

Original Article

Effect of different protein based feed on the growth of mahseer

Efeito de alimentação baseada em proteínas diferentes no crescimento de mahseer

N. Ullah^a, A. Said^a, M. Israr^b, A. Rasool^c, F. Akbar^c, S. Ahmad^d, S. A. Mehmood^d,
H. Jabeen^e, M. Islam^f, S. Muhammad^g, S. Noureen^h, Ume Habiba^h, D. Ahmedⁱ, M. Shah^{a*},
M. A. A. Khan^j and M. Siraj^k

^aUniversity of Swat, Centre for Animal Sciences and Fisheries, Charbagh, Pakistan

^bUniversity of Swat, Department of Forensics Sciences, Charbagh, Pakistan

^cUniversity of Swat, Centre for Biotechnology and Microbiology, Charbagh, Pakistan

^dHazara University Mansehra, Department of Zoology, Mansehra, Pakistan

^eWomen University Mardan, Department of Microbiology, Mardan, Pakistan

^fHazara University Mansehra, Department of Genetics, Mansehra, Pakistan

^gUniversity of Swat, Institute of Agricultural Sciences & Forestry, Charbagh, Pakistan

^hUniversity of Haripur, Department of Forestry and Wildlife Management, Haripur, Pakistan

ⁱUniversity of Haripur, Department of Medical Lab Technology, Haripur, Pakistan

^jUniversity of Peshawar: Peshawar, Centre of Biotechnology and Microbiology, Pakistan

^kDepartment of Zoology, Abbottabad University of Science & Technology, Pakistan

Abstract

For the proper growth of fish, it is necessary to feed the fish with a proper and balanced diet. A study was conducted to find out the effect of different protein-based diets on fingerlings of *Tor putitora* (mahseer). A feed with dietary protein levels of 35%, 40%, 45%, and 50% were prepared. The effect of different protein-based feed on weight gain, standard growth rate (SGR), food conversion ratio (FCR), percent weight gain, food conversion efficiency (FCE), and protein efficiency ratio (PER) was studied. An increase was observed in the growth rate with an increase in protein concentration up to 45%. The fingerlings fed a 45% protein diet shown the highest growth, followed by 50%, 40%, and 35%. The SGR value was greatest for 45% protein diet (8.56) followed by 50% and 40%, while the least values were observed for 35% protein feed (1.57). The same trend was observed for FCE. The highest PER values was observed in fishes fed 45% protein-based feed (0.65) followed by 50% (0.56), 40% (0.38) and 35% (0.17). The food conversion ratio was lowest for 45% protein diet (3.41), while the greatest for 35% protein feed (16.85). It was concluded that a 45% protein-based diet was the best feed formulation for higher production of *Tor putitora*. However, research on the same percentage of protein diet is recommended for yearlings.

Keywords: *Tor putitora*, protein concentration, weight gain, standard growth rate, food conversion ratio, food conversion efficiency, protein efficiency ratio.

Resumo

Para o bom crescimento dos peixes, é necessário alimentá-los com uma alimentação adequada e balanceada. Um estudo foi realizado para descobrir o efeito de diferentes dietas à base de proteínas em alevinos de *Tor putitora* (mahseer). Foi preparado um alimento com níveis de proteína dietética de 35%, 40%, 45% e 50%. O efeito de diferentes alimentos à base de proteína no ganho de peso, taxa de crescimento padrão (SGR), taxa de conversão alimentar (FCR), ganho de peso percentual, eficiência de conversão alimentar (FCE) e taxa de eficiência proteica (PER) foi estudado. Foi observado um aumento na taxa de crescimento com um aumento na concentração de proteína de até 45%. Os alevinos alimentados com dieta de 45% de proteína apresentaram o maior crescimento, seguidos de 50%, 40% e 35%. O valor de SGR foi maior para dieta com 45% de proteína (8,56), seguido de 50% e 40%, enquanto os menores valores foram observados para ração com 35% de proteína (1,57). A mesma tendência foi observada para FCE. Os maiores valores de PER foram observados em peixes alimentados com 45% de ração à base de proteína (0,65), seguido por 50% (0,56), 40% (0,38) e 35% (0,17). A taxa de conversão alimentar foi menor para a dieta com 45% de proteína (3,41), enquanto a maior para a dieta com 35% de proteína (16,85). Concluiu-se que a dieta à base de proteína de 45% foi a melhor formulação alimentar para maior produção de *Tor putitora*. No entanto, a pesquisa sobre a mesma porcentagem de dieta proteica é recomendada para animais de um ano.

