Evaluation of Growth Performance using *Ipomoea aquatica (*Forsk) meal as partial supplementation with fish meal in the diet of Catla catla fry

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Abstract:

The acceptable nutritional value of *Ipomoea aquatica* as ingredients in diets for *Catla catla* fry was experimented under culture system for 60 days. Four experimental diets prepared using dry leaf powder of *Ipomoea aquatica* @ 5%,10% and 15% in treatment T1-T3 respectively while treatment T4 was control diet without *Ipomoea aquatica*. The protein content of 30% was kept uniform in all diets. Feed was provided to fishfry daily twice @ 5% of the biomass to observe length and weight gain in experimental and control diets. Effect of different treatments on growth and survival on fries of *Catla catla* with experimental diets and water quality criteria measured over the 60 days of the experiment indicate that, the length, weight and survival of fry was significantly higher in treatment T3 where dry leaf powder of *Ipomoea aquatica* was provided @ 15% of biomass. Effect of different treatments on water quality, physico-chemical parameters such as Dissolved Oxygen, pH, Alkalinity and Total Dissolved salts were analyzed periodically according to Standard Methods of analysis, American Public Health Association(APHA),1985[2] and benefit cost ration (BCR) was also worked out to find out the economics in different treatments. A benefit-cost ratio (BCR) is a ratio used in a cost-benefit analysis to summarize the overall relationship between the relative costs and benefits of a proposed project. . The BCR is calculated by dividing the proposed total cash benefit of a project by the proposed total cash cost of the project. Prior to dividing the numbers, the net present value of the respective cash flows over the proposed lifetime of the project – taking into account the terminal values, including salvage/remediation costs – are calculated. If a project has a BCR greater than 1.0, the project is expected to deliver a positive net present value to a firm and its investors

Our Hypothesis was that the escalating prices of fish meal and also the uncertain availability of superior quality fish meal have drawn attention of aquaculture nutrition scientists to substitute fish meal by other protein sources to the maximum extent. Apart from the conventional protein sources as soybean meal, oil seed meals, other cereal proteins and agricultural byproducts, non-conventional feedstuffs, i.e., those that have not been traditionally used in commercially produced rations for livestock are now being utilized as fish meal replacers in formulated aqua feeds. *Ipomoea aquatica* are small free-floating aquatic plants with worldwide distribution. The requirements of intensive aquaculture for nutritionally complete feeds have stimulated considerable research and development activities in the fields of fish nutrition and feed technology. Research interest has therefore been redirected towards the evaluation and use of unconventional protein sources for example plant seeds, leaves and agricultural byproducts.

Keywords: ***Ipomoea aquatica***, *Catla catla*, Protein source, feed replacement, growth, feed utilization.

Introduction

Supplementary feeding is the most desirable measure to increase fish yield. The importance of developing cheap, nutritionally balanced artificial diets for fish by using nonconventional protein sources, ranging from plant products to compost or even microbiologic enriched material and agricultural by-product in intensive and semi intensive aquaculture is well established. In fish farming, nutrition is critical because feed represents 40-50% of the production costs. Fish nutrition has advanced dramatically in recent years with the development of new, balanced commercial diets that promote optimal fish growth and health, the development of new species-specific diet formulation supports the aquaculture industry as it expands to satisfy increasing demand for affordable, safe and high quality fish products.

The formulation of efficient and economical fish feed is achieved by increased understanding The nutrient availability, their interaction and relationship with fish growth. To increase the production of fish from pond systems, beyond the level supported by the availability of natural food, supplementary feeds may be used. Formulated supplementary feeds are generally based on regionally available ingredients, and their function is to provide additional major nutrients and to complement the essential nutrients that the fish obtain by consumingnatural food organisms.
Protein is one of the basic components of animal tissues which constitute 45 – 47 % tissue dry matter[9]. Therefore, it is an essential nutrient for body maintenance and growth. Fish use protein efficiently as a source of energy. A high percentage of digestible energy in protein is metabolized in fish than in land animals. The heat increment for protein consumed is lower in fish than in mammals or birds, which gives a higher productive energy value for fish (Lovell, 1989)[8].
Protein is typically the most costly ingredient in a formulated feed. Feed costs are usually the major operational expense in most aquaculture operation because in most aquaculture feeds

