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Evaluation Of Animal Byproducts As Floaters In Fish Feed Formulation Study At Kebbi State University, Nigeria

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ABSTRACT

The increasing demand for sustainable aquaculture practices has led to the exploration of alternative feed ingredients, particularly animal byproducts, to enhance the efficiency and effectiveness of fish feed formulations. This study evaluates the potential of various animal byproducts, including poultry byproduct meal, protein hydrolysates, and spray-dried plasma, as floaters in fish feed for *Clariasgariepinus* (African catfish). The research focuses on assessing the buoyancy characteristics, nutritional composition, and growth performance of fish fed diets incorporating these byproducts. Using a combination of feeding trials and proximate analysis, the study aims to determine the acceptability rate of these compounded feeds. Preliminary findings indicate that certain animal byproducts can significantly improve feed buoyancy while providing essential nutrients that support optimal growth rates. Additionally, the use of floating feeds minimizes nutrient loss and reduces environmental pollution associated with uneaten feed. A feeding experiment was conducted where juvenile *Clarias gariepinus* were fed diets containing varying percentages of organic materials (5%, 10%, and 15%) incorporated into a basal diet with 35% crude protein. Buoyancy tests, growth performance, feed utilization, and haematological indices were measured, alongside water quality analysis. Results showed that the diet containing 15% fish scale exhibited the highest floatation time, while feeds containing feather had higher lipid content. Fish fed on 15% horn diets showed the greatest weight gain, though the feed with 15% fish scale produced the highest specific growth rate and feed conversion ratio. The results suggest that integrating animal byproducts into fish feed formulations not only enhances feed efficiency but also contributes to cost-effective aquaculture practices. Recommendations for future research include further investigations into the long-term effects of these ingredients on fish health and growth performance, as well as exploring additional animal byproducts that could be utilized in floating feed formulations. This study underscores the importance of developing innovative feed strategies that leverage readily available animal byproducts to promote sustainable aquaculture while addressing economic challenges faced by fish farmers.

Keywords: *Clarias gariepinus*, aquaculture practices, haematological indices

INTRODUCTION

The global aquaculture industry has seen remarkable growth in recent decades, driven by the increasing demand for fish as a primary source of protein. As the industry expands, the need for sustainable and economically viable feed alternatives becomes critical. Traditional fish feeds primarily rely on fish meal, which raises concerns about overfishing, resource depletion, and the environmental impact of sourcing these ingredients. This seminar paper evaluates various animal byproducts as potential floaters in fish feed formulations, focusing on their nutritional benefits, economic viability, and environmental implications. (Adewomi, M.A., 2005).

Aquaculture plays a significant role in global food security, providing an essential source of protein for billions of people. However, the reliance on fish meal has led to increased pressure on wild fish populations and marine ecosystems. In response, researchers are exploring alternative feed ingredients that can maintain or enhance growth performance while being more sustainable. Animal byproducts, often considered waste materials in other industries, present a promising avenue for developing innovative fish feeds. (Adikwu, I. A., 2003).

Importance of Floating Fish Feed

Alegbeleye WO, Oresegun A. and Ajitomi, D. (2001). Indicated that floating fish feed has gained prominence in aquaculture due to several advantages:

- Visibility and Monitoring: Floating feeds allow aquaculture operators to observe feeding behavior easily. This visibility aids in managing feeding practices effectively and ensures that fish are receiving adequate nutrition.
- Reduced Waste: Sinking feeds can lead to significant nutrient loss as uneaten feed settles at the bottom of the water body. Floating feeds minimize this waste by remaining on the surface longer, allowing for better feed utilization.
- Enhanced Digestibility: Many floating feeds incorporate ingredients that improve digestibility and nutrient absorption. This is particularly important for species with specific dietary requirements.
- Behavioral Benefits: Floating feeds can stimulate natural feeding behaviors in fish, which may lead to improved overall health and growth rates.

Animal Byproducts as Feed Ingredients

Animal byproducts are derived from various livestock processing operations and can be rich in protein, essential amino acids, and other nutrients beneficial for fish growth. The following animal byproducts are evaluated in this study:

1. Poultry Byproduct Meal (PBM)

Poultry byproduct meal is produced from the rendering of poultry carcasses and offal. It is a high-protein ingredient that can effectively replace fish meal in aquaculture diets.

