DISCUSSION

5.0 DISCUSSION

5.1 PHASE - 1

Catla catla attained higher growth rate and biochemical composition in fish wastes incorporated diets, followed by broiler, fruit and vegetable wastes supplemented feeds. Fish wastes included diet is highly digestible besides providing essential fatty acids, phospholipids, cholesterol and fat soluble vitamins, resulting in higher growth rate, feed utilization efficiencies and calorific value of flesh in *C.catla*. Present findings were comparable with that of Hari and Kurup (2003), who reported that the highest growth performance and feed utilization efficiencies in *Macrobrachium rosenbergii* fed with fish meal based diet, which provided all essential amino acids and enhanced the protein digestibility and feed efficiency. Bureau *et al.* (2002) also noticed that the highest protein quality and fat soluble vitamin content of fish meal incorporated diets boosted weight gain, feed efficiency and protein efficiency ratio in rainbow trout, *Oncorynchus mykiss.*

Plant and animal wastes supplementation improved the growth rate, biochemical composition and nutrient utilization efficiencies in the experimental fishes during the feeding trial. This may be due to the incorporation of plant and animal wastes in the diets, which could have enriched the nutritional quality of the experimental feeds. The present results are coicides with the findings of Sahadevan (1992), who observed highest protein level in the diets improved the growth performance and feed utilization efficiencies in *M.rosenbergii.* During the present investigation, a progressive

increase in protein efficiency ratio and protein productive value with increasing levels of incorporation of plant and animal wastes were noted. Surplus protein content of the experimental feeds used as energy, leading to fat deposition and addition of calorific value of flesh in the experimental fishes.

The present results revealed that fish wastes supplemented feeds increased carcass protein and fat contents in the muscle tissues of the experimental fishes due to its highest protein content, essential amino acids and n-3 highly unsaturated fatty acids. These findings also correlate with the results of Shamsi *et al.* (2006), who reported that highest carcass protein, fat and water contents in muscle tissues of Nile tilapia, *Oreochromis niloticus* fry fed with fish meal based diet, which increased protein efficiency ratio and protein productive value. Highest growth rate and feed intake was observed in cuttle fish, *Sepia officinalis* and marron, *Cherax tenuimanus* (Smith) fed with fish meal included diet, which induced digestibility and absorption (Domingues *et al.*, 2005 and Fotedar, 2004). Presence of all necessary amino acids and n3 - n6 polyunsaturated fatty acids in the fish wastes could increase the nutritional quality of the experimental diets, feed digestibility and absorption, led to improved muscle proximate composition in the experimental fishes.

Poultry is one of the most promising candidates as the supplementary feed in carp culture. The present study have shown that highest weight gain, length gain, biochemical composition and feed utilization efficiencies were obtained in *C.catla* fed with broiler wastes supplemented diet next to fish wastes included feeds. Improved overall growth performances in the

experimental fishes may be due to the highest protein, fat, phosphorus and calcium contents in the poultry wastes incorporated diets. These findings were also supported by Hu *et al.* (2008), who found that incorporation of poultry by-product meal in the diet positively influenced the growth rate (weight gain and specific growth rate) and feed efficiency in gibel carp, *Carrassius auratus gibelio*.

Poultry by-product meal contains indispensable amino acids and high quality protein and lipid contents, which can influence the protein digestibility, protein efficiency ratio and muscle proximate composition in fishes. During the present investigation improved protein efficiency ratio, protein productive value, muscle protein and fat contents were recorded in the experimental fishes fed with broiler wastes supplemented feeds. These results were in accordance with that of Goda *et al.* (2007), who observed the highest body weight, specific growth rate and feed utilization efficiencies in African cat fish, *Clarias gariepinus* fed with supplemented diet containing poultry by-product meal. Similar results are also observed by Webster *et al.* (2000), who used poultry by-product meal as a dietary supplement, which enhanced the weight gain, muscle protein, fat and moisture contents in sunshine bass (*Morone chrysops* x *M.saxatilis*).

