International Journal of Innovative Food, Nutrition & Sustainable Agriculture 12(4):51-62, Oct-Dec, 2024

 www.seahipublications.org **ISSN: 2467-8481**

doi:10.5281/zenodo.14497133

Assessment Of Some Animal By Product As Floaters In Fish Fed Formulation Study At Kebbi State University, Nigeria

Hussaini Shehu[1]; Dr Ahmad Rufa'i Yahayya[2] & Dr. Halima Muhammad Maishanu[3]

[1]Department of Biology
Shehu Shagari College of Education Sokoto, Nigeria
hussainishehu26gmail.com/08034819398

[2]Department of Agricultural science
Shehu Shagari College of Education Sokoto, Nigeria
ahmedrufai79gmail.com/07012346855

[3]Department of Education
Shehu Shagari College of Education Sokoto, Nigeria
Maishanuhalimagmail.com/08065331493

ABSTRACT

Aquaculture is a rapidly growing industry, with feed production as a critical factor influencing fish growth, health, and production costs. This study aimed to assess the buoyancy and nutritional effects of locally compounded fish feeds using organic materials (fish scale, feather, and horns) as floaters for *Clarias gariepinus*. The high cost of conventional fish feed poses challenges for fish farmers in Nigeria, prompting the need for cost-effective alternatives. 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. Haematological analysis revealed a significant increase in red blood cell count and haemoglobin levels in the horn-based feed group. Organic floaters like fish scale and horns in fish feed can enhance floatation and growth performance, with minimal impact on water quality. Further research should focus on optimizing feed formulations using other organic waste materials to support sustainable and cost-effective aquaculture practice.

Keywords: Organic floaters, *Clarias gariepinus*, fish feed, haematological indices

INTRODUCTION

Culture of aquatic animals especially fish has undergone a dramatic worldwide growth in the last few years. The aquaculture industry is the fastest growing food production industry in the world and approximately 50% of all fish consumed is from aquaculture (Thorarinsdottir *et al*., 2011). Aquaculture feed production is an important factor to be considered in fish farming because it has consequences on growth efficiency and feed wastage, it amount to 60-80% of the total management costs of fish farming (Tsevis*et al.,* 2000). The high cost of fish feed is among the major factors affecting fish farming in Nigeria. 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.

However, floating compounded feeds offer numerous advantages over their sinking counterparts.They are more digestible as a result of cooking process, heat and pressure that deactivate destructive enzymes. Increased starch gelatinization helps the feed to be more stable in water by disintegrating less quickly, this gives enough time to the fish to take the meal completely. Moreover, with floating feed the farmer can directly observe the feeding intensity of fish and adjust feeding rates accordingly, because determining whether feeding rates are too low or too high is important in maximizing fish growth and feed use efficiency (Falayi*et al.*, 2004). Another advantage of floating feed is that it gives farmer the ability to visually monitor the health condition of the reared fish as they come to the surface to take the feed (Falayi*et al.*, 2004). It also enables the farmer to observe the feeding habit of the fish thus avoid overfeeding the fish. Extruded compounded feed have very good water stability, floating properties, high digestibility, growth performance, water protection, zero water pollution, optimized labour usage, zero wastage of raw materials (Amalraaj, 2010). The extruded compounded feed is made in such a way that the nutrients in the feed are retained within the periods of thereby enabling fish to consume whole extruded ration (Kearns, 1989). Having floating feed 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, 1982). It also allow 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). 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).

Regardless of the profits and advancement of aquaculture, this industry faces a number of problems, including high feed cost, disease (Morales-Covarrubias., 2004), environmental pollution due to excessive uses of fish feed. The feed used in most of the commercial cat fish culture operations in aquaculture are floating, sinking and mash types feed. Floating diets are usually more expensive than sinking or mash feed because of extrusion process during feed production, needs extra cost add (Giri, 2017). On the other hand sinking and mash feeds rather less expensive to produce than the floating feeds. So farmers need less investment in fish farming. There are some observations on field level that some farmers prefer floating diets for feeding cat fish because it provides opportunity to observe satiation level of the fish. But sometimes due to higher turbidity of water body that hinder water visibility and makes impossible for farmers to observe satiation level of tilapia, as a result excluding the need for relying on floating feed. Previous studies in halibut, *Hippoglossus hippoglossus* have demonstrated that growth, feed utilization and production are affected by the form of the diets used (Suontama*et al.,* 2007). (Limbu, 2015) found inconsistence results in Tilapia when floating and sinking feeds are compared on their effect on growth, feed utilization and yield, found similarity in mean weight gain and daily feed intake for fed on floating and sinking feeds.

