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Effect of Chitosan Supplemented Diet on Survival and Growth of Bagrid Catfish, *Mystus Seenghala* (Sykes)

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Abstract
An experiment was conducted to assess the effect of chitosan supplemented diets on survival and growth parameters of Indian bagrid catfish, *Mystus seenghala*. Five different concentrations (2.0, 4.0, 6.0, 8.0 and 10.0) and control without chitosan incorporated with total fish feed for 60 days. Insignificant variations in physical and chemical parameters of experimental water except pH were found. Studies revealed an ascent in final weight contrasted to initial weight in all treatments. An increasing pattern from D2 to D4 following a decline in D5 and D6 chitosan supplemented diets was calculated in percentage of weight gain, daily weight gain, specific growth rate, feed efficiency ratio and survival rate however food conversion ratio slashed with the increase of chitosan in experimental diets. The distinction of these parameters contrasted with control was found significant ($p<0.05$). Although the protein content of chitosan was more than the control feed. The investigation inferred that the chitosan incorporated into diets of bagrid catfish increased survival rate and improved the growth performance of fish. The work is one of the benchmark data for directing more exploration on the locally accessible feed fixing like chitosan especially with *Mystus seenghala*.

Keywords
Chitosan, Survival, Growth parameters, *Mystus seenghala*.

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INTRODUCTION:
Pisciculture is acknowledged as an important and substantial part of the Aquaculture. The aquaculture industry has been developed and well sustained during the last few decades in India. The accomplishment of aquaculture depends upon the capability of fish farmers to characterize restoratively balanced weight management designs which will meet the improvement necessities of their refined species at a lower cost. Fish meal has been a significant wellspring of protein in fish goes without food considering its high protein quality and acceptableness.

Spectacular research efforts have been made in the progressing past towards the replacement of fish supper by conservative elective plant fixings sources. The suitability of this supplement replacement is uncommonly an issue among fish species and raising conditions.

Chitosan possesses varied utilitarian properties that make it helpful in nutrition [1]. It is one of the non-toxic biocompatible, perishable, eco-friendly biopesticide, biomaterial as well as bio fungicide applied in the development of nanomaterials and bioadhesives [2]. It has become a new candidate as a growth-promoter for farm animals. Investigations

are incontestable that chitosan has insusceptible revitalizing properties in different types of fish [3-5]. The effect of chitosan supplemented diet on the growth of fish has not received much attention.

Mystus seenghala (bagrid catfish or giant river catfish) is an air-breathing fish in the Shahabad district of Bihar. It is one of the largest catfish in India. It has good market demand for its good taste and high nutritional value. It constitutes an important capture fishery of all major rivers of India. Therefore, an endeavour was made to evaluate the effect of chitosan supplemented diets on survival and growth parameters of *Mystus seenghala*. The work will facilitate in choosing the right improved return of this fish.

MATERIALS AND METHODS:

Specimens and Hydrological Parameters

Specimens of *Mystus seenghala* (Sykes) (45-65g body weight, 19-22cm total length) were purchased from the neighbor by market, Arrah (Bhojpur), Bihar. Specimens were acclimatized for a fortnight in the Laboratory. During acclimatization, fishes were fed with trash fish. Physico-chemical parameters of water were resolved throughout the experimental period following standard methods [6].

Preparation of diet and process of feeding

Powder of Chitosan (Mahatani Chitosan Pvt. Ltd., Veraval, India) and commercial fish feed was chosen as a biomaterial for the experiment. The fish meal was used as the control diet (D1) with no chitosan, whereas diet D2, D3, D4, D5 and D6 consisted of chitosan in the proportion of 2, 4, 6 8 and 10g/kg respectively. Before the preparation of pellet feed, ingredients were finely pulverized, mixed and then sieved. Proximate compositions of the ingredients utilized in the formulated diets were analyzed following standard strategies and presented in Table 2 [7]. In experimental diets, amounts of protein varied from 41.23 to 41.10 in D1 to D6.

