

SUMMARY & CONCLUSION

6.0 SUMMARY AND CONCLUSION

The present study has been undertaken to investigate the efficacy of formulated feeds on growth performance, nutritional indices and feed utilization efficiencies of Indian major carp, *Catla catla* (Hamilton, 1822). Low cost, locally available supplementary feed ingredients were identified and utilized in the feed formulation for the edible fish *C.catla* fingerlings. Nutrient values (protein, carbohydrate and fat contents) were estimated in the control feed and different experimental feeds prepared from plant wastes, animal wastes, probiotics, medicinal herbs and veterinary growth promoters.

Biogrowth parameters such as weight gain, length gain and specific growth rate (weight and length) were studied in the control and experimental fishes during 15, 30, 45 and 60 days of the experimental period. Proximate composition such as water content, protein, carbohydrate, fat, ash and calorific content were estimated in the muscle tissues of *C.catla* grown in the control and different treatments before and after the experimental period.

Feed utilization efficiencies were analysed in terms of feed conversion ratio, protein efficiency ratio, protein productive value and feed efficiency in *C.catla* fed with control and different experimental diets after 60 days of the feeding experiment. The salient findings of the present investigation are presented here.

PHASE - 1

- ❖ Nutritional value such as protein, carbohydrate and fat contents were highest (37.91, 13.51 and 15.32% respectively) in T₁₂ feed prepared from 30% fish wastes along with 70% rice bran and ground oil cake. The lowest protein (34.12%), carbohydrate (12.81%) and fat contents (14.01%) were obtained in the control feed prepared from rice bran and groundnut oil cake (1:1ratio).
- ❖ Fish wastes supplemented diet fed fishes (T₁₂) showed maximum weight gain (31.23, 58.81, 82.22 and 104.21%) and length gain (19.15, 46.81, 85.11 and 119.15%) during 15, 30, 45 and 60 days of the experiment. At the end of the experiment, minimum weight and length gain (40.02 and 25.19%) were recorded in the control fishes.
- ❖ Specific growth rate (weight and length) were highest in fishes fed with fish wastes at 30% level (T₁₂) during 15 days (0.95 and 0.81%), 30 days (1.44 and 1.46%), 45 days (1.66 and 1.89%) and 60 days (1.84 and 2.13%) of the experiment and lowest levels (1.14 and 1.01%) were noticed in the control fishes at the end of the experiment.
- ❖ Biochemical composition in muscle tissues of *C.catla* was increased in all the experimental fishes (T₁-T₁₂) than the control fishes. Among the different treatments, maximum water content (79.27%), protein (19.66%), carbohydrate (6.02%), fat (3.41%), ash (3.22%) and calorific contents (168.04 Kcal/gm) were estimated in *C.catla* grown in T₁₂ feed. The minimum biochemical composition were recorded in the

control fishes and the estimated values were 73.29, 18.08, 4.57, 2.58, 2.30% and 145.27 Kcal/gm respectively.

- ❖ Plant and animal wastes supplementation improved feed utilization efficiencies in the experimental fishes. Highest feed conversion ratio of 2.53% was observed in fishes grown in the control feed and lowest value (1.53%) was observed in T₁₂ fishes. Lowest feed conversion ratio in T₁₂ fishes indicates better nutrient utilization.
- ❖ The maximum protein efficiency ratio, protein productive value and feed efficiency (2.88, 7.04 and 66.13%) were obtained in T₁₂ fishes and minimum values (1.69, 3.04 and 25.01%) were noticed in *C.catla* grown in the control feed.
- ❖ Among the twelve different feeds prepared from plant and animal wastes, fish wastes incorporated feed improved better growth, biochemical composition and feed utilization efficiencies, followed by broiler, fruit and vegetable wastes incorporated feeds.

PHASE - 2

- ❖ Probiotics supplementation (Sporlac[®], Provisacc[®], Bioboost[®] and Eubioz[®]) improved the nutritional quality of all the experimental feeds (T₁-T₁₂). Among the twelve different treatments protein, carbohydrate and fat contents were maximum (35.58, 13.46 and 14.93% respectively) in T₁₂ feed prepared from 3% Eubioz[®] and 97% rice bran and groundnut oil cake. Minimum nutrient contents were estimated in the control feed and the contents analysed were 34.12, 12.81 and 14.01%.

