APPARENT DIGESTIBILITY CO – EFFICIENT (ADC) OF *Clarias gariepinus* (BURCHELL, 1822) FINGERLINGS FED DIFFERENT LEVELS OF CO – MIXED OF BETAINE/β – GLUCAN AS FEED ADDITIVE

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ABSTRACT
This study elucidated the apparent digestibility co – efficient (ADC) of Clarias gariepinus fingerlings fed different levels of co – mixed of betaine/β – glucan as feed additive. Five (5) isonitrogenous (40% crude protein) and isocaloric (1,732kcal kg^{-1} gross energy) diets were prepared, where co – mixed of betaine/β – glucan was incorporated as additives at 0.0g/100g, (BBG0 i.e. control), 0.325g/100g (BBG1), 0.75g/100g (BBG2), 1.125g/100g (BBG3) and 1.50g/100g (BBG4). Three hundred (300) C. gariepinus fingerlings with mean initial weight (10.0±0.00g) were stocked at twenty (20) fingerlings per tank in triplicate groups per treatment and fed 3% body weight twice daily. Quantity of feed was adjusted accordingly after every two (2) weeks of sampling for growth performance and survival rate (mean body weight and mortality) for a period of twelve (12) weeks. The water quality parameters were within the recommended ranged for C. gariepinus. Crude protein, crude lipids, dry – matter and carbohydrate digestibility values of the experimental diets were; 86.97±3.5 – 89.25±2.8 %, 83.50±2.6 – 85.35±2.3 %, 66.71±2.4 – 69.35±2.7% and 51.38±1.4 – 52.58±1.5% respectively. There was no significant difference (p>0.05) in the ADC values of crude protein, crude lipids, dry – matter and carbohydrate. The incorporation of co – mixed of betaine/β – glucan additive at different levels into the diet of C. gariepinus fingerlings had no significant (p>0.05) effects on the ADC values of crude protein, crude lipid, dry – matter and carbohydrate. C. gariepinus fingerlings should be fed with co – mixed of betaine/β – glucan as feed additive. However, other feed additives could be employed which may further promote the digestibility of the feed.
Keywords: Apparent Digestibility, Co – Mixed, Betaine, β – Glucan, *Clarias gariepinus*, Fingerlings

INTRODUCTION

Digestibility determination is very important in the selection of feed ingredients for feed formulation and determination of nutrient digestibility (Ali *et al*., 2024). Digestibility is one of the most important aspects in evaluating the efficiency of animal feedstuffs and a basic requirement for formulating fish diets (Ali 2022). Results have shown that the determination of nutrient digestibility is the first step for evaluating the potential of any ingredient for use in the diet of reared species (Ali *et al*., 2024). Falaye *et al.* (2016) reported that feed ingredients' digestibility is not only a useful tool for diet formulation but gives the right estimation for fish growth. Nutrient digestibility may vary among fish species due to differences in the digestive system, enzymes and feed or food consumed (Babale, 2016). Despite these differences and the lack of pepsin in fish without stomach, variations in the digestibility of proteins and lipids among species are very small. Much more pronounced are variations in digestibility of carbohydrates, especially starch (Ali, 2022). Babale (2016) reported that carnivorous fish digest starch to a much lesser degree than omnivorous and herbivorous fish. Differences in digestibility of carbohydrates can also occur among different families of carnivorous fish within the same species (Ali *et al*., 2024). The objective of this study was to elucidates the apparent digestibility co – efficient (ADC) of *Clarias gariepinus* (Burchell, 1822) fingerlings fed different levels of co – mixed of betaine/β – glucan as feed additive.

MATERIALS AND METHODS

The study was conducted at Lay – Joy fish farm, Gombe – Yola Road, Billiri local government area (LGA), Gombe State Nigeria. Billiri LGA lies within Lat. 9°50'N; 11°09′E and Long. 9.833°N 11.150°E. Three hundred (300) *C. gariepinus* fingerlings with mean initial weight (10.0±0.00g) were stocked at twenty (20) fingerlings per tank in triplicates per treatment after one (1) week of acclimatization. The experimental diets contained fish meal (FM), soybean meal (SBM), yellow maize meal (YMM), groundnut cake meal (GNCM) and co – mixed of betaine/β – glucan. All the ingredients were ground into a fine powder using a hammer mill and sieved by a 0.25 mm sieve. Fish meal, soybean meal, groundnut cake meal and yellow maize meal were obtained from commercial suppliers in Gombe, the vitamin/mineral premix, fish oil and chromic oxide (Cr_2O_3) were purchased from TTS Integrated Farms, Lagos, while the betaine powder naturally derived from sugar beets (*Beta vulgaris*) and the β –glucan (β – 1,3/1,6 – D – glucan) powder naturally derived from the baker's yeast (*Saccharomyces cerevisiae*) were obtained from Bon – Amour. Pharmacy Limited Lagos, Nigeria. Five (5) isonitrogenous and isocaloric diets were prepared, each diet with crude protein (CP) content at 40% CP as calculated according to

