Evaluation of some agricultural bye-product as floaters in fish feed formulation

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Abstract

This study was carried out to evaluate the floatation ability of agricultural bye-products (beans pod, maize cob and groundnut shell as floaters) and to further evaluate their proximate composition and effects on growth and haematological indices of *Clarias garipinus*. The experiment was conducted at the fisheries and Hydrobiology Research Unit of Department of Animal and Environmental Biology of Kebbi State University of Science and Technology, Aliero. All analysis was carried out according to standard method. Sixty (60) juveniles *Clarias garipinus* were distributed in to four bowls with 15 juveniles in each bowl. A basal diet of 35% crude protein was prepared 1kg each of basal diet was mixed with 0.0%, 5%, 10% and 15% g/kg of beans pod, maize cob and groundnut shell respectively, (Representing D1, D2, D3 and D4 groups). the results of proximate composition of feed with 10% of beans pod of protein shows the highest parameter ranging from (33.37 $\pm$ 0.50 to 34.60 $\pm$ 0.10) followed by Carbohydrate (25.34$\pm$ 0.01 to 28.74 $\pm$ 0.50), Lipid (17.10 $\pm$ 0.10 to 18.20 $\pm$ 0.50) while the least (11.30±0.22) was in the control of the proximate. The highest percentage lipid content of mean Value of 18.20±0.50% was observed in feed with 5% additives of beans pods while least (17.10±0.01) was in the feed with 10% additives of beans pods. Results on the buoyancy test shows that feed with 15% beans pod had higher floatation of (2288secs) while the least (244secs) was in control. Growth parameters of *Clarias garipinus* fed with agricultural bye-product show that the highest Mean weight gain of (19.81±0.20) was observed in feed with 15% groundnut shell, while the least (18.21$\pm$ 0.10) was on feed with 15% beans pod. The highest percentage means weight gain of (139.44$\pm$3.07) while the least (110.59$\pm$3.01). The highest specific growth rate (1.95±0.10). While the least (1.52$\pm$0.10) was on feed with 15% groundnut shell. The highest feed conversion ratio (2.71$\pm$0.18) was obtained in the feed with 15% beans pods while the least (2.12$\pm$0.03) was on feed with 15% maize cob. The white blood cells, red blood cells, Haematologobin content and packed cell volume were significantly high (25.24±0.01) 0×10^9/L, 4.71±0.02$\times10^9$/L, 7.81±0.01±1.100G/dl and 21.51±0.01% respectively) The water parameter were within the acceptable rage for culture. This study revealed that agricultural by-product can be used to enhance the growth of *Clarias garipinus*, with little or no adverse effects on haematological indices and proximate composition.

Keywords: beans pod, maize cob and groundnut shell as floaters, aquatic organism

Introduction

Fish farming involves raising fish in tanks or enclosures (József *et al.*, 2019) [26]. However, the greatest challenges in aquaculture are the high cost of feed ingredients which makes the feed industries and farmers compromise quality for availability and affordability (FAO, 2008; Ekelemu and Irabor, 2013; Nwachi and Irabor, 2015; Jamabo and Dasimeokuma, 2020; Irabor *et al.*, 2021) [16, 10, 32, 24, 22]. Fish feed manufacturing is an essential consideration in both subsistence and large-scale fish farming since it affects both growth efficacy and wastage (Tsevis, and Azzaydi, 2000; Little *et al.*, 2016; Irabor *et al.*, 2022) [44, 21]. Also, substances in feed forms consumed by fish have been reported to significantly influence the blood profile, thereby the well-being of fish (Adeparusi and Ajayi, 2004; George *et al.*, 2007; Yue and Zhou, 2008; Akintayo *et al.*, 2008; Irabor *et al.*, 2021) [3, 19, 47, 5, 22].

Aquaculture industry is the fastest growing food production industry in the world and approximately 50% of all fish consumed by humans is from aquaculture (Irabor *et al.*, 2021) [22]. The high cost of fish feed is among the major factors affecting fish farming in Nigeria. Aquaculture has gained attention all over the world as means of improving world fish production this is currently on decline due to dwindling output from capture fishery (FAO, 2010) [17].

