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Ompok bimaculatus Rearing Potential with Feed Attractants Used in Aquaculture

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ABSTRACT

IUCN red listed Ompok bimaculatus rearing plays pivotal role in aquaculture. Inclusion of diets with attractants as an alternative for the cellulose replacement gives hope to rear the carnivore species with lesser mortality. Chemo-attractants like betaine, inosine monophospahte, DL-alanine, tryptophan can be supplemented in diet which results in growth increament in fish. The fishes can feed with supplementation with natural attractants viz. dried tubifex, dried earthworm and fish meal. Attractant supplementation in diet results in the improvement in terms of weight gain, specific growth rate (SGR), total biomass and performance index and survivability. Right inclusion rate of suitable attractant (or in combination) at right stocking density for optimum days has to be worked out in region specific manner to bridge the gap of demand and supply of this IUCN red listed species.

Key words: *Ompok bimaculatus, Attractants, Chemo-attractant, Natural attractant, L-tryptophan, Betaine.*

INTRODUCTION

Global fish production has grown steadily in the last five decades, with food fish supply increasing at an average annual rate of 3.2 percent, outpacing world population growth at 1.6percent, resulting in increasing average per capita availability. World per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 20 kg in 2014[82]. The total world fish production was 167 million tonnes in 2014 which was approximately 10 million tonnes higher as compared to 2012[82].

In inland fish production, India is constantly at the second position after China with the production of 4.3 mt[82]. In 2015-16, there was around 10.8 million tonnes fish production in the country, which is around 6.4 per cent of total fish production of the world. From the last decade, where the average annual growth rate of export of fish and fisheries production in the world remaining 7.5 per cent, Indian remain at the first place with an average annual growth rate of 14.8 per cent in the export of fisheries product.

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1. Importance of the species

Ompok bimaculatus, commonly known as Pabda, is an indigenous species and recently gaining its commercial importance owing to its good taste, nutritional value and high market rate. The fish is well preferred to the people of North East India, West Bengal, Bihar and as well as Bangladesh due to its rich lipoprotein content and soft bony structure[42,9]. It is a highly priced fish ranges between of US$ 7-18 per kg in the market[21]. It is also seen frequently in the international ornamental fish trade as two-spot glass catfish due to a round black blotch above and behind the base of the pectoral fin and another at the base of the tail.

It can thrive well in shallow water bodies which makes them more preferred species to be cultured in seasonal water bodies which are mostly prevailed in North-eastern hilly region. Unlike other catfish, the species is pretty shy and peaceful in nature and goes well in poly culture system utilizing all ecological zones within pond environment enhancing the maximum standing crop[45]. In an experiment conducted by ICAR, Tripura centre on monoculture of Pabda which showed the production and net profit of 2202 kg ha^{-1} and Rs. 5, 82, 273 ha^{-1} respectively after 8 months of rearing. Under well maintained culture systems, *O. bimaculatus* attains a size of 85-120 g in 7-8 months[21]. Small floating cages made of locally available, low-cost materials could also be used for rearing this high value fish. The fish has great potential to be considered as a suitable candidate for aquaculture species and system diversification.

Diversification of aquaculture provides a way to supplement the growing demand for fish. System diversification and species diversification are the two major ways to meet the demand for alternative fish species other than IMCs. Pabda, being one of the most preferred fish fits in both the diversification models. Qayyum and Qasim[69] and Debnath *et al.*[21], have reported *Ompok bimaculatus* to become mature at the end of first year of its life and the size of maturity is 10-12 cm.

Nutritional value of this fish is more than that of many large species of fish. They have much quantity of iron suitable for body and also contain more protein and low fat which are easily digestible. These fishes are more popular as diet for rapid development of health at and after the time of sickness. Catfish help to increase body energy and also an excellent source of omega-3 and omega-6 fatty acids, vitamin and mineral etc.

