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To study the acceptability of different feed ingredients like, rice bran, fish meal, mustard oil cake and floating feed in earthen pond fed via *Tor tor* (Hamilton, 1822) fingerlings

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Abstract
An experiment of 45 days was conducted to perceive the acceptability of different feed ingredients *via Tor tor* (Hamilton, 1822) fingerlings in earthen pond. The protein content of the ingredients Rice bran (RB), Mustard Oil cake (MOC), Floating feed and fish meal is recorded as 14%, 30%, 32%, and 45% respectively. These all feed stuffs are formulated as EFI (RB+MOC), EFII (RB+FF) and EFIII (RB+FM). Three experimental ponds uniform sizes of rectangular earthen ponds (20 × 10 × 1.5) meters with triplicate replication was conducted. *Tor tor* fingerlings were collected from Narmada River at Dongarwara ghat in the Hoshangabad. Experiment was started with few days' old fingerling having an average length Pond 1 (EF1) 7.01, (EF2) 6.23, (EF3), Pond 2 (EF1) 6.64, (EF2) 7.00, (EF3) 6.62 and Pond 3 (EF1) 6.50, (EF2) 6.96, (EF3) 6.85cm respectively and average weight Pond 1 (EF1) 3.93, (EF2) 3.55, (EF3) 4.06, Pond 2 (EF1) 3.53, (EF2) 3.88, (EF3) 3.72and Pond 3 (EF1) 3.24, (EF2) 4.00, (EF3) 4.09gm of respectively. 70 fishes were initially stocked. During the experiment acceptability of feed was recorded lowest during initial 03 days. Average acceptability was recorded starting 3 day with EF1 (10-12.5%), EF2 (14-15%) and EF3 (17-20%). Acceptability increased during the last 15 days it was highest with maximum acceptability of EF3 (96-97 %). The acceptability of fish meal was found to be highest as compared to others.

Keywords: *Tor tor*, Experimental feed, Feed Acceptability, Survivavility.

Introduction

Tor tor is the most common Himalayan Mahseer and very attractive sport fish and a decline in abundance in reservoir in India*. Tor tor* is state fish of Madhya Pradesh, commonly known as Badas. *Tor tor* belonging to order Cypriniformes, family Cyprinidae, sub-family Cyprininae (Hamilton, 1822) [1]. *Tor tor* is one of the high prized and esteemed fish of North and North-eastern India. This fish is the native of major river systems in India all along the sub-Himalayan range including Ganga, Yamuna, Ghagra, Gomati, Rapti, Sarda, Ramganga, Kosi, Sone, Rihand, Chambal, Ken, Betwa, Mahanadi, Narmada, Tapti, Mahi, Brahmaputra-Barak river system, Indus, Sutlej and river Beas spread over the states of Uttar Pradesh, Bihar, Haryana, West Bengal (Darjeeling), Assam, Madhya Pradesh, Himachal Pradesh, Punjab and Uttaranchal. On the other side, neighboring countries like Nepal, Bhutan, Pakistan, Bangladesh, Myanmar and China are also doing culture on this fish (Jaya ram, 1999; Desai, 2003) [2]. It inhabit riverine pools and lakes and also in stream with good flow and rocky bottom where they attain the best growth. They are benthopelagic occurs in a tropical freshwater (15-30 °C) at depths of up to 15 meter and migrate upstream to downstream for breeding and feeding. An especially adult of Tor tor is omnivorous in nature. They feed on small fish, insect mollusks, zooplankton, debris, sand, mud, fish scale and bone, fruit, chironomid larvae, water beetles, crustacean, filamentous algae and macrophytes. Juveniles mainly consume insect (Desai, 2003) [2]. The protrusible and suctorial mouth of *Tor tor* shows preference for insect larva and mollusks suggesting its bottom feeding habit. The suctorial action of the mouth has ability to rapidly suck up bottom food (Thomas, 1873) [6]. This fish is famous for its fighting character during angling and because of its exclusive good taste; it is ranked on the top of all commercial catches of river Narmada.

