Assessing the Condition Index of Black Molly (*Poecilia sphenops*) Under Diverse Feeding Strategies

Suvadeep Samanta[1], Sana Ahmed[2], Sufia Zaman[3] and Abhijit Mitra[4]

[1]Research Scholar, Department of Oceanography, Techno India University, West Bengal, EM 4 Salt Lake, Sector V, Kolkata 700091, India.

[2]Assistant Professor, Department of Oceanography, Techno India University, West Bengal, EM 4 Salt Lake, Sector V, Kolkata 700091, India.

[3]Associate Professor, Department of Oceanography, Techno India University, West Bengal, EM 4 Salt Lake, Sector V, Kolkata 700091, India.

[4]Director (Research), Techno India University, West Bengal, EM 4 Salt Lake, Sector V, Kolkata 700091, India.

Abstract

The present study examines the effects of varying protein levels in fish feed on the condition index of black molly (*Poecilia sphenops*), a common ornamental fish, over a two-year period (2022 and 2023). Using 25%, 30%, and 35% protein levels, the results revealed that higher protein content led to greater growth in length and weight, with the 35% protein group showing the most significant physical development as reflected through the value of condition index. However, a decline in the condition index was observed with time across all groups, suggesting that protein alone is insufficient to maintain long-term health. However, this work highlights the need for protein for gaining an optimum condition index value. Python programming was used for data analysis, emphasizing the importance of computational tools in assessing nutritional impacts on ornamental fish health and growth. Overall, the findings stress that while protein-rich diets enhance growth in biomass, a more comprehensive approach is required to sustain health and vitality in *Poecilia sphenops* populations.

Keywords: *Ornamental Fish, Black Molly (Poecilia sphenops), Fish Feed, Condition Index, Python*

1. Introduction

Ornamental fish farming has gained significant attention globally due to its economic value and appeal as a popular hobby. In Indian sub-continent, ornamental fish species can provide an alternative livelihood to the population preferably in the coastal regions who are mostly poverty stricken (Trivedi et al. 2016; Mitra et. al., 2011; Banerjee et. al., 2012; Sengupta et.al., 2013; Mitra, 2000; Mitra, 2013; Mitra and Zaman, 2015; Mitra and Zaman, 2020). Ornamental fish species can provide an alternative livelihood to the island dwellers and to the local population of Indian Sundarbans who are mostly poverty stricken. Culture of these ornamental fishes will upgrade their economic profile as the ornamental fishes have wide internal and exports market (Ahmed et. al., 2022).

The black molly (*Poecilia sphenops*), an ornamental species from the family Poeciliidae, is commonly reared in freshwater aquarium due to its aesthetic value, ease of breeding, and adaptability to varying water conditions (George & Pandian, 1995; Francis, 1992). Although the ornamental fish trade contributes substantially to the global economy, success in breeding and rearing these fish depends on

optimizing dietary conditions, especially protein levels, to ensure robust growth, survival, and reproductive performance (Ahilan et. al., 2010).

Proteins, alongside lipids and carbohydrates, form the foundation of fish nutrition and play a crucial role in metabolism, growth, and reproductive health. Ornamental fish, such as black molly, require higher protein levels in their diet compared to terrestrial animals. This is due to their unique physiological needs and the energy demands in a confined aquarium environment, where they cannot forage naturally as they would in the wild (NRC, 1993). Several studies have highlighted the importance of balanced protein levels for ornamental fish species, including the guppy (*Poecilia reticulata*), sword tail (*Xiphophorus helleri*), and discus (*Symphysodon aequifasciatus*), with protein requirements varying between 29% and 50% depending on the species and life cycle stage (Chong, Hashim & Ali, 2000; Kruger, Britz & Sales, 2001; Elangovan & Shim, 1997).

Black molly fish are livebearers, meaning they give birth to live young rather than laying eggs, making their reproductive health and performance critical to the success of ornamental fish breeding. Nutritional factors, particularly dietary protein levels, directly affect fecundity, fry production, and survival. Studies have shown that inadequate protein intake during the breeding phase can lead to lower fry survival rates, poor reproductive success, and overall decreased health in adult fish. Therefore, determining the optimal dietary protein level for black molly fish is essential for enhancing their growth, reproductive success, and longevity in captivity (Sampath & Pandian, 1984).