Palavras-chave: *Tor putitora*, concentração de proteína, ganho de peso, taxa de crescimento padrão, taxa de conversão de alimentos, eficiência de conversão de alimentos, taxa de eficiência de proteínas.

*e-mail: muzafar@uswat.edu.pk

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1. Introduction

Fish culture is the controlled cultivation and harvest of the fish for market sale. There are many methods used, such as cage culture, culturing of the fish in ponds or tanks, etc. The pond is a water reviser that retains water for fish growing purposes and allows their breeding, feeding, and controlled growth, etc. in a well-planned way (Soccol and Oetterer, 2003). Pond culture is economically more viable than cage culture. The recent cage culture was started in the 1950s, using the synthetic materials advent for construction and was practiced in marine water, brackish as well as in freshwater. Fish culture may be monoculture it might be polyculture, depending on the species combinations (Lone and Lone, 2014a).

For proper growth in culturing practice, it is necessary to feed the fish on proper and balanced diets. In intensive culture, the fish depend on artificial feed. To improve fish production, different factors are taken into consideration in artificial feed formulations, such as the feed must be well balanced, complete, and adequate, while the composition, feeding rate, frequency of feeding, consumption, utilization, and feed preparation method are evaluated keenly, and the best possible feed is prepared (Islam et al., 2002). The main ingredients used in supplementary feed are fishmeal, soybean, blood, sunflower, mustard oil cake, soybean cake, groundnut oil cake (GNOC), and soya oil as a protein source, wheat bran, gluten, and rice polish is added as the sources of carbohydrate, and Dicalcium Phosphate (DCP) as Ca^{+2} and PO_4^{-2} source. Wheat flour, casein, vitamin, mineral premix, and common salt are also used whereas molasses, mineral mixture, Carboxymethylcellulose (CMC), and tapioca are used as binders (Islam et al., 2002; Ullah, 2015). Based on species demand, the concentration of the aforementioned nutrients can be changed in the diets, such as the level of carbohydrates, lipids, and proteins.

The concentration of protein has a direct effect on the growth, physiological, and biochemical aspects of the fish. Mostly feed having higher protein percentage resulted in increased fish growth, weight gain, and specific growth rate (SGR) while a reduced FCR value. Research studies revealed that the increment of protein percentage from 20-45% in fish feed showed the best standard growth rate, highest protein efficiency ratio (PER), highest values for growth and feed efficiency in different fish species (Lone and Lone, 2013). Lone and Lone (2014b) observed that 45% protein-based feed was more effective and feasible for fish as compared to a 20% protein-based diet. Diyaware et al. (2009) investigated the growth performance of hybrid catfish *Heterobranchus bidorsalis* using different concentrated protein-based diets (35%, 40%, 45%, 50%, and 55%). Their results showed that the fish fed a higher protein-based diet were having a higher growth rate. They observed a linear increase with the increase protein levels up to 50% in terms of different parameters including mean weight gain (MWG), mean daily weight gain (MDWG), the apparent protein efficiency ratio (APER), protein index (PI), food conversion ratio (FCR), specific growth rate (SGR), nitrogen metabolism (NM), relative growth rate (RGR), and percentage survival (%SR).

The present study was conducted on mahseer (*Tor putitora*, Hamilton). It is a very tasty and widely consumed fish species, found around South Asian countries,

and is the national fish of Pakistan. Unfortunately, due to habitat loss and other deteriorating environmental factors, its population got declined in most of their indigenous abode, rapidly declining in some parts, whereas it has been declared as a threatened species and got extinct in some parts of Pakistan. Therefore, most of the research studies on mahseer conservation suggested its culture on a wide scale and recommendations have been put forth to prepare the best possible feed, and avoid environmental stressors in order to let it thrive in the wild again (Sawhney and Gandotra, 2009; Ullah et al., 2014, 2015). The study was aimed, to observe the effects of different protein-based artificial diets on the growth of mahseer.

