International Journal of Science, Environment and Technology, Vol. 9, No 2, 2020, 206 – 218
ISSN 2278-3687 (O)
2277-663X (P)

UTILIZATION OF DUCKWEED (*Lemna minor*) MEAL AS PARTIAL SUPPLEMENTATION IN THE DIET OF *Catla catla* FRY

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Abstract: The acceptable nutritional value of *Lemna* Minor as ingredients in diets for *Catla catla* fry was experimented under culture system for 60 days. Four experimental diet was prepared using dry leaf powder of duckweed (*Lemna minor*) @ 5%,10% and 15% in treatment T1-T3 respectively while treatment T4 was control diet without duckweed (*Lemna minor*). The protein content of 30% was kept uniform in all diets. Feed was provided to fish fry 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 *lemna* was provided @ 15% of biomass.
Keywords: *Lemna minor, 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 to use 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 of 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 consuming

*Received Mar 11, 2020 * Published April 2, 2020 * www.ijset.net*

natural food organisms. 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. Protein is one of the basic components of animal tissues which constitute 45 – 47 % tissue dry matter (Murai, 1985)[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). Protein is typically the most costly nutrient in a formulated feed. Feed costs are usually the major operational expense in most aquaculture operation because in most aquaculture feeds Review of Literature 9 fishmeal is a very important and major source of animal protein in the diet of fish and may constitute up to 60% of the total diet. Fishmeal which serves as the main protein source for fish feed because of its high quality protein content, is not only expensive but also usually unavailable (Tacon and Barg, 1998) [14] particularly in developing countries. 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. Duckweeds are small free-floating aquatic plants with worldwide distribution. They are monocotyledons belonging to the family *Lemnaceae* (which is derived from the Greek word 'Limne', meaning pond) and are classified as higher plants or macrophytes. Duckweed meal has been known for its high nutritive value with as much as 40% and above crude protein depending on the culture system (Ahmad *et al*., 2003; Leonard, 1995; Hassan and Edward, 1992, Robinette *et al*., 1980; Hanczakowaski *et al*., 1995). [1][5] [6] [12] Duckweed, as a natural protein source, has a better array of essential amino acids (lysine and methionine) than most other vegetable proteins and more closely resembles animal protein (Hillman and Culley, 1978) [7]. These weeds, which otherwise remain unutilized, and often make the water body unsuitable for fish culture, may be converted into valuable fish flesh through their incorporation as an ingredient in carp diets. Several studies in recent past to make supplementary feeding of fish costeffective 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, readily 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 (Ray and Das, [11]1992, 1994, 1995; Mondal and Ray, 1998, 1999; [10] Bairagi *et al.*, 2002a, 2004)[2]. The aquatic weeds have been shown to contain substantial amount of protein and minerals (Ray and Das, 1994) [11]. It is therefore envisaged to find out the effect of fish feed incorporated with duckweed leaves extract on survival and growth performance of *Catla catla* during fry to fingerling stage of farming.

The objectives of the experiment was

- To evaluate optimum level of duckweed in the diet suitable for better growth in *Catla catla* fry
- To study the effect of duckweed supplemented diet on survival rate of *Catla catla* fry
- To determine the economics of Feed in different treatments.

Material & method

Fresh duckweed was harvested from the Pari talav located in the Botanical garden of Junagadh Agricultural University campus. Duckweed collected were identified following the example of Saygide..er (1996),[13] separated from other plants, washed, and dried until it reached constant weight. Four experimental diet was prepared using dry leaf powder of duckweed (*Lemna minor*) @ 5%,10% and 15% in treatment T1-T3 respectively while treatment T4 was control diet without duckweed (*Lemna minor*). The protein content of 30% was kept uniform in all diets. Feed was provided to fish fry daily twice @ 5% of the biomass. 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 at Inland Fisheries Research Station, JAU, Junagadh. In each treatment 20 number of *Catla spp.* fry of uniform size were stocked. The physicochemical parameters recorded using standard method (APHA) at fortnight intervals in each treatment.

