

## ROLE OF TRYPTOPHAN IN FISH NUTRITION

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### *Abstract*

*Tryptophan is an essential amino acid which plays vital role in protein biosynthesis and not synthesized by the fishes but synthesized by plants and microorganism. Apart from role in biosynthesis of protein it also acts as precursor of serotonin (a neuro transmitter), Niacin (Vitamin B3) and Auxins (Phytohormone). Due to high stocking of fishes they are solely depends on artificial diet ,which are deficient in tryptophan leads to scoliosis and lordosis in fishes. Hence use of tryptophan may be promising nutritional strategy for health management in aquaculture i.e. handling,transport and vaccination etc. This is an small attempt to review the role of tryptophan in fish nutrition*

### **Introduction**

Building blocks of proteins are amino acids (AA) which play important role in maintenance, growth, feed intake, nutrient utilization, immunity, behavior, larval metamorphosis, reproduction as well as resistance to environmental stressors and pathogenic organisms in various fishes. Amino acids are broadly categorized into nutritionally essential and other is non-essential for fish. Essential amino acids are those that cannot be synthesized or inadequately synthesized denovo by animals relative to needs. These amino acids are to be provided through the feed under conditions where rate of utilization are greater than rate of synthesis. Ex- Alanine , Asparagine, Aspartate, Glutamate, Glycine, Serine, Tyrosine. In formulated feed dietary protein is the major and most expensive feed ingredient.(Wilson etal., 2002) Fish meal is the most ideal component of feed and protein source for aquatic animals despite static global production , seasonal and geographical vector of contamination (Trushenski, etal., 2006 ) Due to rise in prices and competition for this valuable protein source in fish feed leads to alternate non fish meal protein sources. For aqua feed to sustain comparable level of feed intake, feed conversion efficiency as well as growth rate and

survival in fishes. Therefore it is necessary to establish dietary requirement of Amino acid and Characterization of alternative protein/ AA source has been a major focus of fish nutritional research. Studies on both aquatic and terrestrial animals show that many of Amino acids regulate key metabolic pathways that are crucial for maintenance, growth, reproduction and immune responses. This review summarized current knowledge on role of Amino acid in fish nutrition and proposed new strategies to guide development of balanced tryptophan incorporated aqua feed.

### **Tryptophan Synthesis**

Tryptophan is the amino acid which is used in biosynthesis of protein. It was first time isolated in 1901 through hydrolysis of casein by Federick Hopkins.(Hopkins and Cole,1901) It has alpha amino acid which is protonated  $-NH_3^+$  form under biological condition and also contain carboxylic acid group which is in deprotonated  $-COO^-$  form in biological condition and side chain indole. It is classified as non polar aromatic amino acid. It is not synthesised by human and animals hence it is essential amino acid and is to be obtained through the diet. Plants and microorganism commonly synthesize tryptophan from Shikimic acid or anthranilate by following process anthranilate condenses with [phosphoribosylpyrophosphate](#) (PRPP), generating [pyrophosphate](#) as a by-product. The ring of the [ribose moiety](#) is opened and subjected to reductive [decarboxylation](#), producing indole-3-glycerinephosphate; this, in turn, is transformed into [indole](#). In the last step, [tryptophan synthase catalyzes](#) the formation of tryptophan from indole and the amino acid [serine](#).(Radwanski and Last,1995)

### **Source of dietary tryptophan**

Tryptophan is mostly found in protein based food or dietary proteins. It is plentiful in oats, red meat, eggs, fish, poultry, sesame, chickpeas, sunflower seed, spirulina, banana , peanuts etc.