Fish, including ornamental species like black molly, require protein as the primary source of essential amino acids, which are *vital* for tissue repair, muscle development, and overall metabolic functions (NRC, 1993). The dietary protein requirements for fish are generally higher than for terrestrial animals due to their aquatic environment, where temperature fluctuations and water quality significantly influence metabolic processes (Chong et al., 2004). Protein deficiency in fish diets can lead to stunted growth, reduced reproductive performance, weakened immune systems, and even mortality. On the other hand, excessive protein can result in inefficient energy use, where excess nitrogen is excreted, leading to water quality issues in confined aquaria.

Numerous studies have emphasized the need to balance protein levels in fish feed. For example, Mohanta, Subramanian, and Korikanthimath (2012) reported that freshwater angelfish (*Pterophyllum scalare*) showed optimal growth and nutrient utilization when fed diets containing approximately 30% protein. Similarly, Elangovan and Shim (1997) found that juvenile *Barbodes altus* exhibited the best growth response when fed diets with 41.7% protein. These findings align with the hypothesis that different fish species have varied protein requirements based on factors such as age, metabolism, and reproductive stage (Sampath & Pandian,1984).

The black molly, like many other ornamental fish, has unique nutritional needs due to its reproductive characteristics and environmental adaptation. Optimal protein levels are necessary not only for the fish's growth but also for enhancing reproductive performance, which is a critical factor for breeders aiming to produce healthy offspring. However, despite the economic and ecological importance of this species, there has been limited research focused on determining its specific dietary protein requirements (Francis, 1992; Beck, Blumer & Brown, 2003).

In livebearer fish species like black molly, dietary protein plays a crucial role in reproductive health. The development of reproductive tissues, ovary maturation, and fry production all depend heavily on protein intake. High-protein diets have been shown to improve fecundity and egg production in various fish species. For instance, many researchers observed that female guppies fed diets containing 43.6% protein exhibited significantly higher reproductive output, including absolute fecundity and fry survival, compared to those fed lower-protein diets. This trend is consistent with studies on other ornamental fish species, such as the swordtail and angelfish, where higher dietary protein levels resulted in better reproductive performance (Chong et al., 2004; Mohanta et al., 2012).

In black molly fish, the relationship between dietary protein and reproduction is also linked to fry survival. Adequate protein intake during gestation ensures the production of healthy fry with better chances of survival in a controlled environment. Studies have shown that low-protein diets can lead to increased mortality rates among fry due to malnourishment and weakened immune responses (Bahnasawy, 2009). The findings of the present study highlight the need for balanced protein levels to improve not only the health of adult fish but also the survival rates of their offspring (Ahilan et al., 2010).

Research on the nutritional requirements of black molly has primarily focused on understanding the species' protein needs for optimal growth and reproduction. Beck, Blumer, and Brown (2003) studied the effects of salinity on black molly metabolism and growth, indicating that environmental factors also influence dietary requirements. However, protein levels in the diet remain the most critical determinant of growth and reproductive success in this species (George & Pandian, 1995).

Studies have shown that black molly fish can tolerate a wide range of dietary protein levels, but their optimal growth and reproductive performance are achieved at higher protein levels. For instance, Bahnasawy (2009) found that Nile tilapia, a closely related species, exhibited the highest growth and survival rates when fed diets containing 35% to 47% crude protein. These findings suggest that black molly may require similar dietary conditions to maximize growth and reproductive output.

The present study builds on this foundation by evaluating the effects of three different dietary protein levels (25%, 28%, and 35%) on the growth and survival of black molly fish over a 120-day period. By focusing on the condition index values, this research aims to provide a comprehensive understanding of how protein levels influence the overall health and productivity of *Poecilia sphenops*.

The primary objective of this research is to determine the optimal dietary protein level required for the growth, survival, and reproductive performance of black molly fish. Specifically, the study aims to investigate the impact of different dietary protein levels (25%, 30%, and 35%) on the condition index and survival of black molly over a 120-day period during two consecutive years 2022 and 2023.

By addressing these objectives, the study seeks to fill a gap in the existing literature on black molly nutrition and contribute valuable insights into improving ornamental fish farming practices.