- Nutritional Profile: PBM typically contains 45-60% crude protein and is rich in essential amino acids such as lysine and methionine. Its amino acid profile makes it an excellent substitute for fish meal.
- Benefits: Incorporating PBM can reduce feed costs while maintaining growth performance comparable to diets containing conventional fish meal. Studies have shown that fish fed PBM-based diets exhibit similar growth rates to those fed traditional diets.
- Economic Viability: The use of PBM can lower production costs significantly due to its lower market price compared to fish meal. This economic advantage is crucial for small-scale aquaculture operations striving for profitability. Ben C, Heck S (2005).

2. Protein Hydrolysates

Protein hydrolysates are created through the enzymatic breakdown of animal proteins into smaller peptides and amino acids.

- Nutritional Profile: These hydrolysates are highly digestible and palatable, making them attractive for inclusion in fish feeds. They often contain bioactive peptides that can enhance growth and immune response.
- Benefits: They have been shown to enhance growth rates and feed conversion efficiency in various fish species, particularly carnivorous ones that require high protein diets. Research indicates that diets supplemented with protein hydrolysates can lead to improved weight gain and feed efficiency.
- Market Potential: The growing trend towards more natural and functional ingredients in aquaculture diets positions protein hydrolysates favorably within the market. (Balarin, J. D. and Haller, R. D., 1982).

3. Spray-Dried Plasma

Spray-dried plasma is derived from animal blood and is known for its high protein content (approximately 80% protein) along with bioactive compounds that can support immune function.

- Nutritional Profile: Rich in immunoglobulins and other proteins, spray-dried plasma can provide additional health benefits beyond basic nutrition. Its unique composition supports gut health and enhances disease resistance.
- Benefits: Its inclusion in fish diets has been associated with improved growth performance and disease resistance. Studies have shown that fish fed diets containing spray-dried plasma exhibit lower mortality rates during disease outbreaks.

Cost-Benefit Analysis: While spray-dried plasma may be more expensive than other ingredients, its potential to improve health outcomes can lead to lower overall production costs due to reduced mortality and better feed efficiency. (Amalraaj, S., 2010) *Clarias gariepinus*, commonly known as the African sharptooth catfish, is a species native to Africa. It was first described by William John Burchell in 1822. This freshwater fish is part of the Clariidae family, known for its air-breathing capabilities, which allow it to thrive in environments with low dissolved oxygen levels. The species has adapted to various aquatic habitats, making it a significant contributor to local fisheries and aquaculture.

Description

Clarias gariepinus is characterized by its elongated body, broad head, and sharp teeth, which are particularly prominent in adult specimens. Key morphological features include:

- Body Shape: The body depth is typically 6-8 times in standard length, with a head that is 3-3.5 times in standard length.
- Fins: It possesses a dorsal fin with 61-80 soft rays and an anal fin with 45-65 soft rays.
- Coloration: The coloration can vary based on habitat but generally features a dark brown or grayish body with lighter underparts.
- Size: This species can grow up to 170 cm in total length and weigh as much as 60 kg, although sizes may vary significantly based on environmental conditions and food availability. (Boyd, C. E., 1985)

Distribution

Clarias gariepinus has an almost pan-African distribution, inhabiting various freshwater environments across the continent. Its range extends from North Africa down to Southern Africa and includes regions such as:

- Natural Habitats: Calm lakes, rivers, swamps, and floodplains are typical habitats for this species. It thrives particularly well in areas subject to seasonal flooding.

- Geographical Spread: The species is found throughout sub-Saharan Africa, including countries like Nigeria, Kenya, and South Africa. It also occurs in parts of the Middle East, including Israel, Syria, and southern Turkey.
- Introduced Areas: Since the early 1980s, *C. gariepinus* has been introduced to various countries worldwide for aquaculture purposes. Notable introductions include regions such as Brazil, Vietnam, Indonesia, and India. In these areas, it may compete with native species and impact local ecosystems. (Dugdale, R. J. L., 2011).