Observation and 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 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 besignificantly higher in treatment T3 in all the years & in pooled. (Table-4). 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-5). The economics of the treatment was calculated in terms of Benefit Cost Ratio (BCR) revealed that, treatment T3 was found to be superior than other treatments over the years. (Table-6a,b,c).

Result

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

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

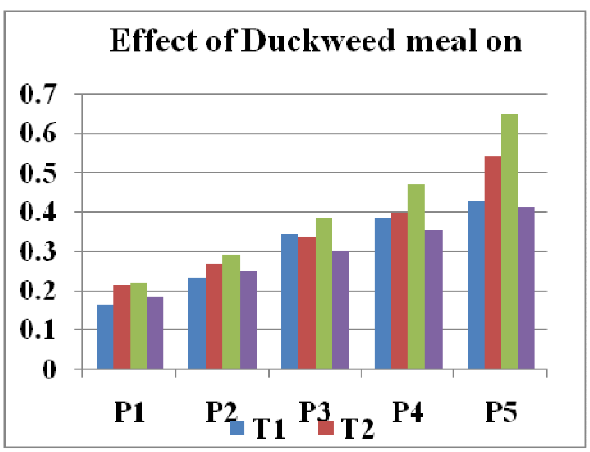
Table 1. Effect of duck weed on length and weight of *C.catla* at fortnight interval in Individual and pooled analysis

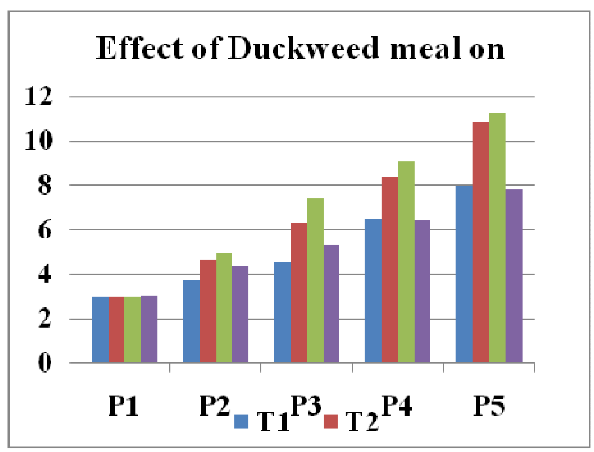
Treat.	Length (cm)				Weight (g)			
	2016	2017	2018	Pooled Mean	2016	2017	2018	Pooled Mean
T_1	5.1204	2.5664	3.8520	3.8463	0.3112	0.1364	0.5392	0.3289
T_2	6.6260	2.5136	4.1080	4.4159	0.3520	0.1286	0.5324	0.3377
T_3	7.1036	2.5608	4.4680	4.7108	0.4036	0.1516	0.6012	0.3855
T_4	5.3800	2.4256	3.8880	3.8979	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.@ 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.@ 5%	**0.244**	**0.05**	**0.134**	**0.9223**	**0.017**	**0.014**	**0.054**	**0.0387**
Int. Treatment X Period								
S.Em.±	0.2945				0.0279			
C.D.@ 5%	**NS**				**0.0346**			
C.V.%	6.14				15.71			

Fig.1. Effect of duckweed (*Lemna minor*) meal on length and weight of *C.catla* at fortnight interval

