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Effects of Commercial Growth Promoter-Enriched Feed on the Growth, Carcass Composition, and Palatability of *Catla catla* (Hamilton, 1822)

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ABSTRACT

Since the use of various commercial growth promoters in aquafeed is increasing in Bangladesh, a feeding trial was conducted for 90 days to evaluate the effects of farm-made feeds enriched with a commercial growth promoter, Charger Gel on the growth, carcass composition, and palatability of *Catla catla*, a candidate aquaculture species of this country. In this trial, four feeds were utilized and treated as four distinct treatments, with a commercial grower feed used as the control feed (CGF0), and three test feeds were made using locally sourced ingredients, incorporating Charger Gel at 4, 6, and 8 g/kg of feed, designated as CGF1, CGF2, and CGF3, respectively. At the trial's end, mean weight gain (MWG), percentage weight gain (PWG), specific growth rate (SGR), survival rate, and feed conversion ratio (FCR) were estimated using standard methods and formulas. Additionally, carcass proximate composition and palatability of cooked fish's flesh were evaluated using AOAC methods and organoleptic sensory techniques. The better MWG, PWG, SGR, and FCR were found in CGF1, while the poorer results were found in CGF0. Higher carcass protein and lipid content, along with a total organoleptic score were recorded in CGF1, whereas the lower values were found in CGF0. The study concludes that utilizing locally available feed ingredients combined with Charger Gel had no adverse effects, and a rate of 4 g/kg feed leads to superior growth and flesh palatability of *C. catla*.

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Introduction

Over the past few decades, Bangladesh's aquaculture industry has flourished, and it is currently the world's fifth-largest producer [1]. Aquaculture in Bangladesh is advancing toward intensification due to the rising demand for food fish and the declining yield of capture fisheries. The intensification, from low-density to high-density culture, is causing a noticeable increase in the demand for fish feeds like never before [2]. An aqua-feed is considered ideal when it bears an optimum amount of essential nutrients, has little or no detrimental impact on the environment and the consumer's health, and is at the same time economically sustainable. However, many feed manufacturers struggle to deliver top-notch feed due to insufficient quality feed components, contaminated ingredients, and various other factors [2]. Additionally, the nutritional information displayed on commercial fish feeds is frequently deceptive, as it tends to inaccurately represent the actual levels of protein and lipids present [3]. Fish meal and fish oil are major sources of protein and lipids in aqua-feed production, but they also have serious sustainability issues. Thus, for sustainable production of fish feed, emphasis is now being given to using locally available plant-based feed ingredients. But, low protein content, poor digestibility, high carbohydrate content, an unfavorable amino acid profile, and the presence of anti-nutritional substances are the biggest issues with using plant products in fish feed [4,5]. However, to improve the efficiency of fish feed and obtain better growth performance, several types of commercial growth promoters are now used in the aqua-feed industry.

Growth promoters are a type of feed additive that primarily are chemical and biological substances added to fish feed to improve fish growth [6,7]. They are now a crucial component of fish diets in intensive and semi-intensive aquaculture systems because they improve the food conversion ratio (FCR), increase digestion and absorption, and lower the mortality of fish. Aquaculture has demonstrated success with the use of such feed additives [8]. According to recent researches, the most popular growth promoters in Bangladesh's aquaculture industry include β-glucan, dietary enzymes, and vitamin and mineral premixes [9-11]. Charger gel, a commercial growth promoter (containing 1-3 D-glucan, polysaccharides, betaine, and β-glucan), is manufactured by Growel Formulations Private Limited. It is regularly used in aqua-feed by the fish farmers of Bangladesh. Khanjani et al. and Meena et al. have extensively documented the impact of β-glucan on growth, survival, resistance, and protection against pathogens in a wide range of fish species [12,13].

Carp fattening with different species, a form of intensive farming, is very popular in the northwestern region of Bangladesh. Feed additives are necessary to fatten fish and improve the utilization of feed for better production and financial outcomes. The concept of using feed additives in the aquaculture sector of Bangladesh is gradually gaining popularity among fish farmers due to its many benefits. Unfortunately, some farmers use these growth promoters indiscriminately without knowing their effectiveness and proper dose. The unregulated use of these growth promoters could pose negative impacts on the flesh composition and palatability of fish that remain largely unaddressed in the country. Among different carp species, *Catla catla* is a common species in feed-based carp fattening systems in Bangladesh. An effective feed formulation for *C. catla* by using locally available feed ingredients with growth promoters at the proper dosage can significantly benefit fish farmers. However, numerous researchers have conducted studies to evaluate the effects of growth promoter-enriched feed on several fish species like *Clarias batrachus, Oreochromis niloticus,* and *Anabas testudineus* [14-16]. But few scientific works have been carried out to assess the impact of growth promoters on the Indian major carps in Bangladesh regarding growth and flesh quality. Therefore, the feeding trial was performed to examine the effects of charger gel-incorporated feed on the growth, carcass compositions, and palatability of an Indian major carp, *C. catla*.