Feedstuffs and their Nutrient Content

Feedstuff used in fish feed formulation are composed mainly of natural product as well as many of the by-product of processing or milling industries but the proportion in which these components are present differs between feeds. Foodstuffs can be classified as energy feedstuffs and protein supplement. The energy feedstuffs contain high amount of carbohydrates, low to high amount of ether extracts or lipid and low amount of protein. Carbohydrates have a sporting effect on protein in artificial feeds so that fish can utilize protein efficiently for growth rather than energy (Eyo, 2004). In the selection of feedstuff for diet formulation. (Madu *el al.,* 2003).

Aquaculture Development in Africa

Aquaculture development in Africa is insignificant compared to the rest of the world (Changadeya*et al.*, 2003). According to Hetcht (2000) the entire continent contributed only 0.4% to the total world aquaculture production for the period 1994 to 1995. In the year 2000 it contributed a mere 0.97% of the total global aquaculture (FAO, 2003). Although the history of aquaculture is relatively recent in Sub-Saharan Africa compared to Asia, and some other parts of the world most known aquaculture systems have been introduced over the last 35 years (FAO, 1996; 1996).

The growth, expansion and production of aquaculture in northern part of Africa especially, Egypt is more advanced in techniques and technicalities in comparison to the Sub Saharan regions. In Sub-Saharan regions aquaculture in most places is still essentially a rural, secondary and part-time activity taking place in small farms with small fresh water ponds (FAO 2012). The systems that are generally practiced range from extensive to semi-intensive cultural systems with limited fish yield, which are mostly consumed directly or sold locally (CIFA 2014). Almost all fish farming is carried out by rural small scale operators in small fresh water ponds as a secondary activity to agriculture. Although there is abundant potential for the development and expansion of aquaculture in this region, factors such as the novelty of aquaculture, the general poor economic conditions in many countries and the relative paucity of entrepreneurial skills and credit facilities hamper its development (FAO, 2012). Aquaculture development in most African countries is primarily focused on socio-economic objectives such as nutrition improvement in rural areas, income generation, diversification of farm activities (integrated farming) and creation of employment especially in rural communities where opportunities for aquaculture in northern part of Africa especially, Egypt is economic activities are limited (CIFA, 2014). This approach over the years has resulted in sustained aquaculture growth in some African countries such as CotéD'ivoire, Egypt, Ghana, Malawi, Nigeria and Zambia (Jamu and Ayinla, 2003). While there is still room for enhancing aquaculture production in Africa through improved production systems, genetics and general farm management principles, the desired and expected growth of aquaculture to meet the ever increasing demand for fish and satisfy its socioeconomic functions is only achievable through cost-effective and high quality fish feed.

Floating Fish Feed

The pelleted fish feed are prone to leaching of nutrients into water due to poor stability and disintegration of feed to the water bottom feeding. This has been shown to lead to significant quantified losses in aquaculture input management (Falayi*et al*. 2003).

Some starches have been identified as local binding agents in fin fish feeci (Falayi et al, 2004, 2003, Orire et. al., 2001). Feed addictives have also been successfully utilized for buoyancy purpose in food technology. However some fish prefer floating pellets while others prefer sinking types, although most cultured fish can be trained to accept floating pellets (Craig and Helfrich, 2009).

