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Dietary Lysine Requirements and Organosomatic Index of Hybrid Clariid Catfish (*Heterobranchus Bidorsalis* ♂ X *Clarias Gariepinus* ♀) ("Heteroclarias")

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ABSTRACT

This study was conducted to evaluate the effects of crystalline Lysine powder on growth performance, nutrient utilization and Organosomatic Index of Hybrid clariid catfish (*Clarias gariepinus* x *Heterobranchus Bidorsalis) (*heteroclarias), fed Lysine supplemented diets with fixed methionine. Five isonitrogenous test diets of (40% crude protein) were formulated, using groundnut cake, fishmeal and graded levels of crystalline Lysine (0.00%, 0.74%, 1.04%, 1.34%, 1.64% dry diets) with constant level of methionine of (0.3% dry diet) as (D1, D2, D3, D4 and D5), the Lysine level in the diet ranges from 0.00% (D1) to 1.64% (D5) respectively. Three hundred (300) heteroclarias fingerlings with mean body weight (7.50±0.05g) were distributed into 15 plastic tanks (65×45×45) cm^3 for the research work at ten (10) per tanks. Fish were fed for 90 days at 5% body weight. The result obtained from these study shows that, weight gain, specific growth rate, feed intake, survival rate and protein efficiency ratio were significantly different (P<0.05) compare with those fed control. Best feed conversion ratio (FCR) was recorded in (D3, 0.93±0.10) and highest specific growth rate in D3, (0.76±0.10). There were significant differences in feed intake across the experimental tanks and the highest feed intake was recorded in D4 with lysine graded level of 1.64%. Carcass protein and lipids increased significantly with increasing lysine levels while the fibre content decreasing significantly with increasing lysine levels in the diets. There was no significant difference (p>0.05) in the Organosomatic index of heteroclarias compared with control. Thus, feed protein reduction to 20% with lysine supplement will reduce feed cost and support growth rate in heteroclarias.

Keyword: Growth response, nutrient utilization, Lysine supplement, Organosomatic index, Hybrid Catfish and isonitrogenous.

INTRODUCTION

Modern fish farming has become indispensable to global nutrition and food stability, providing essential nourishment, economic opportunity, and cultural continuity for communities around the globe. As wild fish stocks dwindle, the steady rise in farmed seafood consumption has been driven by broader global trade, affordable pricing, expanding urban centers, and higher consumer purchasing power. Notably, this growth in both market demand and personal income has accelerated far more rapidly across the Global South in recent years compared to northern nations (Bush *et al.,* 2019; Pieterse, 2017).

By reinforcing regional production and supply networks, aquaculture helps bring fresh food directly to regions with underdeveloped trade infrastructure, significantly boosting local food security and household incomes. Although measuring its precise employment footprint remains challenging, the sector was calculated to support anywhere from 27.7 to 56.7 million full- and part-time jobs globally (Phillips *et al.*, 2016). Ultimately, the exact economic, social, and environmental impact of fish farming varies considerably depending on the country, the specific species cultivated, the systems used, and local environmental conditions (Hambrey, 2017; Harvey *et al.*, 2017; Troell *et al.*, 2014)

Fish cannot synthesize 10 essential amino acids (EAAs), making adequate dietary intake essential for metabolic function and growth, particularly as dry muscle consists of less than 60% protein (Wilson, 2003). L-Lysine is frequently the most limiting EAA, playing a critical role in muscle development, tissue repair, immunity, and hormone regulation (Khan, 2011). EAA deficiencies impair growth and feed efficiency (Cao *et al.,* 2012); yet due to limited species-specific data, African catfish formulations rely on Channel catfish profiles (Fagbenro and Nwanna, 1999; Wilson, 2003). This study aims to replace up to 20% fishmeal with graded Lysine levels in Heteroclarias diets to produce a cheaper, nutritionally comparable feed that boosts aquaculture productivity and economic growth. Understanding the increasing costs and scarcity of fishmeal, it has become increasingly important to find alternative sources of proteins for fish feed. Most of these sources contain insufficient amounts of essential amino acids such as lysine, which requires supplementation. This study was therefore conducted to assess the effects of lysine supplemented diets on the growth performance, nutrient utilization, and organosomatic index of heteroclarias fingerlings.