Review of Literature :

Fish feed is one of the major inputs in aquaculture production which accounts for at least 60% of the total cost of production (Gabriel *et al*., 2007). Fish feed technology is one of the least development sectors of aquaculture particularly in Africa and other developing countries of the World (Gabriel *et al*., 2007). The main constraints of fish feed production include scarcity of fish feed stuffs, high cost of ingredients and competition of ingredients for human use. This constraints have motivated the research for local available and cheap alternative protein feed source that compete less with human for aquaculture industry which aim to reduce the cost of production without compromising fish quality. In view of the worldwide demand for additional sources of food to meet the needs of ever increasing population, the exploitation of plants of low economic importance is a step towards better resource utilization (Telek and Martin, 1983). Water spinach (*Ipomoea aquatica* Forsk.) is a common emergent aquatic plant found in marshy or wet sandy areas or floating on water. Water spinach or morning glory is basically a vine which may form dense masses of tangled vegetation, thus developing impenetrable canopies over the water surface, restricting light penetration into the depths. It is found growing wildly in tropical and subtropical countries and is cultivated widely in China, Indonesia, Thailand, Vietnam, Myanmar, Philippines, Bangladesh and India (Naskar, 1990). Water spinach (*I. aquatica*) is a vegetable that is consumed by people and animals (Kean and Preston, 2001). It has a short growth period, resistant to common insect pests and can be cultivated either in dry or flooded soils. Moreover, water spinach is a vegetable with a high potential to convert efficiently the nitrogen in bio-digester effluent into edible biomass with high protein content (Kean and Preston, 2001).Water spinach is a potential source of feed protein concentrate; the edible portion contain up to 29% crude protein on a dry matter basis and a number of nutrients and minerals (Ly, 2002). *I. aquatica* contains very low amount of anti-nutritive factors such as trypsin inhibitor, calcium oxalate, tannin and phytate (Mandal *et al*., 2008). Although, various leaf meals have been experimented as potential fish feed ingredients to reduce diet cost, the use of water spinach leaf meal has not been experimented. It is against this background the experiment is designed to evaluate the growth potentials and survival of *Catla catla* fry incorporating water spinach leaf meal into the diet.

Objectives:

1. To evaluate optimum level of *Ipomoea aquatica* in the diet suitable for better growth in *Catla catla* fry.
2. To study the effect of *Ipomoea aquatica* supplemented diet on survival rate of *Catlacatla* fry.
3. To determine the economics of Feed in different treatments as Benefit Cost Ratio (BCR).

Material & method

Fresh *Ipomoea aquatica* was harvested from the nearby water body. *Ipomoea aquatica* collected were identified following the example of Saygide..er (1996),[13] separated from other plants, washed, and dried. The dried leaves of water spinach were then grind to make fine powder. Four experimental diet was prepared using dry leaf powder of *Ipomoea aquatica* @ 5%,10% and 15% in treatment T1-T3 respectively by replacing fish meal while treatment T0 was control diet without *Ipomoea aquatica*. The protein content of 30% was calculated using Pearson square method [19] was kept uniform in all diets. Feed was provided to fish fry daily twice @ 5% of the body weight of fish fry. During the experimental period total amount of feed provided in different treatment ranged between 22.47 kg to 30.27 kg wherein quantity of protein was ranged between 6.74-9.081 kg during the year-1, similarly during the year-II it was 46.12- 55.65 kg and protein was 13.83- 16.69 kg, while during the year-III total quantum of feed ranged between 39.30-45.09 kg wherein protein amount was between 11.79-13.52 kg. Fry of Catla catla (20-30 mm) purchased from the Fish Seed Production Unit of Department of Fisheries, Government of Gujarat. The experiment was conducted using Completely Randomized (CRD) design in twenty plastic tanks (1.8'x 1.2' x 0.8') of 20 lit volume. In each treatment 20 number of Catla spp. fry of uniform size 22 mm were stocked. The water quality parameters, temperature, pH, DO were analyzed using Standard Methods for the Examination of Water and Waste Water outlined by APHA (1985) [2] . Water samples from all the tanks also taken on fortnightly basis to see the changes in physico-chemical parameters and their average values were calculated on fortnightly.

