GROWTH PERFORMANCE EVALUATION OF *Clarias gariepinus* FINGERLINGS FED GRADED LEVELS OF COWPEA (*Vigna unguiculata* L.: Walp) HUSK AS SUPPLEMENT FOR FISHMEAL

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BEING THE FINAL THESIS PRESENTED TO THE DEPARTMENT OF BIOLOGICAL SCIENCES, IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTERS DEGREE IN ZOOLOGY (FISHERIES AND AQUATION MANAGEMENT), SCHOOL OF PURE AND APPLIED SCIENCES, FEDERAL UNIVERSITY OF TECHNOLOGY YOLA.

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DECLARATION

I declare that this work was carried out in its original form by ***VALDON Solo Boga,*** of the department of Biological Sciences, Federal University of Technology Yola, Nigeria

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APPROVAL PAGE

This thesis entitled "GROWTH PERFORMANCE EVALUATION OF Clarias gariepinus FINGERLINGS FED GRADED LEVELS OF COWPEA (*Vigna unguiculata* L. Walp) HUSK AS SUPPLEMENT FOR FISHMEAL" By **VALDON Solo Boga,** meets the regulations governing the award of Masters Degree in Fisheries and Aquaculture, Federal University of Technology Yola and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

I dedicated this project to my wife Victoria Solomon and children.

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Abstract

Feeding trial of the nutritive value of cowpea husk as protein substitute in practical diets for *Clarias gariepinus* fingerlings was conducted in concrete tanks. Five experimental diets coded TD1 – TD5 containing (40% crude protein) were formulated in which fishmeal was supplemented at varying levels. Growth performance and nutrient utilization by the fish were based on Mean Weight Gain (MWG), Specific Growth Rate (SGR), Feed Conversion Ratio (FCR), Protein Efficiency Ratio (PER), Net Protein Utilization (NPU), and Apparent Digestibility Coefficient (ADC). Good growth and feed utilization efficiencies were obtained in all treatment diets. However, diet TD1 and TD2 had significantly better growth and feed utilization, MWG varied from 2.08- 12.00g, SGR varied from 0.42-0.92, FCR varied from 2.14-4.20, PER varied from 0.62-0.90, NPU varied from 48.84-67.12. Experimental diets were also subjected to gut evacuation time and apparent digestibility coefficient (ADC). Gut evacuation time was 7.00 hours while apparent digestibility coefficient varied from 72.92-88.49. These results showed that cowpea husk meal was better utilized by Clarias gariepinus fish in diet 2 with 25% cowpea husk inclusion. It was observed that fishmeal in Clarias gariepinus diet can be supplemented up to 25% with cowpea husk, with a better output and at a lower cost. The implication of these results is discussed in the context of lowering cost of fish diet with a view to improve fish production in Nigeria and other tropical countries.

CHAPTER ONE

1.0 INTRODUCTION

Protein is a basic component of animal tissues, therefore an essential nutrient for both production and maintenance. The utilization of protein for maintenance is that of replacement of dead or worn out tissues and proteinous products such as internal epithelial cells, enzymes and hormones, which are recycled quite regularly (Gary, 2001). In fish feeds protein is essentially from fishmeal which remains the single most important and expensive ingredient Adikwu and Haruna (1998). Fish nutritionists in recent times focus on reducing the cost of fish production, by attempting to substitute fishmeal which is the most essential source of protein in fish feeds, with other sources of protein either animal or plant products. Pendergrast et al. (1994), reported that protein in fish feeds constitutes about 64 – 67% of the cost of fish feeds. It shows that reducing the cost of fishmeal will reduce the cost of fish production. Opportunities exist in Nigeria to reduce fish feed cost especially with the availability of local feed ingredients of plant origin rich in crude protein (Anonymous, 2005). The scarcity and ever-increasing cost of feeds and feedstuff have been the most important factors militating against aquaculture production in developing countries. Feedstuff constitutes a major cost of input in aquaculture and in Nigeria; scarcity of Fishmeal has been identified among the critical factors responsible for low and inadequate fish production, Federal Ministry of Agriculture (FMA, 1995). Obasa, (2004) reported that the level of production of any animal depends on the provision of adequate protein, energy, vitamins and mineral salts in the diet in the right proportions.

Fish is an important ingredient in the diet of man since ancient times. Food and Agricultural Organization (FAO, 2006) reported that fish provides 22% of the protein intake in sub-Saharan Africa. This share however, can exceed 50% in countries where other sources of animal protein are scarce or expensive. Olaniyi (1998) revealed that fish provides an estimated 55% of the total animal protein consumed by an average Nigerian. Furthermore Mafemisebi (2004) reported that of all animal protein sources: chicken, goat meat, beef, eggs and recently rabbit meat, fish has the highest metabolisable proteins. Considering aquaculture from inception in Nigeria, imported commercial fish feeds have been promoted as the most favoured feed for fish rearing because they support satisfactory growth. However, the high cost of imported fish feeds has made catfish feeding economically unattractive for the small-scale fish farmer, therefore, the need for locally compounded fish feeds that are nutritionally adequate with ingredients less competed for by man and animals but which would equally bring about optimal growth

1.2 STATEMENT OF THE PROBLEM

One of the major constraints of pond fish production in Nigeria is that of in sufficient supply of fish food. High cost of feed inputs is a major problem to fish farmers in Nigeria, and fish feed is generally considered as the most expensive item in intensive fish farming. According to National Research Council (N.R.C, 1993), fish feed constitutes about 40 – 60% recurrent cost of most intensive fish farming ventures. Adikwu (2003) also reported that nutrition in aquaculture accounts for between forty to sixty five percent (40-65%) of the total operating cost, depending on the level of aquaculture intensification. Fishmeal is the choice item in fish feed production. However, with its high cost the need to source for replacement wholly or partially cannot be over emphasized to bridge the demand and supply gap.

1.3 JUSTIFICATION OF THE STUDY

Profitable fish farming entails the use of good quality feed for cultured fish, an important requirement to successful aquaculture development. The high cost of fishmeal and increasing competition for alternative uses, militates against fish production in many developing countries Nigeria inclusive. A reliable protein supplement such as cowpea husk can be used to replace fishmeal in fish feed for sustainable fish production. It is widely available, less expensive, less competitive, a waste product that can be converted to a valuable protein in fish muscles.