MATERIALS AND METHODS

Experimental Location

This research was carried out at the Teaching and Research Farm of the department of Fisheries and Aquaculture Technology, Federal University of Technology Akure, Ondo State, Nigeria.

Samples Collection

Feedstuffs which include fishmeal, groundnut cake, yellow corn, vitamin premix, binder were purchased from K_2 Akure and L-lysine and L-methionine in crystalline forms, was also purchased from animal care feeds, Akure.

Experimental Fish

A total of 500 heteroclarias fingerlings (7.50 ± 0.05 g) were obtained from a reputable fish farm in Akure, Ondo State. The fish were maintained in plastic tanks (70 cm × 45 cm × 45 cm) at the research farm of the Department of Fisheries and Aquaculture Technology, Akure, where they were acclimated and fed a commercial diet containing 35% crude protein for two weeks prior to the feeding trial. To ensure uniformity in weight and clear the digestive tract of residual feed, the fish were deprived of food for 24 hours before the commencement of the experiment.

Preparation of Experimental Diets

Five isonitrogenous experimental diets containing 40% crude protein (D1–D5) were formulated using groundnut cake and fishmeal, with graded levels of crystalline lysine (0.00%, 0.74%, 1.04%, 1.34%, and 1.64% of dry diets). A constant methionine level of 0.3% was also included in all diets (D1 to D5), as presented in Table I. All ingredients were milled using a hammer mill, thoroughly mixed to ensure uniformity, and then pelleted using a Hobart pelleting machine (Model A. 200T, CAUSA) to produce uniform 2.0 mm pellets. The pellets were sun-dried to achieve a moisture content of less than 10% and stored in a cool, dry environment to prevent contamination. Proximate composition analysis of the diets was conducted following AOAC (2010) standard methods.

Table 1: Gross Composition of Experimental Diets (g/100g) Containing Graded Levels of Lysine with constant Methionine Supplements.

Ingredients	**Diet1**	**Diet2**	**Diet3**	**Diet4**	**Diet5**
Fish meal (72%CP)	20.00	20.00	20.00	20.00	20.00
Groundnut cake (48%CP)	50.00	50.00	50.00	50.00	50.00
Yellow maize (10%CP)	18.00	18.00	18.00	18.00	18.00

Fish oil	6.00	6.00	6.00	6.00	6.00
Carboxymethyl cellulose	4.00	2.96	2.66	2.36	2.06
Lysine	0.00	0.74	1.04	1.34	1.64
Methionine	0.30	0.30	0.30	0.30	0.30
Vit/Min Premix	2.00	2.00	2.oo	2.00	2.00

Analyzed Composition of the Experimental diets (per kg on as fed basis) dry matter fed to *Heteroclarias.*

MOISTURE	7.36 ± 0.35^{a}	8.00 ± 0.67^{ab}	9.50 ± 0.31^{c}	9.16 ± 1.04^{bc}	9.18 ± 0.86^{bc}
ASH	12.20 ± 0.26^{a}	12.06 ± 0.96^{a}	11.49 ± 0.47^{a}	11.43 ± 0.39^{a}	11.76 ± 0.76^{a}
LIPID	16.76 ± 0.25^{a}	20.01 ± 2.01^{cd}	21.59 ± 0.63^{d}	19.57 ± 0.35^{bc}	18.12 ± 0.00^{ab}
PROTEIN	39.86 ± 0.10^{a}	40.31 ± 0.02^{a}	40.37 ± 0.02^{a}	40.38 ± 0.04^{a}	40.42 ± 0.30^{a}
NFE	18.44 ± 0.51^{a}	16.53 ± 2.32^{b}	13.75 ± 0.43^{d}	15.14 ± 0.30^{c}	16.15 ± 0.95^{b}
FIBRE	5.38 ± 0.59^{c}	3.09 ± 0.01^{a}	3.30 ± 0.02^{a}	4.32 ± 0.01^{b}	4.37 ± 0.46^{b}

