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A study on growth performance and survivability of *tor tor* (Hamilton, 1822) fingerlings in earthen pond fed with different feed ingredients

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Abstract
The present work embodies the nutritional requirement studies on *Tor tor*, collected from the river Narmada. During the experiment fingerling with average weight (3.80g) and length (6.75cm) respectively were subjected 3 experimental combination feed EF-1 (RB+MOC), EF-2(RB+FF) and EF-3 (RB+FM) was fed for 45 days. The experiment was performed in earthen pond with triplicate. The protein content of the ingredients rice bran (RB), Mustard Oil cake (MOC), floating feed (FF) and fish meal (FM) is recorded as 14%, 30%, 32%, and 45% respectively. During the experiment lowest Feed Conversion Rate (FCR) was recorded with the pond section feed EF3 values are (P1-0.99) (P2-1.03) and (P3-0.96) respectively. In terms of percentage increment of length and weight with EF-3 feed it revealed that the highest average increment in length is 36.1 % and weight 151.7 respectively. Similarly the highest value of Specific Growth Rate (SGR) 1.336 and Average Daily Growth (ADG) 0.19g/day were recorded highest with EF-3 as compare to EF1 and EF2. Moreover, as compared to all feed combinations EF-3 was found to have the lowest FCR value (0.96) and survivability was highest with EF-3 (64-70%) followed by EF-2 (57-60%) and EF-1 (47-52%). Furthermore, during the experimental period the average concentration of chemical properties of water like pH, DO, Ammonia, Nitrate, phosphate, Total Alkalinity and total hardness was found to be 7.8,9.03 mg/l, 0.035 mg/l, 0.96 mg/l, 0.29mg/l, 224 mg/l and 147 mg/l in respective all experimental ponds. This work also concludes that locally available ingredient when combined in a specific proportion can be a better supplementary feed with fish meal as compare to alone and increase the fish production.

Keywords: *Tor tor*, feed conversion rate, specific growth rate, survivability

Introduction
Aquaculture is considered as one of the most eminent food sector worldwide highlighting the significant contribution of fisheries in nutritional security and in providing employment to millions of people. Among the total fish production of 171 million tonnes in 2016, 88 percent of total turnout was utilized directly for human consumption with per capita consumption of 20.3 kg in 2016 respectively (FAO, SOFIA, 2018) [1]. Indian fisheries and aquaculture plays a landmark role in protein rich food production contributing to improve the nutritional status, besides livelihood support and employment opportunities to more than 14 million people. The total fish production during 2017-18 is estimated to be 12.60 million metric tonnes, of which nearly 65% is from inland sector and about 50% of the total production is from culture fisheries (NFDB http://nfdb.gov.in, 2018) [2]. Tor mahseer, *Tor tor* (Hamilton, 1822) is the most important food and game fish of India after *Tor putitora* (Hamilton, 1822) among all the varieties of mahseer constituting an outstanding fishery in the Narmada River in central India. It has also been established in some of the Indian reservoirs by stocking this fish species (Desai, 2003) [4]. Besides this, *Tor tor* is also the state fish of Madhya Pradesh, commonly known as Badas. It belongs to the to order Cypriniformes, family Cyprinidae, sub-family Cyprininae (Hamilton, 1822) [3, 5, 18]. *Tor tor* is identified as the most common Himalayan mahseer with a potential of very attractive sport fishery and having excellent food value. It is also a highly nutritious fish with good economic value but is tremendously now declining its abundance in reservoirs of India. It inhabits riverine pools and lakes, and can also be found in streams with good flows and a rocky bottom, which are ideal conditions for them to attain the best growth. They are benthopelagic, potamodromous and occur in tropical freshwaters (15-30°C) at depths of up to 15 m. Feeding behavior of *Tor tor* is mainly omnivorous in nature

and feed on small fish, insects, molluscs, zooplankton, debris, sand, mud, fish scales and bones, fruits, chironomid larvae, water beetles, crustaceans, filamentous algae and macrophytes (Desai, 2003) [4]. *Tor tor* is a potential candidate for the development of open water fishery as well as aquaculture. Mahseer prefer fast-flowing rocky streams with crystal clear freshwater and high oxygen content. It can attain a very large size up to 54 kg (Froese & Pauly, 2003) [6]. This species has been categorized as endangered (Anon, 2001; Sharma, 2003) [8] during the Conservation Assessment and Management Plan (CAMP, 1998) [9], however, as per IUCN (2010), the fish has been declared as near-threatened (NT) (Rayamajhi *et al*, 2010) [10]. The key predominate habitat characteristics of assortment areas are cobbles mixed with gravel with a riparian cover of trees and shrubs. The presence of fingerling size fish species in the river imply that it has adapted and there is probability of the establishment of self-recruiting populations in the riverine system (Lal K K *et al*, 2012) [17].

