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Study the effects of dietary administration of Iron Oxide Nanoparticles on the growth parameters of the fish *Labeo rohita*

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Abstract
In this research work, we have studied the effects of Iron Oxide Nanoparticles on the growth parameters of the fish *Labeo rohita*. The Iron Oxide nanoparticles were purchased from the market and mixed with the basal feed in different combinations according to experimental need. In the present study, feeding trials were conducted in for 90 days in triplicate. For this feeding trial, live *Labeo rohita* were captured from the local fish farm located in Bareilly district. Fishes of similar body weight were distributed randomly into five glass tank that were continuously aeriated at Department of Zoology, Bareilly College, Bareilly, U.P. These five fish treatment groups were given five concentrations of Iron oxide nanoparticles *viz* 0 mg/Kg, 15 mg/kg, 30 mg/kg, 45 mg/Kg and 60 mg/Kg. T_1(00 mg/Kg) was the control group that was fed on basal food only, without Iron oxide nanoparticles for the same period. The effects of the Iron oxide nanoparticles were analyzed by observing body length and weight after an interval of 15 days (*viz* 0, 15, 30, 45, 60, 75 and 90 days). Two treatment groups (T_5 and T_4) showed better growth of fishes, than any other treatment group. These results suggest that Iron oxide nanoparticles can be effective for fish growth as they help to increase hemoglobin label in blood of fishes. It could be more effective in the concentration 60mg/kg or 45 mg/kg mixed in the basal feed for *Labeo rohita* in aquaculture practices.

Keywords: Iron oxide nano particles, Growth Performance, *Labeo rohita*

1. Introduction
From the ancient time, aquaculture has played an important role in the fulfilment of huge requirement of animal protein. Thus, it helped to provide the food security for the growing population of the world. There are many protein sources that are provided by terrestrial and aquatic animals. Aquatic protein options are preferable because of its positive health effects and essential compositional features of feed. In all countries of the world, fishes are considered an essential part of the human diet (Mohanty, 2015) [9]. Rohu, *Labeo rohita* is a very important fish species in India (FAO, 2001). It is an important species of carp polyculture system with catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*).
Nanotechnology can be used for medication and nutrition, because the nano-meter dimension materials have novel properties that is different from bulk material and isolated atom (Albrecht *et al*., 2006; Wang *et al*., 2007) [1, 15]. According to the U. S. National Nanotechnology Initiative (NNI), "understanding and control of matter at dimensions of roughly 1 to 100 nm where unique phenomena enable novel applications". In simple words, it may also be defined as "the study, design, creation, synthesis, manipulation and application of functional materials, devices, and systems through control of matter at the nano-meter scale (1-100 nano-meters, one nano-meter being equal to 1 x 10^{-9} of a meter) that is, at the atomic and molecular levels, and the exploitation of novel phenomena and properties of matter at that scale". For proper functioning of organs and tissues, iron is an essential element in the higher animals as well as in the fishes. It has an important role in some physiological processes like lipid oxidation reactions, oxygen transport and cellular respiration (Andersen *et al*., 1997) [2]. Iron oxide nanoparticles have unique physicochemical properties and also have a great potential as food additives, antimicrobial additives, drug carriers and human biomedical applications, etc.

(Huber, 2005) [8]. The use of nanoparticles as food additives is increasing day by day for human consumption. Iron-fortified cereals and drinks are good example of it. Dietary administration of iron oxide nanoparticles can boost bioavailability of iron more in comparison to the other forms of iron (Stephen, 2007) [13].

In recent times nanoparticles are used to increase growth and disease resistance in fishes. So that the present study was designed to observe the effect of Iron oxide nanoparticles on the growth parameters of the fish *Labeo rohita*.

