

Apparent Nutrient Digestibility Assessment and Influence of Gelatinized and Non-gelatinized Corn Starch Based Diet in *Labeo rohita*

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Abstract – Gelatinized and non-gelatinized corn starch based diet was processed at varying protein levels for apparent nutrient (dry matter, ash, crude fat, crude protein and gross energy) digestibility coefficient (ADC) evaluation in *Labeo rohita*. For a tryout of 120 days, six semi purified diets were assembled (T₁: G, 30% CP; T₂: NG, 30% CP; T₃: G, 35% CP; T₄: NG, 35% CP; T₅: G, 40% CP and T₆: NG, 40% CP) in which two replicates were followed for each diet. Chromic oxide was added being an indigestible marker. Apparent dry matter, crude fat and gross energy digestibility was best exhibited by T₆ (12.00%, 79.60% and 32.10%) compared to other test diets while apparent protein digestibility was observed maximum in T₂ (67.70%) followed by T₁(65.40%), T₆ (52.60%), T₅ (40.00%), T₄ (32.60%) and T₃ (20.20%) respectively depicting non-significant variations. In case of ash, the apparent nutrient digestibility was capital in T₄ (18.60 %) comparing others diets where the values being non-significantly different are T₃ (13.40%), T₁ (13.30%), T₆ (12.70), T₅ (12.30%) and T₂ (9.79%) respectively. The described outcomes revealed that *Labeo rohita* may be able to utilize the non-gelatinized corn starch based diet more efficiently and being economical it spares the protein based cost effective feed.

Keywords – Nutrient Digestibility, Chromic Oxide, Protein, Gelatinized, *Labeo rohita*.

I. INTRODUCTION

Pakistan, due to the lack of resources in the production rate is low intensive agriculture. Therefore, introducing the cheap energy source i.e. carbohydrates, the production rate can be improved. Fish fauna is rich in Pakistan, but in warm-water fish, only seven species and in cold water fish only two species are grown on commercial level [1]. Carbohydrates are considered energy cheaper food for the animals, but the ability of fish to digest carbohydrates in the diet has been reported to the difference between different species [2]. This difference can be explained by the different activities of endogenous carbohydrate digestive different fish [3]. However, carps can utilize high level of carbohydrates in the diet. Similarly, carnivorous fish are poorly able to utilize carbohydrates rather than herbivorous and omnivorous fish, but it is well known that the tents were reported to be in better utilization of carbohydrates, because of their omnivorous or herbivorous diet [3]. Rohu, one of three carp (IMC) and an omnivorous fish, has the ability to use carbohydrates to 43% in the diet without adverse health effects [4]. This study aimed to determine the acceptance of corn as the main source of carbohydrates and make a comparison of important aspects of fish metabolism of *L. rohita* fed corn feed (G/NG) at three protein levels i.e. 30%, 35% and 40% in practical and economic systems for commercially

available species of carp i.e. *Labeo rohita*. These new formulations minimize the cost of fish and reduce the waste produced by the fish.

II. MATERIALS AND METHODS

2.1 Experimental diets

The basic feed ingredient i.e. corn was procured and ground to make powder which were added approximately 80% of water (v/w) and autoclaved at 15 psi for one hour to obtain maximum gelatinization. These gelatinized corn ingredients were spread over a tray and dried in oven at 60 C. The dried mass was then pulverized through a hammer mill with 0.5 mm screen. Protein source was gelatin and fat free casein, while lipid source was sunflower oil and cod liver oil and carbohydrate source was corn (G or NG). Chromic oxide was added as an indigestible marker. All these ingredients (Table 1) were ground and sieved to incorporate into diets and mixed well for 30 minutes, then fish oil was slowly added, while mixing thoroughly. Then the dough was given steam for 5 min in an autoclave. Vitamin-mineral premix was added after cooling the dough and then pellets of 2mm were made by hand pelletizer. The pellets were dried in a drying oven for 48 hours and stored until use. Three different crude protein levels (30%, 35% and 40%) were used to formulate six semi purified diets (T₁: G, 30% CP; T₂: NG, 30% CP; T₃: G, 35% CP; T₄: NG, 35% CP; T₅: G, 40% CP and T₆: NG, 40% CP) with either gelatinized or non-gelatinized corn starch.