1.3.1 RATIONALE FOR SELECTION OF INGREDIENT FOR STUDY

It is cheap and surplus during harvesting period in cowpea producing areas.

It can easily be stored under cold and dry temperature conditions.

Less competitive in use between man and farm animals and can easily be converted into fish flesh.

1.3.2 BROAD OBJECTIVE OF THE STUDY

High cost of fishmeal is a major constraint in fish feed formulation, therefore substituting it with alternative protein source that is cheap such as cowpea husk that can support good growth and development in fish can reduce cost of fish feed and production.

1.3.3 AIMS AND OBJECTIVES OF THE STUDY

The objectives of the study are to determine:

(i) the effect of replacing fishmeal with cowpea husk on the growth of *Clarias gariepinus*.

(ii) the extent to which cowpea husk can be substituted for fishmeal for optimum fish production.

(iii) the digestibility of the feed ingredient.

(iv) the reduction in cost of feed.

1.3.4 RESEARCH QUESTIONS

(i) Is the protein content of cowpea husk adequate to supplement fishmeal?

(ii) Does fish fed with cowpea husk attain optimum growth?

(iii) Does the supplement ingredient in the diet adequately digested?

(iv) Is the reduction in the cost of feed adequate?

The result could be used to provide a reliable information and baseline data for the intensification of fish farming of *Clarias gariepinus* in Nigeria and other developing countries.

1.4 RESEARCH NULL HYPOTHESIS

(a) There is no significant difference of feed consumption, between fish meal based diet and Cowpea husk supplemented diet fed to *Clarias gariepinus* ($P > 0.05$).

(b) There is no significant difference between the growth rate of fish fed with Cowpea husk diet and that of fishmeal ($P > 0.05$).

(c) There is no significant difference ($p > 0.05$), between the digestibility of feed containing Cowpea husk meal and that of fish meal fed to *Clarias gariepinus*.

(d) There is no significant difference ($p > 0.05$) between the fishmeal based diet and the Cowpea husk based died.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 COST OF FEED IN AQUACULTURE

The major cost item in fish production is fish feed. Pillay (1993) reported that feed has been estimated to account for about sixty to eighty percent (60-80%) of the total cost of production of fish depending on species and environment. Falayi (2003) observed that fish feed alone has taken the larger share of the cost of production, so that total feed cost accounts for over sixty (60%) percent of the total production. Madu *et al*. (2003), revealed that high cost of feed inputs is a major constraint to fish farmers in Nigeria and fish feed is generally regarded as the most expensive cost item in intensive fish farming. In a related report of Adekumisi *et al*. (2004), showed that one of the major constraints to aquaculture development in Nigeria is high cost of feed which constitute the major fraction of operational cost. They added that dietary protein constitutes about 50% of fish diets hence a larger portion (about 40% or more) of fish diets are made up of fishmeal. National Research Council (NRC,1993) also found out that fish feed takes about forty to sixty percent (40-60%) of the recurrent cost of most intensive fish farming ventures and sometimes negate the economic viability of a farm if suitable feeds are not used. Studies by Haruna and Adikwu (1998) indicated that alternative technologies may be used to reduce cost of fish feeds. In pursuit of these technologies to produce good quality feed for fish that will favourably replace fishmeal, fish nutritionists engage in the studies of the performance of locally available feed ingredients. A key aspect of developing diets for fishes is to determine their capacity to digest common feed stuffs (Masagounder *et al*.,2009).The knowledge of availabilities of nutrients to the fish species aids selection of appropriate ingredients and formulation of cost effective diets. The inclusion of highly digestible feedstuffs into practical diets will also reduce nutrient waste entering water ways and other water bodies.

2.2 PROTEIN UTILIZATION IN FISH DIET

The Nigerian aquaculture depends much on imported commercial fish feed which is costly and out of reach of small-scale farmers. It is important to note that over 30% of fish feed is made of protein (Eyo, 2003), which takes more than fifty percent (50%) of the cost of feed. Sogbesan *et al.* (2004), revealed that fishmeal which constitutes about 50-75% by weight in most aquaculture feeds, is an important ingredient in aquaculture diets because of its biological value. This is in line with the findings of Adekunmisi *et al.* (2004), who reported that dietary protein constitute about fifty percent (50%) of diets. This protein is essentially from fishmeal, and by implication fishmeal is the major cost in fish feed. The quality and quantity of protein are factors that influence the yield of fish in an intensive culture system (Oluwayemisi, 2005). The quality of protein in any diet is principally based on the amount of essential amino acids present. The quality or the amino acid content of protein is the most important factor in optimizing the utilization of dietary proteins (Andrews et. al., 1977). If a feed is grossly deficient in any of the ten essential amino acids, poor performance is inevitable despite the gross protein level. Studies have shown that better feed efficiency can be obtained from a diet containing 24% protein than inadequately balanced diet containing 36% protein (Andrews and page, 1974). Ugwu and Asogwa (2000) stated that dietary protein is not only important as regards the quantity present, but also in the quality i.e. the array of amino acids present.

There are about twenty naturally available amino acids; arginine, histidine, isoleucine, leucine, lysine, methionine phenylalanine threonine, tryptophan, valine alanine, aspartic acid asparagines cystine, glutamine acid, glutamine, glycine, proline, serine, tyrosine (Hardy, 1990). Only the first ten are essential for fish growth because they are not synthesized in fish and so must be provided in the feed. They are referred to as “essential” or “indispensable” (Norris, 2005). Feeding fish with diet deficient in any of these essential amino acids will cause depressed appetite and growth rate of fish (Ayinla, 1991). Fish fed diets lacking in a single dietary essential amino acid becomes inactive and might lose both appetite and weight. However, when the missing essential amino acid is replaced in the diet, its appetite is restored and growth resumes (Gary, 2001). The quality of protein is mainly influenced by its amino acid composition and digestibility. In a related research, Haruna (1997) observed that feedstuffs deficient in any of the ten essential amino acids results in depressed appetite and growth rate of fish.