YEAR-1





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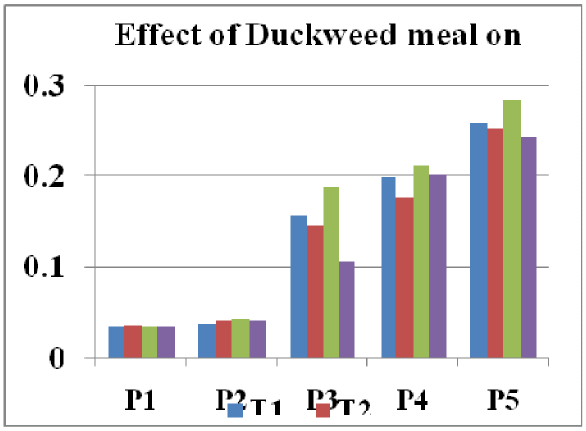
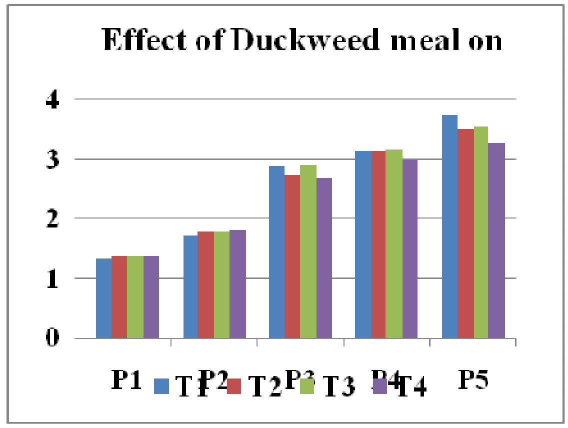
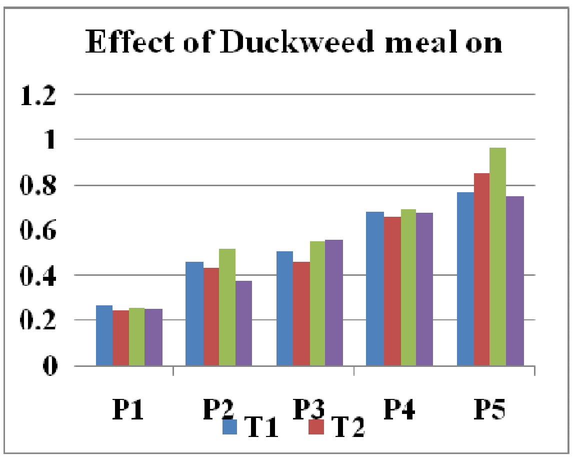

Effect of Duckweed meal on
0.3
0.2
0.1
0
P1
P2
P3
P4
P5
T1
T2


Effect of Duckweed meal on
4
3
2
1
0
P1
P2
P3
P4
P5
T1
T2
T3
T4

YEAR-3


Effect of Duckweed meal on
1.2
1
0.8
0.6
0.4
0.2
0
P1
P2
P3
P4
P5
T1
T2

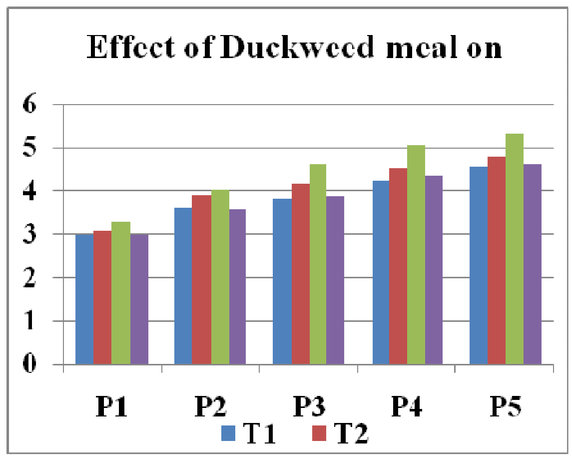

Effect of Duckweed meal on
6
5
4
3
2
1
0
P1
P2
P3
P4
P5
T1
T2

Table 2. Interaction effect of treatment on length (cm) of *C.catla* over the years at Fisheries Research Station, Junagadh