### **Role of tryptophan in aquaculture**

L - tryptophan plays a vital role in synthesis of neurotransmitter serotonin (5-hydroxytryptamine, 5-HT). The first rate-limiting step in the 5-HT biosynthesis is the hydroxylation of TRP to 5-hydroxytryptophan (5- HTP) by the enzyme tryptophan hydroxylase (TPH) (Boadle-Biber, 1993). Serotonin in turn directly blocks cortisol in rainbow trout, *Oncorhynchus mykiss* (Lepage *et al.*, 2002). Dietary supplementation of L-

tryptophan at a minimum level of 1.36% reduced the high density group stress and improved growth performance in *C. mrigala* fingerlings as well. Though 2.72% dietary tryptophan also reduced the stress but 1.36% level appears to be cost effective (Tejpal *et al.*, 2009). Tryptophan supplementation enhanced salt water tolerance of carp that was due to increase in basal cortisol and anti-stress effect of tryptophan and possible increase in serotonergic activity (Hoseini and Hoseini, 2010). Supplemental dietary L-tryptophan suppresses aggressive behaviour in juvenile rainbow trout. This behavioural effect of L-tryptophan (TRP) is likely to be mediated by a stimulation of brain serotonergic activity, but the slow time course of the affect suggests that effects on 5-HT receptor mechanisms may be involved. Furthermore, possible effects of TRP on circulating melatonin levels cannot be excluded as the mechanism of action. Decreasing aggressive behaviour in fish-rearing units by providing feed with increased dietary TRP could be a promising aquaculture management strategy. Since plasma and there by brain, TRP levels are correlated with the amount of feed ingested. The effects of dietary TRP will be most pronounced in dominant individuals, which consume the larger part of the feed offered and are also the most aggressive. Thereby, the tendency to develop strong dominance hierarchies, resulting in stress, reduced disease resistance and highly variable growth rates, may be diminished (Winberg *et al.*, 2001).

According to Fang *et al.*, 2002 tryptophan can be converted into 5 hydroxy tryptamine (serotonin) a neurotransmitter and melatonin a antioxidant. In intensive system aggressive interaction and cannibalism of carnivorous fishes causes substantial loss. Serotonin concentration in brain inhibits aggression behavior. Hseu *et al.*, 2003 found that dietary supplementation of L- tryptophan in juveniles rainbow trout diet leads to inhibit aggression behavior Hoglund *et al.*, 2007 revealed that L – tryptophan reduce cannibalism and stress induced anorexia in juvenile grouper and Leping *et al.*, 2003 shows that it prevents stress induced cortisol surge. Vijayan *et al.*, 1996 use tryptophan to suppress the stress induced cortisol surge, if the cortisol remaining elevated effects negatively on growth, feed intake , protein accretion immunity and disease challenge.

### **Deficiency of tryptophan**

Its deficiency causes scoliosis and lordosis in Sockeye salmon (Halver and Shanks, 1960) and in rainbow trout (Shanks *et al.*, 1962; Kloppel and Post, 1975) but not in case of catfish (Wilson *et al.*, 1978). It also leads to abnormal deposition of calcium in the kidney and bony plates surrounding the notochord and sheath (Kloppel and Post, 1975)

**.Table- Research on dietary supplementation of L-tryptophan with fishes**

Authors	Amino acid	Dose	Length of administration	Species	Initial Stage	Effect
Akiyama et al., 1986	L-Tryptophan	0.24%	4week duration	Chum salmon fry	Early larval stage	Four first weeks of their life with a tryptophan deficient diet causes 57% of total fry was affected by scoliosis
Akiyama et al., 1996	L-Tryptophan	0.1%		Ayu . <i>Plecoglossus alti</i> <i>Öelis</i>	Mature male and Female	Significant increase in the serum testosterone levels thus advancing time of spermiation in males and induced maturation of females.
Tejpal et al., 2009	L-Tryptophan	1.36 % to 2.72 %	60days	<i>Cirrhinus mrigala</i>	2.8g to 3.0g	Mitigating Crowding stress, ↓Cortisol
Hoseini and Hoseini, 2010	L-Tryptophan	0.6%	15days	<i>Cyprinus carpio</i>	14g	↑Osmotic stress tolerance
Ahmed, I. 2012	L-Tryptophan	0.8g 100g <sup>-1</sup>	8 weeks	<i>Heteropneustes fossilis</i>	4.44g	Dietary protein for optimum growth and efficient feed utilization

Hence use of tryptophan may be promising nutritional strategy for health management in aquaculture i.e. handling ,transport and vaccination.

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