2. Materials and Methods

2.1. Experimental Design

Experimental studies were conducted in the wet laboratory at Techno India University, West Bengal, Salt Lake Campus (N 24°34'35.0" & E 88°25'40.9") for a 120-days or 16-weeks period. Approximately 150 black molly fries were sourced from the Kolkata market. These fries were acclimatized for one week. The aquarium at Techno India University, West Bengal, was used three times a year with a four months duration (~16 weeks) for each treatment of feed. Three treatment groups (T1, T2, T3), each consisting of 50 molly fries was taken for our experiment. Three different categories of diets were tested: Diet A (formulated feed with 25% crude protein), Diet B (formulated feed with 30% CP), and Diet C (formulated feed with 35% CP). The fish fries were divided into groups of 150 fish, weighed, and stocked to be utilized for each experimental cycle of 16 weeks in the aquarium placed at 7th floor of Techno India University, Salt Lake Campus. The fishes were raised under controlled conditions for 120 days (~ 16 weeks), with the length, weight, and survival rates being monitored and recorded throughout the experiment.

2.2. Data-Collection

Average Body Weight (W) was determined using a digital weighing scale with an accuracy of 0.01 grams, while Average Body Length (L) was measured using a digital caliper with an accuracy of 0.1 millimeters.

The condition index (K) of the fish was calculated using the formula:

$$K = \frac{W}{L^3} \times 100$$

This formula helps in assessing the overall health and well-being of the fish, with higher values indicating better condition of the aquarium with respect to feed quality. We have tried to maintain the water quality in the aquarium (in all the 3 experimental cycles) almost uniform to nullify the impact of hydrological parameters (preferably water temperature, pH, dissolved oxygen, and suspended particulate matter) on the condition index of the cultured fish species.

2.3. Python program to evaluate K

A Python program was developed to compute the condition index (K) of black molly fish using the formula stated in section 2.2 (Fig. 1). It prompts the user to input the fish's weight and length, then computes and displays the condition index. The program also handles the case where the length is zero to avoid division by zero errors. The result is presented with two decimal precisions for clarity.

```python
# Function to calculate condition index (K)
def calculate_condition_index(weight, length):
    if length == 0:
        return "Length cannot be zero"

    K = (weight / (length ** 3)) * 100
    return K

# Input values for weight (in grams) and length (in centimeters)
weight = float(input("Enter the average body weight of the fish in grams: "))
length = float(input("Enter the average body length of the fish in centimeters: "))

# Calculate the condition index
condition_index = calculate_condition_index(weight, length)

# Output the result
print(f"The Condition Index (K) of the black molly fish is: {condition_index:.2f}")
```

Fig. 1 Python program to evaluate K

3. Results

The condition index results of fish fed with diets containing varying protein percentages are presented in Tables 1, 2, and 3.

The value of condition index was lowest in fish fed with diet having 25% protein (Diet A). In 2022, the mean length of the fish was 2.94 cm, with an average weight of 3.6 gm and a condition index of 17.46. In 2023, the mean length increased to 4.62 cm, and the average weight increased to 4.93 gm. However, the condition index decreased significantly to 5.15 (Table 1).

The value of condition index increased in fish fed with diet having 30% protein (Diet B). In 2022, the mean length was 2.8 cm, and the average weight was 5.89 gm, with a condition index of 28.44. In 2023, the mean length increased to 4.67 cm, and the average weight rose to 8 gm. The condition index was 8.52 in 2023, showing a decline from 2022 (Table 2).

The value of condition index was highest in fish fed with diet having 35% protein (Diet C).
In 2022, the mean length was 2.82 cm, and the average weight was 8.41 gm, with a condition index of 38.05, and in 2023, the mean length increased to 4.67 cm, with the average weight at 9.81 gm. The condition index was 9.97 (Table 3).

It can be stated from the condition index values and the corresponding feed quality in terms of CP that the highest protein content (35%) had the most significant positive effect on fish growth in terms of both length and weight irrespective of years.

We also observed 71%, 79% and 89% survival percentage in the aquarium provided with Diet A, B and C respectively during 2022. In 2023, the values decreased to 69%, 77%, and 81% indicating the necessity of considering parameters other than protein in the fish diet.