For aquaculture to be highly successful there is need for good quality and affordable feed, which can also encourage small scale farmers in the field of aquaculture for sustainable production and also meet the demand for fish. Presently, in Nigeria, there are different fish feeds with different compositions ranging from Coppens, Euro feeds and others but there is competition among them more so they are imported. Fish feed making is a significant factor to be considered in both subsistence and commercial fish farming as it has consequences on both growth efficiency and feed wastage (Tsevis *et al.*, 2000) [44].

Fish feed is a plant or animal material intended for consumption by fish kept in aquariums or pond. Fish foods normally contain macronutrients, trace elements and vitamins necessary to keep captive fish in good health. The extruded compounded feed is made in such a way that the nutrient in the feed are retained within the periods of floating thereby enabling fish to consume whole extruded ration (Olagunju *et al*., 2007)

[38]. Aquaculture feeds can be produced either by steam processing, producing compacted, pressure-pelleted (sinking) feeds; or by extrusion, which produces expanded floating or buoyant feeds. Sinking feeds are solid feed pellets that submerged during application. Despite being cost effective sinking or ordinary fish feed is found to be prone to leaching of nutrients due to poor water stability, poor nutrient retention and immediate sinking to the bottom of ponds at feeding (Falayi *et al.*, 2004) [13]. Having feed floating allow fish to spend less energy accessing the feed unlike when the feed is at the bottom of the water as in the case of sinking pellet feed (Balarin and Haller, 2000) [7]. Lastly, floating feed is regarded as one of the managerial tool use by farmers to observe the eating habit of fish. It also allows the farmer to estimate the quantity of the fish in the pond because the fish always come to the top of the water to consume the floating feed (Falayi *et al.*, 2004) [13]. Therefore, considering the numerous advantages of floating compounded feed listed above, it is important that emphasis should be given to develop floating compounded fish feeds without adverse effect on the quality of compounded nutrients. Prepared or artificial feeds can either be complete or supplemental. Complete diets supply all the ingredients (protein, carbohydrates, fats, vitamins, and minerals) necessary for the optimal growth and health of the fish. Most fish farmers use complete diets, typically made up of the following components and percentage ranges: protein, 18-50 percent; lipids, 10-25 percent; carbohydrate, 15-20 percent; ash, <8.5 percent; phosphorus, <1.5 percent; water, <10 percent; and trace amounts of vitamins and minerals. The nutritional content of the feed depends on what species of fish is being cultured and at what life stage. When fish are reared in high-density indoor systems or confined in cages and cannot forage freely on natural food (e.g., algae, aquatic plants, aquatic invertebrates, etc.). They must be provided a complete diet. In contrast, supplemental (i.e., incomplete or partial) diets are intended only to help support the natural food normally available to fish in ponds or outdoor. The cost of feeding represents about 60 – 80% of total cost of raising fish from start to finish (Orire and Sadiku, 2014, Adekunle *et al.*, 2012) [42, 41]. Commercial fish diets in Nigeria are often imported floating feeds and as a result of the high cost of producing such diets they are usually expensive, creating a huge cost margin compared to when locally produced sinking feeds are used. Although most farmers often use a combination of both types, about 15% floating feeds and 85% sinking feeds (Lovell, 2013). Fish diet production begins with ingredient selection and feed formulation (Adeparusi and Famurewa, 2011) [2]. To formulate a diet that meets a target fish requirement, information on its nutrient requirement, the nutrient compositions of individual ingredients as well as their antinutrient compositions are required (Craig and Helfrich, 2009). Selection of ingredients can be done from a wide range of choices; therefore, it is often necessary to consider the locally availability and cost of the ingredients.

The manufacturing process includes grinding the feedstuff to reduce particle size, mixing the feedstuff, subjecting them to moisture (water or steam), and applying heat and pressure to produce a particular product physical form (Tidwell and Allan, 2001). The choice of physical form may depend on the species of fish, nature of culture system and stage of maturity of fish (Falayi and Sadiku, 2013) [14]. Also, different ingredients combinations produce different levels of pellet buoyancy or spatial characteristic within the water column (Strahm and Plattner, 2001).