To determine the culture potential of mahseer, the domestication of species in captivity will also be helpful. Some researchers over the few decades, have contributed in studying growth parameter and nutritional requirement of other species of *Tor* (Muhammad S. U. K. *et al*, 2018) [11]. Mostly catfishes prefer high rate of protein value feed for their survival and growth. Protein and amino acids are the major organic material in fish tissue constituting about 65-70% of total on dry. Protein is also required for better growth. There are various kinds of protein source present in aquaculture from plant and aquatic animal like mustard oil cake and fish meal. There are feed ingredient which has high source of carbohydrate e.g. Rice brain. The gross protein requirement decreases with increase in age and size of fish. According to their feeding habit fishes prefer their diet as a meal (Singh. R *et al*, 2017) [5]. Fish feed supplemented with more crude protein as compared to that supplemented with low crude protein feeds showed significantly better growth (Abbas *et al*, 2004) [19]. Rice bran is among one of the most easily accessible agriculture by-product utilised in aquaculture because of higher protein and carbohydrates and lower in fat and fiber (Jhingran and Pullin, 1985) [20]. The dietary protein requirement of fingerlings of *T. putitora* was approximately 40% (Hossian M A *et al*, 2002) [12]. The dietary protein requirement of varied number of aquaculture species have been investigated by a number of researchers (Lim *et al*. 1979, Jauncey 1982, Wee and Tacon 1982, Singh and Bhanot 1988) [13-16] and from these studies it can be observed that the dietary protein requirement for each fish species is different and varies with feeding habit, size and water temperature of the farms. The present study is aimed at to generate baseline data on nutrient requirements of traditional feed available at farm level so as to develop appropriate feeds combination to enhance growth of mahseer in captivity under pond condition so as to increase its production.

2. Material and Methods

2.1 Place of Experiment

The whole 45 days experiment was carried out in three different earthen rectangular ponds of size 210 m^2. These selected ponds were divided into three equal sections at field area of CIFE center Powarkheda, Hoshangabad (Madhya Pradesh).

2.2 Experiment concept and design

These selected ponds were divided into three equal rectangular sections with the help of mosquito net; bamboo poles and iron rod fitted in the bottom of the mosquito net to prevent the escaping of fish (21 × 10 × 1.5) meters were used for rearing of fingerlings. Size of the each partition was (7 × 10 × 1.5) meters. Completely randomized design (CRD) was followed through the whole 45 days experiment. Moreover, all experimental ponds were divided into three equal sections before pre-stocking management of the old earthen ponds. Each divided section of individual pond has equal area. The source of water is from bore well/ground water.

2.3 Seed collection of *Tor tor*

There is no commercial hatchery for production *Tor tor* seeds in Madhya Pradesh. We collected *Tor tor* fingerlings from Narmada River at Dongarwara ghat in the Hoshangabad. Collection was done during midnight through cast net, operated along the gently sloping bank of river where the rocky substrate was present with the help of local fisherman. After that fishes were kept in the FRP tanks for acclimatization and nourished with phytoplankton & zooplankton as a feed for better survival.

2.4 Manuring and fertilization of experimental pond

Ponds were fertilized with organic and inorganic manure like; Lime, cow dung, Urea and Single Super Phosphate at the rate of 300kg/Ha, 2000kg/Ha, 25kg/Ha and 30kg/Ha respectively was done prior to stocking of fish. Primary production of planktons depends upon the source of nutrient in water and it act as natural food for the fish during early stage of life.

2.5 Stocking of fish

In each section of ponds the stocking density was 70 fishes (@10000/hectare). The initial length and weight of the fishes were recorded with the help of measuring and weighing scale (average weight 3.80g and length 6.75cm).

2.6 Feed ingredient

The distinct kind of feed ingredients were used during our experiment like; Rice Bran (RB), Mustard Oil Cake (MOC), Fish meal (FM) and Floating feed (FF) (Table no.1). These feed ingredients were grinded fine and experimental feed RB+MOC (1:1) (EF-1), RB+FF (1:1) (EF-II) and RB+FM (1:1) (EF-III) were prepared.

Table 1: Chemical composition of feed ingredient in percent dry matter (DM)

Ingredients	Moisture%	CP %	Crude fat %	Fiber %
Floating feed	10	32	4	5
Fish meal	9	45	10	2
MOC	9	30	7	12
Rice bran	8	14	12	8

2.7 Data analysis for Survivability, Percentage weight gain, ADG, FCR and SGR formulae was employed

Average daily weight gain (ADG) = mean final weight-mean initial weight (g) / Culture day

Survivability = (Total number of fishes harvested – Total number of stocked)/×100

$$\text{Percentage Increment in weight} = \frac{\text{Mean final fish weight-Mean initial fish weight (g)}}{\text{Mean initial fish weight}} \times 100$$

$$\text{Percentage Increment in length} = \frac{\text{Mean final fish length-Mean initial fish length (cm)}}{\text{Mean initial fish weight}} \times 100$$

$$\text{Feed conversion ratio} = \frac{\text{Amount of dry feed consumed}}{\text{Live weight gain}}$$

$$\text{Specific growth rate} = \frac{\text{Log final body weight} - \text{log initial body weight}}{\text{Number of days}} \times 100$$

2.8 Feeding rate and frequency

Feeding rate defines the amount of feed made available to the cultured organism. Determination of the feeding rate or ration size is one of the difficult tasks in aquaculture operation. An optimum ration size is one which given the best growth and FCR. Such aeration if properly dispensed will result minimum wastage of feed and deterioration of water quality. Ration size is variable. A juvenile fish require more energy for metabolism per unit weight and has the potential to grow faster than an adult fish. Ration size therefore need to be modified according to the size and age of the cultured organism. Water quality particularly temperature also affect feeding rate.