Floating pellets produced from feed extruders are in greater demand than sinking pellets produced from Pelletizers because they enable the farmer to observe the feeding activity of the fish, thus prevent wastage of feed. They also exhibit superior physical characters such as greater water stability, digestibility, water protection, zero water pollution and zero wastage of raw materials (Almaraaj, 2010), and in addition supply higher energy than sinking pelleted feed (Johnson and Wandsvick, 1991). Sinking pellets are often characterized by poor water stability thus are easily dissociated in water (Effiong *et al*, 2009). Uneaten feeds that sink to the bottom of the pond usually end up as fertilizers causing high algal bloom and related water pollution problems (Bolorunduro, 2002), such as eutrophication and depletion of oxygen from the culture medium. The use of sinking feeds may also result in impaired growth of fish since it involves a high feed conversion ratio (Johnson and Wandsvick, 1991). Furthermore, the economic implication of using sinking pellets is another challenge for the small scale fish farmer. The direct implication is that most of the feed end up uneaten resulting in waste of resources while additional cost and labor incurred in maintaining healthy water conditions are secondary consequences (Falayi*et al.*, 2006).

Fish Feed Formulation

Feed formulation in fish farming is the method of combining selected grains feed ingredient in varying proportion to comply with predetermined nutrient requirements. The development of new species-specific diet formulation could support and also sustain the aquaculture industry as it expands to satisfy increasing demand for affordable, safe and high quality flesh product. Thus, the process needs the appropriate feed ingredients to produce and meet the minimum requirement of nutrients for cultured fish (Royes and Chapman, 2003). A nutritionally balanced and palatable diet is the criteria that should be given attention to in the formulation of diets from its various ingredients in adequate amount. In aquaculture practice, feed cost has become a major problem in both intensive and semi-intensive fish culture and therefore some consideration needs to be given to address this issue. In supplying adequate nutrition for various aquaculture species, bioavailability of nutrients, diet acceptability (palatability), feed processing, storage methods and chemical contamination can give impact on quality of diet and hence affect the performance of fish and production respectively. Based on nature of culture practice to satisfy the formulation, aquaculture system requires all the nutritional requirements to be fulfilled whereby in semi-intensive fish culture the formulated feed must supply supplementary nutrition used to fortify the naturally available diet (Royes and Chapman, 2003).

Composition of Ingredients

The most comprehensive information on feedstuff composition is provided in the United State - Canada tables of feed composition (NRC, 1993). The compositions of raw ingredients are known to be different based on region and ways of processing as well as storage. The feed ingredients should be analyzed in actual condition prior to feed formulation. Feedstuffs also need to be screened first for the presence any enzyme inhibitors or anti nutritional factors present in the ingredients.

Major source and Pathway of Nutrients in Intensive Aquaculture System

Feed as a major source of nutrients A wide variety of feedstuff was employed in fish and shrimp culture to increase production (Boyd, 2011).These feeds ranged in quality form rations that supply all of the nutrient requirements of culture species to materials such as agriculture waste, industrial by products etc.(Boyd, 2011).The nutrients in feed not only directly consumed by culture species but also leached into the culture system. Unconsumed particles were decomposed by heterotrophic activity affecting all levels of nutrient availability and organism growth in such system (Lori Barck Moore, 2008).

Fish usually consumed almost all feed that supplied to pond (Boyd, 2012).The conversion of feed to fish or shrimp termed the food conversion ratio (FCR). Food conversion ratio of 2.0 or less are completely achieved with high quality feeds, but FCR became higher as food quality decreases (Boyd, 2011). In highly intensive shrimp production FCR was usually between 2.0 to 3.0 (Boyd,2012). One of the reason of high conversion ratio is overfeeding. Although FCR were suitable for economic purposes they were misleading in consideration of water quality (Boyd, 2012) because feeds are usually dry (90 to 95 percent dry mater) while fish contain a high percentage of water (20 to 25 percent dry mater). If the FCR is 1.5, however on a dry weight basis only about 0.25 kg of fish was produced in 1kg of fresh fish. Feed constituents which are not incorporated into fish standing crop are excreted into the water as metabolic waste. The nutrient load from feed to the environment was variable, depending on the nutrients content and the digestibility of the feed used (Beveridge, Food and Nations, 2000).

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).

Objectives of the Study

I. To evaluate proximate composition of feed compounded with fish scale, feather and horn experimental diet.
II. To evaluate the buoyancy potential of feather, fish scales and horn compounded in fish feed at varying inclusion level.