2. Material and Method

2.1. Study site

The present research was carried out in the Government Mahseer Research Station at Thana, district Malakand, Khyber Pakhtunkhwa, Pakistan. A raceway was divided into four quadrates by putting in silver nets. The coordinates of the study site is 34.645253, 72.048378.

2.2. Feed formulation

Feed having four different levels of proteins were prepared in pellet form having 35%, 40%, 45%, and 50% protein concentrations using fish meal (having 62% protein), soybean (having 46% protein), sunflower (having 34% protein), and canola (having 36% protein) as protein sources (Ahmad et al., 2004). Rice polish, wheat bran, and gluten were added as sources of carbohydrate. Dicalcium Phosphate (DCP) was used for ions, canola oil as a fats source, and vitamin-premix was added as a source of essential vitamins (Siddiqui and Khan, 2009). All these ingredients were added in a different amount to each feed to obtain the desired concentration of protein (Table 1).

All these ingredients (except oil which was added later) were taken in a specific amount (Table 1), properly mixed

Table 1. Amount of ingredients in grams used in different formulated feed for mahseer.

Ingredients	^a 35%	^b 40%	^c 45%	^d 50%
Fish meal	20	22	25	25
Soybean meal	20	22	25	30
Sunflower meal	20	24	25	29
Canola meal	18	22	25	30
Rice polish	20	18.3	17	15
Wheat bran	20	18.3	17	15
Gluten	20	18.3	16	15
DCP	1	1	1	1
Vitamin-Premix	2	2	2	2
Canola oil	1	1	1	1

^afeed contain 35% protein; ^bfeed contain 40% protein; ^cfeed contain 45% protein; ^dfeed contain 50% protein.

grind with the help of an electric blender, and sieved. The oil was added to feed in the given amount. After that, water was added until a dough structure was formed as suggested by Giri et al. (2003). After extruding, long threads of feed were formed and kept under the slow turning fan in a dry place for about 12 hours to dry. The dried feed was ground and the desired size pellets were formed as suggested by Hafedh (1999).

2.3. Fish sampling

A total of 24 specimens were stocked to each quadrat after doing their initial morphometry. Initially, body weight and some basic morphometric characters such as total length (TL), fork length (FL), standard length (SL), head length (HL), eye diameter (ED), snout length (SnL), post-orbital length (POL), length of caudal peduncle (LoCP) and body depth (BD) were measured (Table 2). The fish were fed twice a day (morning at 9:00 and dusk at 16:00) in each quadrat at the rate of 4.5% of their body weight.

2.4. Measurement of growth parameters

Month-wise, 8 specimens were captured randomly from each quadrat and were weighed and their morphometric characters were measured. Based on obtained data, other growth parameters such as specific growth rate (SGR), food conversion ratio (FCR), percentage weight (%WT), food conversion efficiency (FCE), and protein efficiency ratio (PER) were calculated by using following formulae (Sawhney and Gandotra, 2009) (Equations 1-5).

$$\text{SGR} = (W_f - W_i / \text{No. of experimental days}) \times 100 \quad (1)$$

$$\text{FCR} = \text{Food fed} / \text{Weight gain} \quad (2)$$

$$\% \text{WT} = (W_f - W_i / W_i) \times 100 \quad (3)$$

$$\text{FCE} = (\text{Weight gain} / \text{Food fed}) \times 100 \text{OR } 1 / \text{FCR} \times 100 \quad (4)$$

$$\text{PER} = \text{Weight gain} / \text{Protein intake} \quad (5)$$

3. Result

The present study was conducted during March through June 2017. The weight of the fish was measured on monthly basis. The initial average weight of all the fish was 8.54 g. The total weight of fish fed 35% protein feed was 01.46 g (17.09%) followed by the group, fed 40% protein feed (3.96 g, 46.37%). Fishes fed 45% protein gained 7.96 g (93.21%) weight during the study while fishes fed 50% protein gained 7.56 g (88.52%) (Table 3).