2. Description of the species

2.1. Systematic position

Kingdom: Animalia
Phylum: Chordata
Subphylum: Vertebrata
Class: Actinopterygii
Order: Siluriformes
Family: Siluridae
Genus: *Ompok*
Species: *O. bimaculatus*

2.2. Identifying characters of *Ompok bimaculatus*

- Elongate body is strongly compressed
- Head depressed and snout rounded
- Mouth is superior (Lower jaw is longer than upper)
- Two pairs of barbells are present. Maxillary barbells extend posterior to (or slightly beyond) anal fin base
- Nostrils widely separated from each other
- Teeth found on jaws and vomer
- Caudal fin is deeply forked and its upper lobe long
- Dorsal side grey, a transverse blackish spot present, behind the operculum on the lateral line, caudal stripped with black spots; besides, there are purple and yellowish spots throughout the body
- Anal fin with 57 or 58 branched rays[71].

2.3. Present status of *Ompok bimaculatus*

The catfish *Ompok bimaculatus*[11], locally known as Pabda (butter catfish), is an indigenous freshwater small fish belonging to the family Siluridae of the order Siluriformes[7]. This catfish commonly available in beels, ponds, rivers and inundated fields as well as streams and lakes with an extensive geographical distribution in India, Bangladesh, Pakistan, Afghanistan, and Burma[41,9]. But over the last few decades its wild population is declining rapidly (> 50%) as a result of several anthropogenic factors like indiscriminate fishing during the breeding season, wide use of pesticide and siltation in habitat[15,9].

Owing to reduced abundance and restricted distribution, this species is endangered in Bangladesh[39] and India[12], also globally categorized as near threatened[40] and facing high risk of extinction[49]. Killing of fry and fingerlings, use of illegal fishing gear, pollution and siltation are also key causes for the declining of this species[36]. Lack of definite information on the biological aspects of this threatened fish species of the river system has hampered the planning and implementation of species specific conservation and management strategies[7].

Being highly demanded and priced, the fish is prioritized recently by the National Bureau of Fish Genetic Resources (NBFGR), India with an aim of dual purposes, firstly, a new species for aquaculture diversification in India and other neighbouring countries; secondly, its culture may be used for conservation and restocking programs which may provide quality brood stock for breeding programs. In aquaculture, the fish did not receive much attention till date due to insufficiency of gravid stocks for experimentation and shortage of information regarding the breeding, larval rearing and culture technology of the fish[12,8].

For conservation the fish, NBFGR with consultation with Govt. of Tripura has declared *O. bimaculatus* as the State Fish of Tripura, India with an effort to develop commercial-scale hatcheries for providing plentiful larvae.

In India, *Ompok bimaculatus* was first spawned by Sridhar *et al*.[83], *O. bimaculatus*, they could produce 1.75 lakh of spawn out of 117 nos. of female but documentation was made for the production of stockable seed[18].

Akhteruzzaman *et al*.[4], developed a viable induced breeding technique of pond-reared pabda for the first time in Bangladesh. Except some observations on the food and feeding habits[19], fecundity, breeding and reproductive biology[35,4], development[46] and nutrient requirement[64], no published information in details is available on this species.

2.4. Feed and feeding habits

Different study on the food and feeding habit of *Ompok bimaculatus*, shows slightly different results but nearly same. Sivakami[80], Arthi *et al*.[6], and Mishra *et al*.[56], have reported it as an omnivorous fish whereas Hanjavanit and Sangpradub[27] and Sangpradub *et al*.[76], have described it as a carnivorous fish. Rainboth[72] documented that *Ompok bimaculatus* feed on crustaceans, fish and molluscs while Sangpradub *et al*.[76], have reported insectivorous nature of this fish species. Sivakami[81] also has observed its preference mainly for insects in his study at Bhavanisagar reservoir, Tamil Nadu. However, the cannibalistic tendencies gradually diminish after the above period. Rao and Karamchandani[73] reported high feeding activity during pre and post spawning period. It has been observed crustacean/fish flesh not only form choice food of the species but also helps in attaining proper gonadal maturation.