Guo *et al.* (2007) noticed that the highest protein (36.3%) and fat content in the poultry by-product meal increased the weight gain, specific growth rate and muscle proximate composition (moisture, protein and lipid) in cuneate drum, *Nibea miichthioides*. Carcass lipid content positively correlated with dietary lipid level irrespective of protein level and carcass protein, fat and ash contents increased with increasing dietary lipid (Subhadra *et al.*, 2006).

These findings support the present work, where highest protein and fat contents recorded in the broiler wastes supplemented diets, which enhanced the protein and fat digestibility, resulting in improved protein, fat, ash and calorific contents in the muscle tissues of the experimental fishes. Abdel-Fattah and EL-Sayed (1994) also reported increased feed utilization efficiencies and body lipid and ash contents in *Rhabdosargas sarba* fingerlings when fed with chicken offal meal.

Plant derived ingredients and corresponding diets had higher protein content and enhanced the digestibility of nutrients in the aquatic animals (Gangadhara *et al.*, 1997). In the present investigation *C.catla* grown in plant wastes (vegetable and fruit wastes) included diets exhibited improved feed intake and feed utilization efficiencies, because of the higher nutrient content, palatability and acceptability of the experimental diets. Better feed conversion ratio, protein efficiency ratio and higher muscle protein content were observed in carp, *Cirrhinus mrigala* fingerlings when fed with soybean meal based diet, which contains all essential amino acids. Soybean meal incorporation improved the palatability of feeds and also enhanced the protein digestibility (Jose *et al.*, 2006). Similarly, Sahzadi *et al.* (2006) observed the dietary supplementation of sunflower meal and cotton seed meal, which enhanced the nutritive value (protein, fat and gross energy) of the feed and boosted the feed digestibility and absorption, resulting in higher weight gain, length gain and specific growth rate in hybrid fingerlings (*C.catla* X *Labeo rohita*).

Apparent digestibility coefficients of plant proteins are remained high in carps. *C.catla* could digest plant-derived

ingredients more efficiently led to more feed intake, feed efficiency and muscle proximate composition. Campana-Torres *et al.* (2005) found that plant derived ingredients (soy paste, sorghum meal and textured wheat) supplemented diet fed to Australian red claw, *Cherax quadricarinatus* showed an increased growth rate, excellent dry matter and protein digestibility of the feeds.

Enhanced body weight, protein efficiency ratio and protein productive values were observed in common carp, *C.carpio* when fed with *Jatropha curcas* diet (Makkar and Becker, 1999). Similar findings were recorded in the present study, where increased growth rate, feed utilization efficiencies and muscle proximate composition were obtained in *C.catla* grown in vegetable and fruit wastes supplemented feeds. Gomes *et al.* (1995) also noticed the incorporation of plant proteins (rapseed, peas, soybean and maize gluten) increased the growth performance and apparent protein digestibility in rainbow trout, *O.mykiss.*

Based on the results of the present investigation, it was concluded that vegetable, fruit, broiler and fish wastes could be included in the feed formulation and used for the growth of *C.catla* fingerlings. This finding would be useful in formulating a cost-effective and eco-friendly farm made feed.

5.2 PHASE - 2

Probiotics used as the alternatives of antibiotics to promote fish growth and health in aquaculture systems. Commercial probiotics used in the present study composed of single strains (Sporlac® and Provisacc®) and mixture of several strains (Bioboost® and Eubioz®), which enhanced the growth performances,

nutritional indices and feed utilization efficiencies in *C.catla* than the control fishes. The results of the present experiment showed a dose-dependent effect of probiotics supplementation in *C.catla* diets. All the experimental diets prepared from different probiotics were well accepted and ingested by the experimental fishes. Hence, the palatability of the test diets was not affected by the use of probiotics as supplement.