Materials and Methods

Research Site and Period

The trial was conducted in twelve cages that were installed in a research pond located on the north side of the Faculty of Fisheries, University of Rajshahi, Rajshahi, Bangladesh (Figure 1), for 90 days in August through October of 2023. Twelve cages (each 2.73 m3) were constructed for this research. The frame of each cage was made of iron rods and covered by a monofilament nylon net with a 5 mm mesh size. An opening was kept on the upper side of the cage for supplying feed and convenient fish handling during sampling.

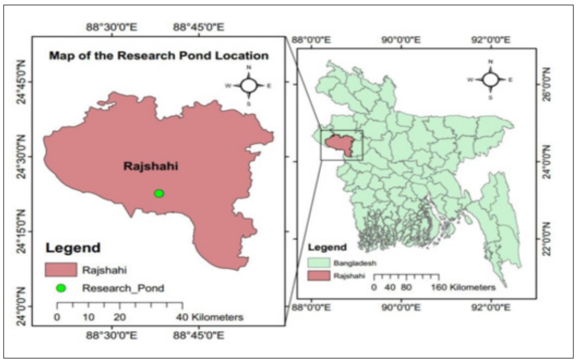

Figure 1: Map of the Research Pond Location

Table 1: Dietary Inclusion of Different Ingredients in Different Treatments

Ingredients (%)	CGF1	CGF2	CGF3
Rice bran	25	25	25
Mustard oil cake	40	40	40
Fish meal	19	19	19
Wheat bran	15	15	15
Molasses	1	1	1
Soyabean oil	0.5	0.5	0.5
Charger gel	4 g	6 g	8 g

Table 2: Proximate Composition of the Test Feeds (Dry Basis)

Component (%)	Test Feeds			
	CGF0	CGF1	CGF2	CGF3
Protein	23.33 ± 0.12^a	23.22 ± 0.13^a	23.36 ± 0.17^a	23.37 ± 0.18^a
Lipid	6.06 ± 0.11^a	6.04 ± 0.16^a	6.13 ± 0.09^a	6.16 ± 0.18^a
Ash	9.70 ± 0.22^a	9.22 ± 0.11^a	9.65 ± 0.10^a	9.31 ± 0.13^a
Carbohydrate	42.67 ± 1.01^a	42.52 ± 1.11^a	42.79 ± 1.13^a	42.43 ± 1.08^a
Moisture	10.74 ± 0.63^a	10.51 ± 0.67^a	10.28 ± 0.71^a	10.43 ± 0.31^a

*CGF0 was designated as the feed without charger gel while CGF1, CGF2, and CGF3 were designated as the feeds with charger gel at 4, 6, and 8g/kg feed, respectively.

*Significant differences are indicated in data with different superscripts in the same row ($p<0.05$).

Collection, Stocking, and Feeding of the Test Fish

From a nearby fish farm, 130 juveniles of *C. catla* were acquired. In the presence of an aeration system, fish were moved to the study area in a proper scientific manner. Before the main study began, the fish were given seven days to get used to the new conditions. Fish were given commercial carp feed at a rate of 5% of their body weight during this time. Following the acclimatization period, 10 fish weighing an average of 150 g were released into twelve cages. After the fish's stocking, the test feeds were administered twice daily (at 9:30 am and 4:30 pm) at a rate of 5% (2.5% + 2.5%) of their body weight. Throughout the study tenure, fish were weighed every two weeks, and the ration size was adjusted accordingly.

Monitoring of Water Quality Parameters

The water quality parameters, including temperature, dissolved oxygen (DO), pH, total alkalinity, carbon dioxide (CO_2), and ammonium-nitrogen (NH_4-N), were measured every two weeks during the study period. The water sample was collected in the morning (9.00–10.00 am). A Celsius thermometer was used to record the water temperature. The pH of the water was measured by a digital pH meter. DO, CO_2, total alkalinity, and NH_4-N concentrations were determined by using the HACH Kit (Model: DR/2010). The values of water quality parameters among the treatments showed no significant variation and were within the productive range for fish culture.

