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Effect of different levels of poultry droppings on growth performance of Indian major carps in the foothills of Arunachal Pradesh, India

Vivekanand Safi, Achom Darshan, Budhin Gogoi, Ram Kumar, Rajashree Saikia, Debangshu Narayan Das

Abstract
This study was conducted to evaluate the effect of different level of poultry droppings on growth performance of Indian major carps (IMC) during May 2013 to April 2014. Three ponds viz. T_0,T_1 and T_2 having an area of 1000 square meters were selected for the study and stocked at the rate of 10,000 fingerling/ha with *Catla catla* (Hamilton), *Labeo rohita* (Hamilton) and *Cirrhinus mrigala* (Hamilton) in the ratio of 3:3:4. The T_1 and T_2 ponds were supplied with poultry excreta from 70 and 90 numbers of broiler birds respectively, except the T_0 (control) pond. Growth per day of *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* were 1.59 g, 1.16 g and 0.83 g in T_1; 1.87 g, 1.49 g and 1.15 g in T_2 and 0.70 g, 0.51 g and 0.41 g in T_0 pond respectively. The T_1 (55.24%) and T_2 (66.28%) ponds showed higher fish production compared to T_0. Higher yield of the T_2 pond indicated the optimum amount of poultry droppings compared to T_1. The water qualities in all ponds were falling in suitable ranges. Judicious amount of poultry droppings were favoured the better yields of fish by maintaining desired level of water quality for aquaculture in foothills of integrated fish- poultry farming (IFPF) system.

Keywords: Integrated fish poultry farming system (IFPF), Indian major carp, poultry dropping, water quality, fish yield, Arunachal Pradesh.

1. Introduction
The low-cost fish production needs use of organic fertilizers and better utilization of naturally available food through composite fish culture [18]. The use of organic manure to increase production of fish was known to Chinese as far back as 4th and 5th centuries [4]. The wide variety of organic manures such as leaf litters, sewage water, livestock manure, industrial waste and night soil have been used to improve fish production [10, 11, 26, 40]. The purpose of pond manuring is primarily to provide adequate amount of nutrients for the phytoplanktons [13, 14, 45]. A shorter cycle of plankton production can be possible through the use of organic manure in comparison to the application of inorganic fertilizer [5, 23].The addition of manure influence the relative abundance of plankton density and their community structure in pond aquaculture system. Several investigations observed that high plankton density is found in the pond treated with organic manure [12]. A direct relationship between average plankton density and fish production was recorded by Smith and Swingle [41]. The proper utilization of organic wastes by integrating with other farming system provides low cost fish production. Integrated fish-poultry farming system is also another best option for low cost fish production [8, 34]. High density and diversity of plankton were found in the pond fertilized with poultry and cow manure than non-fertilized pond [15]. Javed *et al* [25] reported a fish yield of 5955.83kg/ha/year by using poultry manure. However, indiscriminate use of this manure in fish ponds may deteriorate the water quality of the pond. Therefore, it is necessary to know the standard doses of these manures which would keep the physico-chemical parameters of pond water in favorable ranges for survival and growth of fishes [12]. Poultry dropping contains all the major nutrients (N, P and K) and trace elements [25]. Excess use of poultry dropping as pond manure may avert many problems like eutrophication, algal bloom and fish mortality [12].
However, hardly any such studies had taken place in foothill areas of Arunachal Pradesh on the utility of poultry droppings for fish culture. So, the present study was designed to access the effect of manuring fish ponds with different levels of poultry dropping on growth

performance of Indian major carps. Besides, this study standardized the required number of poultry to manure one hectare pond by maintaining favorable water quality parameters and better survivability of fish.

2. Materials and methods

Multilocational trials were conducted at three different places viz. Doimukh (131 msl), Midpu (148 msl) and Balijan (114 msl) in the foothills of Papum-Pare district in Arunachal Pradesh by constructing an IFPF system by using the farmer's field during the period from May 2013 to April 2014 (Fig. 1).