Growth parameters

Various growth parameters specifically the final weight, weight gain, percentage of weight gain, daily growth co-efficient, total feed fed per fish, food conversion ratio, protein efficiency ratio and survival rate were determined following standard techniques [8-10].

Statistical analysis

All observed data were subjected to ANOVA followed by Duncan's multiple range tests to test the distinction between means applying Graph Pad Prism 5 software.

RESULTS AND DISCUSSION:

Physico-chemical parameters

Water quality has a critical job in Aquaculture. Fish are staying in harmony with possible creatures and their condition. Mean estimations of studied parameters of water aside from dissolved oxygen and ammonia were within the admissible range [11]. These qualities except pH were statistically insignificant to each other (Table 1). The present findings showed that supplementation of chitosan significantly improved the quality of the water by increasing the pH concentration of the water. These findings concur with earlier reported improved water quality because of chitosan and chitosan nanoparticles the supplementation in the diet of *Oreochromis nilotica* and *Clarias gariepinus* individually [12, 13].

Table 1: Physico-chemical parameters of experimental water (for F test, Column factor= 5, Row factor=2).

Experimental water	D1	D2	D3	D4	D5	D6	F test
Temperature (°C)	32.0 ± 1.9	32.0 ± 1.9	32.0 ± 1.1	32.0 ± 1.2	32.0 ± 1.7	32.0 ± 1.8	NS
pH	7.12 ± 0.23	7.18 ± 0.91	7.32 ± 0.60	7.49 ± 0.32	7.72 ± 0.71	7.94 ± 0.62	*/** *
DO (mg L^{-1})	6.53± 0.32	6.62 ± 0.34	6.61 ± 0.40	6.64 ± 0.55	6.79 ± 0.19	6.67 ± 0.29	NS
Total Alkalinity (mg L^{-1})	362.09±8.99	361.36±9.79	355.27±7.90	350.45±6.79	350.09±7.88	355.00±8.57	NS
Hardness (mg L^{-1})	148.66±3.63	146.00±1.31	129.33±6.59	141.00±7.09	146.00±8.33	140.33±4.07	NS
Ammonia (mg L^{-1})	0.38 ± 0.02	0.40 ± 0.01	0.39 ± 0.01	0.38 ± 0.03	0.37± 0.06	0.39 ± 0.05	NS

Experimental diets

The artificial diet was prepared by using the ingredients fish meal, Soybean flour, mustard oil cake, wheat flour, rice bran and vitamin and minerals. The proportion of different ingredients and proximate composition of experimental and control

diets has been incorporated in Table 2. The quality of chitin is based on the standard specification concerning the level of ash content (max. 1%), moisture (max. 10%), and colour is off white of the final product [14]. The control and experimental diet groups were fed with diet at the rate of 5% of the bodyweight per day for 60 days.

Table 2: Ingredients and proximate composition of experimental diets.

Ingredient (g/kg)	D1	D2	D3	D4	D5	D6
Fish meal	400	400	400	400	400	400
Soybean Flour	200	200	200	200	200	200
Mustard oil cake	150	150	150	150	150	150
Wheat flour	130	130	130	130	130	130
Rice bran	100	100	100	100	100	100
Minerals and Vitamins	20	20	20	20	20	20
Chitosan	0	2	4	6	8	10
Proximate (%) composition						
Ash	9.10	9.20	9.27	9.28	9.30	9.33
Fat	9.92	9.90	9.94	9.82	9.72	9.82
Fibre	7.26	7.34	7.28	7.50	7.50	7.60
Moisture	7.78	7.95	6.82	8.37	8.04	6.31
Dry matter	93.69	93.18	92.22	92.05	91.96	93.63
Protein	41.23	41.20	41.15	41.14	41.12	41.10
Nitrogen free extract	38.55	38.37	38.40	38.37	38.37	38.38

Despite the fact that LC_{50} of chitosan in fish has not been determined, it has been tested in mice. LD_{50} of chitosan in mice has been found higher than 16 g/kg body weight [15]. Chitosan up to 10 g/kg has been ended up being protected with no clinical indications of harmfulness after a solitary oral organization in male and female Kunming strain mice [16]. From these observations, it might be assessed that 100-160g/kg body weight of chitosan can be utilized in various groups of fishes.