Due to its biological value, fishmeal is incorporated into nearly all fish feeds (Haruna and Adikwu, 2001). Consequently, it is the best quality protein source available to the fish feed manufacturer. However, the high cost of fishmeal and the desire to produce animal protein food have led to the search for alternative technologies that use biological or agro-allied waste. Several studies in this respect to replace fishmeal have been conducted by Haruna and Adikwu, 1999, Fagbenro, 1999, Eyo, 1999, Fagbenro and Davies 2001, Fagbenro and Davies 2003, Ogunji et.al., 2003, Balogun et.al., 2004, Onanuga, 2004, Eyo et al., 2004, Samsons and Ojini, 2004.

2.3 USE OF ENERGY SOURCES TO SPARE PROTEIN

Another form of reducing the cost of protein in fish diets is by utilizing the protein-sparing action of carbohydrate or lipids and thus reducing the amount of fishmeal required (Samsons and Ojini, 2004). This is the tendency to increase the proportion of lipids in fish feed in order to reduce the use of protein for energy production, thus promoting their use for 'structural' purposes as in Salmonids (Hillestad and Johnsen, 1994). Studies have shown that protein is the most expensive component of fish feeds; therefore the only amount needed to support growth should be included in the formulation. Less expensive fats and carbohydrates can be used to supply the required energy for the fish and spare the protein for growth. Lipids in addition to sparing protein, form part of cell membranes and hormones (Haruna 2003).

2.4 CATFISH DISTRIBUTION

Catfish belong to the fish order called Siluriformes: subdivided into the families Ictaluridae, pangasidae and Clariidae and consist of both marine and fresh water species found in most parts of the world. Over 2000 different species have been recorded of which over half are present in South America (Eer et.al., 1996).

Ictaluridae: channel catfish and blue catfish are farmed in the USA

Pangasiidae: *Pangasius sutchi* and *Pangasuis iarnaudi* farmed in Thailand, Cambodia Vietnam, Laos and India.

Clariidae: Asian catfish (*Clarias batrachus*) and *Clarias microcephalus* farmed in Thailand and African catfish (*Clarias gariepinus*) farmed in Africa and Europe (Eer et. al.,1996).

The African Mudfish is widely distributed in Africa. It has an almost pan-African distribution, ranging from the Nile to West Africa, Algeria and South Africa (Viveen et. al., 1985). It also occurs in Asia Minor (Israel, Syria and South of Turkey). All farmed catfish are freshwater species. (Eer et. al., 1996)

Plate 1: African catfish (*Clarias gariepinus)*

2.5 CHOICE OF FISH (*Clarias gariepinus*)

The hardy nature and ability to remain alive out of water for long periods of time is a special value in tropical countries where higher water temperatures cause practical problems during transportation. Catfish have a broad feeding preference and will eat almost anything which is present but show slight preference for small fish measuring up to 30% of their own body length (Eer et. al. 1996). The African catfish spawns naturally and easily in shallow ponds. They are also good candidates for induced breeding in hatcheries. Catfish is widely consumed in many parts of the world and has high consumer preference and acceptability over many other species of fish. They can grow fast when provided with the favourable environment. Apart from using the fish fresh, they can be processed and preserved for longer periods using log fire giving rise to a product widely known as smoked fish.

2.6 FISH ENVIRONMENT

The availability of good water quality is important for all fish farming systems. This is because productivity of any given body of water is determined by its biotic and abiotic properties (Haruna 1997). The environment of the fish must have to be conducive for optimum growth and development, therefore, an ideal water condition is necessary for the survival of fish. All life processes of the fish wholly depend on the quality of its environment. Water quality parameters become more critical in intensive culture systems where fish are raised in artificial ponds with reduced self-purification capacities as compared with natural systems. Water quality assessment is usually aimed at pollution control and planning of water resource management. The physical properties consist of the total dissolved solids (TDS), and total suspended solids (TSS) (measured as conductivity), temperature and turbidity. They are important in digestibility because out door tanks are directly exposed to sun light; therefore, wide temperature values may occur while total suspended solids affect turbidity and water transparency.

2.7 DISSOLVED OXYGEN

This is the single most important critical water quality parameters for fish in pond culture system in the absence of pollution (Boyd and Lichtkoppler, 1979). All aquatic organisms with the exception of some bacteria require oxygen to survive (Wheaton, 1977). Most of these organisms extract their oxygen from the water. Thus, the extraction of oxygen and its addition to the water are critical factors important to the survival of fish. Oxygen can be a limiting factor in aquatic systems. It tends to affect primary and secondary production. Two major sources of oxygen for water are through plant photosynthetic activities which produce oxygen and atmospheric free oxygen. The amount of oxygen in water is increased by primary production which takes place in out-door ponds and by wind action which aerates the water surface. Wheaton (1977), states that the rate of oxygen transfer from air to water depends on water temperature, degree of saturation and turbulence of the air-water interface.

At night photosynthetic process is minimized or stopped due to absence of light. But living organisms (plants and animals) continue to respire and consume oxygen. As a result, dissolved oxygen levels fall low at night before dawn. The oxygen content of natural and pond waters usually reaches its daily maximum just at or slightly after daybreak. Dissolved oxygen levels rise from morning through the afternoon as a result of photosynthesis, reaching its peak in late afternoon. Maximum dissolved oxygen concentrations are usually observed in the mid to late afternoon. Inadequate dissolved oxygen has many effects on fish; fish stops feeding, growth is impaired and fish become stressed thereby becoming more susceptible to diseases, parasites and easy preys.

2.8 TOTAL DISSOLVED SOLIDS (TDS)

Total Dissolved Solids' (TDS), refers mainly to inorganic substances that are dissolved in water. These substances could include carbonate, bicarbonate, chloride, sulphate, phosphate, nitrate, calcium, magnesium, sodium, and other ions. A certain amount of these ions in water is necessary for aquatic life (Stone and Thomforde, 2006). They added that total dissolved solids (TDS) measured in mg/l (or PPM) are solids in water that can pass through a filter (usually with a pore size of 0.45 micrometers).

Alterations in TDS concentrations can be harmful to fish because the density of water determines the flow of water into and out of an organism's cell. Therefore too low or too high TDS concentrations can impair growth and sometimes may even lead to death of aquatic organisms. Total suspended solids (TSS) is similar to TDS, high concentrations of TSS may reduce water clarity, contribute to decrease in photosynthesis, combine with toxic compounds and heavy metals, may lead to increased temperature (Murphy, 2005).