Mean ±S.D. bearing distinct superscript letters within the same row differ significantly ($P < 0.05$). Premix content as supplied by Dotan feed mill, plot 1 and 2 block J, Abiola layout, Ondo road Akure.

Experimental tanks and Fish feeding trial

Apparently healthy (300) heteroclarias fingerlings with mean body weight (7.50±0.05g) were randomly distributed into 15 plastic tanks $(65\times45\times45)cm^3$ filled with 60 litres of water. Fish were randomly distributed into tanks at a stocking density of ten fish per tank. Five groups of fish were assigned to each experimental diet, with three replicate per treatment, over a 90-day feeding trial. All fish were fed twice daily, and each group received its designated diet at a consistent rate of 5% of body weight per day. To monitor growth performance and ensure accurate feeding adjustments, the fish were batch-weighed every two weeks. Feeding rates were then modified based on the updated body weights to maintain appropriate dietary intake throughout the experimental period.

Water Quality Monitoring

Dissolved oxygen concentration

The dissolved oxygen concentration was monitored every three days at 0800h using Hanna 40SE,

Water temperature

Water temperature were monitored every three days and measured using Knick portable meter (Model 912) around 0800h.

Hydrogen ion concentration (pH)

Water pH were monitored and measured using Knick portable pH meter (Model 912) around 08:00h.

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Evaluation of Growth and Nutrient Retention

Assessment of the growth indices was conducted in accordance with the protocols described by Fasakin et al. (2003).

Weight Gain (WG) $WG = W2 - W1$;

Where W2 denotes the terminal fish, mass recorded upon completing the feeding period. and

W1 = the baseline mass of the fish in each tank measured before the trial commenced.

N is the number of weeks of feeding trials

Mean Weight Gain (g/week) $MWG = W_2 - W_1$

Daily weight gain percentage $SGR\ (\%/day) = \frac{100\ (InW_2 - InW_1)}{T\ (day)}$

Where the baseline mass and terminal mass of the fish are denoted by W1 and W2, respectively, and the experimental timeframe is represented by T. InW1 and InW2 were the natural log of weight at the beginning and the end of the feeding trial.

Feeds Conversion Ratio (FCR)

$$FCR = \frac{Feed\ consume\ (g)}{Weight\ gain\ by\ fish\ (g)}$$

Protein Efficiency Ratio (PER)

$$PER = \frac{Live\ body\ weight\ gain\ (g)}{Protein\ intake\ (g)}$$

$$Survival\ (\%) = \frac{No.of\ fish\ at\ the\ end\ of\ the\ experiment}{No.of\ fish\ at\ the\ onset\ of\ the\ experimental\ fish} \times 100$$

Organosomatic Indices:

Hepatopancreas, intraperitoneal fat, spleen, kidney and intestine was sampled from each treatment tanks and use for calculation of the biological indexes. The biometric parameters were calculated by the following formula according to Xu *et al., (*2020);

Intestino Somatic Index = $\frac{Intestine\ weight}{Body\ weight} \times 100$

Hepatosomatic Index = $\frac{Lver\ weight}{Body\ weight} \times 100$

Intraperitoneal Fat Index = $\frac{intraperitonealfat\ weight}{Body\ weight} \times 100$

Spleenosomatic Index = $\frac{Spleen\ weight}{Body\ weight} \times 100$

Gonadosomatic Index = $\frac{Gonads\ weight}{Body\ weight} \times 100$

Retinosomatic Index = $\frac{Kidney\ weight}{Body\ weight} \times 100$

Analytical procedure

Proximate analyses of the diets and fish were performed according to AOAC (2000) protocols at the Centre laboratory of the Federal University of Technology, Akure.