Observation

It was observed that, Effect of different treatments on growth and survival on fries of *Catla catla* with experimental diets and water quality criteria measured over the 60 days of the experiment, which occurred between August– October during the year 2016-2018. After third trials pooled analysis was done using Analysis of variance (ANOVA) and it was observed that, effect of experimental diet on length of fry was found significantly higher in treatment T3 over the years in individual and in pooled. Whereas it was found to be non significant in interaction between treatment x period (TxP). while the interaction effect between year, treatment, and period (YxTxP) was found to be significant. The weight of fry was found significantly higher in treatment T3 over the years in individual and in pooled. Also the interaction effect on treatment was significant in (T), treatment, treatment x period (TxP) and year, treatment and Period (YxTxP). The effect of treatment on survival rate of *Catla* fry was found to be significantly higher in treatment T3 in all the years & in pooled. (Table-2). The effect of treatment on Physico chemical parameters were recorded and it was observed that dissolved oxygen, Alkalinity, pH and TDS were within the permissible range during the experiment (Table-3). The economics of the treatment was calculated in terms of Benefit Cost Ratio (BCR) revealed that, treatment T3 was found to be superior then other treatments over the years. (Table-4a,b,c).

Result

Effect of different treatments on growth and survival on fries of *Catla catla* with experimental diets and water quality criteria measured over the 60 days of the experiment, which occurred between August– October during the year 2016-2018. After third trials pooled analysis was done using ANOVA and it was observed that, effect of experimental diet on length of fry was found significantly higher ($P<0.05$) in treatment T3 over the years in individual and in pooled. Whereas it was found to be non significant in interaction between treatment x period (TxP), while the interaction effect between year, treatment, and period (YxTxP) was found to be significant. The weight of fry was found significantly higher in treatment T3 over the years in individual and in pooled. Also the interaction effect on treatment was significant ($P<0.05$) in (T), treatment, treatment x period (TxP) and year, treatment and Period (YxTxP). The effect of treatment on survival rate of *Catla* fry was found to be significantly higher in treatment T3 in all the years & in pooled. (Table-2). The effect of treatment on Physico chemical parameters were recorded and it was observed that dissolved oxygen, Alkalinity, pH and TDS were within the permissible range i.e Dissoved Oxygen-3-8 ppm, pH- 7.7-8.2, Alkalinity-88-200 ppm, TDS-500-1500 ppm during the experiment Table-3 .

The economics of the treatment was calculated in terms of Benefit Cost Ratio (BCR) which include actual cost of fish culture in terms of experimental diets and control or normal diet and expected income of fish fingerlings considering the prevailing market rates revealed that, treatment T3 was found to be more profitable and superior than other treatments over the years. (Table-4a,b,c). Therefore, the result of the experiment would recommend to the fish farmers to use 15% of Ipomoea aquatica weed powder in the fish feed by replacing fish meal of same quantity to obtain better income.

Discussion

Several studies in recent past to make supplementary feeding of fish cost- effective have been directed to substitute the high cost fish meal with less expensive protein sources. This aspect of feed development research is centered on the search for inexpensive, naturally available and nutritious protein sources that can supply all the nutritional needs of the fish. One obvious approach involves the greater utilization of ingredients of plant origin. Aquatic and terrestrial macrophytes have been used as supplementary feeds in fish farming since early days of freshwater fish culture and still play an important role as fish feeds in extensive culture systems. The efficacy of the leaves of various terrestrial and aquatic macrophytes for partial replacement of fish meal in carp diets has been investigated by a number of workers[11] [10] [15]. The aquatic weeds have been shown to contain substantial amount of protein and minerals[11]. It is therefore envisaged to find out the effect of fish feed incorporated with *Ipomoea aquatica* leaves extract on survival and growth performance of *Catla catla* during fry to fingerling stage of farming.

