients (Per Kg dry weight)

Ingredients of Animal origin								
SI No.	**Ingredients**	**DM %**	**CP %**	**EE %**	**CF %**	**ASH %**	**NFE %**	**Approx. price (Rs/ Kg)**
1	Fish meal	95.16	68.5	8.79	0.3	11.9	5.67	90
2	Shrimp meal	93.25	67.45	6.43	5.07	14.25	0.05	65-110
3	Clam meal	93.17	58.15	12.19	3.22	6.47	13.14	320
4	Meat and Bone meal	92.37	51.36	5.71	1.82	24.87	8.61	95
5	Squid meal	92.36	71.88	5.41	1.62	4.33	9.12	200
6	Silk worm pupae meal	94.87	59.38	24.12	3.08	8.18	0.11	40
7	Casein	91.5	86.5	0.2	1.0	3.7	8.60	400
8	Blood meal	88.0	81.5	1.0	1.0	3.2	13.30	30
9	Krill meal	92.9	58.0	18.0	6.0	13.0	5.0	250
10	Poultry feather meal	89.2	77.9	4.2	0.6	5.4	11.90	35
11	Shrimp shell meal	92.6	36.3	7.0	20.0	30.4	6.30	40
Ingredients of Plant origin								
SI No.	**Ingredients**	**DM %**	**CP %**	**EE %**	**CF %**	**ASH %**	**NFE %**	
1	Rice bran	89.9	12.60	11.30	19.3	10.20	36.50	28
2	Wheat flour	87.40	14.50	3.70	2.70	2.30	64.20	30
3	GNOC	97.90	36.23	7.31	8.23	24.05	21.40	45
4	Mustard oil cake	90.80	23.60	9.60	6.30	10.40	40.90	40
5	Soya flour	94.38	53.82	0.58	4.64	7.92	27.42	60
6	Cotton seed meal	93.00	37.00	6.70	13.0	1.00	35.30	42
7	DDGS	90.66	42.43	6.07	7.05	6.15	28.96	25
8	Wheat gluten	90.14	65.54	2.70	1.20	2.10	18.74	700
9	Tapioca flour	87.13	2.82	0.29	1.79	2.02	82.23	30
10	Yeast (Brewers)	94.7	48.5	3.0	1.9	9.2	37.4	200
11	Yeast (Torula)	93.0	41.0	3.0	1.9	7.8	46.3	150-200

Feed additives

Feed additives are products used in feeds in addition to major ingredients in order to improve the quality of feed and to enhance the growth and overall performance of animals/ fish. Generally, additives are added at low concentrations (<2 %) in the diets. The examples of additives are given in Table 2

Table 2. Additives used in fish feeds

Types	Examples
Binders	Agar, carrageenan, corn starch, tapioca starch, potato starch, carboxymethyl cellulose (CMC), lignosulphonates, hemicelluloses bentonites
Feeding stimulants	Betaine, Choline chloride, L- amino acids
Pigments	Carotenoids, oleoresins
Vitamins	Vitamin C, multi-vitamin mix
Minerals	Ca, Mg, Na, K, P
Antioxidants	Butylated hydroxyl toluene, sodium metabisulphate, butylated hydroxyl anisole
Growth promoters	Probiotics, prebiotics, synbiotics, acidifiers, exogenous enzymes
Immunostimulants	Chitin, chitosan, levamisole, levans, plant based nutraceuticals, propolis, seaweed based sulphated polysaccharides etc.

Antinutritional factors

Antinutritional factors are substances which directly, or through their metabolic products are able to interfere with nutrient assimilation. They may be endogenous or extraneous factors occurring in feeds and ingredients during storage and processing.

Even though plant-derived ingredients are less expensive and more sustainable alternative to fishmeal in fish feeds, the presence of anti-nutritional factors within these ingredients is the major constraint that limits their use.

Table 3. Anti-nutritional factors in common plant based ingredients

Sl No	Ingredients	Anti-nutritional factors
1	Ground nut oil cake	Protease inhibitors, phytohaemagglutinin, phytic acid, saponins, oestrogenic factor, aflatoxin
2	Soybean meal	Protease inhibitors, lectins, phytohaemagglutinin, phytic acids, saponins, phytoestrogens, antivitamins
3	Cottonseed meal	Phytic acid, oestrogenic factor, gossypol, anti-vitamin E factor, cyclopropenoic fatty acid, aflatoxin
4	Corn/maize	Protease inhibitors, phytic acid, tannins, invertase inhibitor, aflatoxin
5	Tapioca	Protease inhibitors, cyanogens, aflatoxin
6	Bengal gram/chick pea	Protease inhibitors, cyanogens, phytic acid, oestrogenic factor, flatulence factor, aflatoxin
7	Mustard oilcake	Glucosinolates, tannins

Online resources

Aquaculture Feed and Fertilizer Resources Information System
http://www.fao.org/fishery/affris/feed-and-feed-ingredient-standards/

Feedipedia- Animal feed resources information system
https://www.feedipedia.org/

Online database of anti-nutritional factors in feed ingredients:
http://www.fao.org/fishery/affris/feed-resources-database/major-anti-nutritional-factors-in-plant-derived-fish-feed-ingredients/en/