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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) [16]. In India, several aspects of mahseer have been studied by a number of investigators, however, very little work have been done on *Tor tor*. Although some preliminary observations of Indian mahseer were reported in early nineties, the sporting and fighting characters of mahseer was highlighted by (Thomas, 1897) [7] and Hora (1939, 1940) [12, 13]. This species has been categorized as endangered (Anon, 2001; Sharma, 2003) [4] during the Conservation Assessment and Management Plan (CAMP, 1998) [17], however, as per IUCN (2010), the fish has been declared as near-threatened (NT) (Rayamajhi *et al*, 2010) [11].

There is different kind of fish species which has distinct feeding habit. Mostly catfishes prefer high rate of protein value feed for their survival. 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. 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. Besides this, carbohydrates are basically source of energy in fishes and lipids also. There are feed ingredient which has high source of carbohydrate e.g. Rice brain. On the other side, Protein is also important in different prospective like; for growth rate, survival rate and for immunity also. High source of protein content is mainly present in animal source e.g. fish meal and in plant source like; mustard oil cake and floating feed. Appropriate diet should be mandatory in aquaculture. So, diet plan has very significant role in fisheries.

Materials and Methods
Site of Experiment
The experiment was carried out in 03 earthen ponds measuring 210 m^2 each and each pond was divided into three sections over a period of 45 days in the laboratory/ field area of CIFE center Powarkheda, Hoshangabad (Madhya Pradesh).

Experiment System
Uniform size rectangular 03 earthen ponds (21 × 10 × 1.5) meters were used for rearing of fingerlings. These ponds were further divided into three sections with mosquito net with the help of bamboo poles, and iron rod fitted in the bottom of the mosquito net to prevent the escaping of fish. Size of the each partition was (7 × 10 × 1.5) meters.

Experiment Design
Completely randomized design (CRD) was followed throughout the experiment. Besides this, whole experimental earthen ponds were divided into three sections before filling the ponds with water and after pre-stocking management of old earthen ponds. Small mesh size mosquito net was set in experimental earthen ponds with the help of bamboo poles, iron rods and silk thread to make compartments in the same pond. Each compartment in the pond has the same area. The source of water is from bore well.

Seed collection of *Tor tor*
There is no hatchery for seed production *Tor tor* in Madhya Pradesh. *Tor tor* fingerlings were collected from Narmada River at Dongarwara ghat in the Hoshangabad. Seed collection was done during night time with the help of local fisherman. *Tor tor* fingerlings were collected by the cast net, operated along the gently sloping bank of river where the rocky substrate was present. Fishes were brought to experimental site and kept in FRP tanks for acclimatization. During the acclimatization period mixed phytoplankton and zooplankton was given as a feed.

Manuring and fertilization
Initial pond fertilization with 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 seed stocking. Manuring was done for primary production of planktons as natural food for the fish.

Stocking
Seventy fishes were stocked in each partition (@10000/hectare) in the morning hours. The initial length and weight of the fishes were recorded.

Feed ingredient
The different feed ingredients used in our experimental feed were 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)

Feed	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

Data analysis for FCR, SGR and Acceptability

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

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

Feeding frequency
The feeding frequency important to ensure maximal FCR and dress weight of the cultured organism. Therefore an important step in the feeding strategy was to determine the optimal frequency of feeding. In this experiment feeding had been given by check tray method. Various Feeding trays were fixed in every pond section with the help of bamboo and ropes. *Tor tor* has a bottom feeding habit so the trays had been kept in the bottom of pond. Dough feed prepared as per the experimental feed mixture. After that different feed ingredients were kept into the tray for feeding. Feed was given once in a day.

Results
Acceptability of feeds
Acceptability was recorded during the initial 03 days of stocking and found as EF-1 (10-12.5%), EF-2 (14-15%) and EF-3(17-20%) (Table no. 2 & Graph no. 1). Acceptability was increased with the increasing culture period. Highest

acceptability was recorded in the last 15 days with EF-1(90-93%), EF-2(94-95%) and EF-3 (96-97%) (Table no. 2)

respectively. Overall the acceptability of fish meal was found to be highest.