3. Challenges in larval rearing

The fish larva is a newly hatched, earliest stage of an animal that undergo metamorphosis, differing markedly in form and appearance from the adult. Most delicate stage and possess maximum chance of mortality. It depends on yolk sac reserve for a certain period and then starts feeding on natural available food. Fish larvae are very susceptible during the early stages of development and require variety of optimal biotic and abiotic factors to survive, develop and grow properly. Newly hatched larvae normally carry a yolk sac which serves as nutrient store for further development that tend to be small and influenced by a variety of determinants. Finding prey items of appropriate size and nutritional characteristics is a difficult challenge in the wild and one of the primary concerns in the culture of larvae.

There are several reasons for mortality during larval rearing. Among them aggression and cannibalism contribute significantly to mortality in aquaculture settings, even where conditions appear to be ideal[32,10]. The prevalence of aggression and cannibalism in a larval rearing can be attributed to intrinsic genetic effects that result in the heterogeneous growth of larvae in addition to extrinsic factors that mediate the aggressive behaviour of larvae. Cannibalism accounts for 15-90% of the total mortalities that occur during the larval rearing phase of finfish due to the aggressive behaviour of fish larvae caused by their high growth and food consumption rate[32,10].Nevertheless, considering the vulnerability of fish larvae, it is always difficult to identify and meet nutritional requirements. Apart from these issues, several other factors may affect the larval rearing, viz.

- Small size of the larvae reducing the effective distance the larvae can travel, as well as the size of the particle that can be consumed
- Extremely fast growth rates and minimal nutritional reserves
- Undeveloped digestive system, which may not digest and assimilate some food sources as efficiently as a fully developed fish[20]
- In addition, larval rearing of *O.bimaculatus* has many other problems, such as:
- Proper larval rearing system including feeding protocol has not been developed
- Cannibalism is reported
- Larval diet has not been standardised
- Optimal use of different dietary supplement in larval food has not been studied.

4. Relevance of attractants to aquaculture

A food particle should deliver the necessary nutrients in a form that can easily be consumed by the fish which will result in more efficient production and increased profits. Substances incorporated in feed at low level to enhance feed intake, growth and utilization are called as feed attractants. Feed contributes more than 50% of the cost of production in intensive aquaculture systems. There is a need to maximize the feed consumption and reduce the feed wastage for the economic success of aquaculture. This can be achieved by use of feed attractants to enhance feed intake, growth and nutrient utilization in aquaculture practices. Supplementation of artificial, dry diets with attractants (feeding stimulants) can increase acceptability, and consequently the consumption of low palatable diets by fry and fingerlings, which can increase growth rate and productivity. This practice can also reduce feeding time and feed wastage, while improving water quality and environmental safety[50].

5. Types of attractants

Dietary feeding stimulants are essential to elicit an acceptable and rapid feeding response .Two type of feed attractants may be considered for use in aqua feed and they can be classified as natural and chemo attractants.

5.1. Natural attractants

Natural ingredient sources which exhibit attractant or feeding stimulant properties are called natural attractants and these are present in impure or crude form. Examples are mussel flesh, shrimp meal and waste, short-necked clam flesh, blood worms, certain terrestrial oligochaete worms, marine fish oils, fish meal, fish soluble, fish protein hydrolysates and soybean protein hydrolysates [5,33,85,29,84,28,53,55].

5.2. Chemo-attractants

These are purified or synthetic substances; they can be extracted from natural attractants. Their common physiochemical properties are non-volatile, low molecular weight (<1,000 kilodaltons), nitrogen-containing, amphoteric, water soluble, heat stable etc. They generally include L-amino acids viz. glycine, alanine, proline and histidine[2,29]. Chemoattractant also includes nucleosides, betaine, and nucleotides[66,53].

6. Role of attractants

- Increased initial palatability and consumption, which results in reduced feed input (complete consumption) and improved overall nutrient mass transfer[30].
- Reduced levels of uneaten or wasted feed which results in improved feed conversion,

water quality, both potentially enhancing growth rate[51].

- Increased feed performance and growth rate which results in reduced leaching, excreted nitrogen, more variation possible in feed formulation[62].
- Reduced time in weaning from living prey to inert feeds[75].
- Reduced dietary levels of expensive feed ingredients which results in improved cost benefit increased byproduct usage[1,54,48].

The use of feed attractant in manufactured aqua feed has received considerable attention in the recent years.