Assurance of the feeding rate is one of the troublesome errands in aquaculture activity. The fish promptly expended the feed and the level of adequacy of all diet plans was pretty much equivalent. Fish were discovered pretty much solid all through the investigation time frame. The growth responses and food use of fingerlings under various dietary treatments are depicted in Table 3.

During this work, the exploratory feeds D2, D3 and D4 with chitosan (2, 4 and 6 g/kg) performed better than trial feed D5 and D6 with 8 and 10g/kg chitosan in *Mystus seenghala*. No outside clinical indications were seen in any treatment during the entire period of the experiments.

Table 3: Growth of *Mystus seenghala* (n=40 and number of replicates=3) fed with different doses of Chitosan for 60 days.

Parameters	Diets and Dose of Chitosan (g/kg)					
	D1(0)	**D2(2)**	**D3(4)**	**D4(6)**	**D5(8)**	**D6(10)**
Initial weight (g)	14.20±0.48	14.30±0.50	14.50±0.64	14.25±0.52	14.40±0.46	14.45±0.50
Final weight (g)	45.33±2.87	47.56±2.46	50.20±1.20	58.39±1.70	52.60±2.62	51.92±2.45
	F value (c=5 and r=2) c=5.37* and r =1.84^{NS}					
Weight gain (g)	31.13±2.39	33.26±2.54	35.70±0.56	44.14±1.18	38.2±2.16	37.47±1.95
Weight gain (%)	219.23±3.98	232.59±3.92	246.21±0.88	309.75±0.23	265.28±4.69	259.31±1.95
Daily weight gain (g)	0.52±0.04	0.55±0.04	0.60±0.01	0.74±0.2	0.64±0.04	0.62±0.03
Specific growth rate (%)	1.93±0.98	2.00±0.65	2.07±1.04	2.35±0.05	2.16±0.89	2.13±0.58
	F value (c=5 and r=2) c=0.48^{NS} and r =81.85***					
Feed Conversion ratio	2.52±0.58	2.37±0.55	2.27±0.35	2.19±0.48	2.08±0.25	2.17±0.58
	F value (c=5 and r=2) c=4.02*and r =69.49***					
Feed Efficiency ratio (%)	36.58±9.0	38.76±8.07	41.03±7.68	51.63±8. 37	44.21±8.86	43.22±9.48
	F value (c=5 and r=2) c=190*** and r =1013***					
Survival rate (%)	42.0±2.0	54.0±4.0	59.0±4.0	68.0±2.0	62.0±0	59.0±2.0
	F value (c=5 and r=2) c=60.10***and r =6.379*					

Survival rate

The survival rate of 42.0±2.0% of *Mystus seenghala* in the controlled (D1) group elevated from 54.0±4.0% in D2 to ideal of 68.0±2.0% in D4 however decreased to 59.0±2.0% in D6 treated fish after 60days of the feeding of chitosan supplemented diets. A significant ($p<0.05$) difference among the dose of chitosan and also the duration of its treatment on the survival rate was calculated (Table 3). A higher survival rate was found in chitosan enhanced *Mystus seenghala* than in the control diet. For the most part, the survival rate was improved in this investigation by chitosan consolidation. This is in concurrence with the findings, who reported a higher survival rate in *Labeo rohita* because of chitosan supplementation in the diet [18]. Very recently, it was investigated that the survival rate of 40.0% of *Clarias batrachus* in the controlled group increased a maximum to 70.0% and then decreased to 66.00% in chitosan supplemented diets after 60days[5].