Applying a feeding rate accurately depends on the accurate estimation of the biomass in the system (average weight × number)

$$\text{Feeding rate} = \frac{\text{Number of seed} \times \text{average weight}}{100} \times 5$$

The feeding frequency is also important to ensure maximal FCR and dress weight of the cultured organism. In this experiment feeding had been given with help of check tray method and different feed ingredients were kept into the tray for feeding. Feed was given once in a day (Singh R *et al*, 2017) [5].

2.9 Water quality parameter

Water quality parameter has significant role in Aquaculture. Fishes are in equilibrium with potential disease organism and their environment; change in the equilibrium such as deterioration in water quality (environment) can result in fish becoming in stressed and vulnerable to disease. It is therefore, important to know water quality parameters and their management that influence on growth and survival of aquatic organism. Changes in this equilibrium, such as deterioration in water quality can result in fish becoming stressed and vulnerable to diseases. Therefore, it is important to know water quality parameters and their management is necessary for better growth and survival. There are various kinds of physical and chemical water quality parameters like DO (Dissolved Oxygen), Transparency, Temperature, pH, Ammonia, Nitrate and Phosphate etc (Singh R *et al* 2017), (Singh. P *et al*, 2017) and APHA (1998) [5, 21, 22].

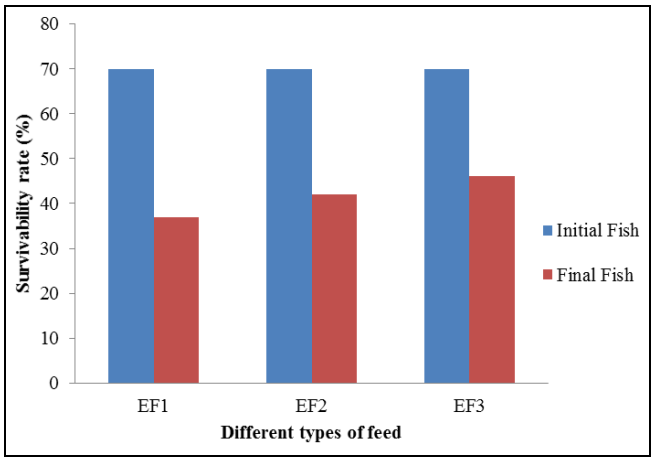
3. Results

3.1 Survivability of Fish

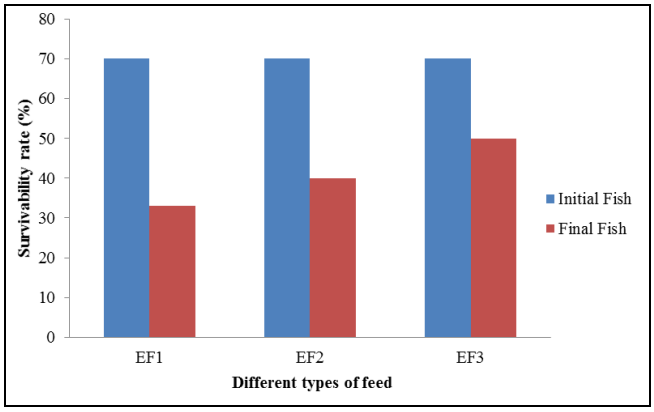
Survival rate was recorded 47.1% to71.45% at the end of 45 days experiment (Table no.2) (Graph no. 1, 2 & 3). Highest survival was recorded with the feed EF-3 and lowest with the EF-1(Table no.2) (Graph no. 1, 2 & 3). Length and weight also highest with the EF-3 as compare to EF-1 and EF-2 respectively (Table no.2) (Graph no. 1, 2 & 3).

Table 3: Total survivability of fish (%)

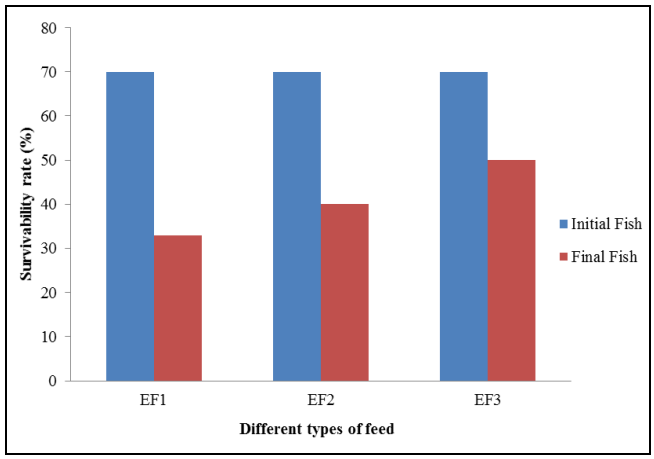
Pond	Feed	Initial number of fish	Final number of fish	Survivability (%)
A	EF1	70	34	48.50
	EF2	70	40	57.10
	EF3	70	45	64.20
B	EF1	70	37	52.80
	EF2	70	42	60.00
	EF3	70	46	65.70
C	EF1	70	33	47.10
	EF2	70	40	57.10
	EF3	70	50	71.40