However owing to the relatively low cost of producing them and the wide distribution of the technology required, they remain the popular choice amongst most fish farmers especially in developing countries such as Nigeria. Extruded fish diets have grown in popularity in the last decade (Giovanni *et al.*, 2019) [20]. Extruded feed is more stable in water and has greater floating qualities. Digesting ease, growth, low water absorption potential, and zero waste of basic materials (Amalraaj, 2010; Avramescu *et al.*, 2020) [6] and greater energy content compared to locally formulate non-extruded feeds (Johnson and Wandsvick, 1991; Weththasinghe *et al.*, 2020) [46]. Whereas non-extruded feeds pollute the environment and cause poor growth efficiency due to feeding waste which corresponds to a high feed conversion ratio (Johnson and Wandsvick, 1991; Juan Baztan *et al.*, 2018, Irabor *et al.*, 2022) [23]. Animal nutritionists are faced with the production of locally formulated aqua feeds that are readily available, and nutritionally adequate at a reduced cost (Mahmoud and Shunsuke, 2019; Geetanjali *et al.*, 2020; Irabor *et al.*, 2021) [18, 22]. The search for an alternative cheaper aqua feed had led to the use of groundnut shells as possible floating material.

Materials and methods

Experimental site

The research was conducted in the Fishery and Hydrobiology unit, Kebbi State University of Science and Technology Aliero. Aliero is a town in northern Nigeria's Kebbi State. Located on latitudes $4^0$23′S and $12^0$26′40″N and longitudes $3^0$6′W and $4^0$27′35″E, Aliero Local Government Area created in the year 1996 with a land mass of about 412.25km^2 and with estimated population of about 125,783 (NPC, 2006).

Procurement of feed ingredients and formulation of diets

Feed ingredients used for the feed formulation were procured as follows: - fish meal, soyabean and groundnut cake (protein sources), yellow maize, wheat bran (energy source), vitamin premix, lysine, methionine, and salt (gari as a binder). All ingredients were procured from Agro-tech Sokoto state and were milled into a fine mixture. Beans pod, Maize cob and Groundnut shells they are readily available free of charge, then milled into powder form and preserved in an airtight container. The Beans pod, Maize cob and Groundnut shell granule was added to the trial diet at levels 5%, 10%, and 5%, milled with other ingredients, mixed and pelleted to size (2mm) with a multiple phase model pelletizer to ensure an equal distribution throughout the feed and finally dried under the shade. Fish samples were weighed biweekly using a sensitive scale to regulate feed mass in every tank for body weight changes.

The feed constituents utilized in diet formulation at a crude protein level of 35%. The feed trial was carried out for (28) days (February - March 2022).

Proximate analysis

Samples of all the ingredients used were subjected to proximate analysis to determine their nutrient composition, according to method described by AOAC (2000) [7]. Crude protein content was determined using Kjeldahl method, crude fiber content using acid-alkaline digestion method, ash content by burning the dried residue for 24hrs in a Galle Kamp Hot spot furnace at 450 0C, moisture content by oven drying of sample at 105 0C until a steady weight was achieved, and crude lipid content by extraction using NHexane.

Buoyancy test

The buoyancy of each of the test diets was determined by placing 10 pellets in an aquarium contains 10 litre of freshwater with the aid of a stop watch; duration of floatation was recorded within the time frame. The number of pellets from each sample remaining afloat after every 60seconds interval was recorded for a period of 60 minutes (Orire and Sadiku, 2014) [42].

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 Fisheries and Hydrobiology 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).

Experimental design

Sixty (60) Juvenile 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 maize cub, beans pod and of groundnut shell 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 was split into two and fed twice daily at 9:00am, and 5:00pm. The plastic bowl was cleaned, before feeding and water level were also maintained in plastic bowl, weekly water in the bowl were drained and replaced.

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.

Weight gain

Mean weight gain (g) = Final mean weight – Initial mean weight (g)

Percentage weight gain

$$\text{PWG} = \frac{\text{Final weight} - \text{initial mean weight}}{\text{Initial body weight}} \text{ X } 100$$

Specific Growth Rate (SGR)

$$\text{SGR} = \frac{\log(\text{W2}) - \ln(\text{W1})}{\text{T}} \text{ X } 100$$

(Kabaherda *et al.*, 2009).