Table 1 Condition Index of black molly fed with traditional feed (25% Protein)

2022	**Length (cm)**	**Weight (gm)**	**Condition Index**
1	1.99	2.91	36.93
2	2.03	3.01	35.98
3	2.27	3.1	26.5
4	2.3	3.2	26.3
5	2.4	3.29	23.8
6	2.58	3.39	19.74
7	2.72	3.48	17.29
8	2.86	3.58	15.3
9	2.99	3.61	13.5
10	3.18	3.77	11.72
11	3.27	3.86	11.04
12	3.41	3.96	9.99
13	3.55	4.05	9.05
14	3.68	4.09	8.21
15	3.82	4.14	7.43
16	3.98	4.16	6.6
Mean	**2.94**	**3.6**	**17.46**
2023	**Length (cm)**	**Weight (gm)**	**Condition Index**
1	4.05	4.66	7.01
2	4.12	4.7	6.72
3	4.2	4.81	6.49

4	4.25	4.83	6.29
5	4.31	4.86	6.07
6	4.42	4.89	5.66
7	4.53	4.91	5.28
8	4.56	4.92	5.19
9	4.64	4.95	4.96
10	4.71	4.99	4.78
11	4.78	5.00	4.58
12	4.96	5.02	4.11
13	4.93	5.03	4.20
14	5.13	5.07	3.76
15	5.18	5.08	3.65
16	5.21	5.09	3.60
Mean	**4.62**	**4.93**	**5.15**

Table 2 Condition Index of black molly fed with feed A (30% protein)

2022	**Length (cm)**	**Weight (gm)**	**Condition Index (CI)**
1	2.3	5.12	42.08
2	2.44	5.65	38.89
3	2.39	5.88	43.07
4	2.4	5.92	42.82
5	2.46	5.05	33.92
6	2.59	5.18	29.81
7	2.69	5.31	27.28
8	2.71	5.49	27.58
9	2.84	5.58	24.36
10	2.9	5.61	23
11	2.93	5.84	23.22
12	3.08	5.97	20.43
13	3.19	6.26	19.28
14	3.28	6.3	17.85
15	3.3	7.42	20.65
16	3.32	7.61	20.8
Mean	**2.8**	**5.89**	**28.44**
2023	**Length (cm)**	**Weight (gm)**	**Condition Index (CI)**
1	3.51	6.79	15.7
2	3.72	6.86	13.33
3	3.86	6.97	12.12
4	4.01	7.08	10.98
5	4.19	7.11	9.67
6	4.31	7.22	9.02
7	4.45	7.41	8.41
8	4.6	7.52	7.73
9	4.69	7.6	7.37
10	4.9	7.99	6.79

11	5.04	8.56	6.69
12	5.19	8.92	6.38
13	5.34	8.97	5.89
14	5.58	9.38	5.4
15	5.63	9.66	5.41
16	5.7	9.92	5.36
Mean	**4.67**	**8.00**	**8.52**

Table 3 Condition Index of black molly fed with feed B (35% protein)

2022	**Length (cm)**	**Weight (gm)**	**Condition Index (CI)**
1	2.3	6.45	53.01
2	2.44	6.76	46.53
3	2.49	6.88	44.56
4	2.5	6.92	44.29
5	2.59	7.05	40.58
6	2.62	7.18	39.92
7	2.69	7.31	37.55
8	2.71	7.49	37.63
9	2.84	8.58	37.46
10	2.9	8.61	35.3
11	2.93	9.84	39.12
12	3.08	9.97	34.12
13	3.19	10.26	31.61
14	3.28	10.3	29.19
15	3.3	10.42	29
16	3.32	10.61	28.99
Mean	**2.82**	**8.41**	**38.05**
2023	**Length (cm)**	**Weight (gm)**	**Condition Index (CI)**
1	3.51	6.79	15.7
2	3.72	6.86	13.33
3	3.86	6.97	12.12
4	4.01	7.08	10.98

5	4.19	8.11	11.03
6	4.31	8.22	10.27
7	4.45	9.41	10.68
8	4.6	9.52	9.78
9	4.69	10.6	10.28
10	4.9	10.99	9.34
11	5.04	10.56	8.25
12	5.19	11.92	8.53
13	5.34	11.97	7.86
14	5.58	12.38	7.13
15	5.63	12.66	7.09
16	5.65	12.92	7.16
Mean	**4.67**	**9.81**	**9.97**