Graph 1: Survivability of Fish in Pond 1



Graph 2: Survivability of Fish in Pond 2



Graph 3: Survivability of Fish in Pond 3

3.2 Length- Weight Relationships

During this experiment the highest length (33.8-38.6 %)

increment was recorded which are fed with the RB+FM (EF-3). Average Length increment with the RB+FF (EF-2) was 20.06% and lowest increment with the MOC+RB (EF-1) is 14.1-15.2% (Table no.3). Weight increment was highest with the EF-3(148-155.3%) followed by EF-2 (106-125%) and EF-1(85-100%) (Table no.3). Final minimum length in Pond 1 is recorded as (EF1-7 cm), (EF2-6.7 cm) and (EF3-7.5 cm) (Table no.3). Also the minimum length in Pond 2 fed with different feed is as (EF1-5.1 cm), (EF2-7.7 cm) and (EF3-7.0 cm) cm and finally in Pond 3 the minimum length is as (EF1-7 cm), (EF2-7.5 cm) and (EF3-8.0 cm) (Table no.3). Final maximum length in Pond 1 (EF1-8.5 cm), (EF2-9.5 cm) and (EF3-10.30 cm), Pond 2 (EF1-9.4 cm), (EF2-9.0 cm) and (EF3-10 cm) and Pond 3 (EF1-9.6 cm), (EF2-10.3 cm) and (EF3-12 cm) (Table no.3). Final minimum weight was Pond 1 (EF1-5.7 g), (EF2-4 g) and (EF3-5.7 g), Pond 2 (EF1-4.8 g), (EF2-5.6 g) and (EF3-5.2 g) and Pond 3 (EF1-4.3 g), (EF2-5.2 g) and (EF3-6.3g) (Table no.3). Final maximum weight was Pond 1 (EF1-8.4 g), (EF2-10.7 g) and (EF3-14 g), Pond 2 (EF1-11.9 g), (EF2-13 g) and (EF3-17.4 g) and Pond 3 (EF1-12.3 g), (EF2-15 g) and (EF3-25 g) (Table no.3). Overall highest increment was recorded with EF3 (Table no.3).

Table 3: representing length and weight relationship of fish

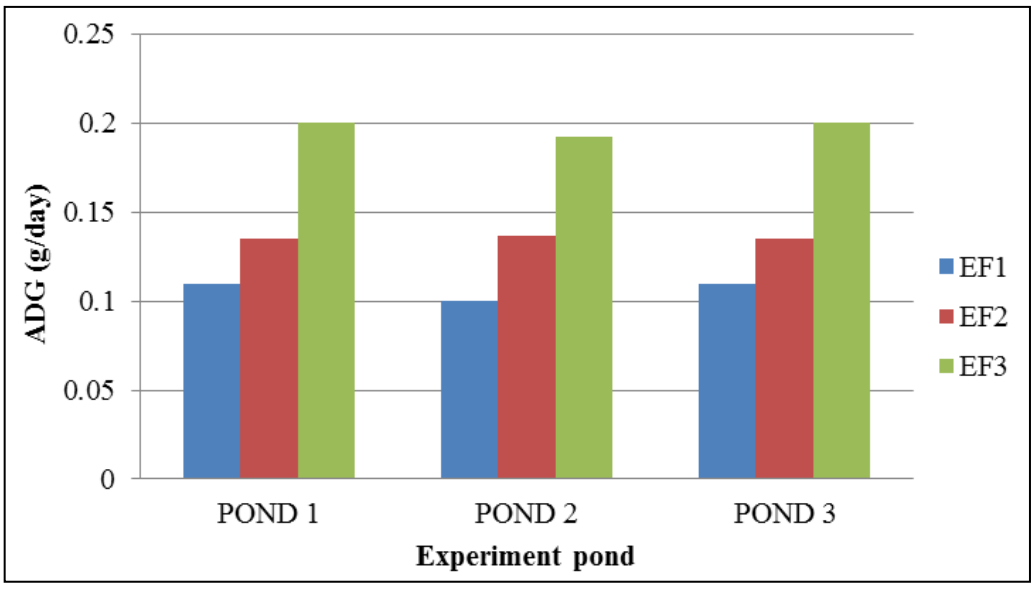
Items	P1(EF1)	P1(EF2)	P1(EF3)	P2(EF1)	P2(EF2)	P2(EF3)	P3(EF1)	P3(EF2)	P3(EF3)
Initial length(cm)	7.01	6.23	6.95	6.64	7.00	6.62	6.50	6.96	6.85
Final length(cm)	8.08	7.92	9.30	7.58	7.82	9.1	7.47	8.46	9.50
% length increment	15.2	27.1	33.80	14.10	11.70	35.9	14.90	21.40	38.60
Final Minimum Length (cm)	7.00	6.70	7.50	5.10	7.70	7.00	7.00	7.50	8.00
Final Maximum Length (cm)	8.50	9.50	10.30	9.40	9.00	10.00	9.60	10.30	12.00
Initial weight	3.93	3.55	4.06	3.53	3.88	3.72	3.24	4.00	4.09
Final weight	7.33	7.61	10.07	6.54	8.00	9.5	6.54	9.00	10.30
% increment weight	86.5	114.3	148	85.20	106.1	155.3	101.80	125	151.80
Final Minimum Weight (g)	5.70	4.00	5.70	4.80	5.60	5.20	4.30	5.20	6.30
Final Maximum Weight (g)	8.40	10.70	14.00	11.90	13.00	17.40	12.30	15.00	25.00