Table 2: Acceptability of feed

Pond	Periods	Acceptability of Feeds		
		EF-I (%)	*EF-II (%)*	*EF-III (%)*
1	0-3 days	10.0	14.0	17.00
	4-35 days	60.0	71.0	85.50
	36-45 days	93.0	95.0	97.00
2	0-3 days	8.5	15.0	17.50
	4-35 days	64.0	71.0	81.40
	36-45 days	90.0	95.0	96.00
3	0-3 days	12.5	15.0	20.00
	4-35 days	60.0	78.5	86.00
	36-45 days	90.0	94.0	97.50
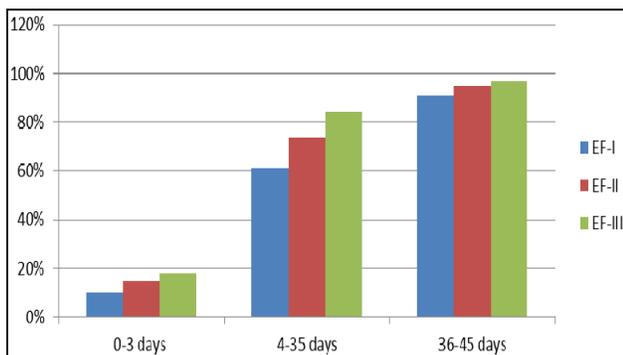
Graph 1: Acceptability of different feeds (X axis for number of days and Y axis for acceptability of feeds)

Feed Utilization
In Aquaculture feed cost account for 50-60% of the expenditure. Therefore best utilization of feed in terms of nutrient is a must to reduce feed cost. Some of the criteria of feed utilization were studied to find out the efficiency of each feed ingredients.

Food Conversion Ratio (FCR)
Lowest FCR was recorded with the pond section fed with EF III and the values are (P1 0.99) (P2 1.03) and (P3 0.96) respectively (Table no.3, Graph no. 3). And the highest FCR was recorded in fish fed with EF1 feed. The values of FCR are recorded as P1 1.76, P2 1.99 and P3 1.81 (Graph no. 2 & 4) respectively in different ponds. And the average FCR of fish fed with EF1 was 1.85 (Table no.3).

**Table 3:** for Food Conversion Ratio (FCR)

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
P1(EF1)	7.33	144.6	3.93	78.6	3.4	66.0	420	0.865	0.594	0.270	1.76
P1(EF2)	7.61	152.2	3.55	71	4.06	81.2	420	0.881	0.550	0.331	1.47
P1(EF3)	10.07	201.4	4.06	81.2	6.01	120.2	420	1.003	0.608	0.394	0.99
P2(EF1)	6.54	130.8	3.53	70.6	3.01	60.2	420	0.815	0.547	0.267	1.99
P2(EF2)	8.00	160	3.88	77.6	4.12	82.4	420	0.903	0.588	0.314	1.45
P2(EF3)	9.50	190	3.72	74.4	5.78	115.6	420	0.977	0.570	0.407	1.03
P3(EF1)	6.54	130.8	3.24	64.8	3.3	66.0	420	0.815	0.510	0.305	1.81
P3(EF2)	8.30	166	4.24	84.8	4.06	81.2	420	0.919	0.627	0.291	1.47
P3(EF3)	10.30	206	4.09	81.8	6.21	124.2	420	1.012	0.611	0.401	0.96
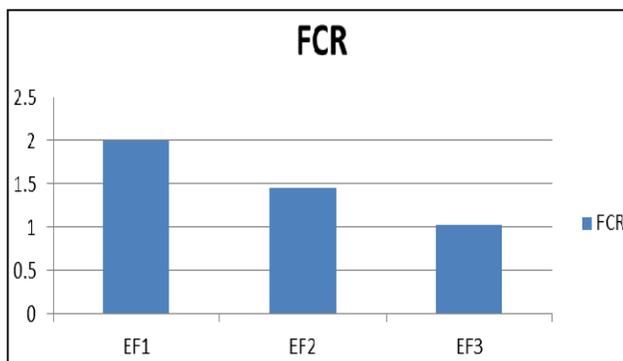
Graph 2: FCR of Pond 1 (X axis for Experimental feeds and Y axis FCR rate)
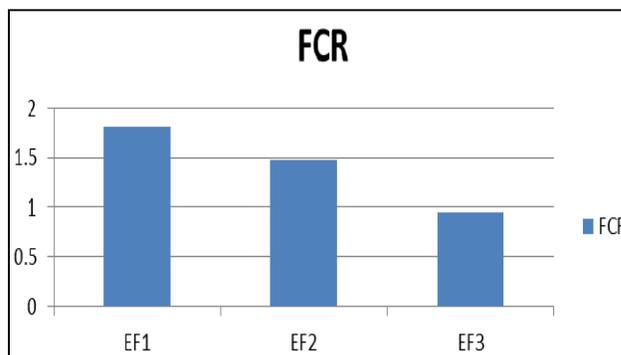
Graph 3: FCR of Pond 2 (X axis for Experimental feeds and Y axis for FCR rate)
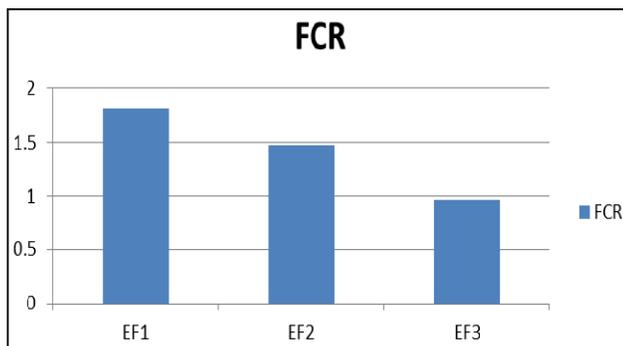
Graph 4: FCR of Pond 3 (X axis for Experimental feeds and Y axis for FCR rate)