Methods and Materials

For the present experiment *Labeo rohita* of similar size and weight were collected from the local fish farm in the Bareilly district. These fishes were distributed in the five experimental groups (*viz* T_1, T_6, T_7, T_8, T_9) and were stocked in properly washed five glass aquaria at Department of Zoology, Bareilly College Bareilly, UP. These experimental fish groups were acclimatized for 15 days before experimentation. Aerators were connected to fish aquaria for continuous aeriation and to maintain dissolved oxygen level in the water. Fishes were provided with basal diet during the acclimatization twice daily. There were 10 fishes per aquarium and each aquarium contain 70 liters water. Thus, the fishes with similar weights were collected to stock in 6 different aquaria (n 10 fishes/aquarium containing 70 liters water). Water quality parameters *viz* temperature, pH, and dissolved Oxygen were observed at regular interval with the help of digital thermometer, universal pH meter and Winkler method. Temperature was maintained between 18 - 28 °C, dissolved oxygen between 5.5 - 6.5 ppm and pH between 7.20 - 8.0.

At the starting of experimental period, length and weight measurement of all the experimental fish groups was done and recorded. In the control group (T_1) fishes were fed with basal feed only with 0 mg/kg Iron oxide nanoparticles for 90 days. While in other four groups, the fishes were fed with basal feed that have concentration of Iron oxide nanoparticles 15 mg/kg (T_6), 30 mg/kg (T_7),45 mg/kg (T_8), 60 mg/kg (T_9), respectively, for 90 days.

Table 1: Percentage composition of experimental diet

S. No.	Treatment	Percentage of different ingredients					
		Rice Bran	Soya bean meal	Mustard oil cake	Wheat flour	Vitamins and minerals	Iron oxide nanoparticles (mg/kg)
1	T_1 (Control)	38.0	25.0	25.0	10.0	2.0	0.0
2	T_6	38.0	25.0	25.0	10.0	2.0	15
3	T_7	38.0	25.0	25.0	10.0	2.0	30
4	T_8	38.0	25.0	25.0	10.0	2.0	45
5	T_9	38.0	25.0	25.0	10.0	2.0	60

The length and weight of each experiment group were recorded at 0, 15, 30, 45, 60, 75 and 90 days of experimental period by using electronic balance and standard scale. Parameters of growth performance were determined using standard formulae as following.

1. Net Length gain = Final length - Initial length

2. Percentage Length Gain = 100 x (Final Length - Initial length) / Initial Length

3. Net Weight gain = Final weight - Initial weight

4. Percentage Weight Gain = 100 x (Final weight - Initial weight)/ Initial weight

5. Survival rate = 100 x number of fishes recovered / Number of fishes stocked

6. Feed Conversion Ratio (FCR) = Total dry feed intake(gm) / wet weight gain (gm)

7. Specific growth rate (SGR) = 100 x In (Final body weight) - In (initial Body weight)/ Number of days.

Results were calculated using standard statistical procedure.

Observation and Results

Table 2: Growth Performance of Rohu (*Labeo rohita*), fed with different concentration of Iron oxide nanoparticles (mean± SD)

Treat-ment	Fish weight (g)		Net weight gain (gm)	% weight gain	Fish length (cm)		Net length gain (cm)	% length gain
	initial	Final			initial	final		
T_1 (control)	15.86±0.35	58.32± 1.62	42.46	268.73	10.76±0.21	16.44±0.26	5.68	52.78
T_6	15.91±0.53	64.62±1.00	48.71	306.16	10.78±0.30	17.71±0.30	6.93	64.28
T_7	16.18±0.51	70.27± 1.24	54.09	334.30	11.02±0.41	18.88±0.33	7.86	71.32
T_8	16.09± 0.51	74.11±1.12	58.02	360.59	11.00±0.32	19.47±0.32	8.47	77.00
T_9	15.91±0.45	78.55±1.15	62.64	393.71	10.93±0.40	20.02±0.42	9.07	82.98

Table 3: Growth Parameters of *Labeo rohita* fed with different concentration of Iron oxide nanoparticles