Research Questions

I. What is the proximate composition of feed compounded with fish scale, feather and horn experimental diet?
II. What is the buoyancy potential of feather, fish scales and horn compounded in fish feed at varying inclusion level?

RESEARCH METHODS

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 drained 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 compositin 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 petridish and dried in an electric oven at s100±2°C for 16-18 h. The samples was kept in a dessicator. 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.

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).

Haematological Examination Procedure

The effect of the additive (fish scale feather and horn) on the blood parameters of the fish samples were determined. The following parameters; packed cell volume (PCV), haemoglobin (HB), Red Blood Cell (RBC), and White Blood Cell (WBC). Haemoglobin (Hb) count was carred out with the cyanomethaemoglobin method; Packed Cell Volume (PCV) by micro haematocrit method. Red blood cell (RBC) and total white blood cell (WBC) counts were carried out using the Neubauer haemocytometer. Analyses were carried out within 48 hours of collection.

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 20

RESULTS

Proximate composition of the fish feeds

Proximate composition of feed incorporated with fish scale, feather and horns Table 4.1. Show that the highest percentage moisture content (11.24±0.50%) was in feed with 5% of fish scale, while the least

(8.03±0.50) was in the control feed. The highest percentage ash content (15.60±0.50%) was observed in feed with 5% of feather, while the least (11.30±0.22%) was in the control feed. The highest percentage lipid content of mean value of 19.30±0.50% was observed in feed with 15% feather while least (17.10±0.01) was in the feed with 10% of horns. The highest percentage crude protein content (35.25±0.50) was observed in the control feed while the least (32.40±0.50) was in the feed with 5% of feather.

Buoyancy of the Fish Feed

The result for buoyancy test is presented in Table 4.2. The results showed that feeds incorporated with 15% of fish scale floated longer (587sec) before it sank followed by feed with 10% of fish scale (481secs) while the least was the control feed (244secs).

Table 1: Proximate composition of the fish feeds incorporated with fish scale, feather and horns

Parameter	Control (0.00%)	5% FS	FTHR	HRNS	10% FS	FHTHR	HRNS	15% FS	FTHR	HRNS
Moisture	8.03±0.50^{a}	11.24±0.50^{c}	10.70±0.50^{c}	10.30±0.04^{c}	10.40±0.50^{b}	10.60±0.50^{d}	9.24±0.07^{b}	10.54±0.50^{c}	9.80±0.14^{b}	10.14±0.03^{c}
Ash	11.30±0.22^{a}	15.50±0.50^{d}	15.60±0.50^{d}	14.50±0.07^{c}	14.30±0.10^{b}	13.50±0.01^{b}	13.10±0.01^{b}	14.44±0.10^{c}	14.80±0.50^{c}	14.24±0.06^{c}
Lipid	18.20±0.05^{b}	18.40±0.50^{b}	18.60±0.50^{b}	18.24±0.06^{b}	17.53±0.50^{a}	18.80±0.10^{b}	17.10±0.06^{a}	18.34±0.50^{b}	19.30±0.50^{c}	18.24±0.50^{b}
Fibre	12.16±0.50^{a}	12.70±0.50^{a}	12.60±0.50^{a}	12.80±0.50^{a}	12.64±050^{a}	12.12±0.06^{a}	12.20±0.06^{a}	12.60±0.01^{a}	12.13±0.50^{a}	12.54±0.50^{a}
CP	35.25±0.50^{d}	34.60±0.50^{c}	32.40±0.50^{b}	33.60±0.06^{c}	33.37±0.50^{b}	34.80±0.05^{c}	33.24±0.50 ^{b}	34.70±0.50^{c}	34.11±0.50^{c}	32.42±0.06^{a}
CHO	28.10±0.01^{d}	25.77±0.06^{a}	27.30±0.50^{c}	28.60±0.01^{a}	28.74±0.50^{d}	28.50±0.50^{b}	24.80±0.50^{d}	28.80±0.10^{d}	28.17±0.10^{d}	25.70±0.10^{d}