Pearson's square method and gross energy content at 1,732kcal kg^{-1} respectively for the feeding the experimental *C. gariepinus* as recommended by Ali (2022) was prepared, where co – mixed of betaine/β – glucan additive was incorporated as additives at 0.0g/100g, (BBG0 i.e. control), 0.325g/100g (BBG1), 0.75g/100g (BBG2), 1.125g/100g (BBG3) and 1.50g/100g (BBG4) as shown in Table 1. Diets were subjected to proximate analysis as described by AOAC (2005). The experimental system consisted of fifteen (15) units rectangular plastic tanks with a water holding capacity of one thousand litres (1,000L) each in a completely randomized design (CRD). Each tank was washed thoroughly with salt, filled to just a little over 1/3 (350 litre) capacity and stocked with twenty (20) fingerlings of *C. gariepinus* with mean initial weight (10.0±0.00g). The *C. gariepinus* fingerlings were fed the experimental diet at 3% body weight two (2) times daily between the hours of 8:00 – 9:00am and 4:00 – 5:00pm for a period of twelve (12) weeks. The quantity of feed was adjusted accordingly after every two (2) weeks of sampling for growth performance and survival rate (mean body weight and mortality). Water temperature, dissolved oxygen and pH were measured weekly using Horiba U – 22 XD multi – parameter water quality checker while ammonia was measured using freshwater aquaculture test kit (Model AQ – 2, Code 3633 – 03, Lamotte U. S. A). Digestibility of diets was determined using the indirect method which relies on use of an inert marker as described by Elezuo (2016). In this study chromium (III) oxide (Cr_2O_3) was used as the marker at 0.5% level of inclusion. Ten (10) hours after feeding, three (3) fish from each treatment and the control were sacrificed through partial decapitation by cutting through the vertebrate column. The gastrointestinal tract was divided into four (4) parts, these were; the stomach, the fore – gut, the mid – gut and the hind – gut as described by Babale (2016). A longitudinal incision was made along the length of the abdomen from the anus to the base of the mouth. The gastrointestinal tract was then carefully removed in other to avoid squeezing the contents from one section of the gastrointestinal tract to another. The hind – gut was severed from the mid – gut. A longitudinal incision was then made in the mid – gut to allowed easy removal of the contents. The faecal sample was then stored in a freezer prior to proximate analysis and the determination of Cr_2O_3. The Cr_2O_3 was quantified as described by Ali (2022).

The weight and percentage of the Cr_2O_3 was calculated using the following formulae:

$$\text{Weight of Cr2O3} = \text{Absorbance} - 0.0032/0.2089$$

Digestibility co – efficient of diets were estimated to determine bioavailability of nutrients. Apparent digestibility co – efficient (ADC) of the feeds were computed using the formula described by Hossain *et al.* (2003).

ADC (%) = 100 x (% nutrient in faeces/% nutrient in feed) x (% marker in feed/marker in faeces).

Data obtained were subjected to one – way analysis of variance (ANOVA) using the GraphPad Instant package for windows 2016 of statistical analysis system (SAS, 2016). Means separation was done at P = 0.05 using Fisher's least significance difference (LSD) method.

Table 1. Ingredient Percentage Compositions (g/100g) of Experimental Diets with Co – Mixed of Betaine/β – glucan Additive

Ingredients (%)	BBG0	BBG1	BBG2	BBG3	BBG4
Fish meal	20.00	20.00	20.00	20.00	20.00
Soybean meal	21.50	21.50	21.00	21.00	21.00
GNC meal	23.00	22.625	22.75	22.375	22.00
Yellow maize	30.00	30.00	30.00	29.75	30.00
Betaine/β – glucan	**0.00**	**0.373**	**0.75**	**1.125**	**1.50**
Fish oil	1.00	1.00	1.00	1.00	1.00
Vegetable oil	1.00	1.00	1.00	1.00	1.00
Starch	1.00	1.00	1.00	1.00	1.00
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
*Vitamin/premix	1.00	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50	0.50
Cr_2O_3	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00

Keys: BBG0 – Betaine/β – glucan (0.0g/100g), BBG1 – Betaine/β – glucan (0.375g/100g), BBG2 – Betaine/β – glucan (0.75.g/100g), BBG3 – Betaine/β – glucan (1.125g/100g), BBG4 – Betaine/β – glucan (1.5g/100g).