2.9 TEMPERATURE

This is another important factor affecting the well being of cultured fish. Fish are poikilotherms and water temperature plays a tremendous role in their feeding. Temperature affects metabolic activities, feeding potential, growth, survival, and reproduction in all fishes (Dupree76 and Hunner, 1984), and efficiency of food conversion (Martinez-Palacios et. al., 1993). Adeniji and Ovie (1990) observed that a 5^0C sudden change in temperature will stress or even kill fish, and this has formed the basis for acclimatization in fish research.

Temperature has a profound effect on the rate of chemical and biological processes in water. For instance, fish require as much as twice oxygen as possible at 30^0C as at 20^0C (Adeniji and Ovie, 1990). Auta (1993) reported that temperature range of 25^0C – 30^0C is ideal for fish production in the tropics.

2.10 HYDROGEN ION CONCENTRATION

The pH of water is a measure of hydrogen ions that cause acidity and alkalinity on a scale of 0 – 14, with 7 being the natural state. In ponds, the time of the day a sample is taken often influence the pH value because of variations in the carbondioxide concentration. During the day, plant remove carbondioxide for photosynthesis, then pH will increase. At night, the pH will decrease as carbondioxide accumulates. Increasing the total alkalinity concentration in water helps buffer against pH changes.

Very low and high pH levels may reduce reproduction in fish associated with death (Stone and Thomforde, 2006). Adeniji and Ovie (1990) found out that acid and alkaline death points are approximately at pH 4 and 11 respectively. They also reported that pH values ranging from 6.5 – 9.0 were observed to be the most suitable for fish production.

2.11 ELECTRICAL CONDUCTIVITY (EC)

This is a measure of how well a solution conducts electricity and is correlated with salt content. Conductivity is typically reported in units of µS/cm (Micro Siemens per centimeter). Freshwater fish generally thrive over a wide range of electrical conductivity. Electrical conductivity (EC) also can be use to give an estimate of the total amount of dissolved solids (TDS) or total amount of dissolved ions in water. Total dissolved solids (TDS) value is measured in mg/l and is about half of the EC (µS/cm). High conductivity is an indication of the presence of large amounts of dissolved salts which may be detrimental to fish. The desirable range is 100 – 2,000µS/cm (Stone and Thomforde, 2006).

CHAPTER THREE

MATERIALS AND METHODS

3.1 COWPEA (*Vigna unguiculata* L.Walp) HUSK

This was obtained from the Food and Agricultural Organization in conjunction with Tree Crop Programme (FAO/TCP) research farm of the Adamawa State University, Mubi. It was properly sun dried ground into powder, and sieved into fine powder. It was included into the diets according to the experimental design (5x3 replicates). A sample was submitted to the laboratory for proximate analysis after the method of the Association for Official Analytical Chemists (A.O.A.C.) (1990).

3.2 COLLECTION AND TRANSPORTATION OF FISH

Three hundred and twenty (320) experimental fish of mean weight 6.00g *Clarias gariepinus* fingerlings were procured from Gesedaddo Farms Limited Yola and transported in a fifty (50) litres half filled Jarican to Fisheries Complex where they were acclimatized for two weeks. During this period, they were fed with imported commercial fish feed (coppens) containing 42% crude protein.

3.3 DIET COMPOSITION AND PREPARATION

Five experimental diets of 40% crude protein were formulated from various ingredients in which cowpea husk was varied to supplement fishmeal at various treatment levels at TD1(0%= control), TD2 (25%), TD3 (50%), TD4 (75%) and TD5 (100%) which lasted for 70 days.

The experimental diets comprised of cowpea husk, fishmeal (clupeid), maize, vegetable oil, cassava, blood meal, groundnut cake, mineral/vitamin premix, sodium chloride and chromic oxide. A forty percent (40%) crude protein diet was formulated using the Pearson's square method. In preparing each of the diets, the proportions of the ingredients (Table I) were weighed separately. Each diet was first mixed dry and later with just enough water to obtain homogenous hard dough. Pelleting was done manually using a disc of a pelleting machine of 2mm diameter. The disc was placed on a container and hand was used to press the dough over the disc and the pellets were collected in the container below. The pellets were sun-dried and stored in labeled containers. The pellets produced had a water stability of about 2 minutes which could be as a result of the presence of cassava as the binder. Each diet was formulated to 100g and sample of each diet was analyzed in the laboratory for proximate composition of the diet (pellets) after A.O.A.C., (1990). The proximate composition was conducted to ensure that the final product contained all the nutritional requirements needed for optimum fish growth and physiological functions.

3.3.2 TABLE 3.1: PERCENTAGE COMPOSITION OF THE EXPERIMENTAL DIETS

Ingredients		Quantity(g)			
Test diet	TD1	TD2	TD3	TD4	TD5
Fishmeal	30	22.5	15	7.5	0
Cowpea husk	0	7.5	15	22.5	30
G/nut cake	15	15	15	15	15
Maize flour	25	25	25	25	25
Blood meal	10.5	10.5	01.5	10.5	10.5
Vegetable oil	9.5	9.5	9.5	9.5	9.5
Cassava binder	5	5	5	5	5
Min./Vitamin premix	3	3	3	3	3
Sodium chloride	1	1	1	1	1
Chromic oxide	1	1	1	1	1
Total (%)	100	100	100	100	100

Plate 11: Samples of pelleted Diets

3.4 EXPERIMENTAL SET UP

The experiment was subjected to a completely randomized design (CRD) with five (5) treatments and three (3) replications, consequently 5 x 3 = 15 experimental units. Concrete tanks were used for the trial, with each experimental tank measuring 1m x 1.5m. Nineteen (19) fingerlings were randomly assigned to each experimental tank. The layout of the experiment is as shown below:

TABLE 3. 2: EXPERIMENTAL DESIGN

	Treatments				
Replicates	TD1 (0%)	TD2 (25%)	TD3 (50%)	TD4 (75%)	TD5 (100%)
I	A	B	C	D	E
Ii	B	C	D	E	A
Iii	C	D	E	A	B

The experimental set-up consisted of fifteen out-door concrete tanks of 1.5m x 1m x 1m capacity (1000 liters), situated at the out-door hatchery in the Fisheries Complex, Adamawa State University Mubi. The concrete tanks were cleaned and washed off debris with salt solution and potassium permanganate as disinfectants. This was done to destroy any existing pathogens, parasites, cyst or spores of parasites in the concrete tanks which may serve as source of infection to the fish.