Microbial feed supplementation Eubioz®, which contains *Lactobacillus acidophilus, Streptococcus thermophilus* and *Saccharomyces boulardii* improved the growth performances and decreased the feed conversion ratio in *C.catla.* The results were consistent with the results of previous researches. A compound additive containing lactic acid bacteria, *L.acidophilus, S.faecium* and *S.cerevisiae* were proved to increase the protein and fat absorption, decrease feed conversion ratio and reduce disease in fishes (Lara-Flores *et al.*, 2003). Taoka *et al.* (2006) also observed that mixed strains of probiotics (*B.subtilis, L.acidophilus, C.butyricum* and *S.cerevisiae*) stimulated the food digestibility and non-specific immune response by improving its enzyme activity such as lysozyme and protease.

The present results showed that feed utilization efficiencies were increased in probiotics supplemented diet fed fishes than the control fishes, because probiotics increased the digestive ability by producing extra cellular enzymes such as proteases, lipases and necessary growth factors. The present findings were coincided with the results of Song *et al.* (2006) and Yang. (1998), who reported enhanced feed utilization efficiencies in *Miichthys miiuy* fed with dietary *Clostridium butyricum*, which influenced digestive enzyme activity. Dietary administration of *S.faecium* M74

improved the intestinal microflora and digestive enzyme activity (protease and lipase), resulted in highest feed utilization efficiencies and muscle proximate composition in *Cyprinus carpio* (Bogut *et al.*, 1998).

A mixture of bacterial strains (*Lactobacillus*, *Streptococcus* and *Saccharomyces* sp.) positively influenced the growth and biochemical composition in *C.catla* by improving the nutritive value of the food, digestion and assimilation ability. Similar results were documented by Balcazar (2003) in *Litopenaeus vannamei* fed with supplemented diet contains mixed cultures of *Bacillus* and *Vibrio* sp., which improved the nutritive value of the food by supplying vitamins and fatty acids. In addition, Ziaei-Nejad (2006) showed that dietary administration of *Bacillus* sp. induced the food absorption and growth performances by enhancing protease levels.

C.catla grown in probiotics supplemented diets exhibited maximum values of growth and muscle proximate composition than the control fishes. The increased nutritional indices found in the experimental fishes probably indicated that supplemented diets induced the feed intake, protein and fat absorption. Yu *et al.* (2008) also reported increased biochemical composition in *L.vannamei* fed with dietary *Bacillus* which can produce a–glucosidase and ß–glucosidase enzymes and thereby it increased the digestion, feed utilization efficiencies and absorption. Probiotics may stimulated the activity of hydrolytic enzymes including proteases and amylases, which positively influenced the weight gain, specific growth rate and feed efficiencies in *C.catla* fed with commercial probiotics, Bioboost®, which contains bacterial and yeast cultures.

Live yeast culture, *S.cerevisiae* improved the nutritional value of the experimental feeds and also enhanced the muscle proximate composition of the experimental fishes. Yeast cultures can involve in the production of vitamins such as vitamin B12 and biotin. Yeast supplementation may also stimulate amylase secretion and brush border enzymes, thereby it influenced the digestion and feed intake in the experimental fishes. Oliver-Novoa *et al.* (2002) showed that dietary supplementation of torula yeast, *Candida utilis* to Nile tilapia, *O.niloticus* improved the nutritional indices and feed utilization efficiencies due to the production of vitamins and amino acids and enhanced the digestive metabolism by the secretion of a -amylase enzyme. Naik *et al.* (1999) used a commercial premix, G-probiotic in tilapia, *O.mossambicus* feed and determined that food conversion ratio and protein efficiency was best at a dose of 7.5 g G-probiotic $kg^{-1}$of diet.