It is concluded that, better growth rate in terms of length and weight, survival rate was obtained when experimental diet (T3) mixed with 15% *Ipomoea aquatica* meal in rearing ponds.

Therefore, it is propose to recommend fish farmers to provide fish feed fortified with *Ipomoea* leaf meal @ 15% to *Catla catla* fry for obtaining better growth, survival rate and Benefit Cost (BCR) of *Catla catla* in rearing ponds.

Table 1. Effect of *Ipomoea aquatica* on length and weight of *C.Catla* in Individual and pooled

	Length (cm)				Weight (g)			
Treat.	**2016**	**2017**	**2018**	**Pooled Mean**	**2016**	**2017**	**2018**	**Pooled Mean**

T1	5.1204	2.5664	3.8520	3.8463	0.3112	0.1364	0.5392	0.3289
T2	6.6260	2.5136	4.1080	4.4159	0.3520	0.1286	0.5324	0.3377
T3	7.1036	2.5608	4.4680	4.7108	0.4036	0.1516	0.6012	0.3855
T4	5.3800	2.4256	3.8880	3.8979	0.2996	0.1246	0.5240	0.3161
S.Em.±	**0.078**	**0.016**	**0.042**	**0.2828**	**0.005**	**0.005**	**0.017**	**0.0119**
C.D. at 5%	**0.219**	**0.045**	**0.12**	**NS**	**0.015**	**0.013**	**0.049**	**0.0410**
CV%	**6.4**	**3.16**	**5.2**	**4.92**	**7.74**	**16.79**	**15.71**	**13.23**
Period								
P1	2.9675	1.3680	3.0850	2.4735	0.1945	0.0337	0.2575	0.1619
P2	4.3915	1.7770	3.7850	3.3178	0.2610	0.0402	0.4500	0.2504
P3	5.8850	2.8080	4.1350	4.2760	0.3415	0.1472	0.5220	0.3369
P4	7.5765	3.1100	4.5600	5.0822	0.4030	0.1965	0.6810	0.4268
P5	9.4670	3.5200	4.8300	5.9390	0.5080	0.2590	0.8355	0.5342
S.Em.±	**0.087**	**0.018**	**0.047**	**0.6046**	**0.006**	**0.005**	**0.019**	**0.0399**
C.D. at 5%	**0.244**	**0.05**	**0.134**	**0.9223**	**0.017**	**0.014**	**0.054**	**0.0387**

Treat.		**Survival (%)**		
	2016	**2017**	**2018**	**Pooled Mean**
T1:	66.00	98.60	94.60	97.083
T2:	57.60	98.80	93.80	90.583
T3:	78.10	99.20	95.80	85.083

Int.	**T4:**	53.52	98.80	93.00	79.461	**Treatment X Period**
	S.Em.+̲	1.496	0.324	0.387	3.408	
	C.D.@ 5%	**4.217**	**NS**	**0.433**	**NS**	
	CV%	**11.72**	**1.64**	**2.05**	**5.32**	
	P1	91.25	100.00	100.00	97.0833	
	P2	75.50	100.00	96.25	90.5833	
	P3	60.00	100.00	93.25	85.0833	
	P4	49.38	97.50	90.50	79.4617	
	P5	40.90	96.75	90.50	76.0500	
	S.Em.+̲	1.673	0.362	0.433	5.9097	
	C.D.@ 5%	**4.715**	**1.021**	**1.221**	**NS**	
	S.Em.+̲	2.0385				
	C.D. @5%	**5.7081**				
	C.V.%	5.32				