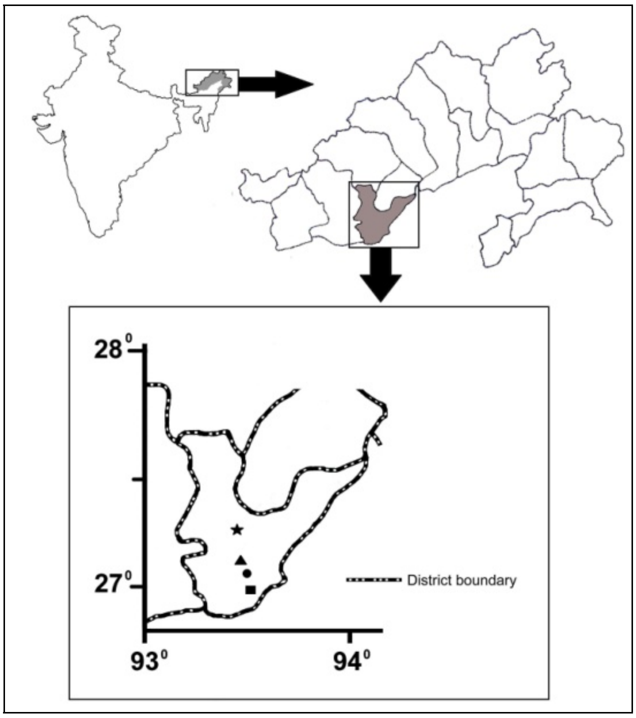

Fig 1: Showing the location of the study site (triangle: Midpu, circle: Doimukh and square: Balijan)

2.1 Pond selection and preparation

Three earthen ponds comprising of the T_1, T_2 and T_0 (control) ponds were selected for the purpose. All the ponds except the T_0 pond were provided with a poultry shed and the poultry droppings received from the rearing birds were used for direct manuring to the respective pond. Each pond has an area of 1000 m^2 with 2.5m of water depth. All the pre-existing ponds were made ready by draining water and sun dried for one month before commencement of the trials. The dried bed of the ponds was ploughed properly and applied lime @250kg/ha. The ponds were filled with ground water as well as rain water up to a depth of 2.5 meters.

2.2 Specification of the construction of poultry shed

Poultry sheds having an area of 105 and 135 square feet were built over T_1 and T_2 ponds respectively, using locally available materials such as woods, thach, and bamboo (Fig 2). Roofing was made using the leaves of Toko-Patta (*Livistona jenkinsiana*) and reinforces with polythene or iron sheet above the Toko-Patta roofing to give more strength. Toko-Patta roofing avoids heat penetration inside the shed. The floor was made of split bamboo with a gap of about 1.0 cm between slats, which facilitated the poultry dropping to fall directly into the culture pond. The poultry shed were built on the northern side of the pond to avoid the shading over the pond. The apex height of the house from the floor was 3.6 m and the height of the walls was 2.72 m. The floor of the shed was 1.5 m above the pond water level. This made a special precaution to allow penetration of sunlight into the pond for proper growth of primary producers.

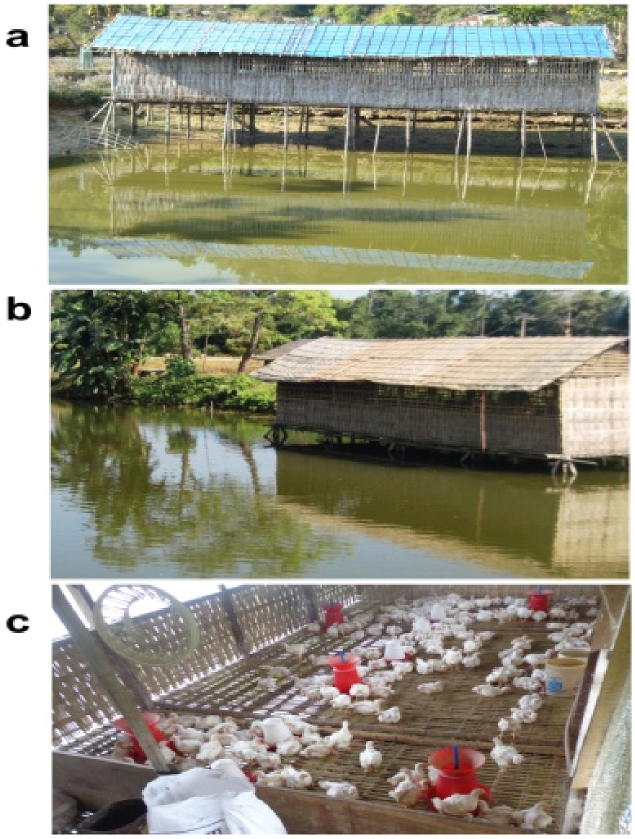

Fig 2 Poultry sheds structure used in the fish cum poultry farming; (a) integrated fish firm at Balijan; (b) integrated fish firm at Midpu; (c) rearing of poultry in the shed build above the culture pond at Midpu