Specific growth rate was highest in *C.catla* grown in probiotic supplemented diets and gives a positive correlation with protein efficiency ratio i.e. dietary protein intake. Lowest feed conversion ratio recorded in the probiotic supplemented diet fed fishes than the control fishes indicated better nutrient utilization. In the present study weight gain, length gain and specific growth rate showed higher values in *C.catla* fed with probiotic feed than the control feed. Bandyopadhyay and Kumar (2006) also achieved highest specific growth rate and protein efficiency ratio and lowest feed conversion ratio in Indian major carps (*C.catla, L.rohita* and *C.mrigala*) fed with probiotic supplemented diets, which improved digestion, feed intake and absorption. Probiotic bacteria, by virtue of their extra cellular enzymes, have been reported an important role in the process of digestion in turbot larvae, *Scopthalmus maximus* L. (Munilla-Moran, 1990).

Sporlac®, Bioboost® and Eubioz®, which contain lactic acid bacteria, boosted the growth rate, biochemical composition and feed utilization efficiencies in the experimental fishes. Lactic acid bacteria has the ability to tolerate the acidic and bile environment of the intestinal tract and also convert lactose into lactic acid, thereby reducing the pH in the gastro intestinal tract and naturally preventing the colonization by many bacteria. This may be the reason for the improvement of feed digestibility and utilization efficiencies of *C.catla* fingerlings during the present study. In support, Suyanandana *et al.* (1998) used *Lactobacillus* sp. as a feed additive in the diets for *O.niloticus* and found out improved gut microflora and digestive enzyme activity, which in turn influences growth performances and feed utilization efficiencies.

During the experimental period, fishes were active, healthy and disease free. This may be due to the incorporation of microbial supplement not only improved the growth rate of *C.catla* and also released antibiotics, thereby not being affected by certain opportunistic pathogens. The present findings were in accordance with Son *et al.* (2009), who noticed that *L.plantarum* incorporated diets increased the percent weight gain and feed efficiency in *Epinephelus coioides*. *L.plantarum* also increased in the fish posterior intestines and stimulated lysozyme and glutathione peroxidase activity, led to enhanced immunity and growth performances. Similarly, Gatesoupe (1994) showed that turbot larvae fed rotifers enriched with lactic acid bacteria had improved the resistance against pathogenic *Vibrio* infection and resulted in a significant increase in the growth rate (Weight and length gain) of the larvae. Probiotic strains (*L.acidophilus* and *L.sporogens*) found to have inhibitory effect on gram-negative bacteria present in the gut

microflora of *M.rosenbergii* post larvae and improved the growth rate (weight gain and specific growth rate) and feed utilization efficiencies (Venkat *et al.*, 2004).

The present results indicate that the use and application of probiotics is very promising, cost effective feed supplement to carp feed manufacture.

5.3 PHASE - 3

The medicinal herbs, *Phyllanthus emblica* and *Cynodon dactylon* incorporated feed induced the growth rate, biochemical composition and feed utilization efficiencies in *C.catla.* Medicinal herbs supplemented diets (T_1–T_6) were well accepted by the experimental fishes.

Digestibility of feed is an important factor to consider in determining the utilization of feed. Medicinal herbs contain potent bioactive substances, which may influence digestive process by enhancing or impairing enzyme activity and improving the digestibility of nutrients. Medicinal herbs included diets stimulated digestive enzyme activity and feed intake, thereby leading to better growth, feed utilization efficiencies and health in the experimental fishes. These results are in harmony with the findings reported by Unnikrishnan (1995) and Jeyaprakas and Euphrasia (1996). They reported incorporation of commercial herbal growth promoter, Livol (IHF-1000) improved the digestion, resulting in enhanced growth performance and feed utilization efficiencies in Indian major carp, *C.catla* and *L.rohita*. Maheshappa (2002) also inferred that the

medicinal herbs incorporated diets boostup digestive enzyme activity and led to increased consumption.