Where,

log = Natural logarithm

W_2-W_1 = Final and Initial weight of fish (g) and

T = Period in days

Feed Conversion Ratio (FCR)

$$\text{FCR} = \frac{\text{Feed fed (g)}}{\text{Weight gain (g)}}$$

Fish Survival Rate

$$\text{SR} = \frac{\text{initial number of fish stocked} - \text{mortality}}{\text{Initial number of fish}}$$

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 were also monitored using DO and TDS meter. The parameters were determined weekly as described by Obaroh and Nzeh (2013) [33].

Temperature and total dissolved solid

The meter was dipped into the water groups to about 10-15cmdept, 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 (Obaroh and Nzeh, 2013) [33].

Blood sampling

The experimental fish were randomly sampled for haematological parameters following the methods of Kori-Siakpere *et al*. (2005). Approximately two (2ml) of blood samples of the fish at the end of the experiment, blood samples of fish were collected from the caudal vein by using sterile syringe, blood collected was expressed into EDTA (anticoagulant) bottle and labeled. The blood samples are taken in the morning time (between 08:00 and 10:00 hours) and is held in ice chest until all samples were collected (Soyinka *et al*., 2015). After the collection of the blood samples were taken to Amma Laboratory and Diagnostic Centre Birnin Kebbi, Kebbi State, for further haematological analysis.

Haematological examination procedure

The effect of the additive (Beans pod, Maize cob and Groundnut shell) on the blood parameters of the sampled fish species was determined at the end of the trial. The following parameters; packed cell volume (PCV), haemoglobin (HB), Red Blood Cell (RBC), and White Blood Cell (WBC). Haemoglobin (Hb) count is done with the cyanomethaemoglobin method; Packed Cell Volume (PCV) by micro haematocrit method. Red blood cell (RBC) and total white blood cell (WBC) counts were done using the Neubauer haemocytometer. Analyses were carried out within 48 hours of collection with the help of automated machine.

Data analysis

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

Results and discussion

a) Proximate composition of the fish feeds incorporated with beans pod, maize cob and groundnut shell

Proximate composition of feed incorporated with beans pod, maize cob and groundnut shell mean is presented in Table 1. Show that the highest percentage moisture content (11.27±0.50%) was in feed with 10% of maize cob, while the least (8.03±0.50) was in the control feed. The highest percentage ash content (15.24±0.50%) was observed in feed with 5% of beans pods, while the least (11.30±0.22%) was in the control group. The highest percentage lipid content of mean value of 19.17±0.50% was observed in feed with 15% maize cob while least (17.10±0.01) was in the feed with 10% of groundnut shell. The highest percentage crude protein content (35.25±0.50) was observed in the control feed while the least (32.40±0.06) was in the feed with 15% of groundnut shell.

Table 1: Proximate composition of the fish feeds incorporated with beans pod, maize cob and groundnut shell

Parameter	Control (0.00%)	BP	5% MC	GS	BP	10% MC	GS	BP	15% MC	GS
Moisture	8.03±0.50^{a}	10.27±0.50^{c}	10.43±0.50^{c}	10.14±0.03^{c}	9.34±0.50^{b}	11.27±0.50^{d}	9.17±0.12^{b}	10.37±0.50^{c}	9.50±0.50^{b}	10.24±0.07^{c}
Ash	11.30±0.22^{a}	15.24±0.50^{d}	15.03±0.50^{d}	14.27±0.06^{c}	13.10±0.10^{b}	13.20±0.50^{b}	13.14±0.07^{b}	14.1 ±0.10^{c}	14.10±0.50^{c}	14.14±0.06^{c}
Lipid	18.20±0.05^{b}	18.20±0.50^{b}	18.03±0.50^{b}	18.17±0.06^{b}	17.10±0.10^{a}	18.10±0.10^{b}	17.14±0.06^{a}	18.10±0.50^{b}	19.17±0.50^{c}	18.14±0.50^{b}
Fibre	12.16±0.50^{a}	12.37±0.50^{a}	12.63±0.50^{a}	12.34±0.06^{a}	12.64±050^{a}	12.80±0.50^{a}	12.24±0.06^{a}	12.84±0.01^{a}	12.37±0.50^{a}	12.50±0.10^{a}
CP	35.25±0.50^{d}	34.24±0.50^{c}	33.63±0.50^{b}	34.74±0.06^{c}	33.37±0.50^{b}	34.10±0.10^{c}	33.24±0.06 ^{b}	34.60±0.10^{c}	34.37±0.50^{c}	32.40±0.06^{a}
CHO	28.10±0.01^{d}	25.34±0.01^{a}	26.43±0.50^{c}	25.64±0.06^{a}	28.74±0.50^{d}	27.60±0.37^{b}	28.10±0.10^{d}	28.14±0.50^{d}	28.37±0.50^{d}	28.10±0.10^{d}