3.3 Average Daily Weight Gain (ADG)

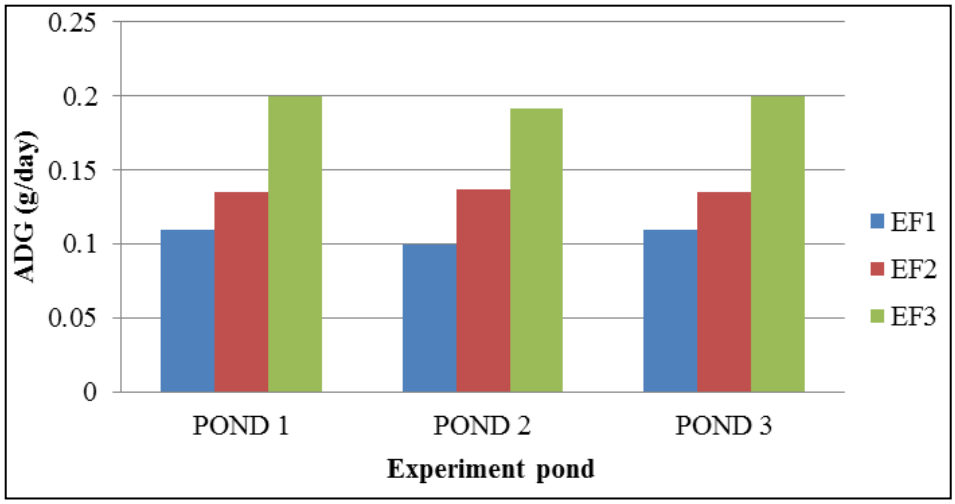
The Highest ADG increment was recorded with EF3 of each pond (P1-0.11) (P2-0.10) (P3-0.11) and average is 0.106g/day (Table no.4) (Graph no. 5). ADG with the EF2 (P1-0.135), (P2-0.137), (P3-0.135) and average is 0.1356g/day (Table no.4) (Graph no. 5). And the lowest ADG was recorded with EF1 of each pond (P1-0.200), (P2-0.192), (P3-0.200) and average is 0.197g/day (Table no.4) (Graph no. 5).

Table 4: representing Average Daily Weight Gain of fish

Pond	Initial WT mean	Final Wt Mean	Avg. Wt Gain	Avg. Daily weight Gain (g/day)
P1(EF1)	3.93	7.33	3.4	0.110
P1(EF2)	3.55	7.61	4.06	0.135
P1(EF3)	4.06	10.07	6.01	0.200
P2(EF1)	3.53	6.54	3.01	0.100
P2(EF2)	3.88	8.00	4.12	0.137
P2(EF3)	3.72	9.50	5.78	0.192
P3(EF1)	3.24	6.54	3.3	0.110
P3(EF2)	4.24	8.30	4.06	0.135
P3(EF3)	4.09	10.30	6.21	0.200



Graph 4: Average weight gain of Fish in Pond 1, 2 & 3



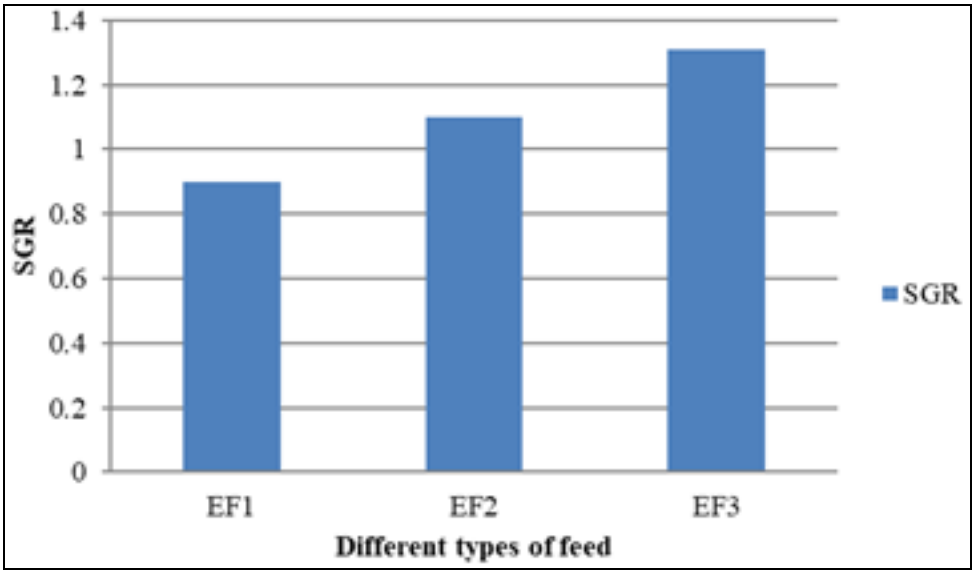
Graph 5: Average daily weight gain of Fish in Pond 1, 2 & 3