The active principles present in *P.emblica* and *C.dactylon* have stimulating the action on gut microflora. The increases in enzyme production can result in improvements in digestibility and availability of nutrients from feed stuffs. Medicinal herbs also reduce the amount of undigested material passing into the large intestine, led to limit the amount of substrate available for proliferation of pathogenic microbes. This may be the reason for the enhanced appetite, food consumption, feed utilization efficiencies and overall health of the experimental fishes in the present study. Venkatramalingam *et al.* (2007) observed that postlarvae of *Penaeus monodon* were fed with different percentages of the herbal appetizer *Zingiber officinalis* enriched *Artemia* and the results showed that significant improvement in digestive enzyme activity (amylase, protease and lipase), which enhanced feed intake, food conversion and production efficiencies.

Medicinal herbs promote lipid metabolism that catabolizes body fatty acids as main energy expenditure, resulting in efficient protein accumulation and growth performances in fishes (Ji *et al.*, 2007). Medicinal herbs also produce antioxidant compounds (carotenoids, flavonoids, benzoic acid, folic acid, ascorbic acid, triterpenoides etc.), which increase carcass unsaturated fatty acids content. Similar findings were observed in the present work, where *P.emblica* and *C.dactylon* enhanced the growth rate and muscle protein, carbohydrate and fat accumulation in the experimental fishes. Zakes *et al.* (2008) explained increased growth rate, muscle protein content and polyunsaturated fatty acids in juvenile pikeperch

(*Sander lucioperca*) when fed with formulated diet containing medicinal herbs, *Astragalus radix* and *Lonicera japonica.*

The improved feed intake and utilization efficiencies of *C.catla* were due to the stimulated digestive metabolism and increased intestinal gut microflora by the incorporation of *P.emblica* and *C.dactylon* in the experimental diets. Medicinal herbs supplementation improved the digestive enzyme activity of protease and amylase in hepatopancrease and intestines, which led to enhance digestion and absorption of food, this in turn could contribute to the improved growth in *L.vannamei* (Yu *et al.*, 2008). Feed conversion ratio, protein efficiency ratio, protein productive value and specific growth rate of *C.catla* administered medicinal herbs were significantly higher than the control fishes, because *P.emblica* and *C.dactylon* can inhibit the proliferation of pathogenic bacteria and preferentially maintain the intestinal microflora, resulting in improved digestibility and absorption. Further, Liu *et al.* (2004) reported that the improved digestion, absorption and growth rate of common carp, *C.carpio* fed with Chinese herbal medicines was due to the increased beneficial microflora in the intestine.

Papaya leaf meal contains an enzyme papain, which increased the protein digestion, food conversion ratio, specific growth rate and weight gain in *P.monodon* postlarvae fed with 16% unsoaked papaya leaf meal diet (Penaflorida, 1995). Similar effects were detected in the present investigation, where *P.emblica* and *C.dactylon* supplemented diets induced the digestive enzyme activity, which positively influenced protein, carbohydrate and fat digestion and absorption, thereby it increased the feed utilization efficiencies and muscle proximate composition in *C.catla.* Ashraf and Goda (2008) reported dietary Ginseng herb (Ginsana® G115) greatly

enhanced the growth performance, diet utilization efficiency and hematological indices in Nile tilapia, *O.niloticus* fingerlings.

The herbal growth promoters help to induce the transcription rate. This process leads to increased RNA, total amino acid and finally increases the production of proteins in the cells. Thereby *P.emblica* and *C.dactylon* promoted protein synthesis in the muscle tissues, led to increased weight gain and length gain in the experimental fishes. The present results were also supported by Al-Salahy (2002), who found that the incorporation of onion and garlic to the diets of *Clarias lazera* induced transcription rate, amino acid uptake and lead to high protein synthesis in the muscle tissues. Extract isolated from the medicinal plant, *Sesuvium portulacastrum* enhanced the muscle and liver RNA, which enhanced protein synthesis, resulting an increased muscle proximate composition, weight gain and length gain (Johnson and Banergi, 2007).