2.3 Selection of Poultry breeds and numbers of birds

In the experiment, we have selected the Vencob white broiler breed based on the local poultry farmer's information on its high growth rate (1.6 to 1.8kg/45 days approx.) and readily availability of one-day old chicks for immediate use. The average weight of the day old chicks was 38.3g. Broiler chicks of 70 and 90 numbers were reared in the poultry sheds of T_1 and T_2 ponds respectively for providing a continuous supply of poultry droppings to the culture ponds. No supplementary feed and fertilizer were applied in T_0 (Control), T_1, and T_2ponds during the study period.

2.4 Stocking of fish in rearing ponds

Fish seeds (fingerling stages of IMC) were procured from the State Government Fish Hatchery, Emchi, Arunachal Pradesh. The fingerlings were treated with common salt solution (5ppm) for 5 minutes and acclimatized in a happa of size 10x5x3 ft^3 which was fixed at the same stocking pond for five days, then stocked only those healthy fingerlings in respective ponds @ Catla (*Catla catla*) 3: Rohu (*Labeo rohita*) 3: Mrigal (*Cirrhinus mrigala*) 4 by maintaining a stocking density of 10,000 fingerling/ha. The initial average weight/ total length of the fingerlings of Catla, Rohu, and Mrigal were 2.6g /3.4 cm, 2.3 g / 5.3cm and 3.2 g / 5.8 cm respectively.

2.5 Water quality parameters

Various physico-chemical parameters such as water temperature (WT), pH, dissolved oxygen (DO), specific conductivity (SC), total alkalinity (TA), total hardness (TH), total dissolved solids (TDS), and turbidity were monthly analyzed [6, 17]. The plankton samples were collected by filtering 50 liters of water through a plankton net (mesh no. 25, pore size 60µm). The filtrate collected in the collecting vial were transferred and concentrated in a measuring cylinder [37] and quantitative analysis of plankton was done following the drop count method [29].

2.6 Fish health monitoring
Random monitoring of growth rate and health conditions of the stocked fishes (from 30 samples each of Catla, Rohu, and Mrigal) were done in three month intervals from each of the ponds.

2.7 Management of IFPS system, harvesting and yield records
Broiler chicks were raised in a brooder house for fifteen days, and then transferred to the poultry shed. The chicks were fed readymade starter feed available at the market for the first 21 days and finisher feed was provided for the remaining days. The 40-45days old broiler birds were sold out and no poultry dropping was supplied to the ponds during 15 days till reintroduction of new batches of chicks in the poultry sheds. During this interval of 15 days, cleaning and disinfection of poultry shed were done for continuation of the second batch. In this way, six batches of the broiler and a single harvest of fish were done at the end of the experiment. The stocked fishes were harvested by draining the pond water after the completion of twelve months and accordingly the total productions from each of the T_1, T_2 and T_0 ponds were recorded. The following parameters and formulas were used to evaluate the growth performances and final yield of both fish and poultry:

For fish:
Length gain (cm) = Average final length - Average initial length
Weight gain (g) = Mean final weight - Mean initial weight
Specific growth rate (SGR) = (final weight - initial weight)/Culture period in days
Survival rate (%) = Number of fish harvested × 100/ Number of fish stocked
Yield kg/ha/yr = biomass at harvest - biomass at stock

For Poultry:
%Weight gain (g) = (Mean final weight - Mean initial weight) ×100/Mean initial weight
% Survival rate = (Number of bird harvested×100)/Number of bird reared
Yield (Kg /yr) = biomass at harvest - biomass at stock