Table 1: Percentage composition of test diets

Ingredient	30% CP	35% CP	40% CP
Casein %	26.57	30.57	35.20
Gelatin %	4.00	8.00	5.00
Corn%G/NG	42.43	42.43	42.4
Cellulose %	15.00	7.00	7.40
Sunflower:Codliver oil (2:1)%	8.00	8.00	6.00
Carboxymethyl cellulose %	1.00	1.00	1.00
Vitamin+mineral mix %	2.60	2.60	2.60
Vitamin C %	0.10	0.10	0.10
Vitamin B %	0.10	0.10	0.10
Glycine %	0.20	0.20	0.20
BHT %	0.02	0.02	0.02

(*the antioxidant ButylatedHydroxy Toluene was added at 0.02% of the added oil.)

2.2 Experimental design and feeding protocol

Labeo rohita fingerlings purchased from government fish seed hatchery, Satiana road, Faisalabad were allowed to acclimate at ambient conditions fed on control diet (NG, 30% CP) for one week before initiating the trial. After acclimatization, fingerlings were transferred randomly into glass aquaria [90L×30W×45H (cm) with 29 L water capacities each]. For each treatment there were two replicates and in each replica forty fingerlings were stocked. Fish were given test diets at the rate of 4% live wet body weight twice a day (morning and afternoon) in the feeding aquarium.

2.3 Analytical methods

Representative samples of six experimental diets and dried samples of feces of every replica were homogenized separately in a mortar pestle and chemically analyzed by [5] protocols: oven drying at 105°C for dry matter (DM);

microkjeldahl analysis for crude protein, chloroform methanol extraction method [6] for crude fat through 10454 soxtec system HTz, electric furnace for ash. Chromic oxide (Cr₂O₃) was estimated in dried feed and feces according to [7] through UV/VIS2001 spectrophotometer.

III. RESULTS

The digestibility of nutrients is not defined precisely in many commercial feeds and it is shown that feed performance and digestibility can be increased with the use of extrusion technology [8]. Present study is comparing the digestibility of gelatinized and non-gelatinized corn feed at various protein levels. Apparent nutrient digestibility coefficient (%) of test diets is shown in Table 2.

Table 2: Apparent nutrient digestibility coefficient (%) of dry matter, ash, crude fat, crude protein and gross energy for test diets using chromic oxide as inert marker

Treatment	Dry matter (%)	Ash (%)	Crude fat (%)	Crude protein (%)	Gross energy (%)
T ₁ G,30%CP	10.00	13.30	65.50	65.40	22.72
T ₂ NG,30%CP	9.40	9.79	68.90	67.70	22.59
T ₃ G,35%CP	7.50	13.40	72.50	20.20	26.85
T ₄ NG,35%CP	7.50	18.60	71.80	32.60	26.00
T ₅ G,40%CP	6.90	12.30	74.70	40.00	27.70
T ₆ NG,40%CP	12.00	12.70	79.60	52.60	32.10

The apparent nutrient digestibility coefficient (ADC) of dry matter was maximum for the T₆: NG, 40% CP (12.00 %) and this was followed by the T₁: G, 30% CP (10.00%), T₂: NG, 30% CP (9.40%), T₃: G, 35% CP, T₄: NG, 35% CP (7.50%) and T₅: G, 40% CP (6.90%) respectively.

Table 3: Analysis of variance for dry matter digestibility (%) of test diets

S.O.V	d.f.	S.S.	MSS	F. Ratio
Between diets	5	18.98833	3.797667	65535 ^{NS}
Within diets	0	0	65535	
Total	5	18.98833		

NS = Non-significant (P>0.05); * = Significant (P<0.05); ** = Highly significant (P<0.01)

The apparent nutrient digestibility coefficient (ADC) of ash was maximum for the T₄: NG, 35% CP (18.60 %) and this was followed by the T₃: NG, 35% CP (13.40%), T₁: G, 30% CP (13.30%), T₆: NG, 40% CP, T₅: G, 40% CP (12.70% and 12.30%) and T₂: NG, 30% CP (9.79%) respectively. The results indicate that maximum ash consumption occurs in non-gelatinized corn at 35% protein level in fish.