4. Discussion

The results presented in Tables 1, 2, and 3 offer a comprehensive analysis of the effects of varying protein levels (25%, 30%, and 35%) in the feed of black molly fish on their growth and condition index over two years. Protein is an essential nutrient for the growth and overall health of fish, and its varying levels in feed can significantly impact their development. In the study, black mollies fed with 25% protein (Table 1) exhibited the slowest growth, as reflected in both length and weight, with a mean length of 2.94 cm and weight of 3.6 gm in 2022. By 2023, the length increased to 4.62 cm and weight to 4.93 gm, but the condition index showed a sharp decline from 17.46 to 5.15. This indicates that while the fish did grow, their overall health or well-being may have been compromised, likely due to inadequate protein intake or any other parameters not considered in this research. The condition index, a measure of the fish's health and robustness, continued to decrease, signalling that the 25% protein diet might not provide sufficient nutrition for optimal growth and maintenance.

Fishes fed with 30% protein (Table 2) showed better growth outcomes than the 25% group, with a mean length of 2.8 cm and weight of 5.89 gm in 2022, increasing to 4.67 cm and 8 gm in 2023, respectively. However, the condition index, which was 28.44 in 2022, dropped to 8.52 in 2023, indicating a decline in health despite the fish's increase in size and weight. This suggests that while the 30% protein feed was more effective than the 25% protein feed in promoting growth, it might still not be sufficient for maintaining the fish’s health over a longer period.

Fishes fed with 35% protein (Table 3) demonstrated the most significant growth, with a mean length of 2.82 cm and weight of 8.41 gm in 2022, which increased to 4.67 cm and 9.81 gm in 2023. The condition index, starting at 38.05 in 2022, dropped to 9.97 in 2023, which, while still showing a decrease, was relatively better compared to the other groups. The 35% protein feed clearly promoted the greatest growth in terms of both length and weight, making it the most effective diet in the study for enhancing physical development. However, the decline in condition index across all groups over time raises

concerns about factors beyond protein content that could be affecting the fish's health, such as feed quality, nutrient absorption, or environmental factors. Although the 35% protein diet yielded the best growth results, the drop in condition index suggests that protein alone may not be sufficient to ensure long-term fish health and well-being. The decline in condition index could imply that other nutrients, or perhaps even the balance of nutrients, play a critical role in maintaining fish vitality, and that simply increasing protein content may not address all the fish's dietary needs. The findings from this study underline the importance of not only focusing on protein levels but also considering the overall composition of the feed to ensure that it meets the comprehensive nutritional requirements of the fish. Additionally, the observed growth patterns suggest that while higher protein diets contribute significantly to fish growth, there may be diminishing returns in terms of the condition index, which could be influenced by other dietary or environmental factors. This study highlights the need for further research into the precise nutritional balance required for optimal growth and health in black molly fish, including the roles of fats, carbohydrates, vitamins, and minerals in conjunction with protein. Moreover, it raises the question of whether the condition index, as a metric of health, is being influenced by factors such as feed quality or environmental conditions, including water quality, temperature, and stocking density, which could have played a role in the declining condition index observed across all protein levels over time.

In conclusion, we presume that while the 35% protein feed led to the most significant physical growth, it is evident that protein alone cannot guarantee the overall health of black molly fish, as indicated by the condition index decline with the passage of time. These points to the need for a more balanced approach to fish nutrition, where protein is optimized alongside other essential nutrients to promote not only growth but also sustainable health and vitality in fish populations.