3. Results
3.1 Effect of poultry dropping on physico-chemical parameters of water
Various physico-chemical parameters viz. water temperature, pH, dissolved oxygen, total alkalinity; total hardness, total dissolved solids, and turbidity were analyzed during the study period. The value of the all physico-chemical parameters in the three ponds were recorded (Table 1, 2 & 3).The water temperature was maximum T_1 (29.8 ^{0}C), T_2 (29.7 ^{0}C), and T_0 (29.8 ^{0}C), during April and minimum in T_1 (15.2 ^{0}C), T_2 (15.4 ^{0}C) and T_0 (15.8 ^{0}C) during, January.
In the T_1 (7.4) and T_2 (7.7) pond, higher values of pH were recorded during October while in the T_0 (7.4) it was highest during April; however, the lower values were observed both in T_1 (6.2) and T_0 (6.1) during August and T_2 (6.6) during January. The dissolved oxygen recorded maximum in January in all the ponds (T_1-9.6 mg/l, T_2-9.9 mg/l and T_0- 9.6 mg/l) but lowest in May (T_1-6.8 mg/l) and (T_0-6.6 mg/l) except T_2 (7.1mg/l) in June. The peak values of total alkalinity was in May (T_1-97 mg/l, T_2-116 mg/l and T_0-95 mg/l) and minimum value of T_1 (64 mg/l) and T_2 (88 mg/l) were in February, though T_0 (65 mg/l) showed its minimum in December. Total hardness in all ponds were maximum during September (T_1-114 mg/l, T_2-141 mg/l and T_0-116 mg/l) and minimum during January (T_1-69 mg/l, T_2-95 mg/l and T_0-65 mg/l).Turbidity level was highest during April (T_1-27.23NTU, T_2-48.98 NTU and T_0-28.21 NTU) and lowest during January (T_2- 22.98 NTU and T_0-13.98 NTU) and October (T_1-16.84 NTU). Highest value of conductivity in T_I and T_0 were 0.496µS/cm and 0.511 µS/cm respectively during August, while in T_2 was 0.574 µS/cm during July. The lowest conductivity value in T_2 and T_0 were 0.276µS/cm and 0.232µS/cm respectively during March while in T_1 was 0.205µS/cm during December. Total dissolved solids recorded its peak in T_1 (198 mg/l) and T_0 (194 mg/l) During December while in T_2 it was 274 mg/l during October. The lowest values of the total dissolved solids were T_1 (73 mg/l) and T_0 (71 mg/l) while in T_2 was 161 mg/l during May.

Table 1: Physico-chemical parameters of water in poultry droping treated T_1 pond

Parameters	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April
Water Temp (^{0}C)	29.7	29.4	29.2	28.6	26.1	25.5	23.3	16.2	15.2	16.4	27.3	29.8
pH	6.8	7.2	6.8	6.2	7.2	7.4	7.2	6.7	6.5	6.8	7.1	7.3
Dissolved oxygen (in mg/l)	6.8	7.2	7.3	7.1	7.3	7.5	7.9	8.7	9.6	8.6	7,8	7.1
Conductivity (µS/cm)	0.294	0.409	0.493	0.496	0.386	0.410	0.387	0.205	0.413	0.386	0.214	0.278
Total Alkalinity (mg/l)	97	89	96	91	76	75	82	73	75	64	66	96
Total Hardness (mg/l)	108	103	105	108	114	106	99	72	69	89	92	98
Turbidity (NTU)	21.21	23.09	25.34	22.23	24.27	16.84	19.12	20.11	14.21	25.67	26.98	27.23
Total Dissolved Solids (mg/l)	139	166	159	166	178	188	175	198	185	178	73	178

Table 2: Physico-chemical parameters of water in poultry dropping treated T_2 pond

Parameters	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Water Temperature (^{0}C)	29.6	29.7	29.2	28.3	26.5	25.6	23.3	15.9	15.4	16.6	27.2	29.7
pH	6.8	7.1	6.9	7.1	7.2	7.7	7.2	7.1	6.6	6.7	7.3	7.5
Dissolved oxygen (in mg/l)	7.4	7.1	7.4	7.6	7.9	8.2	8.7	9.7	9.9	9.5	8.4	7.7
Conductivity (in µS/cm)	0.336	0.481	0.574	0.526	0.485	0.487	0.483	0.434	0.481	0.484	0.276	0.294

Total alkalinity (in mg/l)	116	111	115	113	107	101	103	104	99	88	89	115
Total hardness (in mg/l)	126	120	122	134	141	134	103	96	95	112	114	124
Turbidity(in NTU)	37.93	43.98	47.91	36.12	33.88	24.96	23.82	24.78	22.98	35.81	36.46	48.98
Total dissolved solids (in mg/l)	161	182	176	206	241	274	221	248	209	198	186	199