- ❖ *C.catla* grown in different probiotic treatments (T₁-T₁₂) exhibited highest growth rate than the control fishes. However, maximum weight gain (28.50, 56.17, 76.98 and 95.24%) and length gain (18.02, 47.41, 86.01 and 107.98%) were recorded in T₁₂ fishes during 15, 30, 45 and 60 days of the experiment. At the end of the experiment, minimum weight and length gain (43.16 and 27.76%) were recorded in the control fishes.
- ❖ Eubioz[®] (contains mixed cultures of bacteria and yeast) supplemented diet fed fishes (T₁₂) showed highest specific growth rate (weight and length) during 15 days (0.89 and 0.73%), 30 days (1.33 and 1.37%), 45 days (1.56 and 1.80%) and 60 days (1.84 and 2.08%) of the experiment. Lowest specific growth rate (weight and length) values of 1.18 and 1.18% were recorded in the control fishes at the end of the experimental period.
- ❖ Probiotics incorporation in the experimental feeds enhanced the biochemical composition in the muscle tissues of *C.catla* after 60 days of experimental period. Highest water content (77.63%), protein (19.93%), carbohydrate (6.24%), fat (3.45%), ash (3.14%) and calorific content (170.78 Kcal/gm) were estimated in T₁₂ fishes and minimum biochemical composition (72.75, 18.58, 4.85, 2.73 and 2.33% and 150.61 Kcal/gm) were noticed in the control diet fed fishes.
- ❖ Feed utilization efficiencies were improved in the experimental fishes fed with different probiotics than the control fishes. Highest feed conversion ratio (2.21%) was recorded in the control fishes and T₁₂ fishes showed lowest feed conversion ratio (1.48%), which indicated better nutrient utilization.

- ❖ Maximum values of protein efficiency ratio (2.68%), protein productive value (6.21%) and feed efficiency (62.82%) were recorded in *C.catla* grown in T₁₂ diet and minimum values of 1.71, 3.11 and 24.11% were in the control fishes.
- ❖ Of all the experimental diets (T₁-T₁₂), 3% Eubioz[®] supplementation improved maximum growth, biochemical composition and feed utilization efficiencies in *C.catla*. Although different combinations of all the probiotics supplementation enhanced the overall growth performances of *C.catla*, the maximum growth, proximate composition and feed utilization efficiencies were obtained in the Eubioz[®] supplemented fishes, followed by Bioboost[®], Provisacc[®] and Sporlac[®].

PHASE - 3

- ❖ Medicinal herbs (*Cynodon dactylon* and *Phyllanthus emblica*) enriched the nutritional quality (protein, carbohydrate and fat contents) of the experimental feeds (T₁-T₆). Among the six different feeds highest protein (35.55%), carbohydrate (14.15%) and fat content (14.29%) were estimated in T₆ feed prepared from 15% *P.emblica* and 85% rice bran and groundnut oil cake. Lowest protein, carbohydrate and fat contents (34.12, 12.81 and 14.01%) were estimated in the control feed.
- ❖ Growth rate was increased in *C.catla* fed with *C.dactylon* and *P.emblica* (T₁-T₆) than the control fishes. 10% *P.emblica* supplemented diet (T₅) enhanced maximum weight gain

(20.39, 36.17, 61.01 and 74.68%) and length gain (13.62, 29.52, 62.02 and 84.22%) in T₅ fishes during 15, 30, 45 and 60 days of the experiment. At the end of the experiment, minimum weight and length gain (40.13 and 26.98%) were recorded in the control fishes.

- ❖ Maximum specific growth rate (weight and length) were observed in T₅ fishes during 15 days (0.75 and 0.61%), 30 days (1.26 and 1.28%), 45 days (1.53 and 1.85%) and 60 days (1.72 and 1.96%) of the experiment. Minimum specific growth rate values of 1.27 and 1.16% were noticed in the control fishes at the end of the experiment.
- ❖ *C.catla* grown in the different experimental diets showed an enhanced biochemical composition in their muscle tissues. Highest water content (77.04%), protein (19.76%), carbohydrate (6.10%), fat (3.40%), ash (3.10%) and calorific content (168.75 Kcal/gm) were estimated in the fishes fed with 10% *P.emblica* and lowest values (72.27, 18.53, 4.77, 2.75 and 2.37% and 150.20 Kcal/gm) were recorded in the control fishes.
- ❖ Dietary utilization efficiencies were increased in the experimental fishes fed with medicinal herbs than the control fishes. Feed conversion ratio was maximum (2.17%) in control fishes and *C.catla* grown in T₅ feed showed minimum feed conversion ratio (1.51%), which indicated better nutrient utilization.
- ❖ Highest protein efficiency ratio (2.38%), protein productive value (5.64%) and feed efficiency (54.62%) were noticed in T₅ fishes and lowest values of 1.71, 3.18 and 23.23% were recorded in the control fishes.

- ❖ Both medicinal herbs (*C.dactylon* and *P.emblica*) improved the better growth performances in the experimental fishes. However, 10% *P.emblica* supplementation boosted highest growth, biochemical composition and feed utilization efficiencies in *C.catla* fingerlings.