7. Effect of attractant on different parameters

7.1. Effect of attractant on growth

McGoogan and Gatlin[54] reported that glycine (2%) supplementation enhanced growth and feed efficiency of red drum fed with soybean meal-based diets. Gomes *et al*.[26], also showed that soy protein concentrate-based diets reduced the feed intake of European sea bass but addition of an amino acid attractant mixture improved feed intake, growth and feed efficiency of fish fed with soy protein concentrate-based diets.

Betaine has been shown to act as a feed attractant in Red sea bream, *Chrysophyrys major*[25] and European eel, *Anguilla anguilla*[53] which showed a positive result.

Rahimabadi *et al*.[70], studied the effect of different levels of dietary betaine on growth performance, food efficiency and survival rate of pike perch fingerlings. Fishes were fed with live food, biomar without betaine, 1% betaine added to biomar and 2% betaine added to biomar in 1000 l concreted tanks. It has been found that higher weight gain, SGR and FCR has been found in the group of fishes fed with 2% betaine added to biomar.

Kolkovski *et al*.[48], studied the effect of krill hydrolysate as a feed attractant in two fresh water fish species yellow perch *Perca flavescens* and lake white fish *Coregonusclupea formis*. Krill hydrolysate coated diet increased growth of yellow perch juvenile by 31% compared to control diet which is fed with live artemia.

Chabbert *et al*.[14], found that diets containing 60g/kg feeding stimulant had a beneficial effect in terms of growth, homogenous size distribution and feed intake in elvers and glass eels of *Anguilla anguilla* which were fed with two types of feeding stimulants (FS) that were based on processed marine feeding stimulants (MBFS) and yeast proteins feeding stimulant (YBFS). Elvers fed with 60 g /kg MBFS and YBFS diets grew 11.9% and 5.6% faster than the control group.

Changan *et al*.[16], also studied the food intake, growth performances, body composition and digestive ability of *Huchotaimen* which were improved by feeding the basal diets along with the attractants @ 0.2% dimethyl-β-propiothetin, 0.2% trimethylamine oxide and 0.2% betaine, respectively, but there were no changes in growth parameters by supplementing 0.05% sodium-5'-inosinate whereas the immune response was improved.

Xue and Cui[88] studied the effects of several feeding stimulants on Gibel carp (*Carassius auratus gibelio*) fed diets with or without replacement of fish meal (FM) by meat and bone meal (MBM) and found that Gibel carp fed with the FM diet had higher feed intake than those fed the MBM diet, but the difference was significant only in the experiments on betaine, glycine and L-methionine. None of the tested feeding stimulants showed feeding enhancing effects in FM diets. All feeding stimulants showed feeding enhancing effects in MBM diets, and the optimum inclusion level was 0.5% for betaine, 0.1% for glycine, 0.25% for L-lysine, 0.1% for L-methionine, 0.25% for L-phenylalanine and 0.1% for squid extract. The squid extract had the strongest stimulating effect among all the stimulants tested.

The key factor in weaning fish larvae or juveniles to dry diets is the attractiveness of food. Feed attractiveness and stimulation of fish ingestion involve physical stimuli such as colour, and movement of food as well as chemical stimuli such as smell and taste of food particles[47].

Nunes *et al*.[60], studied behavioral response of *Litopenaeus vannamei* fed with different feed attractants.The study was carried in three phases, including an initial stage (Phase I) to validate the methodology and apparatus used, here FMBO (fishmeal–Brazilian origin) and FMPO (fishmeal–Peruvian origin) showed the best result among seven different stimulatory raw materials (SRM) used. In Phase-2 nine commercially available attractants were compared, among them 4 attractants viz. complex of amino acids with enzymatically digested bivalve mollusk (CAA), condensed fish soluble protein (CFSP), squid liver meal (SLM), whole squid protein hydrolysate (WSPH) have shown best effects. In phase-3, the best four commercial attractants selected were compared under 0.5% and 1.0% levels and found that both CFSP and CAA at 1.0% level were significantly more chosen by shrimp than other attractants used.