Statistical Evaluation

A Complete Randomized Design (CRD) was employed to structure the experiment and analyzed the resulting data via Analysis of Variance (ANOVA). Differences among treatment means were considered significant at $p < 0.05$ using SPSS version 25.0, particularly for growth performance and nutrient utilization across the various treatments. Where significant differences were detected, mean separation was performed using Duncan's Multiple Range Test and Tukey's test.

RESULTS

Water Quality Parameters

The water quality parameters in tanks are presented in Table 2. There were no significant differences (P>0.05) in temperature; dissolved oxygen; ranged from 5.70±0.05 mg/l to 5.94±0.05, and the hydrogen ion concentration (pH); has its lowest value of 6.12±0.05 in control treatment D1 and highest values 7.18±0.05 in treatment D2.

Table 2: Water quality parameters of tank water

Parameters	D1	D2	D3	D4	D5
Temperature (^{0}C)	26.70±0.05^a	26.65±0.05^a	26.58±0.05^a	26.60±0.05^a	26.65±0.05^a
DO_2 (mg/l)	5.78±0.05^a	5.94±0.05^a	5.80±0.05 ^{a}	5.80±0.05^a	5.70±0.05^a
Conductivity	20.65±0.05^a	20.60±0.05^a	20.65±0.05^a	20.60±0.05^a	20.70±0.05^a
pH	6.12±0.05^a	7.18±0.05^b	6.15±0.05^a	7.15±0.05^b	7.16±0.05^b

Mean ± S.D. with different superscript are significantly different from each other (P<0.05)

Growth Performance and nutrient utilization of *Heteroclarias* fed supplemented diet containing varied levels of L-Lysine with constant Methionine (0.30g/100g).

After 90 days of feeding, dietary lysine supplement for Heteroclarias had good effects on fish specific growth rate, Protein efficient ratio, Protein Intake weight gain and Feed conversion ratio. The highest value of SGP was obtained in fish fed with diet D3 0.76±0.10 and the least value was obtained in fish fed the control diets. Fish fed with 1.04g/kg of lysine inclusion (D3) showed the highest weight gain and the best FCR. However, the highest survival rate was recorded in fish fed diets D1 and D3 while the least was observed in fish fed diet D4, (Table 3).

Table 3: Growth performance and nutrient utilization of fish fed lysine supplemented diets

Parameters	D1	D2	D3	D4	D5
IW	71.55±2.45^a	73.23±0.88^{ab}	73.74±1.89^{ab}	74.70±1.39^{ab}	75.26±1.60^b
FW	109.63±5.21^a	128.44±2.72^{ab}	146.71±8.81^b	131.27±24.10^{ab}	136.35±8.42^b
WG	38.08±7.14^a	55.21±2.16^{ab}	72.97±10.63^b	56.57±22.98^{ab}	61.10±9.90^{ab}

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SGR	0.48±0.08[a]	0.62±0.02[ab]	0.76±0.10[b]	0.65±0.22[ab]	0.66±0.09[ab]
FI	65.37±0.71[a]	65.77±1.86[a]	67.28±2.71[a]	67.68±4.88[a]	72.65±1.46[b]
FCR	1.75±0.29[b]	1.19±0.04[ab]	0.93±0.10[a]	1.34±0.54[ab]	1.21±0.21[ab]
FER	0.58±0.11[a]	0.84±0.03[ab]	1.08±0.12[b]	0.82±0.31[ab]	0.84±0.16[ab]
PI	27.01±0.49[a]	27.37±0.76[a]	28.04±1.14[a]	28.25±2.02[a]	30.59±0.54[b]
PER	0.95±0.18[a]	1.33±0.06[ab]	1.75±0.26[b]	1.36±0.55[ab]	1.45±0.23[ab]
SVP	100.00±0.00[a]	96.67±5.77[a]	100.00±0.00[a]	93.33±5.77[a]	96.67±5.77[a]

Key: IW, Initial weight, FW, Final weight gain, WG, Weight gain, FI, feed intake, SGR, Specific growth rate, FCR, Feed conversion ratio and PI, Protein intake.