The total length of the fish was measured four times. The initial average total length was 9.12 cm. Changes in length were observed after one month in fish fed different protein-based feed. Fishes fed by 35% protein feed gained a total of 01.58 cm (17.32%) followed by fishes fed 40% protein-based feed (3.38 cm, 37.06%). Fishes fed 45% protein feed was 12.6 cm in final measurement, total length increase was 7.38 cm (80.92%). Fishes fed by 50% protein feed had 12.4 cm final total length, total increase length was 6.98 cm (76.54%) (Table 4).

3.1. Growth parameters measurements

The gain growth was in the order of 45% > 50% > 40% > 35% protein-based diet. The average net weight gained was: 7.96 g, 7.56 g, 3.96 g, and 1.46 g at 45%, 50%, 40%, and 35% protein-based feed respectively. There were a linear increase and direct association between the weight and concentration of protein in the feed. The SGR value highest in fishes fed 45% protein feed and lowest in those fishes fed 35% protein feed. The FCR value in this study was highest in the group of fingerlings fed on

Table 2. Different initial morphometric characters (in cm) of three fish specimens.

Specimens	TL	FL	SL	HL	ED	SnL	POL	LoCP	BD
1.	10.70	9.45	8.60	2.40	0.70	0.8	1.10	1.60	2.10
2.	9.70	8.55	7.80	2.30	0.55	0.65	1.05	1.25	1.80
3.	7.10	6.20	5.70	2.05	0.40	0.60	1.00	1.00	1.50

TL (Total length), FL (Fork length), SL (Standard length), HL (Head length), ED (Eye diameter), SnL (Snout length), POL (Post-orbital length), LoCP (Length of caudal peduncle), and BD (Body depth).

Table 3. Weight of sampled fishes in grams fed by different feeds.

Feed	Weight in grams				Total weight gained	Percentage of total weight gain
	Initial (March)	April	May	June		
^a 35%	8.54	9.17	9.6	10	1.46	17.09
^b 40%	8.54	10.08	11.23	12.5	3.96	46.37
^c 45%	8.54	11.58	13.9	16.5	7.96	93.21
^d 50%	8.54	11.51	13.7	16.1	7.56	88.52

^afeed contain 35% protein; ^bfeed contain 40% protein; ^cfeed contain 45% protein; ^dfeed contain 50% protein.

Table 4. Overall measurement of total length (cm).

Feed	Length in cm					Total Increment in length	Percent length increment
	Initial (march)	April	May	June			
^a 35%	9.12	9.7	10.2	10.7		1.58	17.32%
^b 40%	9.12	10.7	11	11.55		3.38	37.06
^c 45%	9.12	11.01	12.05	12.6		7.38	80.92
^d 50%	9.12	11	12.03	12.5		6.98	76.54

^afeed contain 35% protein; ^bfeed contain 40% protein; ^cfeed contain 45% protein; ^dfeed contain 50% protein.

Table 5. Different growth parameters of stocked fingerlings.

S. No	Growth parameters	^a 35%	^b 40%	^c 45%	^d 50%
1.	Weight gained (g)	1.46	3.96	7.96	7.56
2.	FCR	16.85	6.53	3.41	3.59
3.	FCE	5.94	15.31	29.33	27.85
4.	SGR	1.569	4.258	8.559	8.129
5.	%weight gained	17.09	46.37	93.21	88.52
6.	PER	0.17	0.38	0.65	0.56

^afeed contain 35% protein; ^bfeed contain 40% protein; ^cfeed contain 45% protein; ^dfeed contain 50% protein.

35% protein feed (16.85) and lowest for 45% protein diet fed fish (3.41). In our result, the ratio of FCR decreased with an increase in the concentration of protein up to 45%. The percentage of weight gain in this investigation was highest for the group of fingerlings fed 45% protein feed while the lowest was for 35% protein fed fishes. The order of weight gain was 45% > 50% > 40% > 35% based on the protein diet. Food conversion efficiency (FCE) was observed to be the highest for the fishes fed 45% protein feed (29.33) and lowest in those fed 35% protein feed (5.94). The order of FCE was 45% > 50% > 40% > 35% protein-based diet. The protein efficiency ratio (PER) was the lowest for 35% protein feed while the highest for 45% protein-based feed. The values of PER were 0.17, 0.38, 0.65, and 0.56 for fish fed 35%, 40%, 45%, and 50% protein-based feed formulations respectively (Table 5).