References

1. Ahilan, B., Nithiyapriyatharshini, A., & Ravaneshwaran, K. (2010). Influence of certain herbal additives on the growth, survival, and disease resistance of goldfish, *Carassius auratus* (L). *Tamil Nadu Journal of Veterinary and Animal Sciences, 6* (1), 51.
2. Ahmed, S. et al. (2022). Distribution of Major Ornamental Fishes in the Estuaries of Indian Sundarbans, *Parana Journal of Science and Education,* 8 (6), 1-8.
3. Bahnasawy, M. (2009). Effect of dietary protein levels on growth performance and body composition of monosex Nile tilapia, *Oreochromis niloticus* L. *Pakistan Journal of Nutrition, 8* (5), 674-678.
4. Banerjee, S., Choudhury, A., & Manna, B. (2012). Ornamental fish farming as a livelihood alternative for the rural poor: A study from West Bengal, India. *International Journal of Aquatic Biology*, **3**, 128-136.
5. Beck, M. L., Blumer, L. S., & Brown, J. L. (2003). Effects of salinity on metabolic rate in black mollies. *Tested Studies for Laboratory Teaching, 24*, 211-222.
6. Chong, A. S. C., Hashim, R., & Ali, A. B. (2000). Dietary protein requirements for discus (*Symphysodon spp*.). *Aquaculture Nutrition, 6*(4), 275-278.
7. Chong, A. S. C., Ishak, S. D., Osman, Z., & Hashim, R. (2004). Effect of dietary protein level on the reproductive performance of female swordtails *Xiphophorus helleri* (Poeciliidae). *Aquaculture Nutrition,* 10, 361-367.
8. Elangovan A. & Shim K.F. (1997). Growth response of juvenile Barbode altus fed isocaloric diets with variable protein levels. Aquaculture, 158(3), 321-329.
9. Francis, R. (1992). Nutritional needs of ornamental fish. *Journal of Aquaculture*, 38, 67-73.

10. George, J. P. et al. (1995). George, T. and Pandian, T. J. (1995). Production of ZZ females in the female-heterogametic black molly, *Poecilia sphenops*, by endocrine sex reversal and progeny testing. Aquaculture, 136, 81-90.
11. Kruger, D.P., P.J. Britz & Sales, J (2001). The influence of livefeed supplementation on growth and reproductive performance of swordtail (*Xiphophorus helleri* Heckel 1848) broodstock. Aquaculture Science Conservation 3, 265-273.
12. Mitra A (2000) The Northeast coast of the Bay of Bengal and deltaic Sundarbans. In: Seas at the Millennium – An environmental evaluation, Chapter 62 (Editor: Charles Sheppard, University of Warwick, Coventry, UK), Elsevier Science 143-157.
13. Mitra Abhijit, Halder Piu, & Banerjee Kakoli (2011). Changes of selected hydrological parameters in Hooghly estuary in response to a severe tropical cyclone (Aila). Indian J Mar Sci 40(1), 32-36.
14. Mitra A. (2013). Sensitivity of Mangrove Ecosystem to Changing Climate. Published by Springer, ISBN: 978-81-322-1508-0 (Print) 978-81-322-1509-7 (Online), XIX:323.
15. Mitra A, Zaman S (2015) Blue carbon reservoir of the blue planet. Published by *Springer*, ISBN 978-81-322-2106-7 (Springer DOI 10.1007/978-81-322-2107-4).
16. Mitra A (2020) Mangrove Forests in India, published by Springer, Cham. Hardcover ISBN 978-3-030-20594-2, Softcover ISBN 978-3-030-20597-3, XV:361.
17. Mohanta, K. N. et al. (2012). Dietary protein requirement of freshwater angelfish, (*Pterophyllum scalare)*. *Indian Journal of Fisheries*, 59, 65-69.
18. NRC (National Research Council). (1993). *Nutrient Requirements of Fish*. Washington, DC: National Academy Press.
19. Sampath, K. et al. (1984). The influence of protein intake on growth and reproduction in fish. *Journal of Fish Biology*, 25, 289-300.
20. Sengupta, Kasturi; Roy Chowdhury, Mahua; Bhattacharyya, Subhra Bikash; Raha, Atanu; Zaman, Sufia & Abhijit Mitra. Spatial variation of stored carbon in *Avicennia alba* of Indian Sundarbans. *Discovery Nature, (ISSN: 2319-5703)*, 2013, Vol. 3 (8), pp. 19 -24.
21. Trivedi, S., Zaman, S., Ray, Chaudhuri, T., Pramanick, P., Fazli, P., Amin, G. and Mitra, A. 2016. Inter-annual variation of salinity in Indian Sundarbans. Indian Journal of Geo-Marine Science, 45 (3), 410-415.