Plate II1a: Top view of Experimental Tanks

Plate II1$_{b:}$ Side view of Experimental Tanks

The tanks were filled up to a depth of 1m and maintained at that level through out the experimental period, leaving a space of 0.5m as free board. The water collected was exposed to the air for dechlorination to take place.

3.5 STOCKING DENSITY

At the end of the acclimatization period, fingerlings were stocked randomly at the rate of 19 fish per tank. Nineteen (19) fingerlings were randomly picked and their weights were measured using a top loading sensitive balance (EK- 4100). This was done by taking some quantity of water into a container (about 1 litre) and the reading was set at 0-level (to remove 0-error), the fingerlings were then introduced into the container and weighed to give the weight of the fish in each tank stocked.

3.6 FEEDING RATE AND PRACTICES

The fish were starved for 48 hours to empty their gastro-intestinal tract and increase their appetite before the experimental diet was fed to the fish (Eyo et al., 2004, Madu and Ufodike, 2003). A ten week (70 days) feeding trial was carried out in triplicates of each group of nineteen fingerlings. Daily ration was calculated based on the body weight of the fingerlings at 4%, (2%) in the morning: 9 – 10am and 2% in the evening 4.00 – 5.00pm through out the experimental period. The reason for this feeding regime was because unlike tilapia that are frequent feeders due to their small rudimentary digestive systems, catfish can consume a large quantity of diet at one feeding, and therefore may not feed again for the next eight to twelve (8 -12) hours after that (Castaldo 1995). The fish in each of the tanks were removed and weighed fortnightly for growth performance, and daily records for mortality was taken. Weighing was done in the morning between 7.00 and 8.00am to minimize heat stress. Feeding quantity was then adjusted to the new weight.

3.7 WATER QUALITY PARAMETERS

Careful monitoring of water quality parameters was necessary to manage and maintain conditions within acceptable limits. The dissolved oxygen in the experimental tanks was routinely monitored in the mornings between 8 – 9am weekly with the aid of a portable hand held probe (Jenway 9500 D0 meter). At the beginning of each reading the tip of the probe is inserted into distilled water before dipping it into the tanks. After reading the value of each tank the tip of the meter is rinsed by dipping the probe tip into distilled water before inserting it into the next tank. Readings were taken once it is stabilized on the probe. Dissolved oxygen meter Extec DO 600 that uses electrical power is sometimes used to measure the DO to compare with the hand held reading**.**

In addition, routine monitoring of other water quality parameters, temperature, pH, total dissolved solids and electrical conductivity was conducted using (Jenway 5021 pH and conductivity meter and Exstik DO 600 temperature and dissolved oxygen meter). The procedure is rinsing the probe with distilled water before and after each reading of the various tanks.

3.8 ANALYSES OF FISH GROWTH AND NUTRIENT UTILIZATION

Data Collection: Fish were weighed at the beginning of the experiment, week 2, week 4, week 6, week 8, and at the end of the study period week 10. Diet performance was evaluated on experimental fish using standard methods as follows:

$$\text{Weight Gain (\%)} = 100\ \frac{(\text{Ln final body weight} - \text{Ln initial body weight})}{\text{Initial body weight}}$$

$$\text{Specific Growth Rate (SGR \% day)} = 100\ \frac{(\text{final body weight} - \text{initial body weight})}{\text{Time duration/days}}$$

$$\text{Feed Conversion Ratio (FCR)} = \frac{\text{Dry weight of feed fed (g)}}{\text{Fish weight gain (g)}}$$

$$\text{Protein Efficiency Ratio (PER)} = \frac{\text{Fish weight gain (g)}}{\text{Protein intake}}$$

$$\text{Net Protein Utilization (NPU)} = \frac{\text{Protein retained in grams}}{\text{Protein consumed in grams}} \times 100$$

3.9 GUT EVACUATION AND DIGESTIBILITY

At the end of the experimental period (10 weeks), the adjudged best experimental diet was subjected to gastric evacuation time and apparent digestibility tests. This was done to determine the time taken for the feed to be digested in the gut. Fish of 0.5kg average weight were acclimatized, fed to satiation (ad-libitum) daily for fourteen (14) days. On the 15th day, they were fasted for twenty four (24) hours to obtain Standard Clearance of the stomach and thereafter fed to satiation with diet (Haruna, 1999). After an hour, they were transferred into well-washed transparent plastic containers and were observed for the first faecal droppings and the time noted. The period between the time of feeding and the first faecal droppings became the gut evacuation time.

Fish were returned into the tanks and were fed the next day to satiation. An hour to the gut evacuation time, they were removed and killed. With the aid of razor blade, they were incised and faeces were collected from the lower one third (1/3) of their intestine, after the method of Henken et.al. (1985). Faecal samples were pooled, weighed and preserved in four percent (4%) formalin and analyzed using the acid digestion method of Furukawa and Tsukahara (1966). Apparent Digestibility Coefficient (ADC) for dry matter, protein and carbohydrate were calculated according to the method of Austreng and Refstie (1979);

$ADC = (a-b)/a \times 10^2$

Where a= nutrient in feed/marker in feed, and

b= nutrient in faeces/marker in faeces.

Apparent digestibility coefficient gives a relative measure of the extent to which ingested food and its nutrient components have been digested and absorbed by the fish (De Silva and Anderson, 1995). It is used to determine the percent nutrients that were assimilated into the body tissues of the fish and the percent nutrients which remained in the faeces according to the observation of Haruna, (1999).

STATISTICAL ANALYSIS

Data collected on Mean Weight Gain (MWG), Specific Growth Rate (SGR), Feed Conversion Ratio (FCR), Protein Efficiency Ratio (PER), Net Protein Utilization (NPU) and Apparent Digestibility Coefficient (ADC) were analyzed by one way ANOVA and significant differences were determined using Duncan's Multiple Range Test by the Statistical Analysis Software (SAS) at significant level of P=0.05.