Regression Analysis of Specific Growth Rate (SGR%) against varying levels of Dietary Lysine

Figure 1 presents Lysine (Lys) requirement concentration in the diets of heteroclarias. The experiment revealed that heteroclarias fed with varying Lys levels, yet lower, levels of Lys (T1, T2) resulted in a slight increase in the growth of heteroclarias fingerlings. The specific growth rate (%) exhibited a significant difference ($p<0.05$) between the treatments, showing an upward trend as the dietary Lys levels increases up to 1.34g/100g (T3). However, further supplementation of dietary Lys (T4 and T5) led to a decline in the specific growth rate. From the graph, the actual optimum level was determined to be 1.03g/100g with the regression equation $y = 2.3359x^4 - 8.5262x^3 + 9.7882x^2 - 3.2776x + 0.44$ as stated in figure 5 and $R^2 = 1$.

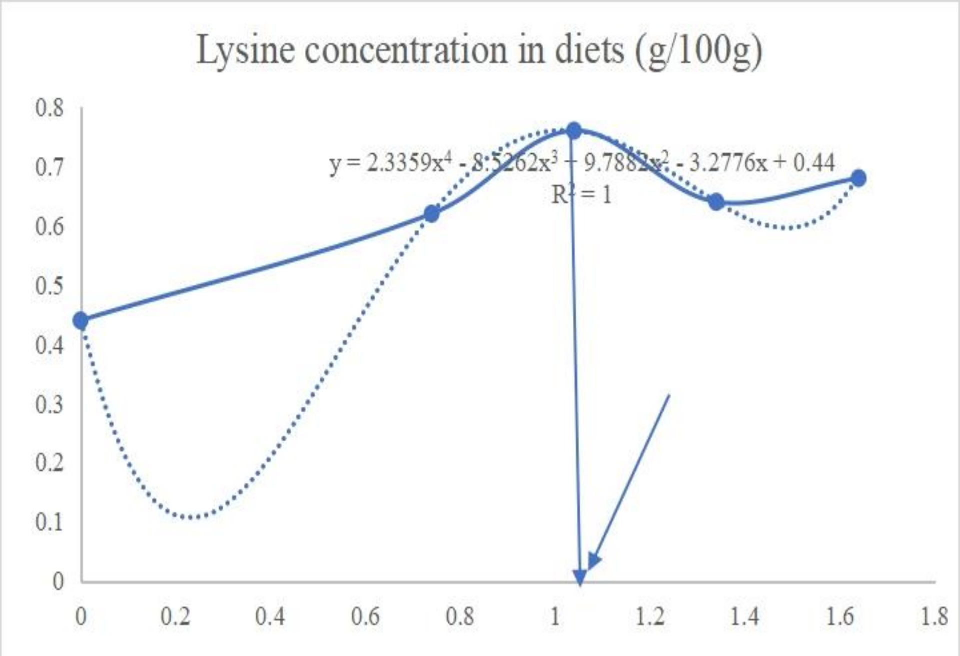

Figure 1: Lysine requirement of Heteroclarias (3rd degree polynomial regression analysis)

Proximate composition of heteroclarias fed experimental diets containing graded levels of Lysine with constant Methionine (0.30g/100g).

There were significant differences ($p<0.05$) in the crude protein, lipid and NFE of the fish fed graded levels of lysine supplemented diets, there was drastically differences between the initial crude protein and final crude protein of fish before and after feeding trials values range from (53.86%) and (67.41), thus the lowest was observed in fish fed control diet (54.30%) while the highest was recorded in fish fed D5.