Table 3: Physico-chemical characteristics of water in the T_0 (control) pond

Parameters	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Water temperaure (^{0}C)	29.4	29.6	29.4	28.2	25.9	25.3	23.4	16.2	15.8	16.6	26.9	29.8
pH	6.7	7.2	6.5	6.1	7.2	7.3	7.2	6.6	6.5	6.7	7.2	7.4
Dissolved oxygen (in mg/l)	6.6	6.8	7.2	7.5	7.7	7.9	8.3	9.1	9.6	9.2	8,2	7.4
Conductivity (in µS/cm)	0.296	0.424	0.496	0.511	0.389	0.417	0.389	0.196	0.432	0.396	0.232	0.274
Total alkalinity (in mg/l)	95	84	89	88	82	76	78	65	69	68	70	93
Total hardness (in mg/l)	105	102	104	107	115	104	93	71	65	84	86	91
Turbidity (in NTU)	21.02	23.25	25.71	23.12	21.42	15.25	16.71	16.12	13.98	24.98	24.88	28.21
Total dissolved solids (in mg/l)	129	168	154	162	179	168	166	194	182	174	71	174

3.2 Effects of poultry dropping on fish growth

After twelve months of rearing, fishes were harvested from all the three ponds. The observed survival rates of fishes were 84%, 88% and 67% in T_1, T_2 and T_0 ponds respectively. Growth performance of fishes in terms of mean length, weight gain and production were presented in Table 4. The growth rate (g/day) was found highest in Catla followed by Rohu and Mrigal in decreasing order. Average weight gain during harvesting period were 682.55±2.418g (1.87g/day), 544.12±1.260g (1.49g/day) and 418.46±1.426g (1.15g/day) for Catla, Rohu, and Mrigal respectively in the T_2 pond in comparison to the T_1 pond (Catla- 580.74±1.941g, Rohu-423.33±1.263g and Mrigal-302.54±1.425g) and T_0 (Catla - 255.41±0.542g, Rohu-184.84±1.506g and Mrigal-152.99±1.482g).

The significantly ($p<0.05$) highest weight gain (682.55g) was recorded in Catla but lowest weight gain was found in Mrigal (418.46g) in T_2 pond. However, in case of T_1, highest weight gain was observed in Catla (580.74g) and lowest in Mrigal (302.54g) but weight performance of Rohu were 544.12g, 423.33g and 184.84g in T_2, T_1 and T_0 respectively. In case of T_0 highest growth was recorded in Catla (255.41g) and lowest in Mrigal (152.99g). The results indicate that significant ($p<0.05$) difference in the average weight gain in T_2 in comparison to T_1 and T_0. The specific growth rate of fish in T_2 pond significantly higher as compared to T_1 and T_0 ponds (Table 5). Further, we observed that fishes cultured in the T2 pond had better growth rate, length, and weight gain performance as compared to T_1 and T_0 (Fig 3)

Table 4: Growth performance of Catla, Rohu and Mrigal in the, T_1, T_2 and T_0 ponds*. L= length (in cm) and W= weight (in g)

Fish species	Pond	1st month		5th month		9th month		12th month (Harvest time)		Growth rate (g/day)
		L ±SD	W ±SD	L ±SD	W ±SD	L ±SD	W ±SD	L ±SD	W ±SD	
Catla catla (Ham.)	T_1	7.31 ±0.164	41.25 ±0.131	9.84 ±126	165.62 ±0.472	14.63 ±0.175	384.37 ±0.484	20.62 ±0.237	580.74 ±1.941	1.59
	T_2	9.62 ±0.125	53.65 ±0.158	11.85 ±0.058	284.21 ±0.521	18.85 ±1.215	402.21 ±1.327	22.44 ±0.128	682.55 ±2.418	1.87
	T_0	04.87 ±0.146	26.55 ±0.182	9.25 ±0.125	83.99 ±0.786	13.88 ±0.208	152.21 ±0.426	17.11 ±0.126	255.41 ±0.542	0.70
Labeo rohita (Ham.)	T_1	07.13 ±1.262	84.62 ±0.426	09.75 ±1.921	172.48 ±1.213	16.27 ±0.332	264.53 ±0.462	26.13 ±0.241	423.33 ±1.263	1.16
	T_2	08.89 ±0,028	135.86 ±0.146	12.40 ±0,158	242.15 ±1.116	19.82 ±0.224	384.51 ±1,216	29.13 ±0.214	544.12 ±1.260	1.49
	T_0	03.43 ±0.048	23.87 ±1.156	9.85 ±0.042	98.52 ±0.148	12.91 ±0.246	124.99 ±0.347	15.15 ±0.126	184.84 ±1.506	0.51
Cirrhinus mrigala (Ham)	T_1	9.21 ±0.211	120.34 ±0.142	11.54 ±1.722	176.27 ±0.341	16.43 ±0.437	224.15 ±1.617	19.13 ±0.342	302.54 ±1.425	0.83
	T_2	11.10 ±0.110	205.13 ±0.206	15.21 ±0.140	278.10 ±1.082	19.12 ±0.126	356.12 ±1.612	23.92 ±0.210	418.46 ±1.426	1.15
	T_0	06.84 ±0.019	30.64 ±0.142	10.82 ±0.162	58.15 ±0.186	14.28 ±0,212	98.80 ±1,142	17.54 ±0.825	152.99 ±1.482	0.41