S.Em.+̲	0.2945	0.0279
C.D. at 5%	**NS**	**0.0346**
C.V.%	6.14	15.71

Table-2- Effect of treatments on survival rate of fries

Table-3. Yearwise Observation of Physico-chemical parameters

YEAR	**DO_2(ppm)**	**pH**	**Hardness (ppm)**	**Alkalinity (ppm)**	**TDS (ppm)**
2016	3.6-8.4	7.3-7.8	80-130	52-102	603-756
2017	4.1-6.8	7.5-8.4	70-80	72-110	605-670
2018	4.2-7.0	7.5-8.5	76-130	76-126	601-760

Table-4a. Effect of treatment on Benefit Cost Ratio year-I

Treatment	No. of fry stocked/tank	Conversion x1000	Cost of fry at the rate of 90/1000	Survival %	Treatment wise Quantum of feed utilized (kg)	Per kg cost of feed (Rs)	Treatment wise cost of feed utilized (col.6*7)	# Other Misc. Expense (INR)	Total input cost (4+8+9) INR	Total number of Fingerling Produced	Income from sell of Fingerling at the rate of Rs.300/1000	BCR
1	2	3	4	5	6	7	8	9	10	11	12	13
T1	20	20000	1800	66.00	22.98	17.00	390.66	110	2300.66	13200	3960	1:1.7
T2	20	20000	1800	57.60	26.40	17.50	462.00	110	2372.00	11520	3456	1:1.4
T3	20	20000	1800	78.10	30.27	16.50	499.45	110	2409.45	15620	4686	1:1.9
T4(C)	20	20000	1800	53.52	22.47	16.00	359.52	110	2269.52	10704	3211	1:1.4

Table-4b. Effect of treatment on Benefit Cost Ratio year-II'

Treatment	No. of fry stocked/tank	Conversion x1000	Cost of fry at the rate of 90/1000	Survival %	Treatment wise Quantum of feed	Per kg cost of feed (Rs)	Treatment wise cost of feed utilized (col.6*7)	# Other Misc. Expensed (INR)	Total input coast (4+8+9)	Total number of Fingerling Produced	Income from sell of Fingerling at the rate of	BCR

					utilized (kg)				**INR**		**Rs.300/1000**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
T0(C)	**20**	**20000**	**1800**	**97**	**45.37**	**18.40**	**834.80**	**120**	**2754.80**	**19400**	**5820**	**1:2.11**

Table-4c. Effect of treatment on Benefit Cost Ratio year-III

Treatment	Conversion x1000*	Cost of fry at the rate of 90/1000	Survival %	Treatment Wise Quantum of feed utilized **(kg)**	Per kg cost of feed **(INR)**	Treatment wise cost of feed utilized (col.6*7)	# Other Misc. Expenses (INR)	Total input coast (4+8+9) INR	Total number of Fingerling Produced	Income from sell of Fingerling at the rate of INR.300/1000	BCR
1	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
T0 ©	20000	1800	95.80	45.09	18.92	853.10	130	2783.10	19160	5748	1:2.1
T1	20000	1800	94.60	40.44	19.50	780.00	130	2710.00	18920	5676	1:2.0
T2	20000	1800	93.80	39.93	19.22	767.45	130	2697.45	18760	5628	1:2.0
T3	20000	1800	93.00	39.30	19.80	778.14	130	2708.14	18600	5580	1:2.0

T1	**20**	**20000**	**1800**	**95**	**49.83**	**17.90**	**891.96**	**120**	**2811.96**	**19000**	**5820**	**1:2.06**
T2	**20**	**20000**	**1800**	**97**	**46.12**	**17.56**	**809.86**	**120**	**2729.86**	**19400**	**5820**	**1:2.13**