Table 4: Analysis of variance for ash digestibility (%) of test diets

S.O.V	d.f.	S.S.	MSS	F. Ratio
Between diets	5	41.76608	8.353217	65535 ^{NS}
Within diets	0	0	65535	
Total	5	41.76608		

NS = Non-significant (P>0.05); * = Significant (P<0.05); ** = Highly significant (P<0.01)

The apparent nutrient digestibility coefficient (ADC) of crude fat was maximum for the T₆: NG, 40% CP (79.60 %) and this was followed by the T₅: G, 40% CP (74.70%), T₃: G, 35% CP (72.50%), T₄: NG, 35% CP, T₂: NG, 30% CP (71.80% and 68.90%) and T₁: G, 30% CP (65.50%).

Table 5: Analysis of variance for crude fat digestibility (%) of test diets.

S.O.V	d.f.	S.S.	MSS	F. Ratio
Between diets	5	117.0333	23.40667	65535 ^{NS}
Within diets	0	0	65535	
Total	5	117.0333		

NS = Non-significant (P>0.05); * = Significant (P<0.05); ** = Highly significant (P<0.01)

The apparent nutrient digestibility coefficient (ADC) of crude protein was maximum for the T₂: NG, 30% CP (67.70 %) and this was followed by the T₁: G, 30% CP (65.40%), T₆: NG, 40% CP (52.60%), T₅: G, 40% CP, T₄: NG, 35% CP (40.00% and 32.60%) and T₃: G, 35% CP (20.20%).

Table 6: Analysis of variance for crude protein digestibility (%) of test diets.

S.O.V	d.f.	S.S.	MSS	F. Ratio
Between diets	5	1770.968	354.1937	65535 ^{NS}
Within diets	0	0	65535	
Total	5	1770.968		

NS = Non-significant (P>0.05); * = Significant (P<0.05); ** = Highly significant (P<0.01)

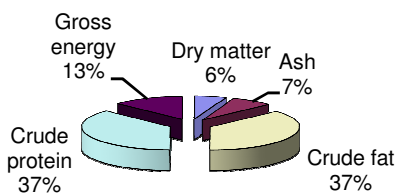
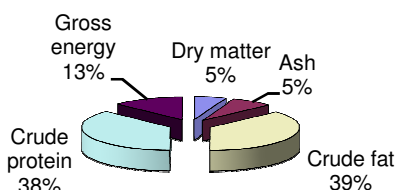
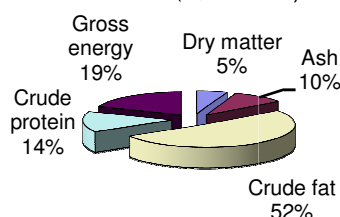
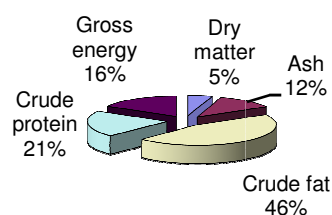
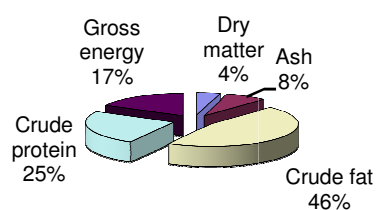
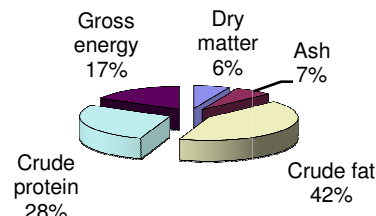
The apparent nutrient digestibility coefficient (ADC) of gross energy was maximum for the T₆: NG, 40% CP (32.10 %) and this was followed by the T₅: G, 40% CP (27.70%), T₃: G, 35% CP (26.85%), T₄: NG, 35% CP, T₁: G, 30% CP (26.00% and 22.72%) and T₂: NG, 30% CP (22.59%).