Ecological Adaptations

Clariasgariepinus exhibits several ecological adaptations that enhance its survival:

- Air-Breathing Ability: The presence of an accessory breathing organ allows this catfish to breathe air when necessary, enabling it to survive in low-oxygen environments.
- Dietary Habits: As an omnivorous bottom feeder, it consumes a wide variety of prey including crustaceans, insects, and plant material. This adaptability in diet contributes to its success in diverse habitats.
- Classification of *Clariasgariepinus*
- Kingdom: Animalia
- Phylum: Chordata
- Class: Actinopterygii
- Order: Siluriformes
- Family:Cichlidae
- Genus: *Clarias*
- Species: *Clarias ganiepinus*

Statement of Problem

Aquaculture in Nigeria like other West African countries is underdeveloped. It contributes 0.57% global aquaculture production (Lehane *et al.,* 2013). Uneaten feeds that sink to the bottom of the pond usually end up as fertilizers causing high algal bloom and related water pollution problems (Irabor *et al.,* 2021); Leading to poor growth or feed wastage which increases the cost of production leading to pollution of rearing facilities and increased bacterial loads, there might be disease outbreak. When large quantities of pollutants are released, there may be an immediate impact as measured by large scale sudden mortalities of fish. Also when these pollutants are found in the water environment, they result in immunosuppressant, reduced metabolism and damage to gills and epithelia. Alleged pollution-related diseases include epidermal papilloma, fin/tail rot, gill diseases, hyperplasia, liver damage, and neoplasia. Also, when the feeds sink in excess, they cause change in colour of the water thereby preventing penetration of sun light in the water. Ordinary or sinking fish feed are prone to leaching of nutrient in pond waters due to poor water stability, poor nutrient retention and immediate sinking and disintegration during feeding (Falayi*et al.,* 2003). While extruded floating fish feed has significant advantage over locally produced dried sinking pellets, they are however expensive (Falayi*et al.,* 2003).

Aim of the Study

The aim of this study was to assess the effectiveness of locally compounded fish feed using organic materials as floaters.

Objective

i. To assess the acceptability rate of the compounded fish feed by *C. gariepinus*.
ii. To determine the growth performance and haematological indices of the *Clarias gariepinus* after fed with locally compounded feed.

Research Questions

i. What is the acceptability rate of the compounded fish feed by *C. gariepinus*?
ii. What is the growth performance and haematological indices of the *Clarias gariepinus* after fed with locally compounded feed?

MATERIALS AND METHODS

Experimental Procedures

Experimental Diets

Ten (10) feeds were prepared for the experiment, which include: Diet 1 (0% Feather, fish scale and horn) the control diet. Diet 2 (5% Feather, fish scale and horn), Diet 3 (10% Fish Scale, Horn and Feathers), Diet 4 (10% Fish Scale, Horn and Feathers).

Experimental Design

Sixty (60) Juveniles of African catfish (*Clarias grapienus*) were distributed into 4 plastic bowls (i.e 15 juveniles in each bowl). The control diet (D1) has no additive Diet 2-4 contain 10% to 15% of fish scale, feather and horn respectively. Experimental fish in each plastic bowl were fed at the same body weight for 4 weeks of the feeding trial period. The daily ration were split into two and fed twice daily at 9:00am, and 5:00pm.The plastic bowl were cleaned, before feeding and water level were also maintained in plastic bowl, the water in the bowl was dreained and replaced weekly.

Buoyancy Test

The floating ability of pellets was evaluated for 1hour, ten pellets/flakes samples were randomly selected. They were placed in an aquarium containing 10 litres of water (0.5m x 0.75m x 0.25m). With the aid of a stop watch duration of floatation was recorded within the time frame of 1 hour.

Proximate Composition Analysis

The proximate composition of the experimental diets were analyzed using methods of AOACC (2005) as follows:

a) Determination of Moisture content

The 5-10 g of experimental diets sample was taken in a petri dish and dried in an electric oven at s100±2°C for 16-18 h. The samples was kept in a desiccator. The weight loss in the process was expressed as % moisture content in the sample.

b) Determination of Fat, ash and carbohydrate

Proximate composition analyses for fat, ash and carbohydrate was carried out. Fat content of the fish experimental diets samples was determined using the exraction Soxhlet method. Ash content was determined by heating 1 g of the sample at 550°C for 24 h.

c) Determination of Protein Content

The total nitrogen content of the experimental diets was determined using a micro system of Kjeldahl (Kjeltec System 1002, Sweden). Crude protein was estimated by multiplying the total nitrogen content (% N) by the factor 6.

Acceptability Test

The acceptability of the experimental diets from Organic material was assessed using the "time to strike index" (Eyo, 1997). Six *Clarias gariepinus* were starved for 24 hrs and unstarved to increase their desire for food. They were left in a aquarium, containing 10 litres of water. Pellets of each dietary type was droped into the aquarium. The mean time that elapsed from the moment the pellet drops on the water surface to the moment the first and/or last fish picks the pellet with its mouth was recorded in seconds. This experiment was replicated thrice for each dietary type.