Final weight

Final weight of 45±2.87g *Mystus seenghala* in controlled (D1) group increased from 47.56±2.46g in D2 to ideal of 58.39±1.70g in D4 yet somewhat diminished to 51.92±2.45g in D6 treated fish after 60days of the feeding of chitosan supplemented diets. It has been found that in a 91 days experiment, chitosan supplementation significantly ($p<0.05$) improved daily weight gain of *Clarias gariepinus* fingerlings [13]. Recently, it was reported that the final weight of 169.33g *Clarias batrachus* in the controlled group increased a maximum to 184.00g and then decreased to 180.92g in chitosan supplemented diets after 60days [5]. It has also been observed that feeding of 3 or 5 g chitosan/kg diet increased the growth rate of *Oreochromis niloticus* [18].

Specific growth rate

The specific growth rate of 1.93±0.98% *Mystus seenghala* in controlled (D1) group also increased from 2.00±0.65% in D2 to ideal of 2.35±0.05% in D4 however diminished to 2.13±0.58% in D6 treated fish after 60days of the feeding of chitosan supplemented diets. It was studied the effect of 0, 0.5, 0.75, 1 and 1.25g/kg chitosan for 90 days on *Labeo rohita* and found that T3 gave the highest significant increment in specific growth rate [17]. Some workers assessed the impact of 0, T1 (2.5g of *Allium sativum*, *Curcuma longa*, *Tinospora cordifolia* and *Withania somnifera*), T2 (0.25g Vitamin C) and T3 (2.5g chitosan) for 102 days on *Cyprinus carpio haematopterus* and observed that T3 gave the best significant increase in specific growth rate [19].

Feed Conversion ratio

On the other hand, the feed Conversion ratio of 2.52±0.58 *Mystus seenghala* in controlled (D1) group diminished from 2.37±0.55 in D2 to an ideal of 2.19±0.48 in D4, however, increased to 2.17±0.58 in D6 treated fish after 60days of the feeding of chitosan supplemented diets. These changes were found statistically significant ($p<0.05$). Earlier, it was contemplated the effect of 0, 0.5, 0.75, 1 and 1.25g/kg chitosan for 90 days on *Labeo rohita* and found that T3 gave the highest significant increase in feed conversion ratio [17]. According to an assessment, the impacts of dietary chitosan on *Carassius auratus gibelio* and got better lessening of feed conversion ratio with diets having 1.8, 4.0 and 7.5g/kg chitosan than the diets with 10.0 and 20.0g/kg chitosan [20].

Feed efficiency ratio

Further, the feed efficiency ratio of 36.58±9.0% *Mystus seenghala* in controlled (D1) group expanded from 38.76±8.07% in D2 to ideal of 51.63±8.37g in D4 but slightly diminished to 43.22±9.48% in D6 treated fish after 60days of the feeding of chitosan supplemented diets. These changes were statistically significant ($p<0.05$). The highest feed efficiency ratio in *Mugil cephalus* were seen in the diet containing 10 g/kg chitosan which had a significant difference compared with other treatments ($p<0.05$) [21]. Recently, it has been investigated that the feed efficiency ratio of 39.78% *Clarias batrachus* in the controlled group increased a maximum to 44.30% and then decreased to 43.52% in chitosan supplemented diets after 60days [5].

The observations of the current study were on the line that the chitosan was effective in increasing weight gain and growth parameters of *Mystus seenghala*, which was in concurrence with the consequences of earlier workers [5, 18 and 20].

CONCLUSION:

The current investigation inferred that chitosan-based diets gave a higher survival rate and growth rate indices and less food conversion ratio in comparison to fish meal-based diets. The work might be one of the gauge information for leading further examination on the chitosan likewise locally such accessible feed fixings with catfish like *Mystus seenghala* and different fishes.

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CONFLICT OF INTEREST:

There is no conflict between the authors.

AUTHORS CONTRIBUTION STATEMENT:

The first author supervised the work and suggested the journal to publish the paper. On the other hand, the second author planned and conducted the work to write the paper.

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