Table 7: Analysis of variance for gross energy digestibility (%) of test diets.

S.O.V	d.f.	S.S.	MSS	F. Ratio
Between diets	5	62.56873	12.51375	65535 ^{NS}
Within diets	0	0	65535	
Total	5	62.56873		

NS = Non-significant (P>0.05); * = Significant (P<0.05); ** = Highly significant (P<0.01)

The statistical analysis of the above mentioned results (Table 3-7) showed non-significant variations among all experimental diets while Figure 1 and 6 indicated the highest digestibility of dry matter in T₁ and T₆ (7%) within diets while figure 4 depicted the maximum ash consumption in T₄ (12%) with different test diets. Crude protein was highest (38%) in T₂ as shown in figure 2 whereas crude fat and gross energy were maximum digestible by T₃ (52% and 19%) as shown in figure 3.

T1 (G, 30% CP)

Fig.1. Apparent nutrient digestibility coefficient (%) for T₁ (G, 30% CP)
T2 (NG, 30% CP)

Fig.2. Apparent nutrient digestibility coefficient (%) for T₂ (NG, 30% CP)
T3(G,35% CP)

Fig.3. Apparent nutrient digestibility coefficient (%) for T₃ (G, 35% CP)
T4(NG,35%CP)

Fig.4. Apparent nutrient digestibility coefficient (%) for T₄ (NG, 35% CP)
T5(G,40%CP)

Fig.5. Apparent nutrient digestibility coefficient (%) for T₅ (G, 40% CP)
T6(NG,40%CP)

Fig.6. Apparent nutrient digestibility coefficient (%) for T₆ (NG, 40% CP)

IV. DISCUSSION

Digestibility describes the fraction of the nutrients of energy in the feedstuff that is not excreted in the feces. Digestibility is one of the most important aspects of evaluating the efficiency of feed stuffs. [2] reported that

increased gelatinization decreased the dry matter digestibility. Similar trend was observed in the present study as non-gelatinized T₆: NG, 40% CP showed the maximum digestibility. This also showed that protein levels has no effect on carbohydrate digestibility as reported by [9] 28% and 35% CP levels showed non-significant variations among G/NG corn. Our results indicates that maximum ash consumption occurs in non-gelatinized corn at 35% protein level in fish same as reported by [3]; [10]; [11] that 35% protein level observed to be the optimum for contents of ash retention. [12] reported high lipid digestibility at 35% protein level while [2] reported fat digestibility affected by increasing level of gelatinization in corn. On contrary, present study indicates the lipid digestibility better at 40% protein level in non-gelatinized corn test diet comparing all other in *L. rohita*. These results also indicated that fat digestibility affected by different protein levels as reported by [9], both G/NG corn showed non-significant variations with reference to different protein levels. [2] reported the maximum protein digestibility at gelatinized 40% protein level in *L. rohita* while NG, 30% CP diet produced better protein digestibility, nutrient utilization and energy compared to other [12], as proper balance between dietary protein and energy is important for optimum growth. Less energy of rohu fingerlings fed low protein (30%) reported [12]. Total energy and carbohydrate digestibility were found 80% in fish fed NG, 35% CP [3]. On contrary, results from present study indicate the maximum total digestible energy in test diet with non-gelatinized 40% protein level, which means that gelatinization, affected the rate of digestibility in *L. rohita* in every aspect i.e. dry matter, ash, lipid, protein and gross energy while 40% protein level proves suitable in dry matter, lipid and total energy digestibility while 30% for protein digestibility in *L. rohita* which is in agreement with [13].

V. CONCLUSION

It may, therefore, be concluded that non-gelatinized corn at 40% protein level proved as a promising fish feed ingredient being more efficiently utilized and gave better growth, digestibility and tissue deposition results in *Labeo rohita*. The palatability of non-gelatinized corn and its excellent nutritional value including high level of protein and relatively high nutritional digestibility, proved to be a high quality ingredient for this fish. The results of present study could be useful as starting point for formulating cost effective, nutritionally balanced fish diets by sparing protein with carbohydrate sources.

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