Acquisition of the Experimental Fish

A total of 60 *Clarias gariepinus* juveniles of approximately equal body weight of 14.10-17.10g were purchased from a private hatchery in Aliero Local Government area. The catfish juveniles were transported to the Hydrobiology and Fisheries Research Unit of Animal and Environmental Biology Department, Kebbi State University of Science and Technology, Aliero. The fishes were acclimatized for one week, during which they were fed with the control diet (35% crude protein).

Determination of Growth Parameters

The body weights were recorded on weekly basis by weighing all the fishes in each experimental unit on a field weighing balance.

Fish Survival Rate

$$SR=\frac{initialnumberoffishstocked-mortality}{initialnumberoffish}x100$$

Feed conversion efficiency (FCE)

$$FEC=\frac{\text{Final weight of fish x100}}{weightoffeedgiven}$$

Mean Weight Gain

Mean weight gain(g)=final mean weight –initial mean weight(g)

Percentage Weight Gain

$$PWG=\frac{finalweight-initialmeanweight}{initialbodyweight}x100$$

Specific Growth Weight

$$SGR=\frac{w2-w1}{T2-T1}x100$$

Where in = Natural logarithm

$W_1 =$ Initial weight of fish(g)

$W_2 =$ final weight of fish (g)

$T_1 =$ Initial period

$T_2 =$ final period in days

Water Quality Analysis

Temperature, pH, Dissolved oxygen and Total Dissolved Solid were monitored throughout the course of the experiment. Temperature was measured with mercury in glass thermometer; Hydrogen ion concentration was monitored with pH meter. Dissolved oxygen and Total Dissolved Solid was also monitored using DO and TDS meter. The parameters were determined weekly as described by (APHA *et al*.,2017).

Temperature and Total Dissolved Solid

The meter was dipped into the water groups 10-15cm depth, the readings were taken at the point where the mercury thread became static. While for TDS reading were also taken when the digital display reading became steady (APHA *et al*.,2017).

3.6.2 pH

The pH meter was standardized using pH 4, 7 and 9 buffer solutions. Water samples from four groups were collected in a clean labeled reagent bottle. Sixty (60) ml of the water was measured into a clean beaker, the probe was dipped into the beaker, the reading was recorded when a steady figure was obtained. Each time a sample was determined, the probe is dipped into distilled water and wiped with tissue paper before using it again (APHA *et al*.,2017).

Dissolved Oxygen

The meter was dipped 10-15cm depth; the readings were taken at the point where the reading became steady (APHA *et al*.,2017).

3.8 Statistical Analysis

Data obtained on proximate composition, growth, and water parameters were subjected to One-way Analysis of Variance (ANOVA) and means from the various treatments were compared for significant different using Ducan's Multiple Range Test (DMRT) of the system analytic statistic (SAS) statically package version 22.0.

RESULTS

Acceptability score of the Fish Feed

The results for acceptability score test is presented in Table 4.3. The starved fishes accepted the feeds incorporated with the three (3) animal by-products at 10% had the highest acceptability rate of (0.0134±0.05s) while feed incorporated with 10% on the non starved fishes; the feed has the least of acceptability (0.04±0.05) to (0.070±0.010s). The starved fishes had the highest rate of acceptability between (0.0134±0.05) to (0.02±0.05)

Growth Performance of *Clarias gariepinus*

Table 1 shows the growth parameters of *Clarias gariepinus* fed experimental diets for the period of 28 days. The highest Mean weight gain of (19.80±0.20) was observed in feed with 15% feather while the least (18.20± 0.10) was on feed with 15% fish scale. The highest percentage means weight gain of (139.44±3.07) while the least (110.58±3.01).The highest specific growth rate (1.95±0.10) While the least (1.12±0.10) was on feed with 15% horns. The highest feed conversion ratio (2.71±0.18) was obtained in the feed with 15% fish scale while the least (2.12±0.03) was on feed with 15% feather.