Mohanta *et al*.[57], observed potential of earthworm as dietary protein source for *Labeo rohita* advanced fry. Three iso-nitrogenous and iso-caloric experimental diets have been prepared and were fed ad libitum for 35 days. Earthworm was used in three forms viz. whole earthworm, earthworm custard and pelleted earthworm diet. It has been found that significantly improved weight gain, food conversion ratio, specific growth rate, protein efficiency ratio in case of pelleted earthworm diet.

Tusche *et al*.[87], studied effect of different dietary levels of potato protein concentrate (PPC) supplemented with feed attractants on growth performance of rainbow trout (*Oncorhynchus mykiss*).Five diets were formulated by partial and total replacement of FM(fish meal) protein (20%, 40%, 60%, 80% and 100%) with PPC and one experimental diet without PPC as control. Blood meal and synthetic amino acid mixture were supplemented as feed attractants. Experimental diets were fed twice per day until apparent satiation for 56 days. It has been found that use of feed attractants (80 g/kg blood meal, 10 g/kg synthetic amino acids) increased inclusion levels of PPC up to 60% without any negative effects on fish performance.

Hashim *et al*.[31], studied supplementation of artificial diets for Catfish (*Clarias macrocephalus*) fry with tubifex. Three-week-old fry were fed with experimental diets at protein levels of 30% and 35% fish meal dominant and 35% and 40% soybean dominant types for 8 weeks. Nine treatments were tested with four treatments consisting wholly of experimental diets, one of tubifex (control) and the remaining four diets supplemented with live tubifex. Fishes fed with live tubifex showed better growth and feed efficiency than those reared without supplemented diets. It has been seen those on the 30% and 35% fish meal dominant feed showed significantly better growth and feed conversion than those fed @ 35% and 40% soybean dominant diet. This study indicates that supplementation of artificial diets with live tubifex at 2% body weight can effectively promote growth and feed conversion efficiency of *the Clariasmacro cephalus* fry.

Lim *et al*.[52], studied the potential of betaine, taurine, nucleotide and nucleoside as feeding stimulant for juvenile *Oxyeleotris marmoratus* through behavioural assays using agar gel pellets. It has been found that Ingestion rates of both inosine and inosine 5' monophosphate disodium were significantly highest but inosine was identified as the most potent feeding stimulant even at the lower concentrations tested in the study.

Prayogi[67] studied the effect of earthworm meal supplementation in the diet on quail's growth performance in attempt to replace the usage of fish meal. Four iso-nitrogenous and iso-caloric diets have been prepared with the inclusion level of 0, 5, 10, 15% earthworm meal. It has been concluded that 10% supplementation gave a good growth performance of the quail because it has high BW gain and low feed conversion.

7.2. Effect of attractant on palatability

Some studies in fish have shown that inclusion of attractants led to improved feed palatability and intake. This has been demonstrated in seabass, *Dicentrarchus labrax*[22], striped bass, *Morone saxatilis*[61], olive flounder, *Paralichthys olivaceus*[17], nile tilapia, *O.*

niloticus[24] and Indian major carp, *Labeo rohita*[78].

Nagel *et al*.[59], found that blue mussel meal improved the palatability of rapeseed protein-based diets for turbot. He used blue mussel as a feed attractant in diet supplemented with 0%, 2%, 4% or 8%. After experiment, it is found that with increasing mussel meal inclusion, the daily feed intake and specific growth rate for turbot has increased.

Kader *et al*.[43], studied complete replacement of fishmeal (FM) by dehulled soybean meal(DSM) with crude attractants supplementation in diets for red sea bream, *Pagrus major*. Fishmeal was gradually replaced @ 70, 80, 90 and 100% with DSM. All the replacement diets (except the control, FM100%) were supplemented with 10% FS (fish soluble), 5% KM (krill meal) and 5% SM (squid meal) to complement amino acid profile of the test diets and as palatability enhancer. Fishes were stocked in 100-l polycarbonate circular tanks at a rate of 15 fish per tank and fed upto satiation twice a day for 56 days. The growth parameters were significantly better in fish fed diet with 70% and 80% replacement compared to other diets. There were no significant difference in feed efficiency ratios, protein efficiency ratios and proximate compositions among dietary treatments.