Treat. T / P	1st Year (2016)				2nd Year (2017)				3rd Year (2018)				Pooled mean			
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
P1	2.9600	2.9600	2.9400	3.0100	1.3480	1.3760	1.3760	1.3720	3.000	3.0800	3.2800	2.9800	2.4360	2.4720	2.5320	2.4540
P2	3.7000	4.6340	4.8780	4.3540	1.7200	1.7920	1.7880	1.8080	3.620	3.9000	4.0200	3.6000	3.0133	3.4420	3.5620	3.2540
P3	4.5100	6.3420	7.3600	5.3280	2.8840	2.7400	2.9200	2.6880	3.820	4.2000	4.6400	3.8800	3.7380	4.4273	4.9733	3.9653
P4	6.5000	8.3440	9.0600	6.4020	3.1400	3.1400	3.1600	3.0000	4.240	4.5600	5.0800	4.3600	4.6267	5.3480	5.7667	4.5873
P5	7.9320	10.8500	11.2800	7.8060	3.7400	3.5200	3.5600	3.2600	4.580	4.8000	5.3200	4.6200	5.4173	6.3900	6.7200	5.2287
Int. Treat. x Period																
S.Em.±	0.173				0.036				0.095				0.2945			
C.D.@5%	**0.489**				**0.1**				**NS**				**NS**			
C.V.%	6.4				3.16				5.2				6.14			
Int. Year x P x T																
S.Em.±	0.1159															
C.D.@5%	**0.3244**															

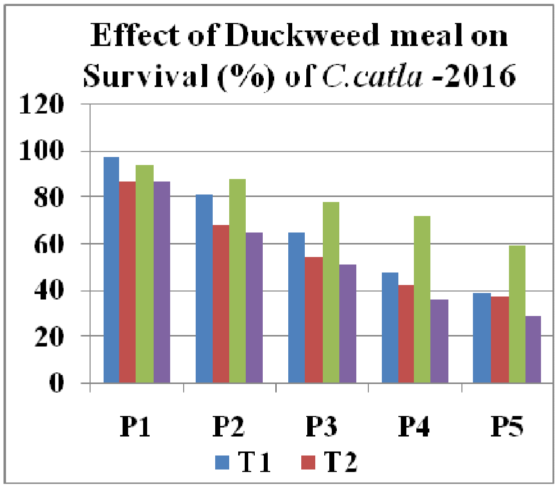
Table 3. Interaction effect of treatment on Weight (gm) of *C.catla* over the years at Fisheries Research Station, Junagadh

Treat. T / P	1st Year (2016)				2nd Year (2017)				3rd Year (2018)				Pooled mean			
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
P1	0.1640	0.2120	0.2180	0.1840	0.0338	0.0340	0.0336	0.0332	0.2720	0.2460	0.2620	0.2500	0.1566	0.1640	0.1712	0.1557
P2	0.2340	0.2700	0.2920	0.2480	0.0364	0.0410	0.0426	0.0408	0.4660	0.4380	0.5160	0.3800	0.2455	0.2497	0.2835	0.2229
P3	0.3420	0.3360	0.3880	0.3000	0.1560	0.1400	0.1880	0.1048	0.5060	0.4640	0.5560	0.5620	0.3347	0.3133	0.3773	0.3223
P4	0.3860	0.4000	0.4720	0.3540	0.1980	0.1760	0.2100	0.2020	0.6840	0.6620	0.7000	0.678	0.4227	0.4127	0.4607	0.4113
P5	0.4300	0.5420	0.6480	0.4120	0.2580	0.2520	0.2840	0.2420	0.7680	0.8520	0.9720	0.7500	0.4853	0.5487	0.6347	0.4680
Int. Treat. x Period																
S.Em.±	0.012				0.01				0.039				0.0279			
C.D.@5%	**0.033**				**0.029**				**NS**				**0.0346**			
C.V.%	7.74				16.79				15.71				15.71			
Int. Year x P x T																
S.Em.±	0.0240															
C.D.@5%	**0.0673**															

Table 4. Effect of Duckweed Meal on Survival of *C.catla* at fortnight interval at Fisheries Research Station, Junagadh

Treat.	Survival (%)			
	2016	**2017**	**2018**	**Pooled Mean**
T_1:	66.000	98.600	94.600	97.0833
T_2:	57.600	98.800	93.800	90.5833
T_3:	78.108	99.200	95.800	85.0833
T_4:	53.520	98.800	93.000	79.4617
S.Em.±	1.496	0.324	0.387	3.4088
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			