Foot note: Values on the same column with the different superscript are significantly different P<0.05
Key: FS- Fish scale, FTHR= Feather, HRN= Horns, CP = Crude protein, CHO = Carbohydrate

Table .2 Floating period of each experiment diet

	Control D1 (Secs)	5% D2 (Secs)	10% D3 (Secs)	15% D4 (Secs)
FS	244	357	481	587
FTHR	244	325	425	456
HRN	244	160	330	345

Foot note: FSW= Fish scale, FTHR= Feather, HRN= Horns

DISCUSSION

This study showed that adding of animal by-products (fish scale, feather and horns) had little or no effects on the proximate composition of the feed. At the end of the experiment, the appropriate inclusion in right percentage of fish scale exhibited floating in fish feed and improved growth. This finding is almost in line with the finding of Murugan *et al*. (2020) who reported that moisture, ash, lipid, fibre and crude protein are the most common proximate composition with the highest percentage content, and fish bones as additive has no effect on proximate composition.

The buoyancy potentials of the feeds revealed significant differences across experimental diets. The best floatation quality was expressed in fish scale with 15%. It revealed a progressive relationship between inclusion levels. The floatation potential of the feeds revealed significant differences ($P<0.05$) across experimental diets. Floating feed proved to be superior in the experiment due to its higher water stability compared to sinking feed. Kearns and Hilton (2002) similarly observed that increasing the amount of cow blood in feed improved its floatability.

The results of acceptability reveals that the starved fishes accepted the feed incorporated with the animals bye-products of 15% additives had the highest acceptability rate compared to studies, this work aligns with findings in Ornamental fish, where poecilia readily accepted diets containing feed additive of *Poecilia*in diets (Murugan *et al*., 2020).

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. Optimize Feed Formulation: Experiment with different ratios of organic materials (fish scale, feather, horns) to improve nutrient content and buoyancy.
ii. Conduct Long-term Feeding Trials: Perform extended studies to assess the effects of organic materials on fish growth, health, and performance.
iii. Evaluate Nutrient Utilization: Investigate how organic floaters affect nutrient absorption and digestion efficiency in fish.

ACKNOWLEDGEMENT

This research was sponsored by Tertiary Education Trust Fund through Institutional Based Research to Shehu Shagari College of Education, Sokoto with Batch No. TETF/DR&D/CE/COE/SOKOTO/IBR/2024/VOL 1/BATCH 10: S/NO. 27

REFERENCES

Abaelu, A.M., Makinde, M.A, and Akinrimisi, E.O. (1979). Melon (egusi) seed protein 1: Study of amino acid composition of defatted meal. *Nutural Reproduction International.***20**: 605-613.

Abbott, J.C., and Makeham, J.P. (1979). *Agricultural Economics and Marketing in the Tropics.* Logman. 165pp.

Abdulkarim, M. and Ipinjolu J.K. (1998). Effect of diet containing varying levels of millet offalon the growth performance of *Oreochromis niloticus*.The*34th Annual Proceeding of Agricultural Society of Nigeria* (ASN), pp, 121 – 125

Abdulkarim, M., Bununu, K. and Mohammed, A. (2005). Fish and Fisheries of Gubi DamGanjuwa Local Government Area Bauchi. *Journal of League of Researchers in Nigeria,* **7**(1): 7 – 12.

Adekola, B. B. (2001). Strategic fish feed development for sustainable and cost effective farmed fish production. Opening address on the 1st National FISON Symposium on fish nutrition and fish feed technology held at NIORM, Lagos, and 26th – 29th October, 1999. Ed Eyo, AA.

Adewomi, M.A. (2005). Effect of mixed feeding schedules with varying dietary crude protein levels on the growth and feed utilization of *Clarias gariepinus* fingerlings. *Journal of Fish and Aquatic Science*, **5**: 304-310.

Adikwu, I. A. (2003). A Review of Aquaculture Nutrition in Aquaculture Development in Nigeria. In – Preceedings, National Workshop on Fish Feed Development and Feeding Practices in Aquaculture Organized by FISON.

Ajibola O.O., Eniyemo, S.E., Fasina, O.O., Adeeko KA (1990). Mechanical Expression of Oil from Melon Seeds. *Journal of Agricultural. Engineering*. Res. 45: 45-53.