PHASE - 4

- ❖ Veterinary growth promoters (Vimeral[®] and Supplevite[®]) incorporation improved the nutritional quality of the experimental feeds (T₁-T₆). Among the six different treatments the nutrient contents such as protein, carbohydrate and fat contents were maximum (35.58, 13.18 and 14.50% respectively) in T₆ feed prepared from 15% Supplevite[®] along with 85% rice bran and groundnut oil cake. Minimum protein, carbohydrate and fat contents (34.12, 12.81 and 14.01%) were estimated in the control feed.
- ❖ Different combinations of veterinary growth promoters boosted the growth rate in all the experimental fishes. Of all the different treatments highest weight gain (19.38, 34.84, 59.03 and 73.82%) and length gain (10.94, 27.66, 59.57 and 80.85%) were recorded in T₅ fishes fed with 10% Supplevite[®] during 15, 30, 45 and 60 days of the experiment. After 60 days of the experimental period, control fishes showed lowest weight and length gain (41.00 and 24.33%).
- ❖ Maximum specific growth rate (weight and length) during 15 days (0.62 and 0.41%), 30 days (1.04 and 1.08%), 45 days (1.42 and 1.63%) and 60 days (1.59 and 1.85%) of the

experiment were observed in T₅ fishes. Minimum specific growth rates (1.15 and 1.01%) were observed in *C.catla* grown in the control after 60 days of the experimental period.

- ❖ Supplementation of Vimeral[®] and Supplevite[®] increased the muscle proximate composition in all the experimental fishes (T₁-T₆) than the control. T₅ fishes exhibited highest water content (76.37%), protein (18.93%), carbohydrate (5.42%), fat (3.05%), ash (2.83%) and calorific content (157.98 Kcal/gm), whereas control fishes showed lowest biochemical composition (73.19, 18.01, 4.56, 2.55 and 2.31% and 144.01 Kcal/gm) after the experimental period of 60 days.
- ❖ Veterinary growth promoters incorporated diet enhanced the feed utilization efficiencies in the experimental fishes. Highest feed conversion ratio (2.51%) was recorded in the control fishes and lowest feed conversion ratio (1.71%) was noticed in T₅ fishes.
- ❖ The highest value of protein efficiency ratio (2.34%), protein productive value (5.72%) and feed efficiency (46.13%) were noticed in T₅ fishes and lowest values (1.58, 3.00 and 25.01%) were recorded in the control fishes.
- ❖ Of all the experimental diets, 10% of supplevite[®] supplementation improved growth rate, biochemical composition and feed utilization efficiencies in *C.catla*. However, different combinations of both veterinary growth promoters enhanced the overall growth performances.

The following conclusions may be drawn from the present investigation:

- Fish feeds prepared from plant and animal wastes (vegetable, fruit, broiler and fish wastes) were proved to be an effective supplement for the enhancement of nutritional quality of the experimental feeds and overall growth performance of *Catla catla*.
- All the four selected probiotics included diets were able to improve the growth, nutritional quality and feed utilization efficiencies of *C. catla*.
- Dietary supplementation of medicinal herbs, *Cynodon dactylon* and *Phyllanthus emblica* were efficient for the improvement of muscle proximate composition, growth rate and dietary utilization of *C. catla*.
- In *C. catla* veterinary growth promoters incorporated feeds were found to boost the growth rate, biochemical composition and feed utilization efficiencies.
- All the selected feed ingredients were well accepted and digested by the experimental fishes and were found to ensure the nutritional quality of the experimental feeds.

Present study clearly hold promise for the effective, economical and eco-friendly farm made feed preparation and production of safe-aqua food.

Recommendations

- Aquaculture industries can take steps in the manufacture of fish feed by using the wastes (plant and animal wastes), probiotics, medicinal herbs and veterinary growth promoters for the enhancement of growth rate of edible fishes.
- Role of single and mixed cultures of microbial supplements in the fish feed formulation can be studied for the enhancement of growth, yield and health of the different fish species.
- Probiotics used for fish feed preparation can be further enhanced by using engineered novel strains of bacteria and yeast cultures for the improvement of nutritional status of fish culture.
- Even though probiotics improved the overall growth of *C.catla*, studies can be carried out to assess the exact mechanism of action of probiotics on the gastro intestine of fishes.
- Further studies can be carried out to isolate the active principles of various medicinal herbs, which can be used for fish feed preparation and its role on the enhancement of growth rate.
- Immunostimulatory effect of various herbal biomedicines can be studied in various edible fishes.
- Women entrepreneurs can be involved in this project to ensure their economy.

- Fish farmers and their families can involve in the preparation of nutritionally rich, balanced fish feeds using the selected low cost, locally available wastes and medicinal herbs.

Finally, if scientific opinion joined with the knowledge of fish farmers and industry, the supply of protein rich food to the burgeoning population as well as the economic efficiency of the country will certainly improve a lot.