3.4 Specific Growth Rate and Food Conversion Ratio

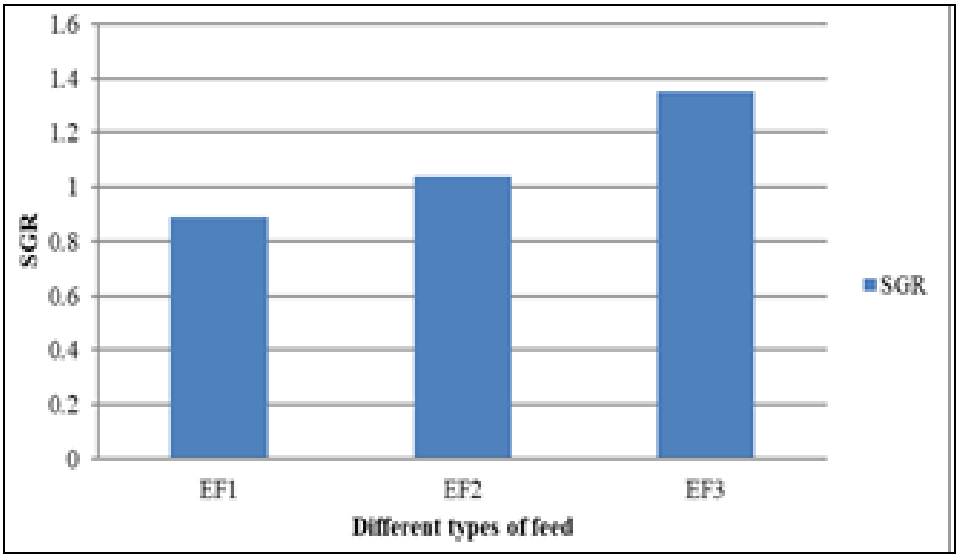
Fish fed with EF3 showed the highest SGR and recorded as (P1-1.315) (P2-1.357) (P3-1.337) and the average SGR is 1.336 (Table no.5) (Graph no. 6, 7 &8). Also SGR for fish fed with EF2 was found to be (P1-1.103), (P2-1.047), (P3-0.972) and average is 1.040 (Table no.5) (Graph no. 6, 7 &8). The lowest SGR was recorded with EF1 of each pond (P1-0.902), (P2-0.892), (P3-1.016) and the average SGR is 0.936 (Table no.5) (Graph no. 6, 7 &8). On the other hand, Minimum FCR was observed with feed EF3 with and the values are (P1-0.99) (P2-1.03) and (P3-0.96) respectively. And the average FCR with EF3 feed is found to be 0.96 as compare to other feed ingredients. The values of FCR recorded in P1-1.76, P2-1.99 and P3-1.81 during 45days experiment in different ponds (Table no.5). And the average FCR of fish fed with EF1 is 1.85. FCR of fish fed with EF2 are (P1-1.47), (P2-1.45) and (P3-1.47) respectively in different ponds and the average FCR for EF2 is recorded as 1.46 (Table no.5) (Graph no. 6, 7 &8). And the highest FCR was recorded in fish fed with EF1 feed (Table no.5).