CHAPTER FOUR

4.0 RESULTS

PROXIMATE ANALYSIS OF COWPEA (*Vigna unguilata* L. Walp) HUSK

Cowpea husk was subjected to chemical analysis, for dry matter, crude protein, ether extract, crude fibre, total ash and nitrogen free extract, the values obtained are as shown in Table 4.1.

TABLE 4.1: PROXIMATE COMPOSITION OF COWPEA HUSK

COMPOSITION	%
Dry Matter	92.55
Crude Protein	12.97
Ether Extract	0.65
Crude Fibre	33.40
Total Ash	7.24
Nitrogen Free Extract	45.74

TABLE 4.2: PROXIMATE COMPOSITIONS OF EXPERIMENTAL DIETS

COMPOSITION	D1	D2	D3	D4	D5
Moisture	3.02	3.03	3.23	3.26	3.68
Crude Protein	56.45	45.85	43.76	41.05	36.72
Ether Extract	7.54	6.84	4.37	3.26	2.42
Crude Fibre	4.85	18.87	20.15	20.36	21.75
Ash	2.35	4.05	4.78	5.05	5.67
Nitrogen Free Extract	21.41	16.23	17.25	16.87	15.41

Table 4.2: above shows the gross nutrient composition of the diets. The Crude Protein (CP) decreased with increasing concentration of cowpea husk inclusion in the diets. The Crude Protein (CP) content of the control diet (56.45) was higher than those substituted with cowpea husk at different levels. The Ether extract steadily decreased with the increasing concentration of cowpea husk across the diets. The Crude fibre increases as the concentration of cowpea husk increases in the diets. The Ash content also increased with the increasing concentration of cowpea husk in the diets.

TABLE 4.3: PROXIMATE COMPOSITION OF FISH CARCASS BEFORE AND AFTER EXPERIMENT

Composition	Initial %	Diets %				
		TD1	TD2	TD3	TD4	TD5
Crude protein	58.12	59.56	51.60	50.23	46.52	43.96
Ether extract	5.20	5.32	6.10	5.75	4.94	4.38
Total Ash	16.55	17.48	22.90	24.54	25.21	27.87
Nitrogen free extract	17.19	16.20	17.34	16.87	16.10	15.85

The proximate composition of the experimental fish before and after experiment is presented in Table 4.3 above. It showed that there was a decrease in the protein content of the fish fed with seventy five percent (75%) and one hundred percent (100%) cowpea while diets 4 and 5 had lower values.

TABLE 4.4: MEAN WATER QUALITY PARAMETER VALUES OBTAINED DURING THE TEN WEEKS EXPERIMENTAL PERIOD

PARAMETER	MEAN					SEM
	TD1	TD2	TD3	TD4	TD5	
Temperature ^{0}C	23.93^a	23.71^a	23.51^a	23.73^a	23.74^a	0.15
Dissolved Oxygen mg/l	5.42^a	5.55^a	5.88^a	5.61^a	5.36^a	0.13
Ph	7.20^b	7. 21^{ab}	7.32^{ab}	7.35^a	7.32^{ab}	0.03
Conductivity (µS/cm)	191.04^a	193.03^a	192.87^a	197.05^a	197.49^a	4.65

Means in the same row, having the same superscript are not significantly different (P>0.05) at 5% level of significance using Duncan Multiple Range Test (DMRT).

SEM=Standard error of the pooled means.

TABLE 4.5: SUMMARY OF GROWTH INDICES FEED UTILIZATION AND SURVIVAL RATE OF *C. gariepinus* FINGERLINGS

Growth Indices	Diets					SEM
	TD1	TD2	TD3	TD4	TD5	
Initial Mean Weight Gain (g)	6.15^{a}	6.23^{a}	6.20^{a}	6.15^{a}	6.20^{a}	0.12
Final Mean Weight Gain (g)	18.15^{a}	16.71^{a}	10.53^{b}	9.03^{b}	8.28^{bc}	0.26
Mean Weight Gain (g)	12.00^{a}	10.48^{a}	4.33^{b}	2.88^{bc}	2.08^{bc}	0.13
Initial Standard Length (cm)	4.20^{a}	4.60^{a}	4.60^{a}	4.70^{a}	4.60^{a}	0.12
Final Standard Length (cm)	13.86^{a}	12.46^{a}	11.30^{b}	10.02^{bc}	9.76^{bc}	0.30
Mean Standard Length (cm)	9.66$^{\mathbf{a}}$	7.85^{ab}	6.70^{ab}	3.55^{b}	3.43^{b}	0.18
Specific Growth Rate (SGR)	0.92^{a}	0.84^{a}	0.63^{b}	0.51^{bc}	0.42^{bc}	0.05
Feed Conversion Ratio (FCR)	2.14^{c}	2.23^{c}	3.30$^{\mathbf{b}}$	4.06^{a}	4.20^{a}	0.47
Protein efficiency ratio (PER)	0.90^{a}	0.78^{b}	0.75^{b}	0.64^{c}	0.62^{c}	0.05
Net Protein Utilization (NPU)	67.12^{a}	64.25^{ab}	57.42^{b}	49.04^{c}	48.84^{c}	2.88
Condition factor (K_2)	0.71	0.72	0.86	0.89	0.89	
ADC	88.49^{a}	88.00^{a}	82.86^{b}	75.49^{c}	72.93^{cd}	5.32
Survival Rate (%)	91.22^{a}	92.98^{a}	91.22^{a}	87.71^{a}	87.71^{a}	2.05

TD = Test diets (1, 2, 3, 4&5), SEM = Standard error of means, ADC= Apparent Digestibility Coefficient

Means with different superscript on the same row differ significantly ($P<0.05$)

The results of this experiment from the data collected showed that water quality Parameters monitored during the experimental period were not significantly different ($P>0.05$), except for pH which showed a significant difference ($P<0.05$) at 5% level of significance between the control and treatment four (TD4). The minimum and maximum values obtained are as followed; temperature 20.60^{0}C – 28.30^{0}C ± 0.15, dissolved oxygen (DO) 2.46mg/l – 8.70mg/l ± 0.13, pH varies between 6.5 – 7.8 ± 0.02 and conductivity of 92.00 – 290.00 ± 4.65. A summary of growth performance and nutrient utilization is presented in Table 5. Appreciable growth response was observed in treatments (TD2) and (TD3) while treatments (TD4) and (TD5) had lower growth performance.