RESULTS

The results of the apparent digestibility co – efficient (ADC) of the *C. gariepinus* fingerlings fed different levels of co – mixed of betaine/β – glucan additive diet is presented in Table 2. ADC values of crude protein ranged from 86.97±3.5 – 89.25±2.8%; ADC value of crude protein was highest in BBG2 (89.25±2.8%), while BBG0 had the least value (86.97±3.5%). ADC of crude lipid values ranged from 83.50±2.6 – 85.35±2.3%; ADC value of crude lipid was highest in BBG2 (85.35±2.3%), while BBG0 had the least value (83.50±2.6%). ADC values of dry – matter ranged from 66.71±2.4 – 69.35±2.7%; ADC value of dry – matter was highest in BBG2 (69.35±2.7 %), while BBG0 had the least value (66.71±2.4%). ADC values of carbohydrate ranged from 51.38±1.4 – 52.58±1.5%; ADC value of carbohydrate was highest in BBG0 (52.58±1.5%), while BBG2 had the least value (51.38±1.4%). Therefore, there was no significant difference ($p>0.05$) in the ADC values of crude protein, crude lipid, dry – matter and carbohydrate between the fish fed diets with co – mixed of betaine/β – glucan additive at different levels compared with that of the fish fed control diet (BBG0).

Table 2: Apparent Digestibility Co – efficient (ADC) of *C. gariepinus* Fed Co – Mixed of Betaine/β – glucan Additive Diet

Digestibility Indices (%)	BBG0	BBG1	BBG2	BBG3	BBG4
ADC of crude protein	86.97±3.5^{a}	87.54±2.7^{a}	89.25±2.8^{a}	87.90±2.9^{a}	87.15±2.1^{a}
ADC of crude lipid	83.50±2.6^{c}	83.82±3.5^{c}	85.35±2.3^{c}	83.94±2.7^{c}	83.70±3.0^{c}
ADC of dry – matter	66.71±2.4^{b}	67.01±2.2^{b}	69.35±2.7^{b}	67.90±2.2^{b}	66.75±2.4^{b}
ADC of carbohydrate	52.58±1.5^{d}	52.03±1.3^{d}	51.38±1.4^{d}	51.90±1.5^{d}	52.35±1.6^{d}

Mean values in each row with similar superscripts are not significantly different ($p>0.05$).

DISCUSSION

The ADC values of crude protein, 86.97 – 89.25% obtained in this study was comparable with the values of 87.06 – 89.03% reported by Falaye *et al.* (2016) for *C. gariepinus* juveniles fed differently processed tropical almond (*Terminalia catappa*) kernel meal and cake – based diets and significantly lower than the values of 59.58 – 96.69% reported by Ananias *et al*. (2014) for *C. gariepinus* fingerlings fed varying inclusion level of *Canarium schweinfurtii* (African elemi) oil. The high ADC values of crude protein obtained in fish fed diets with co – mixed of betaine/β – glucan additive and control diet (BBG0) indicated that the experimental fish properly utilized the protein in all the experimental diets. The ADC values of crude lipid, 83.50 – 85.35% obtained in this study was comparable with the values of 84.33 – 87.65 % reported by Fagbenro *et al.* (2010) for *C. gariepinus* fed sunflower and sesame seed meals and significantly higher than the values of 56.79 – 69.54% reported by Babale (2016) for *C. gariepinus* fingerlings fed various inclusion levels of processed water melon (*Citrullus lanatus*) seed cake diets The slightly high ADC values of crude lipid obtained in all the fish fed diets with co – mixed of betaine/β – glucan additive and control diet (BBG0) suggested that the amount of lipid ingested and digested were the required quantity by *C. gariepinus* for the best conversion of feed into flesh. The ADC values of dry – matter, 66.71 – 69.35 % obtained in this study was comparable with the values of 71.84 – 74.54% reported by Falaye *et al.* (2016) for *C. gariepinus* and significantly lower than the values of 69.39 – 91.91% reported by Orire and Ozoadibe (2014) for *C. gariepinus* fed graded level of soybean waste. The good ADC values of dry – matter obtained in all the fish fed diets with co – mixed of betaine/β – glucan additive and control diet (BGG0) indicated good diets acceptance and utilization by the *C. gariepinus*. The ADC values of carbohydrate, 51.38 – 52.58% obtained in this study was higher than the values of 28.20 – 51.86% reported by Fagbenro *et al.* (2010) for *C. gariepinus*. The low ADC values of carbohydrate obtained in all the fish fed diets with co – mixed of betaine/β – glucan additive and control diet (BBG0) suggested that the amount of carbohydrate ingested and digested were the required quantity needed by *C. gariepinus* for the best conversion of feed into flesh.

CONCLUSION

Incorporation of co – mixed of betaine/β – glucan additive at different levels into the diet of *C. gariepinus* fingerlings had no significant ($p>0.05$) effects on the ADC values of crude protein, crude lipid, dry – matter and carbohydrate. However, other feed additives could be employed this may further promotes the digestibility of the feed

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