n = 3. Values are expressed as Mean ± Standard deviation, Groups with similar superscript along the raw shows no significant difference at $P < 0.05$, Key: CP = Crude protein, CHO = Carbohydrate

Buoyancy tests

The result for buoyancy test is presented in Table 2. The results showed that feeds incorporated with 15% of beans pod floated for a longer time (2288secs) before it sank followed by feed with 10% of beans pod (638secs) while the least was the control feed (244secs).

Table 2: Floating period of each experiment diet

	Control D1 (Secs)	5% D2 (Secs)	10% D3 (Secs)	15% D4 (Secs)
MC	244	450	485	580
BP	244	512	638	2288
GS	244	425	428	590

Key: MC= Maize cob, BP= Beans pod, GS= Groundnut shell

Acceptability test

The result for acceptability test is presented in Table 3. The starved fishes accepted the feeds incorporated with the three (3) agricultural bye-products at 15% had the highest acceptability rate of 2 seconds in the average while feed incorporated with 10% on the non starved fishes; the feed has the least of acceptability rate of 4-7 seconds. The starved fishes had the highest rate of acceptability between 1-2 seconds.

Table 3: Acceptability rate of experimental diets (Groundnut shell, beans pod and maize cob)

	Control		5%		10%		15%	
	Starved (sec)	Non starved	Starved (sec)	Non starved	Starved (sec)	Non starved	Starved (sec)	Non starved(sec)
MC	01	04	01	04	02	06	02	02
GS	02	04	01	06	02	07	01	02
BP	01	04	01	05	01	04	02	02

Growth performance of *Clarias garipinus* fed with 15% beans pod, maize cob and groundnut shell

Table 4 shows the growth parameters of *Clarias garipinus* fed experimental diets for the period of 28 days. The highest Mean weight gain of (19.81±0.20) was observed in feed with 15% groundnut shell, while the least (18.21± 0.10) was on feed with 15% beans pod. The highest percentage means weight gain of (139.44±3.07) while the least (110.59±3.01). The highest specific growth rate (1.95±0.10) While the least (1.52±0.10) was on feed with 15% groundnut shell. The highest feed conversion ratio (2.71±0.18) was obtained in the feed with 15% beans pods while the least (2.12±0.03) was on feed with 15% maize cob.

Table 4: Growth Parameters of *Clarias garipinus* fed with 15% Beans pod, Maize cob and Groundnut shell

Ti	Control D1 (0.00%)	D2 (BP 10%)	D3 (BP 15%)	D4 (GS 15%)
FSR (%)	73.40±15.05^{b}	86.70±3.52^{c}	66.70±8.32^{a}	73.40±15.05^{b}
MR (%)	4.34±0.12^{b}	2.34±0.05^{a}	5.34±0.01^{c}	4.34±0.12^{b}
AIW (g)	17.10±0.10^{b}	14.60±0.21^{a}	14.10±0.10^{a}	14.20±0.10^{a}
FW (g)	35.80±0.28^{d}	32.80±0.28^{a}	33.57±0.28^{b}	34.34±8.37^{c}
MWG (g)	18.82±0.10^{a}	18.21±0.10^{a}	19.34±0.20^{b}	19.81±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}

n = 3, Values are expressed as Mean ± Standard deviation, Groups with similar superscript along the row shows significant difference at *P*< 0.05, Keys: 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

Haematological indices of *Clarias garipinus* fed with 15% maize cob, groundnut shell and beans pod