P.emblica supplemented diet fed fishes showed highest growth performance, nutrient utilization efficiencies and biochemical composition than the fishes fed with *C.dactylon* incorporated diet. Because, *P.emblica* incorporation improved the nutritive value of the experimental feeds due to its highest ascorbic acid and vitamin C contents, which helps to boost the functioning of immune system of the experimental fishes, thereby helps in preventing a wide range of diseases. *P.emblica* also improved the weight gain, specific growth rate and protein accumulation due to the positive nitrogen balance. Essential minerals such as chromium, zinc, copper, iron and cobalt content of *P.emblica* help in maintaining proper functioning of the metabolic activities of the experimental fishes.

Apart from enhancing the growth rate medicinal herbs also acts as immunostimulants to elevate the non-specific defence mechanism and prevent disease outbreaks. So, there was no mortality observed during the feeding trial and all the experimental fishes were active and healthy throughout the experimental period. Dietary supplementation of herbal immunostimulants, *Emblica officinalis, C.dactylon* and *Adathoda vasica* improved the immunological parameters and reduced the microbial infection in gold fish, *Carrasius auratus* (Minomol, 2005). Similar work was carried out by Citarasu *et al.* (2006), who used herbal medicinal plants including *C.dactylon* as a dietary supplement and found that improved immunological (phogocytic activity and bactericidal activity), haematological and biochemical parameters in the shrimp, *P.monodon.* Dietary supplementation of herbal immunostimulants *P.amarus* and *C.dactylon* enhanced the immune system and reduced the viral infection in *P.monodon* (Balasubramanian *et al.*, 2007 and 2008). Punitha *et al.* (2008) inferred that grouper, *Epinephelus tauvina* fed diets containing *P.niruri* and *C.dactylon* improved the non-specific defense mechanism including extracellular and intracellular respiratory burst activities, phogocytosis in blood leucocytosis, total plasma protein level, which influenced specific growth rate and condition factor.

Components present in the medicinal herbs and ayurvedic products provide vigor in a system worn out by disease, they also provide energy by acting as tonic to the body. Dietary supplementation of medicinal herbs *C.dactylon* and *P.emblica* improved the overall growth performances and health of *C.catla* fingerlings. The present findings revealed that medicinal herbs are a positive dietary supplement to induce effective technical and economical propagation for carp culture industry.

5 .4 PHASE - 4

All the experimental diets were palatable and were readily consumed by *C.catla* throughout the experiment. When these commercial growth promoters, Vimeral® (vitamin mixture) and Supplevite® (vitamin and mineral mixture) were mixed into the practical feed ingredients and pelletize, it would decrease the solubility into water and result in alleviating the leaching loss.

During 60 days of the feeding experiment veterinary growth promoters boosted the growth rate in the experimental fishes. This may be due to the presence of vitamin E in the veterinary growth promoters (Vimeral® and Supplevite®) supplemented diet, which reduces the peroxidation of polyunsaturated fatty acids and their phospholipid esters in membranes increased the growth rate in *C.catla*. These findings were supported by Ruff *et al*. (2001), who reported that dietary vitamin E and C supplement protect n-3 highly unsaturated fatty acid levels from peroxidation resulting in better growth performances in *L.vannamei*.

Feed utilization efficiencies and growth rate were highest in the experimental fishes fed with Vimeral® and Supplevite®, which contain vitamin and mineral mixture. Vitamin C content of supplemented diets (T_3-T_6) might be helpful for proper nutrient utilization, because ascorbic acid plays an important role in certain aspects of protein metabolism and it is an important molecule in the overall health of *C.catla*. Tewary and Patra (2008) pointed out dietary vitamin C supplementation may increased dietary utilization efficiencies by enhanced protein metabolism and it also modulate

the non-specific immune response by enhancing phagocytosis-mediated leukocyte functions and bacterial activity.