Analysis of Growth Performance and Feed Consumption

The weight of the fish in each cage was noted during the initial sampling, which took place during the fish stocking. After stocking, sampling was done every two weeks to keep a record of the fish's weight. The following formula was used to determine the growth performance and feed efficacy by mean weight gain (MWG), specific growth rate (SGR), and feed conversion ratio (FCR).

- MWG = MFW - MIW
  Where, MFW = Mean final weight and MIW = Mean initial weight
- SGR (%) = {100 (ln FBW – ln IBW)/T}
  Where, FBW = final body weight, IBW = initial body weight, and T = Time
- FCR = Feed Fed (dry weight)/Live weight gain

Chemical Analysis of Fish Flesh

The flesh samples of three fish from each cage were taken at the end of the trial, and the samples were kept in the refrigerator. The flesh samples were transferred to the laboratory to be analyzed for chemical composition through crude protein, lipid, carbohydrate, moisture, and ash content using standard methods [17].

Palatability Test for Cooked Flesh

At first, collected fish from each cage of the four treatments were scaled, gutted, and cut into fish loins. After washing, 500 g of fish from each treatment was cooked following conventional procedures and spices. After finishing the cooking, the cooked fish loins were served to the chosen panel of consumers for sensory assessment. Each member of the panel was provided with the following data sheet (Table 3), and their judgments were recorded on a numerical scale described by Huss [18].

Table 3: Organoleptic Scoring for Palatability Test of Fish

Palatability Indicators/ Organoleptic Criteria			Score
Odor	**Taste**	**Texture**	
Species-specific	Meaty flavor	Firm/elastic	10
Fresh fish	Sweet	Firm/springy	8
Slightly fishy or sour	Slightly fishy	Less firm	6
Sour and stale	Slightly sour/ off-flavor	Softer	4
Strong ammonia	Slightly rotten	Very soft	2
Rotten smell	Spoiled	Slippery	0

Statistical Analysis

Using SPSS-21 computer software (SPSS, USA), statistical analysis was carried out using one-way analysis of variance (ANOVA) and Duncan's multiple-range test after the normality of the data had been confirmed. The significant differences were considered at $p > 0.05$.

Results

Growth Performance and Feed Utilization

The mean values of MWG, PWG, SGR, and FCR of the test fish fed with four different feeds are given in Table 4. The fish fed with charger gel-incorporated feeds exhibited higher growth performance and feed utilization compared to the control fish. Significantly higher values of MWG, PWG, and SGR were recorded in the fish fed with CGF1, and the lower value was found in the fish fed with CGF0. In the case of FCR, a better (lower) value was found in the fish fed with CGF1, followed by CGF2 and CGF3, whereas the poorer (higher) value was found in the fish fed with CGF0. There was no significant difference in the values of MWG, PWG, SGR, and FCR in the fish between CGF2 and CGF3.

Table 4: The Mean Values of Growth and Feed Utilization Parameters

Parameters	Treatments			
	CGF0	CGF1	CGF2	CGF3
MIW (g)	154.19 ± 9.62^a	154.37 ± 9.56^a	155.75 ± 6.83^a	152.85 ± 8.57^a
MFW (g)	293.28 ± 17.42^c	345.56 ± 19.82^a	319.37 ± 17.65^b	312.20 ± 16.14^b
MWG(g)	143.09 ± 12.60^c	191.19 ± 16.64^a	163.62 ± 12.11^b	159.35 ± 15.44^b
PWG (%)	92.63 ± 6.22^c	123.84 ± 8.59^a	105.06 ± 7.84^b	104.31 ± 8.21^b
SGR (%)	0.77 ± 0.04^c	0.95 ± 0.05^a	0.84 ± 0.04^b	0.83 ± 0.03^b
FCR	2.92 ± 0.22^c	2.20 ± 0.17^a	2.63 ± 0.25^b	2.67 ± 0.31^b

*CGF0 was assigned to the fish fed with feed without charger gel while CGF1, CGF2, and CGF3 were assigned to the fish groups fed with feed with charger gel at 4, 6, and 8g/kg feed, respectively.

*Significant differences are indicated in data with different superscripts in the same row ($p<0.05$).

Carcass Composition

The analyzed data for carcass protein, lipid, carbohydrate, moisture, and ash content is given in Table 5. The fish fed with charger gel-incorporated feeds exhibited significantly higher protein, lipid, and carbohydrate deposition in their flesh than the fish fed with control feed. The highest carcass protein and lipid contents were recorded in the fish fed with CGF1, whereas a significantly elevated level of carbohydrate was found in fish fed with CGF3. Carcass moisture content didn't show any significant variation, but the higher value was recorded in the fish fed with CGF0 and the lower value in the fish fed with CGF1. Significantly superior ash content was obtained in the fish fed with CGF0 compared to other test groups, while the lowest amount was found in the fish fed with CGF3.