Mean values for haematological indices of *C. gariepinus* fed with beans pod, maize cob, and groundnut shell are presented in Table 5. There was increased in values of some haematological parameters of *C. gariepinus* fed with varying concentrations of the three (3) agricultural bye-products. The highest white blood cell of (9.51±0.010) was in feed with 15% groundnut shell while the least (7.81±0.010) was observed in control feed. The highest red blood cell of (0.93±0.01) was in feed with 15% maize cob while the least (0.86±0.01) was observed in feed with 15% groundnut shell. The highest haemoglobin content of (7.81±0.01) was in feed with 15% groundnut shell while the least (4.71±0.02) was observed in the control feed. The highest packed cell volume of (25.24±0.01) was in feed with 15% groundnut shell while the least (21.51±0.01) was observed in feed with 15% beans pod. The result showed significant difference (*P*<0.05) for all the parameters measured, when compared with the control.

Table 5: Haematological indices of *Clarias gareipinus*

	Control	Bp15%	Mc 15%	Gs 15%
WBC (x10^{9}/L)	7.81±0.01^{a}	8.51±0.02^{b}	8.42±0.01^{b}	9.51±0.01^{c}
RBC (x10^{9}/L)	0.90±0.02^{b}	0.89±0.05^{a}	0.93±0.01^{b}	0.86±0.01^{a}
Hb (g/dL)	4.71±0.02^{a}	7.71±0.01^{c}	5.61 ± 0.01^{b}	7.81±0.01^{c}
PCV (%)	24.61±0.02^{b}	21.51±0.01^{a}	25.21±0.01^{c}	25.24±0.01^{c}

n = 3. Values are expressed as Mean ± Standard deviation, Groups with similar superscript along the raw shows significant difference at *P*< 0.05

Physicochemical Parameters of Water used for Culture

The result on temperature and TDS shows that there are no significant differences between the control and other treatment groups. While the result of pH and DO also show no significant Differences among the groups (Table 6). Result of temperature in this study ranged of 29.21± 0.51 to 29.21±0.72 ^{0}C. The pH treatment ponds ranged from 6.36±0.21 to 6.36±0.23, while Total dissolved solid (TDS) of all treatment bowls ranged between 210.75± 0.08 to 211.00 ±0.06ppm.

The dissolved oxygen (DO) in all treatment bowls ranged from 5.50±0.01 to 6.00±0.03mg/l.

Table 6: Physicochemical Parameters of Water used for Culture

Parameters	Temperature(^{0}C)	pH	TDS (pp/m)	DO (mg/l)
D1 Control	29.21±0.72^{a}	6.36±0.22^{a}	210.75±0.08^{a}	6.00±0.03^{b}
D2 BP (15%)	29.21±0.72^{a}	6.36±0.23^{a}	211.00±0.05^{b}	5.50±0.01^{a}
D3 MC (15%)	29.21±0.51^{a}	6.36±0.21^{a}	211.00±0.05^{b}	5.50±0.05^{a}
D4 GS (15%)	29.21±0.25^{a}	6.36±0.22^{a}	211.75±0.04^{b}	5.51±0.06^{a}

n = 3. Values are expressed as Mean ± Standard deviation, Groups with similar superscript along the column shows significant difference at *P*< 0.05, Key: TDS= Total dissolved solid; DO= Dissolve Oxygen

Discussion

The finding of this study showed that adding of agricultural by-products (Beans pod, maize cob and groundnut shell) had little or no effects on the proximate composition of the feed. This finding is in line with the finding of Obim *et al*., (2011) [35] who reported that melon shell as additive has no effect on proximate composition. These studies showed that the appropriate inclusion in right percentage of beans pod exhibited floating in fish feed and improve growth.

The floatation potential of the feeds revealed significant differences (*P*<0.05) across experimental diets. The best floatation quality was expressed in Bean pod with 15%. It revealed a progressive relationship between inclusion level and floatation performance. Almost the same trend was recorded by Onada and Ogunola (2019) [40] when the inclusion of cassava flour and brewer yeast increased, and floatability increased. Also, Eze and Eyo (2018) [11] reported an increased baobab leaf meal concentrate in the fish diet led to higher floating time. Although at Groundnut shell 5%, a drop-in floating time was observed. Generally, the result did not correspond with the report of Momoh *et al.* (2016) [30] who had decreased floatation period, as the inclusion level of yeast was reduced in test diets. Considering growth performance and feed floatation quality, the best was achieved at a 15% inclusion level.