YEAR-1



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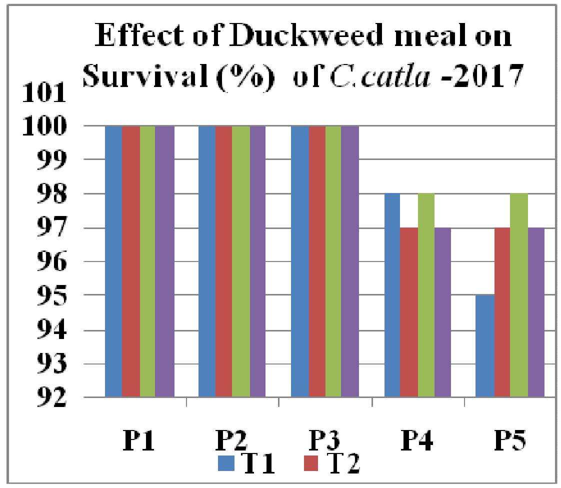

YEAR-3

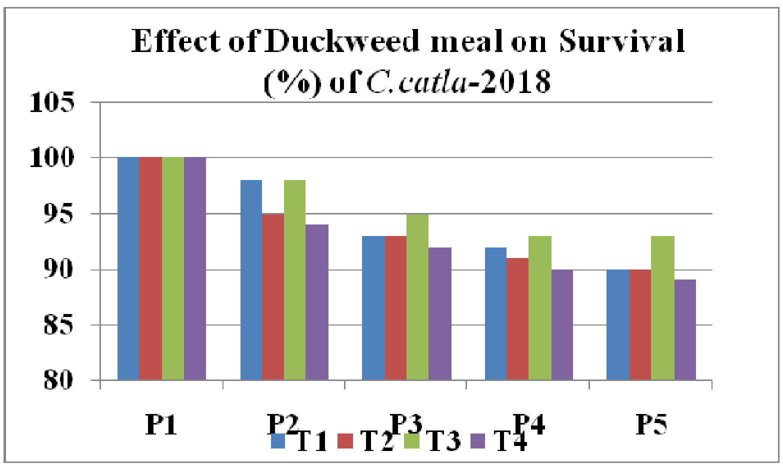

Table 5: Year wise Range of Water quality parameters

Year	Water quality Parameters				
	DO2(ppm)	pH	Hardness (ppm)	Alkalinity (ppm)	TDS (ppm)
2016	3.6-8.4	7.2-8.8	80-130	52-102	603-756
2017	4.1- 4.8	7.5-8.4	70-80	72-110	605-670
2018	4.2- 8.0	7.5-8.5	76-130	76-126	601-760

Table-6a. Effect of treatment on Benefit Cost Ratio year-I

Treatment	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) INR	Total number of Fingerling Produced	Income from sell of Fingerling @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-6b. Effect of treatment on Benefit Cost Ratio year-II

Treatment	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) INR	Total number of Fingerling Produced	Income from sell of Fingerling @Rs.300/1000	BCR
1	2	3	4	5	6	7	8	9	10	11	12	13
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
T3	20	20000	1800	98	55.65	17.11	952.17	120	2872.17	19600	5880	1:2.04
T4(C)	20	20000	1800	97	45.37	18.40	834.80	120	2754.80	19400	5820	1:2.11

Table-6c. Effect of treatment on Benefit Cost Ratio year-III

Treatment	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. Expenses (INR)	Total input coast (4+8+9) INR	Total number of Fingerling Produced	Income from sell of Fingerling @Rs.300/1000	BCR
1	3	4	5	6	7	8	9	10	11	12	13
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	95.80	45.09	18.92	853.10	130	2783.10	19160	5748	1:2.1
T4(C)	20000	1800	93.00	39.30	19.80	778.14	130	2708.14	18600	5580	1:2.0

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