Table 5: Carcass Composition of Fish Flesh of Four Treatments (% Wet Basis)

Parameters	Treatments			
	CGF0	CGF1	CGF2	CGF3
Crude Protein	15.64 ± 0.11^b	16.58 ± 0.15^a	16.46 ± 0.17^a	16.53 ± 0.17^a
Lipid	2.49 ± 0.13^c	3.01 ± 0.11^a	2.82 ± 0.09^b	2.70 ± 0.15^b
Carbohydrate	1.49 ± 0.09^c	1.76 ± 0.12^b	1.71 ± 0.18^b	1.82 ± 0.16^a
Moisture	76.78 ± 1.02^a	76.14 ± 1.13^a	76.42 ± 1.02^a	76.41 ± 1.18^a
Ash	2.06 ± 0.15^a	1.43 ± 0.11^b	1.32 ± 0.22^b	1.27 ± 0.21^b
FCR	2.92 ± 0.22^c	2.20 ± 0.17^a	2.63 ± 0.25^b	2.67 ± 0.31^b

*CGF0 was assigned to the fish fed with feed without charger gel while CGF1, CGF2, and CGF3 were assigned to the fish groups fed with feed with charger gel at 4, 6, and 8g/kg feed, respectively.

*Significant differences are indicated in data with different superscripts in the same row ($p<0.05$).

Palatability of Cooked Flesh

Using the organoleptic sensory scoring system on a scale of 1-10, the selected panel consumers were asked to score the cooked flesh's odor, taste, and texture. Table 6 displays the mean scores. The highest score for odor was obtained for CGF1, whereas the lowest score was recorded for CGF0. A significantly better score for taste was recorded in the flesh of fish fed with charger gel-enriched feeds in comparison to the control group, where the highest score was found in the fish fed with CGF1. When compared to other fish groups, the texture score of the fish fed with CGF1 was noticeably higher. According to the total score, the fish fed with CGF1 came out as better palatable in terms of overall odor, taste, and texture compared to other fish groups.

Table 6: Organoleptic Scores of Cooked Fish Flesh Under Four Treatments

Organoleptic Criteria	Treatments			
	CGF0	CGF1	CGF2	CGF3
Odor	7.03 ± 0.67^b	7.83 ± 0.29^a	7.80 ± 0.41^a	7.17 ± 0.49^b
Taste	7.11 ± 0.59^c	8.67 ± 0.89^a	7.90 ± 0.77^b	7.81 ± 0.68^b
Texture	7.43 ± 0.89^b	8.43 ± 1.67^a	7.23 ± 0.99^b	7.37 ± 1.02^b
Total Score	21.57 ± 1.28^c	24.93 ± 1.57^a	22.93 ± 1.77^b	22.35 ± 1.35^b
Rank	4th	1st	2nd	3rd

*CGF0 was assigned to the fish fed with feed without charger gel while CGF1, CGF2, and CGF3 were assigned to the fish groups fed with feed with charger gel at 4, 6, and 8g/kg feed, respectively.

*Significant differences are indicated in data with different superscripts in the same row ($p<0.05$).

Discussion

Growth Performance and Feed Utilization

In the feed-based aquaculture system of Bangladesh, the farmers largely depend on suitable growth promoters for better fish production. If the growth promoter's doses are not in proper concentration, it may hamper the production. The growth promoter under the present study, charger gel contains 1-3 D-glucan, polysaccharides, betaine, and beta-glucans. According to the manufacturer, charger gel is capable of working in immune mechanism to boost immunity, acts by stimulating macrophages and receptors, activities bacteroids, and phagocytosis, protects the secretory and excretory glands to gear up the general health by improving appetite, digestion, FCR, green gland, and hepatopancreas function, helps as a growth stimulant indirectly, and detoxifies any feed, and pathogenic toxin sand saves the hepatopancreas from degeneration. Scientific reports demonstrated that charger gel enhances the growth performance of different fish species [14,19].

However, in our study, we assessed the growth performance and feed utilization of *C. catla* by administering test feeds containing different doses of charger gel. The estimated data showed that the fish fed with charger gel-incorporated feed at 4 g/kg exhibited superior WG, PWG, SGR, and FCR compared to the other treatment groups. The data obtained from the fish fed with CGF2 and CGF3 indicated a substantial enhancement in the growth of this fish species with the inclusion of charger gel in the feed at certain levels. The key components within charger gel include β-glucan, betaine, and glycoprotein, which have different positive effects on fish. β-glucan offers an overview of its functions in promoting growth, survival, and defense against infectious agents relevant to fish and shellfish [13]. The growth efficacy and feed utilization efficiency of hybrid groupers may be enhanced with a 0.5% betaine supplement [20]. The synergistic impact of the three components within the charger gel may exert a noteworthy influence, serving as an effective growth stimulant for the test fish. Ray et al. claimed that the SGR of *L. rohita* fingerlings was significantly increased due to the dietary inclusion of β-glucan. Jaramillo and Gatlin reported similar results in striped sea bass, while Misra et al. found analogous findings in Rohu fingerling [21-23].