Mineral mixture supplemented diet fed fishes showed maximum growth, nutritional indices and feed utilization efficiencies than the control fishes during the present study. Mineral supplement can enhance the protein, carbohydrate and fat metabolism in fishes and this may be the reason for the improvement of growth rate in *C.catla* grown in Supplevite® incorporated feeds. Yang *et al.* (2006) and Ye *et al.* (2006) also recorded higher growth rate, feed utilization and body composition in juvenile silver perch (*Bidyanus bidyanus*) and grouper (*E.coioides*) fed with phosphorus included mineral mixture, which increased fat metabolism and the amount of energy-yielding nucleotides available for protein synthesis.

Commercial vitamin and mineral mixture (Supplevite®) containinig zinc can induce protein utilization in *C.catla* through its relationship with insulin and carboxypeptidase B, which is a pancreatic exopeptidase, contains zinc as an essential structural element. Due to the improved protein utilization and feed efficiency, mineral mixture incorporation boosted muscle proximate composition and growth rate in the experimental fishes. Similarly, Remseyer *et al.* (1999) found that the increased protein digestibility, weight gain and nutrient utilization in *O.mossambicus* was due to the induced carboxypeptidase activity by zinc incorporated mineral mixture supplemented feed. Zinc also induced dietary phosphorus utilization by inducing the activity of intestinal alkaline phosphatase and protein metabolism resulting in stimulated weight gain and body composition in rainbow trout (Cain and Garling, 1995).

Vitamin mixture (Vimeral®) supplementation stimulated the appetite, feed intake and food conversion in the experimental fishes. This may be due to the role of vitamins in the metabolism of aminoacids, carbohydrates and lipids and it is also required in several specific carboxylation and decarboxylation reactions. Mohamed *et al.* (2000) noticed that highest weight gain, specific growth rate, food conversion ratio and protein efficiency ratio in catfish, *Clarias batrachus* fed with supplemented diet containing biotin. Biotin is the part of coenzyme of several carboxylating enzymes such as pyruvate carboxylase and acetyl CoA carboxylase, which have a role in gluconeogenesis, fatty acid synthesis and degeneration and functions of the Krebs cycle.

Veterinary feed supplement containing vitamin and mineral mixture improved the weight gain and metabolism in the experimental fishes was due to its ability to prevent fat deposition and fighting against stress. Vitamin and mineral mixture also increased appetite, nutritional quality of the experimental feed and reduces feed conversion ratio. The present results were in accordance with the findings of Kharatmol (2006), who observed that improved weight gain, specific growth rate and nutrition utilization in *M.rosenbergii* fed with vitamin and mineral mixture supplemented diet influenced appetite, feed intake and provides strength against stressors.

Vimeral® and Supplevite® contain mixture of vitamins A, D3, B12 and E prevents anemia, acts against stress and improves muscle strength. Vitamin B complex with vitamin C improves metabolism, appetite and prevent ulcers in the experimental fishes. Vitamin mixture also enhances immunity, dietary utilization efficiencies and restores vigor thereby it improves

growth rate, biochemical composition and nutrient utilization efficiencies in *C.catla* during the present study.

All the experimental fishes were active, appeared healthy and there was no mortality recorded during the feeding trial. Vitamin and mineral supplementation not only increased the growth, but also provided strength and vitality to fight against diseases and increased overall performance of the experimental fishes. Dietary mineral mixture supplement have been found to influence the antibody production and provided resistance against pathogenic bacteria, *Edwardsiella ictaluri* in channel catfish resulting in improved growth performances (Eya and Lovell, 1998). Mineral mixture containing calcium, phosphorus, copper, iron, zinc, selenium, cobalt and magnesium, which helps in the formation of blood, enhances the phagocytic action of leucocytes and boosts up immunity in fishes. This may be the reason for the enhancement of overall growth performances and health of the *C.catla* in the present investigation.

The supplementation of veterinary growth promoters (Vimeral® and Supplevite®) containing vitamin and mineral mixtures improved the growth, muscle proximate composition and nutrient utilization efficiencies in Indian major carp, *C.catla*. Thus veterinary growth promoters can better be incorporated to develop environment - friendly feed for *C.catla*.