Discussion

This current research work was an effort with an intention to upgrade the knowledge in nutrition science which plays a significant role in aquaculture. In our experiment we used different feed ingredient like (RB, FF, MOC and FM) because these are traditional feeds available in farmer's farm. Main aim is to find 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. And also make fish culture more economical.

Acceptability and utilization of distinct feed ingredients on wildly caught fingerlings of *Tor tor* was found to be very less at starting days of experiment. These fishes were taking some time to adjust at different environment conditions during experiment. Acceptability of different feed ingredients by fishes at starting 03 day with P1, 2 & 3 (EF1) 10-12.5%, P1, 2 & 3 (EF2) 14-15% and P1, 2 & 3 (EF3)17-20% was on very low rate (Table no.2). Firstly acceptability rate increased slightly during 4-35 days of culture in all ponds and the highest acceptability was recorded with the RB+FM (EF3) 80-85 % (Graph no.1) as compared to other feed ingredients. Secondly during last 15 days of culture period, feed acceptability was recorded highest with EF3 96-97% (Table no.2) again showed the best acceptable diet. Overall study shows the acceptability of fish meal and rice bran (EF3) was found to be highest (Table no. 2 and Graph no. 1). Feed utilization is one of the main 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 EF3 (0.96) which is a combination of RB+FM followed by the EF2 (1.46) combination of RB+ FF and EF1 (1.85) combination of RB+ MOC (Table no. 3) (Graph no. 2, 3 & 4). This relates to the previous experiments conducted by Akram *et al* and Kangku Oliver *et al* reported that showed 40% protein and 41.21 % protein containing feed fed *Tor tor* gave the best result [3]. In the previous experiment the FCR value was found as 0.82±0.02. Highest increment in overall length and weight was found with the same protein containing feed (40 % CP), with as high as 98.5±3.5 mm and 6.317±1.1 g, over a period of 12 months (365 days) and weight increment was 239.48±6.7 %. Cheap carbohydrate containing ingredient like rice bran can partially replace the protein containing ingredients and substantially decrease the feed cost. On the other side, feed conversion ratio (FCR) was significantly highest in T3 compared to other groups and low palatability of the inert diet has higher FCR in treatments T2 and T3,

better feed consumption when 50% of the live preys are substituted by inert diet provides future avenues for formulating low feed cost for this species. EPA and DHA (HUFA) play a major role growth process during early stages of this fishes. In the present experiment, EPA/DHA levels were comparatively higher in enriched Artemia than present in the inert diets. This result may explain a major beneficial role of live food as an effective carrier vehicle for EPA/DHA during early stages. Fry percent survival was significant after 45th day of experimental trial by Singh s.k, U Mishra., *et al* [18].

Conclusion

This research can be one of the baseline data for conducting further research on the locally available feed ingredients especially for mahseer fishes. In the entire research, we have found out that wild fish collected from rivers take some time to acclimatize in a new pond environment. It is important that we keep it in monitoring tanks to check the feeding and mortality rates. We have also 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.

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