The Feed Conversion Ratio (FCR) was lowest in diet 1 followed by diet 2 and then the control. However, significant difference was observed between the control and diets 3, 4 and 5.

GROWTH PERFORMANCE GRAPH OF *Clarias gariepinus*

The response of *Clarias gariepinus* to the test diets in terms of growth is illustrated by plotting a growth performance graph as shown in figure 1. It shows that growth increased steadily from the initial set up of experiment to the end. The results however, revealed that diet 1with 100% fishmeal gave the highest Mean Weight Gain (MWG). Diet 1 is therefore adjudged to be the best experimental diet used.

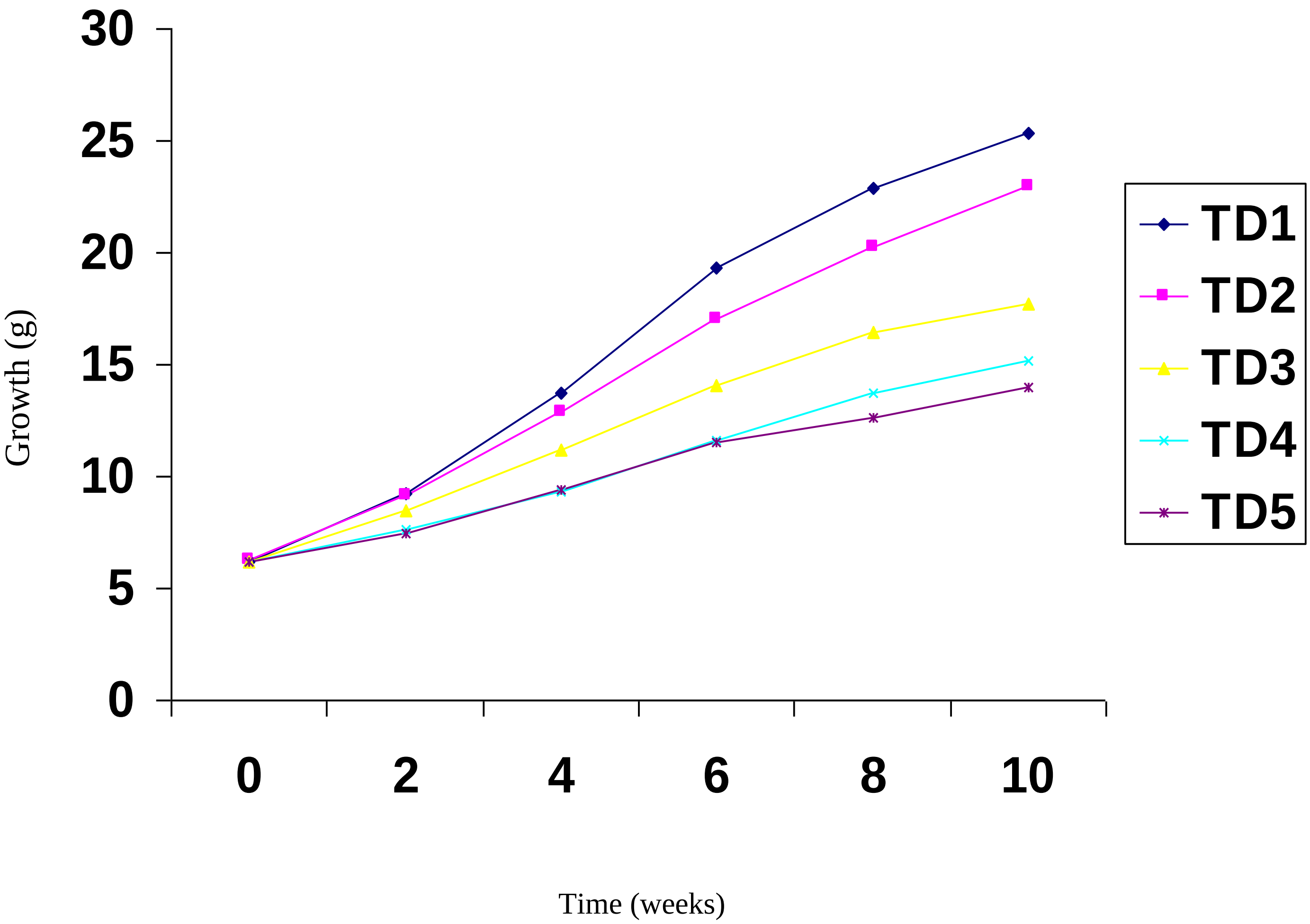

Figure 4.1 Growth performance of *C. gariepinus* for a period of 10 weeks

TABLE 4.6: FEED COST ANALYSIS

Experimental diets	Cost (N)/Kg	Relative fishmeal diets	Decrease in feed cost (%)	FCR	Feed cost(N/Kg) weight gain	Relative to fishmeal diet
TD1 (0%)	21	100	0.00	2.14	36.06	100
TD2 (25%)	18	85.71	14.29	2.23	32.89	91.20
TD3 (50%)	13.5	64.29	35.71	3.30	28.39	78.72
TD4 (75%)	12	54.14	45.86	4.06	26.89	74.57
TD5 (100%)	9	42.86	57.14	4.20	23.89	66.25

The local market prices were fish meal N700, cowpea husk N300, ground nut cake N250, blood meal N200, vegetable oil N200, cassava N120, mineral/vitamin premix N1200, salt N100 and chromic oxide N5,000.