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Table-1

Treat.	**Length (cm)**				**Weight (g)**			
	2016	**2017**	**2018**	**Pooled Mean**	**2016**	**2017**	**2018**	**Pooled Mean**
T0	5.3800	2.4256	3.8880	3.8979	0.2996	0.1246	0.5240	0.3161
T1	5.1204	2.5664	3.8520	3.8463	0.3112	0.1364	0.5392	0.3289
T2	6.6260	2.5136	4.1080	4.4159	0.3520	0.1286	0.5324	0.3377
T3	7.1036	2.5608	4.4680	4.7108	0.4036	0.1516	0.6012	0.3855
S.Em.+ −	**0.078**	**0.016**	**0.042**	**0.2828**	**0.005**	**0.005**	**0.017**	**0.0119**
C.D. at 5%	**0.219**	**0.045**	**0.12**	**NS**	**0.015**	**0.013**	**0.049**	**0.0410**
CV%	**6.4**	**3.16**	**5.2**	**4.92**	**7.74**	**16.79**	**15.71**	**13.23**
Period								

P1	2.9675	1.3680	3.0850	2.4735	0.1945	0.0337	0.2575	0.1619
P2	4.3915	1.7770	3.7850	3.3178	0.2610	0.0402	0.4500	0.2504
P3	5.8850	2.8080	4.1350	4.2760	0.3415	0.1472	0.5220	0.3369
P4	7.5765	3.1100	4.5600	5.0822	0.4030	0.1965	0.6810	0.4268
P5	9.4670	3.5200	4.8300	5.9390	0.5080	0.2590	0.8355	0.5342
S.Em.+ –	**0.087**	**0.018**	**0.047**	**0.6046**	**0.006**	**0.005**	**0.019**	**0.0399**
C.D. at 5%	**0.244**	**0.05**	**0.134**	**0.9223**	**0.017**	**0.014**	**0.054**	**0.0387**

Table-2

Treat.		**Survival (%)**		
	2016	**2017**	**2018**	**pool ed**
T0	53.52	98.80	93.00	79.461
T1:	66.00	98.60	94.60	97.083
T2:	57.60	98.80	93.80	90.583
T3:	78.10	99.20	95.80	85.083
S.Em.+ –	1.496	0.324	0.387	3.408
C.D.@ 5%	**4.217**	**NS**	**0.433**	**NS**
CV%	**11.72**	**1.64**	**2.05**	**5.32**
P1	91.25	100.00	100.00	97.0833
P2	75.50	100.00	96.25	90.5833
P3	60.00	100.00	93.25	85.0833

P4	49.38	97.50	90.50	79.4617
P5	40.90	96.75	90.50	76.0500
S.Em.±	1.673	0.362	0.433	5.9097
C.D.@ 5%	**4.715**	**1.021**	**1.221**	**NS**
S.Em.±	2.0385			
C.D. @5%	**5.7081**			
C.V.%	5.32			

Table-3. Yearwise mean Observation of Physico-chemical parameters

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YEAR	DO_2(ppm)	pH	Hardness (ppm)	Alkalinity (ppm)	TDS (ppm)
2016	3.6-8.4	7.3-7.8	80-130	52-102	603-756
2017	4.1-6.8	7.5-8.4	70-80	72-110	605-670
2018	4.2-7.0	7.5-8.5	76-130	76-126	601-760

eatment	No. of fry stocked/tank	Conversion x1000	Cost of fry @90/1000	Survival %	Treatment wise Quantum of feed utilized (kg)	Per kg cost of feed (Rs)	Treatment wise cost of feed utilized (col.6*7)	# Other Misc. Expensed (INR)	Total input coast (4+8+9)	Total number of Fingerling Produced	Income from sell of Fingerling at the rate of Rs.300/1000
									INR		
	3	4	5	6	7	8	9	10	11	12	13
	20000	1800	97	45.37	18.40	834.80	120	2754.80	19400	5820	1:2.11
	20000	1800	95	49.83	17.90	891.96	120	2811.96	19000	5820	1:2.06
	20000	1800	97	46.12	17.56	809.86	120	2729.86	19400	5820	1:2.13
	20000	1800	98	55.65	17.11	952.17	120	2872.17	19600	5880	