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Table 4: Proximate result of fish fed graded levels of lysine after feeding trials

Parameter	Initial	D1	D2	D3	D4	D5
Moisture	3.45 ± 0.13^{a}	8.80 ± 0.13^{c}	7.52 ± 0.47^{b}	8.03 ± 0.08^{b}	8.14 ± 0.24^{b}	7.88 ± 0.07^{bc}
Ash	10.05 ± 0.54^{a}	17.40 ± 0.41^{d}	15.28 ± 0.37^{c}	14.70 ± 0.45^{c}	13.10 ± 0.30^{b}	11.39 ± 0.36^{ab}
Lipid	20.02 ± 0.85^{d}	13.48 ± 0.44^{c}	12.21 ± 0.19^{b}	12.13 ± 0.21^{b}	12.14 ± 0.24^{b}	10.61 ± 0.27^{a}
Protein	53.86 ± 0.63^{a}	54.30 ± 0.48^{ab}	60.36 ± 0.16^{c}	59.27 ± 0.52^{b}	61.71 ± 0.84^{d}	67.41 ± 0.51^{e}
NFE	12.62 ± 0.05^{d}	4.85 ± 0.11^{bc}	4.33 ± 0.41^{b}	5.87 ± 1.03^{c}	4.91 ± 1.19^{bc}	2.74 ± 0.60^{a}

Mean ± S.D. with different superscript are significantly different from each other (P<0.05)

NFE (nitrogen free extract) = 100-% crude protein + % crude Lipid + crude fibre + % ash)

Organosomatic Indices of Heteroclarias fed with graded levels of Lysine with constant Methionine level (0.30g/100);

Table 5: Presented the Organosomatic index of Heteroclarias fingerlings fed with the graded levels of Lysine with constant Methionine (0.30g/100g), there was no significant differences (p>0.05) in the organosomatic indices measured after the feeding trials of 90-days, it was observed that the fish fed diets D1 had a slight change in Retinosomatic index (RSI) (3.53) while the fish fed with D5 recorded the lowest value (2.86), the Hepatosomatic index (HIS) has the highest value in fish fed D1 (3.54) while the lowest value was observed in the fish fed D3 (2.79). However, the result obtained from intestino-somatic index (ISI) showed a slight variation in fish fed D1 with highest value of (11.80) while the lowest is recorded in D3 (10.52).

Table 5: Organosomatic indices of Heteroclarias Fed with graded levels of Lysine with constant Methionine (0.30g/100g)

Parameter	D1	D2	D3	D4	D5
IFI	1.31 ± 0.82^{a}	1.29 ± 0.70^{a}	1.82 ± 0.52^{ab}	1.17 ± 1.66^{a}	1.20 ± 0.54^{a}
ISI	11.80 ± 2.00^{b}	11.77 ± 0.29^{b}	10.52 ± 4.26^{a}	10.90 ± 1.66^{a}	11.89 ± 3.20^{b}
HIS	3.54 ± 0.37^{b}	3.47 ± 0.47^{b}	3.37 ± 0.87^{b}	2.79 ± 0.76^{a}	2.91 ± 1.10^{a}
SSI	2.91 ± 0.68^{a}	2.81 ± 0.73^{a}	2.75 ± 0.64^{a}	2.94 ± 0.90^{a}	2.97 ± 0.33^{a}
RSI	3.53 ± 0.71^{b}	3.32 ± 0.58^{b}	2.86 ± 0.38^{a}	3.33 ± 0.28^{b}	3.45 ± 0.29^{b}

Mean ± S.D. with different superscript are significantly different from each other (P<0.05)

Intestine somatic index -ISI, Hepatosomatic index -HIS, Intraperitoneal fat index -IFI, Spleenosomatic index -SSI, Gonadosomatic index -GSI, Renosomatic index -RSI.