Table.1 Acceptability rate of experimental diets

	Control		5%		10%		15%	
	Starved (sec)	Non starved	Starved (sec)	Non starved	Starved (sec)	Non starved	Starved (sec)	Non starved(sec)
FS	0.01±0.05	0.04±0.10	0.024±0.05	0.036±0.01	0.013±0.05	0.04±0.05	0.020±0.01	0.050±0.01
FTHR	0.01±0.05	0.04±0.10	0.030±0.010	0.060±0.010	0.18±0.010	0.074±0.010	0040±0.010	0.024±0.05
HRN	0.01±0.05	0.04±0.10	0.050±0.01	0.070±0.01	0.050±0.01	0.070±0.001	0.046±0.015	0.080±0.010

Table 2 Growth Parameters of *Clarias garipinus* fed with 15% Fish scale, feather and horns

Parameters	Control D1 (0.00%)	D2 (FS 15%)	D3 (FTHR 15%)	D4 (HRNS 15%)
FSR (%)	73.30±13.05[b]	80.0±3.12[c]	66.70±8.32[a]	53.40±15.05[b]
MR (%)	4.30±0.12[b]	5.34±0.05[a]	7.34±0.01[c]	3.34±0.12[b]
AIW (g)	17.10±0.10[b]	34.60±0.21[a]	14.10±0.10[a]	14.20±0.10[a]
FW (g)	35.80±0.28[d]	37.20±0.28[a]	28.60±0.28[b]	31.34±8.37[c]
MWG (g)	18.80±0.10[a]	18.20±0.10[a]	19.40±0.20[b]	19.80±0.20[b]
PMWG (%)	110.59±3.01[a]	124.66±3.05[b]	138.58±3.10[c]	139.44±3.07[c]
SGR (g)	1.95±0.10[d]	1.80±0.10[b]	1.87±0.10[c]	1.52±0.10[a]
FCR	2.60±0.34[c]	2.71±0.18[d]	2.12±0.03[a]	2.28.0.01[b]

Foot note: FSR = Fish Survival Rate, MR = Mortality Rate, AIW = Average Initial Weight, FW = Final Weight, MWG= Mean Weight Gain, PMWG= Percentage Mean Weight Gain, SGR = Specific Growth Rate, FRC = Food Conversion Ratio Values on the same column with the different superscript are significantly different P<0.05

Results Analysis

According to the results, feather increase the growth performance as observed wth regards to feed intake among fishes. The 10% of feather diet gave the highest among treatment groups on all parameters of growth performance such as: mean final weight, mean weight gain, average daily gain, specific growth rate and survival rate when compared with control group. The various feed forms have not demonstrated a noticeable effect on growth performance so far. This is likely due to the short rearing period in the experiment, which had a limited impact on fish growth, reducing stress from factors like poor water quality and food competition. Though specific growth rate was significantly different but all the parameters of floating feed had positive trend of increasing followed by sinking feed and the lowest mash feed. Bishop *et al*., (1996) reported that the growth of *Oreochromis niloticus* fry was not compromised by replacing 9.9% of the total diet with feather meal. (El Gamal, A.,2017).

The effect feeding graded levels of feather meal as floater on digestibility, The variations in the blood profile of the sampled fish revealed the substances ability to enhance the immune system and antibiotic potential of organic material, especially with the proportionate increase in feed additive (Fish scale, feather and horns) haematological parameters of *Clariasgariepinus*were evaluated. Fish also accepted the feeds incorporated with organic materials. Among the ingredients tested, fish scale has high percentage floatation than others. However, there was a slight reduction from inclusion of percentage level which possibly resulted from reduced palatability of feed due to increased fiber content. Nevertheless, the sinking nature of locally formulated feed gives rise to loss in water-soluble nutrients (vitamins and amino acids) and water pollution from the uneaten food.

The result of the water quality parameters recorded at the beginning and at the end of the study indicated that the water quality parameters were at recommended levels. This occurred as a result of continuous changing of the water during the study period.

CONCLUSION

The proximate composition of feed incorporated with fish scale, feather and horns has little or no effect on the proximate composition. Fish accepted the feeds incorporated with organic material. Among the ingredients tested, fish scale holds the highest potential to enhance floatation of pellets, over other organic material, it has also positive growth response and had no effects on haemotological indices of *Clarias gariepinus*.

RECOMMENDATIONS

i. Monitor Water Quality Regularly: Emphasize regular monitoring of water quality parameters to manage the environmental impact of fish feeding.
ii. Education and Training for Farmers: Provide training for farmers on floating feeds and feeding strategies to minimize waste and optimize growth.
iii. Encourage aquaculture practitioners to adopt locally compounded fish feed with organic floaters as a sustainable alternative to conventional feed.

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