*Each data is a mean of 30 separate determinations.

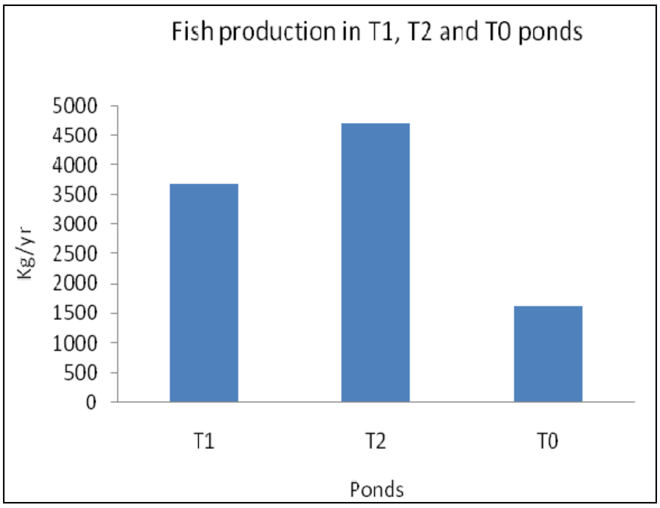

Fig 3: Total production of fishes in T_1, T_2 and T_0 ponds (in kg/ha/yr).

Table 5: Specific growth rate of three species of Indian major carp in T_1, T_2 and T_0 ponds.

Ponds	Specific growth rate		
	Catla	Rohu	Mrigal
T_1	1.58	1.18	0.89
T_2	1.82	1.49	1.18
T_0	0.65	0.46	0.42

3.4 Effect of poultry dropping on plankton density

The difference in plankton densities in T_1 and T_2 was mainly due to the effect of poultry dropping; having high level of nitrogen and phosphorus, which directly enriched the nutrient level of soil and the soil slowly released the nutrient into the water body and these nutrients play a major role in the luxurious growth of phytoplankton and zooplankton. Therefore, fish cultured in the T_1 and T_2 pond attained more growth as compare to the T_0 pond. The population density of plankton in the T_1 and $T_{2,}$ ponds were greater than the T_0 and it might be due to the gradual release of N, P, and K during decomposition processes of poultry dropping in the ponds. The peak level of plankton productions were 674, 767 and 530 numbers/l, while low density of plankton were 384, 538 and 342 numbers/l respectively in the T_1, T_2, and T_0 (Table 6). The reason behind might be varying amount of fresh poultry dropping loading in the T_1 and T_2 ponds.

Table 6: Density of phytoplankton and zooplankton in T_1, T_2, and T_0 ponds.

Ponds	Phytoplankton (numbers/liter)	Zooplankton (numbers/liter)	Total plankton (numbers/liter)
T_1	573	101	674
T_2	641	126	767
T_0	532	98	630

3.5 Growth performance of the Vencob broiler birds reared in the T_1 and T_2 integrated ponds

The percentage survival of the Vencob broiler birds in the T_1 and T_2 ponds were 92.26% and 94.58% respectively. Percentage weight gain in T_1 and T_2 ponds were 144.3g and 148.2g respectively. The total production of broiler birds were 598 kg/yr and 786 kg/yr in T_1 and T_2 ponds respectively (Table 7).

Table 7: Average growth performance of Vencob broiler birds reared for the T_1 and T_2 fish-poultry integrated ponds.