This result shows increase in growth which supported similar works carried out in melon shell (Obi *et al*., 2013) [34], baobab leaf meal (Eze and Eyo, 2018) [11], cassava flour, and brewer yeast (Onada and Ogunola, 2019) [40] where growth rate improved significantly with their inclusions in the feed of fish. The observed weight gain across sample groups fed varying diets of agricultural bye-products meal is also buttressed by the findings of Oduntan *et al.* (2019) [36], where increased weight gain was reported for *C. gariepinus* fed different levels of plantain peel additives. A similar trait was observed by Agbabiaka *et al*. (2013) [4] when maize was substituted at various levels for plantain peel. Oladipupo and Salami (2020) [37] reported high growth performance when watermelon peel was fed at various inclusion levels to *C. gariepinus.* The same growth pattern was observed in *C. gariepinus* fed varying concentrations of walnut shell (Ayoola and Omoile, 2019) [9].

Feed utilization (feed intake, mean weight gain, feed conversion ratio, and specific growth rate) demonstrated a significant difference (*P*<0.05) between diets, particularly when agricultural bye-product meal inclusion levels were raised. Eze *et al.* (2019) [12] reported increased values for feed utilization as the percentage of moringa leaves and methionine increased in the feed fed to *C. gariepinus* fingerlings. 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. This is in harmony with Oduntan *et al.* (2019) [36] and Oladipupo and Salami (2020) [37] who respectively reported reduced feed utilization in *C. gariepinus* fed increased inclusion levels of plantain peel and watermelon peel. The study's finding contradicted that of Adegbesan *et al.* (2019) [1], who reported enhanced feed consumption in C. gariepinus fed increased ginger root powder meal.

The survival rate was reported to be significantly higher at with an inclusion level and showed the feed was readily digestible and absorbable by fish samples. A similar finding was recorded by Oladipupo and Salami (2020) [37] in their study, where diets containing watermelon peels at varying inclusion levels were fed to *C. gariepinus* fingerlings. In another study, Adaniyi *et al.* (2018) reported optimum survival rate in *C. gariepinus* fed diets with Tamarind pulp and leaf meal as additives.

The health status of fish species is significantly expressed via blood profile (Muttappa *et al.*, 2015; Irabor *et al.*, 2021) [31, 22]. The variations in the blood profile of the sampled fish revealed the immune-stimulatory and antibiotic potential of agricultural bye-products, especially with the proportionate increase in feed additive (Beans pod, Maize cob and groundnut shell) with WBC count. In line with this, Omeje *et al.* (2019) [39] also reported increasing WBC count of *Oreochromis mossambicus* fed inclusion levels of pawpaw seed meal. Similarly, Asian sea bass and rainbow trout had high WBC when fed increased levels of maize cob (Borkovic *et al.*, 2004; Rashidian *et al.*, 2020) [43].

Generally, the triggered HB within fish-fed treated diets suggested a high influx of oxygen which is healthy for fish. Although it disagreed with the report by Omeje *et al.* (2019) [39] who reported that low HB in *O. mossambicus* fed pawpaw seed meal. The trend observed for PCV in the study was in contrast with Kakwi and Olusegun (2020) who stated a significant decline of PCV in *Cyprinus carpio* as the inclusion level of *Mucuna pruriens* seed increased. Although at Beans pod 10% there was a significantly decreased which could be increased physiological stress on fish (Kumar *et al.*, 2019) [28]. The differences observed in RBC across treatments agree with the observations of Millet *et al.*, (2005), Khan *et al.* (2006), and Rezaei *et al.* (2009) [29, 27].

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 Beans pod, maize cob and groundnut shell has little or no effect on the proximate composition. Fish also accepted the feeds incorporated with agricultural by-product. Among the ingredients tested, beans pod has high percentage floatation than others; fish fed with the agricultural bye-product incorporated into the diet of *Clarias gariepinus* as basal ingredient improves the growth rate than in the control.

Recommendations

Further research should be carried out on another Agricultural by-product. Also the subsequent researches need to be directed towards determining the nutrient utilization of these diets on different species of fish.

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