Treatment	Specific Growth Rate	Feed Conversion Ratio	Survival rate
T_1(Control)	1.44	3.14	80.00
T_6	1.55	2.97	83.33
T_7	1.63	2.87	90.00
T_8	1.69	2.79	100.00
T_9	1.77	2.71	93.33

In the present study, we have studied the effect of different concentration of Iron oxide nanoparticles (0 mg/kg, 15 mg/kg, 30 mg/kg, 45 mg/kg, 60 mg/kg) with basal feed in *Labeo rohita* for 90 days. After the completion of experimental

period of 90 days, we have observed significant increase in the growth of *Labeo rohita* fed with nanoparticle mixed feed. The highest net weight gain was observed in T_9 (62.64 gm) followed by T_8 (58.02) in comparison of control test T_1 (42.46). Percentage weight gain was highest in T_9 (393.71) followed by T_8 (360.59) in comparison to control test T_1 (268.73). The highest net length gain was in T_9 ((9.07 cm) followed by T_8 (8.47 cm) in comparison to control test (5.68). The highest Percentage length gain was observed in T_9(83.98) followed by T_8 (77.00) in comparison to control test T_1 (52.78).

The highest specific growth rate was observed inT_9 (1.77) in comparison to control test (1.44). Highest feed conversion ratio was observed in T_1(3.14) and highest survival rate was observed in T_8 (100%).

Discussions

Iron is an important micronutrient as it has major role in the defense against various infections and functioning of the immune system. Iron oxide nanoparticle (Fe_2O_3 NPs) has unique physicochemical properties. Iron oxide nanoparticle (Fe2O3 NPs) has a great potential as feed additives, due to their potential biocompatibility and its super paramagnetic properties (Huber, DL. 2005) [5]. Iron is an essential nutrient for the growth of the fish and the improvement of their physiological and immunological parameters. Ferrous fumarate ($C_4H_2FeO_4$) is an important Iron supplement for fish and it is essential because dietary requirements are not equal to natural iron sources due to low solubility and low bioavailability (Hilty *et al*., 2011) [7].

In a previous study, the level of Fe was increased in prawns if Fe_2O_3 NPs added in diets. This study found that Fe_2O_3 NPs supplemented feed significantly improved the bioavailability of iron (Srinivasan *et al*., 2016) [12]. Similarly, ferrous sulphate and ferrous oxide nano particles supplemented diets resulted in the increase of iron in *Labeo rohita* (Behera *et al*., 2014) [4]. Significant improvement in the growth, immune response and survival was reported if nano $FeSO_4$, $FeC_6H_6O_7$ and Fe_2O_3 supplemented feed was administered in fishes (*Oreochromis aureus, Salmo salar, L. rohita, Ictalurus punctatus, Oncorhynchus mykiss* and *Oreochromis niloticus)* (Behera, 2014) [4]. Nanoparticles of iron oxide have important physicochemical properties and also have potential as food additives, antimicrobial additives, human biomedical applications and drug carriers, etc. (Huber, 2005) [5].

In the present study, Iron oxide nanoparticles have shown significant increase in the growth of the fish *Labeo rohita* as it increases the bioavailability and absorption of iron in the body. Iron is an essential part of hemoglobin and other biomolecules. It has an important role in some physiological processes like lipid oxidation reactions, oxygen transport and cellular respiration (Andersen *et al*., 1997) [2]. So that Iron oxide nanoparticles incorporation in the fish feed can increase growth and disease resistance in the fishes but continuous and quality research is needed for this.

Conclusion

In the present study we have observe significant increase in the weight and length of the fishes fed with different concentration of Iron oxide nanoparticles. The maximum growth was observed in 60 mg/kg concentration of Iron oxide nanoparticles. So that we can conclude that Iron oxide nanoparticles in an adequate quantity can fulfil the iron deficiency in the fishes and cause increased fish production.

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