Integrated pond	% Survival ±SD	% Weight gain (g) ±SD	Yield (kg/yr) ±SD
T_1	92.26±0.621	144.3 ±0.347	598 ±4.274
T_2	94.58 ±0.842	148.2 ±0.752	786 ±3.635

4. Discussion

Physico-chemical parameters of water play an important role in the biology and physiology of fish [7]. The water temperature was recorded to be lowest during January and maximum during April and the ranges between 15.2 to 29.8 ^{0}C found suitable for fish culture in the present study (Table: 1, 2 & 3). Water temperature greater than 18ºC was best for survival and growth of warm water fishes and many species suffered and died below 12ºC [33]. The water temperature ranged 24 ºC to 30 ºC was found suitable for raising carps in a pond environment [39]. Indian major carps (IMC) reduced physiological activity and food intake in lower temperature (below 22.6 ºC), whereas higher temperature (22.6 ºC up to 33.0 ºC) had opposite effects [9]. The water temperature ranging between 29.32 to 32.95 ºC is most suitable for the warm water fish culture [43, 20]. The tropical fish growth rate is higher in temperature between 25 ºC and 32 ºC [36]. The dissolved oxygen was recorded highest in January in all ponds (9.6-9.9 mg/l) but lower value in May (6.8mg/l) in T_1 and 6.6 mg/l in T_0. The variation in DO concentration in aquatic bodies might be caused due to seasonal variation in temperature and fluctuations of photosynthetic and respiratory activities of the aquatic biomass [11, 19]. The range of dissolved oxygen in all the studied ponds did not differ significantly and were in concordance with the findings of Mahhboob and Sheri [31]. The ideal range of DO level for fish culture is 5 to 15mg/l and in DO concentration between 2-4mg/l, fish cease to feed, reduce locomotion, and use the available oxygen to support physiological system rather than growth [36, 7, 17]. It was observed that the ranges of pH in T_1, T_2 and T_0 were 6.2-7.4, 6.6-7.7 and 6.1- 7.4 respectively. The higher pH value is normally associated with higher photosynthetic activity in water [24, 34] and the variation of pH in poultry dropping treated ponds were probably because of cumulative effects of other biotic and abiotic factors, along with input of additional poultry droppings [38]. The pH ranging from 5.0 to 9.0 was found reasonably appropriate for carp farming as well as for biological productivity [30, 22, 8]. The pH recorded from all the integrated fish-poultry farming (IFPF) experimental ponds were within the acceptable range. The pH ranges between 6.7 to 9.5 is optimal for fish culture, above and below of this range exert stress to the fish [39, 46]. Total alkalinity varies between 64–97mg/l in T_1, 88–116mg/l in T_2, and 65–95mg/l in T_0. The fluctuation of total alkalinity in T_2 was greater due to the effect of poultry dropping. The dispersed carbonate and bicarbonate ion made the pond water slightly alkaline in nature meeting the suitability for growth and survival of aquatic organism [35, 16, 42]. The ideal value of alkalinity is 50-300 mg/l for undertaking fish culture [39]. The alkalinity values of all ponds use for the IFPF trials were within the desirable ranges. Total hardness of T_1 fluctuated between 69-114 mg/l. In case of T_2 and T_0 it varies between 95-141mg/l and 65-116 mg/l respectively. The recommended hardness of pond water for fish culture ranges between 20 mg/l to 180 mg/l [39, 17]. Uniformity in alkalinity and hardness further revealed that the dissolved nutrients were in balanced amount which provided a congenial water quality parameters and conducive environment for plankton production. Our findings were in conformity with the study of Mahhboob and Sheri [31]. Turbidity of T_2 pond between 22.98-48.98NTU, but in case of T_1 and T_0, it varies between 16.84-27.23NTU and 13.98-28.21NTU. The fluctuation of turbidity in T_2 pond was higher because of poultry dropping loading was more. Similar finding was observed by Hassan M and Javed [20]. The total dissolved solid fluctuated between 73-198mg/l in T_1 pond, but in case of T_2 and T_0, it varies between161-274mg/l and 71-194mg/l respectively. The total dissolve solid was highest in T_2 pond as it received the highest amount of poultry droppings. The total dissolved solid level varies in pond water due to the variable amount of poultry dropping and plankton [2, 26].