7.3. Effect of attractant on survivability

Yilmaz[89] found that when 4 days old African catfish larvae*Clariasgariepinus* were fed with trout starter diet, minced beef liver, fresh water mussel, dried tubifex, DL-alanine and betaine supplemented trout starter, artemia nauplii and a combined diet consisting of boiled chicken egg yolk, minced mussel and dried tubifex as the first feed after yolk absorption for a week. At the end of the experiment, it was observed that DL-alanine and betaine supplementation did not improve the larval growth and compared to other feeds but in ten days old postlarvae, DL-alanine and betaine supplementation improved the growth and survival rates. It has been found that DL-alanine and betaine did not have any attracting role in the pre-larval stage, however, in the post-larval stage; they had a very strong effect on the survival and growth rate of the African catfish.

Incorporation of betaine in the diet of *Labeo rohita* fingerlings was studied by Shankar *et al*.[78], which reveals the incorporation of betaine @ 0.25% is best in terms of survival.

Murthy *et al*.[58], studiedthe efficiency of betaine as a feed attractant on growth, survival and feed utilization of common carp (*Cyprinuscarpio*). Betaine was incorporated @ 0.25% and 0.50% and fed for 60 days. Diet supplemented with 0.25% betaine showed higher growth in terms of specific growth rate, survival, and food conversion rate and protein efficiency ratio.

Sarkar *et al*.[77], studied the performance of different types of diets on larval rearing of endangered *Chitala chitala* .Fifteen days old post-hatchlings were stocked for 28 days in a 30 L recirculatory tanks using eight different diets i.e. live feed (tubifex worms, chironomous larvae, zooplanktons,), dry feed (dry tubifex, spirulina, daphnia) and other non-conventional feed (fish eggs and boiled egg-yolk). It was found that specific growth rate (SGR) and survivability were highest in post-hatchlings of *C.chitala*fed on live tubifex worms.

Hung *et al*.[38], studied larval rearing of *Pangasiusbocourti*using artemianauplii, cladoceran, trout starter diet and tubifex. It has been concluded that artemianauplii and tubifex worms resulted the same survival rates .The study confirmed the feasibility of completely replacing artemianauplii by tubifex worms.

Przyby *et al*.[68], studied effect of betaine (in the form of betafin) on carp fry rearing in ponds. Three isonitrogenousand isocaloricdiets have been prepared. BETAFIN preparation containing 96% of betaine was added to the experimental feeds @0.15 and 0.2%. It has been found that the best food conversion ratio and the highest survival rate were obtained in 0.2% supplementation.

Artificial feeds are reported to result in low growth, large growth variation and associated with the resulting size variation, a decreased survival[44,34]. Recently in Japan the use of 'artificial' feeds is replacing an increasing part of the *Tubifex* spp. traditionally used for the first feeding of *A. japonica* glass eels. These feeds are reported to give a survival of 70-90% and a growth comparable to Tubifex.

Pavadi*et al*.[65], found that a combination of natural flavour extracts (choline, chloride and BHT), amino acids (alanine, valine, glycine, proline, serine and histidine, glutamic acid, tyrosine and betaine) @ 0, 1.0, 1.5 and 2.0% levels in the diet of freshwater prawn juveniles has promoted the growth, survival and feed utilization in prawn and recommended a level of 10 g/kg diet to be optimum.

8. Importance of Tryptophan

Tryptophan is one of the essential amino acids for fish and is required for a wide variety of metabolic activities. As it is found in lowest concentrations in most animals including fish, it plays a rate-limiting role in protein synthesis[74]. Hence, the dietary tryptophan requirement is low compared with other essential amino acids. Apart from being a structural component of all proteins, tryptophan is a precursor for synthesis of serotonin, melatonin and niacin. This amino acid is also known to be a stress suppressor in some species.