Table 5: SGR and FCR of fish

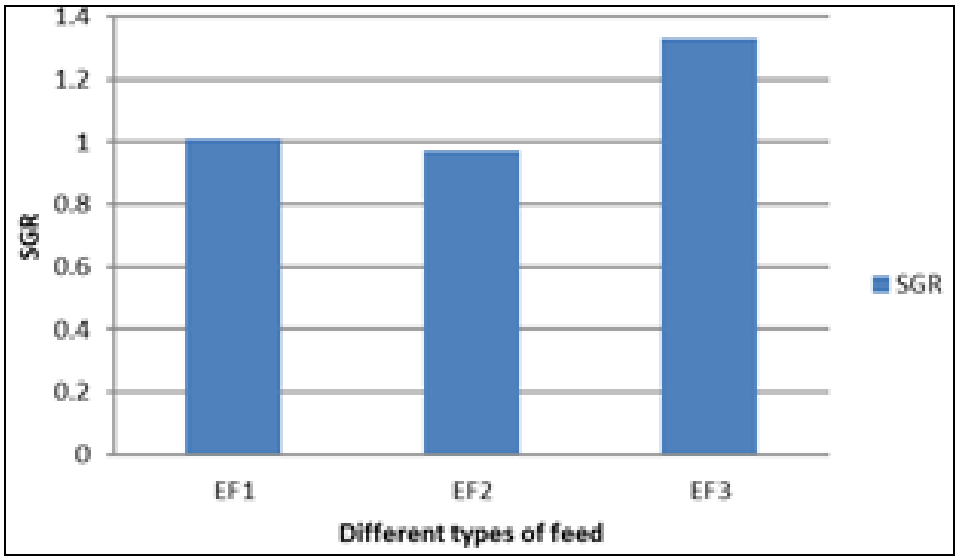
POND	F. WT MEAN	Total Final Wt	Initial Wt Mean	Total Initial Wt	Avg.Wt Gain	Total Wt. Gain	Feed intake	ln Final Wt	ln Initial Wt	ln FW – ln IW	FCR	SGR
P1(EF1)	7.33	144.6	3.93	78.6	3.4	66.0	420	0.865	0.594	0.270	1.76	0.902
P1(EF2)	7.61	152.2	3.55	71	4.06	81.2	420	0.881	0.550	0.331	1.47	1.103
P1(EF3)	10.07	201.4	4.06	81.2	6.01	120.2	420	1.003	0.608	0.394	0.99	1.315
P2(EF1)	6.54	130.8	3.53	70.6	3.01	60.2	420	0.815	0.547	0.267	1.99	0.892
P2(EF2)	8.00	160	3.88	77.6	4.12	82.4	420	0.903	0.588	0.314	1.45	1.047
P2(EF3)	9.50	190	3.72	74.4	5.78	115.6	420	0.977	0.570	0.407	1.03	1.357
P3(EF1)	6.54	130.8	3.24	64.8	3.3	66.0	420	0.815	0.510	0.305	1.81	1.016
P3(EF2)	8.30	166	4.24	84.8	4.06	81.2	420	0.919	0.627	0.291	1.47	0.972
P3(EF3)	10.30	206	4.09	81.8	6.21	124.2	420	1.012	0.611	0.401	0.96	1.337



Graph 6: Representing SGR of fish in pond 1



Graph 7: Representing SGR of fish in pond 2



Graph 8: Representing SGR of fish in pond 3

3.5 Water quality analysis

Water quality parameters are also monitored to check the effect of various feed on water quality. Parameters like Temperature, transparency, pH, DO, CO_2, Total Alkalinity, total hardness, Ammonia, nitrate and phosphate are monitored in 15 days interval. During the experimental period the average concentration of chemical properties of water like pH, DO, Total Alkalinity and total hardness was found to be 7.8,9.03 mg/lit, 224 mg/lit and 147 mg/lit respectively (Table no.6). The average concentration of Ammonia in pond 1, pond 2 and pond 3 is 0.046, 0.013 and 0.046 mg/lit respectively (Table no.6). The average concentration of Nitrate in pond 1, pond 2 and pond 3 is 0.93, 1.02 and 0.93 mg/lit respectively (Table no.6). The average concentration of phosphate in pond 1, pond 2 and pond 3 is 0.22, 0.32 and 0.34 respectively (Table no.6). The physical parameters like temperature and transparency was also monitored. The temperature of water during the entire experiment ranges from 21 to 28°C. Transparency decreased during the period and ranges from 37-45(Table no.6).

Table 6: Representing water quality parameters

Ponds	Periods (days)	Parameters									
		Temp(°C)	Transparency (cm)	pH	DO (mg/lit)	CO_2 (mg/lit)	T. Alkalinity (mg/lit)	T. Hardness (mg/lit)	Ammonia (mg/lit)	Nitrate (mg/lit)	Phosphate (mg/lit)
Pond 1	0-15	27	45	7.8	9.60	Nil	214	166	0.01	0.9	0.4
	16-30	24	40	7.5	7.20	Nil	240	160	0.04	1.0	0.04
	31- 45	21	37	7.4	7.30	Nil	232	140	0.09	0.9	0.24
Pond 2	0-15	27	43	8.0	10.0	Nil	232	134	0.01	1.00	0.50
	16-30	23	42	7.8	10.0	Nil	260	162	0.01	1.02	0.36
	31- 45	21.2	38	7.7	8.40	Nil	216	158	0.02	1.06	0.10
Pond 3	0-15	28	44	8.4	9.6	2	244	164	0.08	0.90	0.20
	16-30	23	40	8.0	10.0	Nil	190	124	0.01	0.90	0.04
	31- 45	21	39	7.8	9.20	Nil	188	122	0.05	1.00	0.10

4. Discussion

This experimental research was an effort made with an intention to upgrade aquaculture nutrition science, with respect to commercially important fish such as *Tor tor*, by using different feed ingredient (RB, FF, MOC and FM) for finding out the best combination of feed ingredients for better FCR value and thereby decreasing the cost of feed. This will help our farmer friends in formulating feed out of the locally available agriculture bi products like MOC, RB etc. making fish culture more economical. Despite of various previous attempts to formulate the diets as per the nutritious requirement of the fish, this work was undertaken to encompass a featured work on all the aspects of feed formulation, feeding and its impact on various physico-biochemical aspects of the test species. These findings can be used by future researchers in feed formulation and in understanding the nutritional requirement of this fish species and will be beneficial to the fish farmers for aquaculture nutrition.