DISCUSION

Discussion of the water quality

All water parameters (temperature, Dissolved oxygen, pH and conductivity) in all cultured tanks were not significantly different. There was no adverse effect of the water quality parameters of the cultured tanks. All physicochemical water parameters remained within acceptable limits as reported by Omitoyin, (2000); Ajani *et al.*, 2015) for Clariid fishes.

Nutritional Profile of the Formulated Feeds

The proximate analysis of the formulated diets revealed no significant difference in crude protein content; however, significant variations were observed in lipid, ash, crude fibre, and nitrogen-free extract (NFE) levels. Overall, the lysine-supplemented diets showed higher values of lipid, ash, crude fibre, and NFE compared to the control diet. These findings showed that lysine supplemented diet can enhance the nutritional quality of practical diet when properly formulated as stated by Faturoti and Ajiboye, 2011 and Rachmawati *et al*., (2022). The overall nutrient profile of the diets indicated that lysine is a promising essential amino acid capable of meeting the nutritional requirements of heteroclarias fingerlings.

Evaluation of Growth and Nutrient Retention

In the current investigation, Supplementing lysine allows for the reduction of expensive, high-quality, animal-based proteins (fishmeal) up to (20%) in favor of cheaper alternative plant proteins without significantly reducing the growth of the fish, Lysine supplementation enhances the fish's ability to retain nutrients, increases muscle deposition, and helps in the reduction of nitrogenous waste in the water. Biomass accumulation and development velocity are typically regarded as the primary indicators of production efficiency (Bilal *et al.*, 2020). The study indicated that Heteroclarias exhibited positive responses to all lysine-supplemented diets, as shown by improved growth and nutrient utilization outcomes. Growth performance measures, including mean final weight (MFW), mean weight gain (MWG), specific growth rate (SGR), and feed intake (FI), were higher in fish fed lysine-enriched diets than in those on the control diet (0.00 g/100 g). Among the treatments, fish fed 1.04 g/100 g lysine (D3) demonstrated the best overall performance in MFW, MWG, SGR, and FI. These results agree with previous studies (Ng *et al.*, 2000; Marimuthu *et al*., 2011; Andem, 2013; Ashley-Dejo *et al.*, 2014; Odedeyi and Ademeso, 2015), which reported improved growth in *Clarias gariepinus* as dietary lysine levels increased. However, the present study also observed a decline in growth performance indices in diets D4 and D5, where lysine inclusion levels were higher. A similar pattern was seen regarding nutritional metrics, specifically feed efficiency ratio (FER), protein efficiency ratio (PER), and total protein intake (PI) which agrees with Rachmawati *et al.* (2022), who reported that lysine supplementation improves growth and feed utilization only up to an optimal level (about 1–2%), beyond which performance may decline. The slight reduction observed in D4 and D5 supports this trend. Overall, the results indicate that the optimal lysine inclusion level for heteroclarias was 1.04 g/100 g (20% CP + 1.04 g/100 g lysine), which enhanced growth performance without negative effects.

Carcass composition of Heteroclaria Fed Experimental Diets containing graded levels of lysine with fixed methionine (0.30g/100g);

The carcass composition of the study fish heteroclarias showed significant differences ($p<0.05$), the final crude protein of the study fish fed practical diets were drastically differed from the initial crude protein after feeding trial of (90-days), with the initial of (53.86Cp) and D1 having the lowest value of (54.30CP) while the highest value was observed in diet 5 (67.41CP) respectively. This result agreed with Nwanna and Bolarinwa (2001) who reported that the crude protein of the African catfish increased after feeding trials. However, there were reduction in the Lipids and moisture content of the study fish heteroclarias fingerlings fed supplemented graded levels of Lysine with a fixed methionine of (0.30g/100g dry wt) range from treatment1 (20.02) to treatment5 (10.61) and treatmentreatment1 (8.80) to treatment2 (7.52). The reduction occurs with the increase in inclusion levels of L-Lysine this aligned with the finding of (Nguyen *et al.*, 2013), (Cao *et al.*, 2012) suggested that Lysine is associated with nitrogen retention and it reduces the fat proportion in the fish body. This trend suggests a potential preventive effect against high-fat diet-induced obesity as reported by (Zhang *et al.*, 2007; Nishimura *et al.*, 2010). This is aligned with the present study indicated that higher doses of L-Lysine with fixed L-methionine could effectively contribute to reducing Lipid/Fat deposition Hybrid Clariid Catfish fingerlings. The present study also agreed with the finding of (Sargent *et al.*, 2002) who highlight that amino acid deficiencies-specifically lysine and methionine impair the liver’s ability to synthesize apolipoprotein because essential amino acids are needed to produce very low-Density lipoproteins and L-carnitine. Thus, the overall nutrient composition of the formulated diets indicated that Lysine supplemented diets is a promising diet to optimizing nutrient requirement of Heteroclarias fingerlings.

