

Amino acids of fish and shellfishes and importance of essential amino acids

Proteins and Amino acids

- Proteins are composed mostly of amino acids linked with peptide bonds and cross linked between chains with sulphhydryl and hydrogen bonds.
- Gross energy of protein is 5.60 kcal/g.
- Proteins are major nutrient in fish tissue constituting about 65-75% of the total on the dry weight basis
- Proteins are also required for synthesis of new tissues and hence growth.

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- Proteins are among the most important constituents of all living cells and represent the largest chemical group in the animal body, with the exception of water;
- The whole fish carcass contains on an average 75% water, 16% protein, 6% lipid and 3% ash.
- Proteins are essential components of both the cell nucleus and cell protoplasm, and accordingly account for the bulk of the muscle tissues, internal organs, brain, nerves and skin.

Amino acids

- Although over 100 different amino acids have been isolated from biological materials, only 25 of these are commonly found in proteins.
- Individual amino acids are characterised by having an acidic carboxy group (COOH) and a basic nitrogenous group (NH₂).
- In view of the presence of both acidic and basic groups, amino acids are amphoteric (i.e. Have both acidic and basic properties)

Classification

- For nutritional purposes, amino acids may be divided into two groups
- Essential amino acids (EAA): those amino acids that cannot be synthesized within the animal body or at a rate sufficient to meet the physiological needs of the growing animal, and must therefore be supplied in a ready made form in the diet.
- Ex: Methionine, arginine, threonine, tryptophan, histidine, isoleucine, lysine, leucine, valine and phenylalanine

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- Non-essential amino acids (NEAA): those amino acids that can be synthesized in the body from a suitable carbon source and amino groups from other amino acids or simple compounds such as diammonium citrate, and consequently do not have to be supplied in a ready made form in the diet.
- Ex: proline, glutamic acid, aspartic acid, hydroxylproline
- From a feed formulation viewpoint, it is important to know that the NEAA's cystine and tyrosine can be synthesized within the body from the EAA's methionine and phenylalanine respectively.

Classification based on chemical structure

- **Mono amino mono carboxylic acid:** glycine, valine, threonine, leucine, isoleucine
- **Mono amino dicarboxylic acid:** aspartic acid, glutamic acid
- **Diamino mono carboxylic amino acid:** arginine, lysine
- **Sulphur containing amino acid:** cystine, cysteine, methionine
- **Aromatic and heterocyclic amino acid:** Phenyl alanine, tyrosine, tryptophan, histidine, proline

Amino acid composition and protein Quality

- The protein quality of a feed ingredient is dependent upon the amino acid composition of the protein and the biological availability of the amino acids present.
- In general, the closer the EAA pattern of the protein approximates to the dietary EAA requirement of the species, the higher its nutritional value and utilization.
- example, under certain conditions some of the amino acids may be unavailable because the proteins in the diet are incompletely digested.
- Thus, for carnivorous fish and shrimp species, the cellulose cell wall within plant protein sources may render the proteins present within the cell inaccessible to the digestive enzymes.
- In other cases, digestion may be hindered by the presence of enzyme inhibitors within the food protein like trypsin inhibitor within raw soybeans.

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- Although it is possible to inactivate these inhibitors by moderate heat processing, under conditions of excessive heat treatment proteins become more resistant to digestion due to peptide bond formation occurring between the side chains of lysine and dicarboxylic acid.
- The free epsilon amino groups of lysine are particularly susceptible to heat damage, forming addition compounds with non-protein compounds (i.e. reducing sugars such as glucose) present in the food stuff. This reaction is known as the Maillard reaction, and renders the lysine biologically unavailable.
- Substances other than reducing sugars which are known to react with the free epsilon amino group of lysine include gossypol; phenol based compound present in cottonseed meal. Thus an estimate of the biological availability of amino acids within feed proteins gives an indication of protein quality.

Essential amino acid requirements (% dietary protein) of some fish and prawn species

Amino acids	Rohu	Catla	Mrigal	Common carp	Tilapia	Rainbow trout	Prawn	Milk fish
Arginine	5.75	4.80	5.25	4.3	4.2	5.0	3.70	5.2
Histidine	2.25	2.45	2.13	2.1	1.7	1.8	0.70	2.0
Isoleucine	3.00	2.35	2.75	2.5	3.1	2.0	0.60	4.0
Leucine	4.63	3.70	4.25	3.3	3.4	3.5	1.00	5.1
Lysine	5.58	6.23	5.88	5.7	5.1	4.5	3.20	4.0
Methionine	2.88	3.55	3.18	3.1	2.7	3.5	1.20	2.5
Phnylalanine	4.00	3.70	4.00	6.5	5.5	4.5	1.70	4.2
Threonine	4.28	4.95	4.13	3.9	3.8	2.0	1.60	4.5
Tryptophan	1.13	0.95	1.08	0.8	1.0	0.5	0.50	0.6
Valine	3.75	3.55	3.50	3.6	2.8	3.2	2.06	3.6