Alebeleye, H., Steck, S.E., Gaudet, M.M., Eng Britton, J.A., Teitelbaum, S.L., Neugut, A.I. and Gammon, M.D. (2007). Cooked meat and risk of breast cancer-lifetime versus recent dietary intake, *Epidemiology*, **18**(3):373-382.

Alegbeleye WO, Oresegun A. and Ajitomi, D. (2001). An assessment of jackbean (Canavali sensiformis) meal as an ingredient in the diets for *Clarias gariepinus* fingerlings fish nutrition and fish feed technology in Nigeria. Proceedings of the first National Symposium on Fish Nutrition and Fish feed technology Lagos. pp. 89- 94.

Amalraaj, S. (2010). Extruded floating fish feed a boon for farmers. Online Publication The Hindu: Sci Tech / Agriculture.

Amend, D.F. (1970) Mycobacterium infection of salmonids-prevention and treatment. Spectrum Publication Amsterdam. Fish. Soc. No 5, pp258- 2665

AOAC (2000). Official Methods of Analysis of Balarin, J.D. and Haller R. D (1982): The Intensive culture of tilapia in tanks, receiving cases in recent advances in aquaculture. (Eds. J. F. Mur, R.K Roberts), Lonon Croon Heln Ltd, 260-360.

Atwood, H., Fontenot, Q., Tomasso, J., and Isely. (2001). Toxicity of nitrite to Nile tilapia: effect of fish size and environmental chloride. North American Journal of Aquaculture, 63(1), 49-51.

Avnimelech, Y. (2014). Control of microbial activity in aquaculture system: active suspension ponds. . World Aquaculture, 34 (4),, 19-21. .

Axelrod, H.R. and Warren, E.B. (1971) African Cichlids of Lake Malawi and Tanganyika. U.S.A.

Balarin, J. D. and Haller, R. D. (1982). The intensive culture of tilapia in tanks, raceways, and cages. In: Muir, J. F. and Roberts, R. J. (Eds.), Recent Advances in Aquaculture (pp. 265-355).Westview Press, Boulder, Colorado.

Ben C, Heck S (2005). Fisheries and the millennium development goals. Solutions for Africa. NAGA 28: 8-13.

Bock, A. (1999*). Introduction to fish culture*. International Centre for Aquaculture and Aquatic Environments. Auburn University. Alabama-U.S.A, pp. 1- 4.

Boström, B., & Pettersson, K. J. H. (2010). Different patterns of phosphorus release from lake sediments in laboratory experiments. 91, 415-429.

Boyd, C. E. (1985). Water Quality in Fisheries Management. In Fisheries Management (pp.27-36). *American Fisheries Society*.

Boyd, C.E. (1982). Water quality management for pond fish culture. *Development in Aquaculture and Fisheries Science* **9**: 29 – 36.

Breitburg, D. L., L. Pihl, and S. E. Kolesar **(**1983**)** Effects of low dissolved oxygen on the behavior, ecology and harvest of fishes: A comparison of the Chesapeake Bay and Baltic- Kattegat Systems, **58**:241-267

Bruton, M.N., (1979). The breeding biology and early development of *Clarias gariepinus* (Pisces, clariidae) in Lake Sibaya, South Africa, *Trans. Zool. Soc*. London, **35**:1-45.

Campbella, D. (1985). Large scale cage farming of *Sorotherodon nilotica. Agriculture*. **48**:57-

Carpenter, S. R., Caraco, N. F., Correll, D. L., Howarth, R. W., Sharpley, A. N., & Smith, V. H. J. E. a. (2016). Nonpoint pollution of surface waters with phosphorus and nitrogen. 8(3), 559-568.

Chakroft, M. (1976) Appropriate Technology for Development Fresh Water Fish Pond Culture and Management. Ed. Volunteer in Technical Assistance (Vita) Manual Series No. 36E,

Channel Catfish *Ictalurus punctatus*. J. World Aquac. Soc. 30, 123–127. doi:10.1111/j.1749-7345.1999.tb00325.x