Organosomatic Index of Hybrid Cat fish (Heteroclarias) Fingerling fed Experimental Diets Containing Graded Levels of Lysine with fixed Methionine

Organosomatic indices can be described as the ratios of organs to body weight, measured organs in relation to body mass, can be directly linked to toxic effects of chemicals on target organ (Guillo and Hinton, 2008). It can also be used as indices of changes in nutritional and energy status (Maxwell and Dutta 2005). Organ indices can be a critical indicator on the effects of dietary treatments in cultured fish. The fish intestine is an important organ involved in digestion of ingested feed (Ganguly and Frasad, 2012). However, there was no significant different($p>0.05$) in the HIS indicate Liver stress or Fat deposition of the Heteroclarias fed Lysine supplemented diets compared to fish fed control diet, the present finding agreed with (Fagbenro *et al.*, 2010), who observed reduction in HIS of fish fed Lysine supplemented diets and suggested that high HIS indicate Liver stress or Fat deposition is often linked to dietary imbalances in fish health. There were no significant differences ($p<0.05$) in Intraperitoneal fat index (IFI) compared to the control fish range from (1.17 and 1.82) also, there was slight change in the instestino-somatic index (ISI) range from (10.52 and 11.89) demonstrated the health of the digestive tract of Heteroclarias, the gut is the first line of defense and the primary engine for growth; if it isn't well-developed, the best diet in the practical diets won't matters. Thus, Organosomatic indices are quantitative ratios that can be used to assess the health, reproductive status, and physiological condition of an organism by comparing the weight of specific organs (e.g., liver, gonads, heart, spleen) to the total body weight. These indices are widely used in eco-biological monitoring studies to detect stress, pollution, or nutritional changes. The present study suggested that, organosomatic indices can also be used to monitor the effect of Lysine supplemented diets in Heteroclarias.

CONCLUSION

This study demonstrates that supplementing *Heteroclarias* (*Clarias gariepinus* × *Heterobranchus bidorsalis*) fingerling diets with crystalline Lysine while maintaining a fixed methionine level significantly improves growth performance, nutrient utilization, and carcass composition. Diet 3 (1.04% Lysine inclusion) yielded the most optimal performance, achieving the best Feed Conversion Ratio (0.93±0.10) and the highest Specific Growth Rate (0.76±0.10). Furthermore, Lysine supplementation did not adversely affect the Organosomatic Index of the fish, indicating that physiological organ balance was maintained throughout the 90-day period.

Recommendations

Optimal Inclusion Level: Formulate *Heteroclarias* diets with 1.04% crystalline Lysine alongside 0.3% fixed methionine to maximize feed efficiency and specific growth rates.

Cost Reduction in Aquafeeds: Utilize crystalline Lysine supplementation as a strategy to reduce crude protein levels to 20% without sacrificing growth performance, thereby lowering overall commercial feed production costs.

Further Research: Conduct economic analyses to determine the exact cost-benefit ratio of crystalline Lysine inclusion at a commercial scale, and investigate potential interactive effects of varying methionine levels alongside optimal Lysine supplementation.

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