CHAPTER FIVE

5.1 DISCUSSION

Optimum protein requirement for satisfactory growth, performance and efficient nutrient utilization in fish has been reported to be 40% (Machiels and Henken 1985 and Dengani et al., 1989). The summary of growth responses are as presented in Table 5. There was a general increase in the weight gain of fish across the treatments, but growth became lower with fishmeal replacement at seventy five percent (75%) and one hundred percent (100%) cowpea husk meal inclusion levels, this agreed with the findings of Haruna, (2002). There was no significant differences between the control diet (TD1) and test diet (TD2), in Mean Weight Gain (MWG), $p>0.05$. However, there was significant difference ($P<0.05$) in MWG between treatment 2 and test diets 3, 4 and 5 even though there was increase in growth performance. The higher growth performance in combined feeding regime can be explained by synergetic effect of combining two biological compounds to have a single and superior effect, than when applied individually. This observation is in agreement with the reports of previous authors that combined protein sources is better than single protein source for diets (Sogbesan et.al., 2005 and Sogbesan and Ugwumba, 2006). They reported that, the ability of an organism to convert nutrients especially protein into body tissues will positively influence its growth performance. This was justified by the high mean weight gain in twenty five percent (25%) cowpea husk meal inclusion fed to fingerlings.

Results from this study showed that a well balanced feed based on twenty five percent (25%) cowpea husk meal has the potentials of being as efficient in supporting growth as a fish-based diet. Growth declined with cowpea husk meal inclusion above fifty percent (50%). This could be adduced to a single or combined effect of missing essential amino acid(s), low digestibility of the nutrients or presence of growth inhibitors. This is in line with the report of Adikwu and Haruna, (1999), who reported that the control diet (0% groundnut leaf) elicited the highest growth, but not significantly different from 25%GL and 50%GLdiets, growth rate declined with increasing groundnut leaf inclusion in the diets.

Specific Growth Rate (SGR) was significantly different between the treatments. The values obtained were similar to the observations of Adikwu and Haruna (1999), which suggested that protein sources other than fishmeal could produce satisfactory growth in *C. gariepinus*. Diet 5 with one hundred percent (100%) cowpea husk gave the highest Feed Conversion Ratio (FCR) of 4.20 while diet 1 with (0%) cowpea husk inclusion gave the lowest FCR value of 2.14. This is similar to the observation of Obasa, (2004), whose values were between 2.13 – 2.77, on growth survival and nutrient utilization of the brackish water catfish (*Chrysicthys walkeri*) fry as affected by dietary protein and energy levels. This also agreed with the studies of De Silva and Anderson, 1995, who reported that food conversion ratio with lower value, indicated an improved outcome.

Net Protein Utilization (NPU) values varied from 48.84–67.12 with the control having the lowest value. This is similar to the values obtained by Obasa, et al., (2004) whose values were from 41.42 – 53.54 observed on the growth performance and nutrient utilization of Nile Tilapia *(Oreochromis niloticus*) fed mucuna (*Mucuna atterima*). De Silva and Anderson (1995) reported that Protein Efficiency Ratio is a measurement of how well the protein sources in a diet could provide the essential amino acids requirement of the fish fed. Gastric evacuation rate and time of the experimental diet fed was 7.00 hours after feeding the fish. This is similar to the reports of Haruna and Adikwu, (1998), in African Catfish, *Clarias gariepinus* fed different protein sources. Apparent Digestibilty Coefficient varied from 72.93 – 88.49, with the control diet having the highest ADC. This agreed with the reports of Haruna, and Adikwu, (2001) on Biological and Nutritive Evaluation of Sorghum bran in the African Mud Catfish (*Clarias gariepinus*, Burchell, 1822) and Haruna,(2002)on the nutritive evaluation of coconut cake as replacement for fishmeal in the diets of the African Mud Catfish, *C. gariepinus* (Burchell 1822).

Apart from optimum protein requirement for satisfactory growth, fish performance can also be affected by various water quality parameters; such as temperature, pH, dissolved oxygen (DO), conductivity along with inherent factors of growth and species differences (Balogun et. al., 2004). Average water temperatures fell within 20.60^{0}C-28.30^{0}C, conductivity of 92.00µS-290.00µS, pH of 6.50-7.80 and dissolved oxygen of 2.46mg/l-8.70mg/l recorded during this experimental period fell within the normal range required for optimum fish growth in fresh water fish culture. This is in line with the report of Auta, (1993) who observed a temperature range of 25^{0}C-30^{0}C, pH 6.7-9.0 and dissolved oxygen of 5.0mg/l in a similar experiment carried out in tanks. Adeogun et al., (2004), reported a temperature range of 25^{0}C-30^{0}C; pH of 6.0-7.7 and dissolved oxygen of 3.0-10.0mg/l for Heterobranchus and Heteroclarias cultured in pond system. In addition, Balogun, et al .(2004), reported a temperature range of 23^{0}C-27^{0}C, pH 6.3-7.8 and dissolved oxygen of 6.3-9.6mg/l for optimal growth performance of *Oreochromis niloticus* cultured under aquaria conditions.

5.2 ECONOMIC STUDY

The cost evaluation showed that the inclusion of cowpea husk in African catfish diets seemed to be economic and sharply reduced the feed cost of African catfish fingerlings diets as recorded in Table 7. These results indicated that inclusion of cowpea husk in Africa catfish diets reduced the total cost of feed cost. However, high levels of supplementing fishmeal by cowpea husk above 25% adversely affected the growth and feed utilization parameters (Table 6). Incorporation of cowpea husk in the diets of the African catfish could be economic, as this supplementation sharply reduced feed costs by 8.36%, 19.50% and 25.10%, for TD2, TD3, and TD4 respectively.

SUMMARY, CONCLUSION AND RECOMMENDATION

From the aforementioned results, it could be concluded that incorporation of plant protein sources such as cowpea husk can substitute fish meal in African catfish fingerlings diets at 25% of fish meal protein under similar experimental conditions.

The economic study showed a reduction in the feed cost of African catfish supplemented with cowpea husk.

From the forgoing, it is therefore recommended as follows that;

(i) further studies be carried out using cowpea husk meal as fish feed in other species.

(ii) experiment to be carried out using cowpea husk inclusion in fish feeding trials under aquaria and earthen ponds conditions.

(iii) further research is to be conducted into the partial inclusion of cowpea husk meal up to fifty percent (50%) or less with smaller differences in the inclusion levels.

(iv) fish feed industries and fish nutritionist should include cowpea husk meal up to 25% in fish diets as protein substitute to cut down cost of production, also providing a good profit margin.

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