4. Discussion

Mahseer (*Tor putitora*) fingerlings fed on different protein-based feed contain various protein concentrations (35%, 40%, 45%, and 50%) for 3 months. The findings of the result expressed that the fingerlings fed 45% protein-based feed attained the highest weight, while those fed 35% protein feed attained the lowest weight. The order of weight gain in fishes fed different protein-based feed was 45% > 50% > 40% > 35%. The average net weight gained was 7.96 g, 7.56 g, 3.96 g, and 1.46 for 45%, 50%, 40%, and 35% protein-based feed respectively. The results of the current study shown similarities with the results of Akand et al. (1989) as they

observed that the weight gain of the fish increased with increasing levels of dietary protein from 19.87% to 35.43%. A similar result was also shown by Diyaware et al. (2009).

Similarly, Ahmad et al. (2004) conducted research and observed the highest growth, final weight gain, percent weight gain, and SGR for Nile tilapia fry fed a 45% protein diet followed by those fed 35%, and the poorest growth performance of fish fry was obtained for the fish fed 25% protein diet. According to Siddiqui and Khan (2009), the SGR for fries of on fry and young Nile Tilapia fed on feed containing 20% of the protein was the lowest (0.989) and was the highest (1.276) for fish fed a 40% protein-based diet. In our investigation, the SGR value was highest for fingerling fed 45% protein-based feed, and the lowest for 35% protein fed to fish. So all the studies show similarities. The present study indicates that the FCR value was greatest in the group of fingerlings fed 35% protein-based feed (16.85) and lowest in those fed 45% protein feed (3.41). Low FCR in a 45% protein diet showed its efficient utilization. According to Siddiqui and Khan (2009), the FCR of fishes fed 20% protein was the highest (2.397), whereas they observed 1.964, 1.894, and 2.324 for 30%, 40%, and for 50% protein-based fed fish groups. Both the research shows similarities. A similar result was also indicated by Lone and Lone, (2014^a).

In our investigation Protein efficiency ratio (PER) was the lowest (0.17) in those fed 35% protein feed while the greatest (0.65) in those fed a 45% protein diet. The result indicates the increment in protein concentration

in feed leads to a high value of PER. According to Sarkar et al. (2015), Protein efficiency ratio (PER) is directly proportional to the percentage of protein they observed that the group fed 15% of protein their PER was the lowest (0.07 ± 0.01) while those fed 25% protein was having the highest PER (2.04 ± 0.02). A similar result was also shown by Lone and Lone (2014a). Hafedh (1999) conducted a study on Nile Tilapia to find out the effect of various dietary proteins (25%, 30%, 35%, 40%, and 45%) on their growth performance. They reported the best PER value (1.69 ± 0.2) in fishes fed 30% protein while the lowest (1.39 ± 0.1) value was observed for the fish fed 45% protein. The differences of these studies and variation as compared to the present study might be due to the use of different species, as well as changes in climatic condition and water quality of the study area and ambient water respectively. Food conversion efficiency (FCE) was observed to be the highest for the fingerlings fed a 45% protein diet (29.33) while the lowest in those fed 35% protein feed (5.94). According to Sawhney and Gandotra (2009), among 30%, 35%, 40%, 45% 50% protein-based feeds, the FCE in fish fed 30% protein diet was the lowest (7.621) while that fed on 45% was having the highest FCE (14.46). According to Akand et al. (1989), the FCE value for 0% protein was 0.44 ± 0.02 , while the highest FCE (0.56 ± 0.02) was observed for the fish fed the highest protein level (39.1).

5. Conclusion

The study concluded that the most effective feed for the fingerlings of *Tor putitora* was a 45% protein-based diet. Fish fed 45% protein-based diet attained the best growth, in terms of increase in body weight and body length, and also led to effects on the growth parameters (SGR, FCR, PER, and FCE). For better culture and higher production of mahseer at Mahseer Research center Thana (Malakand district, Khyber Pakhtunkhwa) and mahseer farmers at the adjoining/adjacent areas, a 45% protein-based diet is recommended.

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