Additionally, Hussein et al. found that the addition of commercial feed additives to diets improves growth, feed utilization, and net financial return in comparison to the control group [24]. The results of current findings coincide with the study results of Islam et al. who found that the utilization of charger gel-enriched feed at 4 g/kg led to notable enhancements in growth specifically in terms of MWG, SGR, and FCR of *Labeo rohita* [19]. From the study, we found that growth performance and feed utilization with the 4 g/kg dose of charger gel were better than the other two doses (6 and 8 g/kg) which justified the dose recommended by the manufacturer of this growth promoter.

Carcass Composition

Fish body composition is considered significant in fish farming as it affects fish growth, survival, and the food consumption efficiency [25]. Nutritional state and health status of the fish are often indicated by the protein and lipid content in their carcass [26]. The present research showed that the inclusion of charger gel in the feed can influence the carcass quality of *C. catla*. Proximate analysis of the fish flesh showed that there was a significant difference in carcass protein content, and the higher value was recorded in fish fed with feed at the 4 g/kg dose than the control group. The main active ingredient of charger gel is β-glucan, and its positive effect on increased protein deposition in fish has been reported in numerous studies [27,28].

Crude lipid content in fish muscle was found to be significantly higher in fish supplemented with the 4 g/kg dose compared to other treatments. In an earlier study, Schmidt et al. reported high levels of lipids in starry flounder due to feeding of β-glucan-enriched feed [29]. However, a decreased level of body lipid content with the increased amount of β-glucan in the diet has been reported by Hoang et al. in young pompano fish (*Trachinotus ovatus*) [28]. This discrepancy might be attributed to how different species of fish physiologically respond to dietary β-glucan. Inclusion of growth promoters in the fish diet didn't have any significant effect on the ash and moisture content of *C. catla* (Table 5). Similarly, addition of dietary β-glucan also didn't show any influence on the ash content of Pompano Fish (*Trachinotus ovatus*), as argued by Rufchaie and Hoseinifar [27]. The present result is also backed up by the findings of Schmidt et al. where the moisture content of Starry Flounder (*Platichthys stellatus*) was not affected by dietary β-1-3-glucan [29].

Palatability of Cocked Flesh

The scores of the palatability indicators of cooked fish indicated that the inclusion of charger gel has the capacity to influence the flavor, taste, and texture of the test fish. Expert panelists' feedback regarding these aspects indicated that the fish fed with charger gel-incorporated feed at 4 g/kg achieved the highest organoleptic scores, followed by the fish fed with charger gel-incorporated feed at 6 g and 8 g/kg, respectively. This outcome might be attributed to the result of the notably elevated lipid content in the carcasses of fish fed with charger gel-incorporated feed. Lipids have a well-established role in influencing the texture and flavor of foodstuffs, which is attributed to the production of volatile oxidation products and the taste imparted by short-chain free fatty acids [30]. The present research outcomes are alike with the report of Islam et al. who performed an investigation on the impacts of different growth promoters and found fish fed with charger gel-enriched feed at 4 g/kg showed the highest organoleptic scores than other growth promoters. However, studies on the impact of growth promoter-enriched feed on the palatability of fish are scarce, and thus further research is required to draw definitive conclusions [19].

Conclusion

The overall research demonstrates that the utilization of locally available feed ingredients along with growth promoters leads to superior growth, carcass quality, and changes in palatability attributes of *C. catla* compared to the chosen commercial feed. The present study suggests that the addition of charger gel at 4.0 g/kg feed is more functional for *C. catla*. Drawing upon the results of this study as well as previous investigations the manufacturer's recommended dose of charger gel for fish is justified but more research is also essential in large scale to optimizing the dose of this growth promoter for carp species.

Ethical Statement

No animals were harmed during the experiment. All procedures performed in this investigation were in accordance with the ethical guidelines provided by the International Council for Laboratory Animal Science (ICLAS) for researchers.

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Conflict of Interest

The author(s) declare that they have no known competing financial or non-financial, professional, or personal conflicts that could have appeared to influence the work reported in this paper.

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