There was not much difference in survivability in fishes fed with different feed ingredient. The survival rate of fingerlings ranges from 49.46% to 67.1%. Overall the survival rate was found highest in the entire pond with EF-3 (65-71 %). And the lowest survival was found with EF-1 (49.46%). Kangku Oliver *et al* 2012 [23] in their research found that the average survival rate was 98 and 95% for the hatchery produced and wild fingerlings, respectively fed with similar kind of feed. As our fish seed were collected from wild the survival rate may be affected. This studies shows that some time is needed to acclimatize the wild fishes to be domesticated and feed have not much important role to play.

Feed utilization is one of the important objectives of this research. One of the biggest challenges is to lower the FCR value of any feed ingredient or to find out the best combination of feed ingredients so as to get best FCR with cheaper ingredients. In our experiment lowest FCR was recorded with the feed EF-3 (0.96) which is a combination of RB+FM followed by the EF-2 (1.46) a combination of RB+ FF and EF-1 (1.85) a combination of RB+ MOC. On the other hand, lowest FCR (0.82±0.02) was observed in T-3 (40 % CP), as compared to the other two high protein treatments. The highest FCR (1.8±0.03) was recorded for T-4, which received feed containing 20 % CP. The mean±SEM for the treatment set was 0.21±0.01. ANOVA for FCR revealed no significant differences ($P > 0.05$) among the treatment groups ($df = 31$) by Akram A L, and Swapna K L, 2013 [3].

In our experiment, highest SGR was recorded with the EF-3 (1.336) which are fed with the RB+FM followed by EF-2(1.040) and EF-1(0.93) respectively. The specific growth rate was found to be directly proportional to the protein content of the feed ingredient. Though the study was conducted for only 45 days it is interesting to find more facts when cultured for a longer period of time and SGR was 0.145±0.002. The highest values of SGR (0.145±0.002) and PER (0.846±0.02) were recorded in the case of T-3. In conclusion, the best feed composition of T-3 was documented with the lowest FCR value of 0.82±0.02. The Specific Growth Rate (SGR) analysis revealed the highest SGR value 0.145±0.002 in the case of treatment 3, as compared to fish subjected to ACF. The mean±SEM for the treatment set was 0.026±0.001. ANOVA in the case of SGR revealed significant differences ($P < 0.05$) among the treatment groups ($df = 31$) by Akram A L, and Swapna K L, 2013 [3]. Furthermore, Shyma and Keshavanath (1993) [24] observed the highest weight gain of mahseer, *T. khudree* fed with 40% protein diet but Shankar (1988) [25] observed the best growth rate of *T. khudree* with a 35.29% protein diet. In contrast, Joshi *et al*. (1989) [26] reported that 35% protein diet containing egg yolk in *T.putitora* showed better results with a higher efficiency as compared to the other test diets.

We observed highest length (33.8-38.6 %) increment in fish fed with the RB+FM (EF-3) during our experiment. Average Length increment with the RB+FF (EF-2) was 20.06% and lowest increment was with the MOC+RB (EF-1) is 14.1-15.2% (Table no.3). Total weight gain was highest in fish fed with EF-3(148-155.3%) followed by EF-2 (106-125%) and EF-1(85-100%) (Table no.3). Further, *Tor tor* fry with an average length and weight of 44.5 mm and 2.102 g respectively were subjected to 3 experimental feeds containing 25 % CP (T-1), 30 % CP (T-2) and 40 % CP (T-3), with a control group fed on feed containing 20 % CP. The highest increment in overall length and weight were observed in the case of T-3 (40 % CP), with as high as 98.5±3.5 mm and 6.317±1.1 gms, over a period of 12 months.

The Highest ADG increment was recorded with EF3 (0.19 g/day, average) and minimum with the EF1 (0.11/day, average). There is slight difference with the report suggested by K. Oliver *et al* 2012 [23] when studied with hatchery and wild collected fingerling which shows 0.74 g/day and 0.38 g/day respectively. Since our experimental fishes were also procured from riverine system, the weight gain is slightly on the lower side.

On the other hand, we observed different water quality parameters during our 45 day research work like: pH, DO, Total Alkalinity and total hardness was found to be 7.8,9.03 mg/lit, 224 mg/lit and 147 mg/lit respectively (Table no.6). All water quality parameters were almost optimum throughout the whole experiment with minute fluctuations. Muhammad S. U. K. *et al*, 2018) [11] also observed water temperature throughout the present experimental period was found within the suitable range and another parameters also like: Dissolve oxygen and etc. The highest temperature (32.6 **ºC**) was recorded in the month of April due to relatively high intensity of sunlight and absence of cloud in the sky and the lowest 22.0 **ºC** was recorded in January. The mean temperature varied from 26.05 ºC to 31.05 ºC from February to October and that was varied from 22.25 ºC to 27.4 ºC during November to January in T1 and T2, respectively.

6. Conclusion

It is crystal clear that, the after math of our experiment confirmed that *Tor tor* fishes started to take locally available ingredients like RB, MOC and also high protein containing floating feed and fish meal. But as similar to other previous research mahseer can feed on high protein feed ingredients for better growth in terms of FCR, SGR, ADG etc. All the experimental feed does not have much of impact on survivavility. Very less variation can be seen in terms of survivability.

7. References

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