8.1. Tryptophan : As a stress suppressor and control cannibalism

Hseu *et al*.[37], studied the effect of exogenous tryptophan (TRP) on cannibalism, survival and growth in juvenile grouper, *Epinephelus coioides.* Diets supplemented with TRP @ 0.25%, 0.5% and 1% were fed to 38-day-old juvenile groupers in 200 liter tank @750 fish per tank for 10 days. These diets were effective in increasing the levels of 5-HT in the brain of groupers which results in slightly lower cannibalism than in controls. However, body weight and total length of fishes fed with TRP were significantly smaller than those of control. It has been found that cannibalism among juvenile groupers could be mitigated to the best by the oral administration of TRP @ 0.5% of dry diet.

Hoglund *et al*., studied suppression of aggressive behaviour in juvenile Atlantic cod (*Gadus morhua)* by L-tryptophan supplementation. They have found that dietary supplementation with the serotonin precursor; L-tryptophan (TRP) suppresses aggression. A significant decrease in aggressive acts was seen after changing to TRP-supplemented feed. The mean number of aggressive acts was also significantly lower in the TRP-treated group compared to a control group not receiving TRP treatment. It has been seen that juvenile Atlantic cod are highly aggressive and supplementing the feed with TRP affects central 5-HT (serotonin)signalling systems and reduces the aggressive behaviour.

Papoutsoglou *et al*.[63], studied the effect of dietary L-tryptophan and tank colour on growth performance of rainbow trout (*Oncorhynchus mykiss*) juveniles reared in a recirculating water system. Fishes were reared for 11 weeks in black, light blue and white tanks and fed either a commercial diet (CD) or the same diet supplemented with tryptophan (2 g/100 g diet). Tryptophan supplemented diet resulted in depressed growth, increased food consumption and food conversion ratio, decreased body protein and increased body lipid, reduced liver total lipids and a marked increase in hepatosomatic index. It was concluded dietary supplementation of tryptophan failed to act as a stress-releasing factor and probably evoked an amino acid imbalance.

Tejpal *et al*.[86], studied that dietary supplementation of L-tryptophan mitigates crowding stress and augments the growth in *Cirrhinus mrigala* fingerlings. Four diets containing 0, 0.68, 1.36 or 2.72% L-tryptophan were fed to fishes stocked in two different stocking densities @3% for 60 days. It has been found that L-tryptophan supplemented groups have higher growth, SGR and PER in both the stocking densities. Cortisol level was found to be significantly higher in the high density group than the low density. Gradual supplementation of L-tryptophan in diet significantly reduced the cortisol level both in high density and low density group fish. But 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 which is cost effective also.

8.2. Effect of tryptophan on growth and survival

Ahmed *et al*.[3], studied dietary tryptophan requirement of fingerling Indian major carp, *Cirrhinusmrigala*. Six isonitrogenous and isocaloric amino acid test diets with graded levels of L-tryptophan (0.06, 0.16, 0.26, 0.36, 0.46 and 0.56 g 100/g dry diet) were formulated. Fish were randomly stocked in triplicate groups in 70 L flow-through indoor circular tanks and fed experimental diets @5% of their body for eight week. Maximum live weight gain, lowest feed conversion ratio and highest protein efficiency ratio were measured at 0.36% dietary tryptophan. It has been concluded that diets for fingerling of *C. mrigala*should contain tryptophan @ 0.38 g/100 g dry diet for optimum growth and efficient feed utilization.

Fatma and Khan[23] studied dietary tryptophan requirement of fingerling Rohu, *Labeorohita* based on growth and body composition. Casein-gelatin-based is nitrogenous and isocaloricamino acid test diets simulating the amino acid profile to that of 40% whole chicken egg protein except for tryptophan were formulated. Maximum LWG (live weight gain), best FCR (1.28), and highest PER (1.95) were recorded @ 0.40% tryptophan of the diet. The optimum requirement of fingerling *L. rohita*for L-tryptophan is recommended in the range of 0.36-0.38% using second-degree polynomial regression analysis.

CONCLUSION

It is concluded that the dietary chemo-attarctant supplementation could be a promising aquaculture management strategy for carnivorous fish as it showed significantly better survival without affecting the growth. Dietary supplementation of attractant in the diet of fish has the potential to reduce cannibalism consequently improving the survival of pabda fry. Further comparative study between different supplementation may be conducted for choosing the cheap source of attractant.

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