The biological productivity of any aquatic system is generally judged through the qualitative and quantitative estimation of plankton, which form the natural food of fish [3]. In present study, the maximum length and weight gain in *Catla catla, Labeo rohita* and *Cirrhinus mrigala* was observed in T_2 which received poultry droppings from 90 birds and also in T_1 which received poultry droppings from 70 birds in comparison to T_0. The better growth of fishes in T_1 and T_2 may be attributed to the effect of poultry dropping which release nutrients in the water body. The three fish species *Catla catla, Labeo rohita* and *Cirrhinus mrigala* gained significantly different length and weight under different levels of broiler manure fertilization [25-20]. Maximum weight gain in treated pond were recorded during July, August, September, October and November months due to optimum temperature while lowest weight gain were recorded during December, January and February due to low temperature. It was reported that low temperature (22.6 ^{0}C) decreased the activity and food intake whereas the high temperature (up to 33 ^{0}C) had opposite effects [43]. The water temperature was the most important variable which contributed significantly towards the fish yield increment [38]. The best temperature which had positive and significant influence on increase in fish weight was ranging from 29.32 to 32.95 ^{0}C [2].

In the present investigation, higher fish production was recorded in T_1 (3681.30 kg/ha/yr) and T_2 (4714.00 kg/ha/yr) as compared to that of T_0 pond (1622.00 kg/ha/yr). The higher fish production in T_1 and T_2 in comparison to T_0 is due to the effect of poultry dropping. It was reported that broiler dropping added in pond have significant effect on fish growth, which gave the better net fish yield of 3617.50 kg/ha/year [1, 21]. The growth performance of six species viz. *Catla catla, Labeo rohita, Cirrhinus mrigala, Hypopthalmichthys molitrix*, *Ctenopharyngodon idella* and *Cyprinus carpio* under the influence of artificial feed, broiler dropping, buffalo manure, N:P:K (25:25:0) and a control pond for a period of one year. Broiler manure and N:P:K (25:25:0) fertilization remained the best treatment for maximum fish production of 9400 kg/pond/year and 7300 kg/pond/year, while the fish production for artificial feed, buffalo manure and control pond were 6200, 4400 and 1500 kg/pond/year respectively [31]. Manuring of the pond with poultry dropping triggered significant increases in fish production compared to control pond. Treated pond T_1 and T_2 showed 55.24 and 66.28% higher fish production compared to that of T_0 pond. It was recorded a daily growth rate of 2.75 g, 2.36 g and 2.18g respectively for *Catla catla, Labeo rohita* and Catla –Rohu hybrids employing cow dung and poultry manure in ponds [27]. The better growth rate for Indian major carps in poultry manure treated pond (1.93 g, 1.66 g and 1.2 g per day for Catla, Rohu and Mrigal respectively) than in the gober gas slurry treated ponds (1.38 g, 1.10g and 0.97g per day for Catla, Rohu, and Mrigal respectively) [30].

The population density of plankton in the T_1, T_2 ponds were significantly (p<0.05) increased as compared to T_0. The plankton density varies in poultry dropping treated ponds in compared to traditional fish culture pond [25, 44]. The peak level of plankton productions were 674, 767 and 530 numbers/l in July while low density of plankton were 384, 538 and 342 numbers/l in January in the T_1, T_2 and T_0 respectively. The variation in plankton production might be due to varying amount of poultry dropping loading in the T_1 and T_2 ponds. The decomposition processes of poultry dropping in the integrated fish-poultry farming system gradually release N, P and K which triggers plankton productivity [39].

The percentage survival of the Vencob broiler birds in T_1 pond was 92.26% and T_2 pond was 94.58%. Percentage weight gain in T_1 and T_2 ponds were 144.3g and 148.2g respectively. The total productions of ready birds were 598kg/yr and 786kg/yr in T_1 and T_2 ponds. The rate of survival and growth was dependent on the several factors like the climatic condition of the particular place and types of feed use [1]

5. Conclusion

The growth and production of the Indian major carps were pertaining to the amount of poultry droppings and also to the physico-chemical parameters of water in the studied ponds. Net fish production was higher in the poultry dropping treated ponds (T_1 and T_2) compare to control ponds, and the result clearly indicates that the poultry manure enriched the soil nutrients and pond water thereby enhanced plankton productions by making the pond environment more congenial for fishery purposes. The present investigation affirmed that the fish production in foothills areas can be increased through Poultry cum fish culture by judicious utilization of poultry droppings. It is concluded that moderate application of poultry dropping at the rate of 1 chick/ 11.1 sq. m is ideal in maintaining suitable water quality and plankton productivity which ultimately enhanced fish growth and overall higher production of fish per unit area. Excessive uses of poultry dropping deteriorate water quality, resulting in eutrophication and stress to the culture fish.

6. References

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