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Michael KG
Department of Fisheries, Modibbo Adama University of Technology, Yola, Nigeria

Amos N
Department of Fisheries, Modibbo Adama University of Technology, Yola, Nigeria

Solomon K
Department of Fisheries, Modibbo Adama University of Technology, Yola, Nigeria

Corresponding Author:
Michael KG
Department of Fisheries, Modibbo Adama University of Technology, Yola, Nigeria

Growth performance of *Clarias gariepinus* fingerlings fed varying inclusion levels of toasted African mesquite (*Prosopis africana*) seed meal

Michael KG, Amos N and Solomon K

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Abstract
Growth performance of *Clarias gariepinus* fed varying inclusion levels of toasted *Prosopis africana* seed meal was carried out for 40days in a plastic tank. African mesquite was toasted. 40% crude protein diets were formulated using Pearson square method in which African mesquite seed meal was included at varying levels of Diet 1 - 0%, Diet 2 - 5%, Diet 3 - 10%, Diet 4 - 15% and Diet 5 - 20% African mesquite seed meal. 100 *Clarias gariepinus* fingerlings were acclimatized for 24hours and stocked in 40 Liter circular plastic tank, each tank was duplicated and labeled according to the inclusion level. The initial weight and length were taken at the beginning of the experiment and also weekly to adjust the quantity of feed given to the fish at 5% body weight. Feeding was done two times a day (morning and evening). Water quality was measured and experiment monitored for daily mortality. The cost benefit analysis was also determined. The result of the experiment shows that the best weight gains (28.22 ± 5.23^{a}), specific growth rate (1.90 ± 0.25^{a}), feed conversion ratio (0.88 ± 0.08^{b}), relative growth rate (82.42 ± 4.06^{a}), protein intake (959.5 ± 85.6), protein efficiency ratio (0.0045 ± 0.00^{a}), feed intake (24.7 ± 2.20^{a}) and gross energy (4.55 ± 0.00) were from fish fed with Diet 5. The temperature, dissolved oxygen and pH were not significantly different ($p\leq0.05$). The highest net production value with (28225.00 ± 529.66^{a}), and benefit cost ratio with (521.36 ± 78.94^{a}) were recorded in Diet 5. Based on findings from this research, 20% inclusion of *Prosopis africana* seed meal can replace soybean without affecting the profit of the farmers.

Keywords: *Prosopis africana, Clarias gariepinus,* weight gain, specific growth rate, feed conversion ratio

Introduction
Good nutrition in animal production systems is essential to economical production of a healthy, high-quality product [1]. In fish farming (aquaculture), nutrition is critical because feed typically represents approximately 50 percent of the variable production cost. Fish nutrition has advanced dramatically in recent years with the development of new, balanced commercial diets that promote optimal fish growth and health. The development of new species-specific diet formulations supports the aquaculture industry as it expands to satisfy increasing demand for affordable, safe, high quality fish and seafood products [1].

One of the areas which the fisheries potential of Nigeria could be exploited is through aquaculture, the development and expansion of which would however depend mainly on many factors [2]. These include the availability of good quality and relatively inexpensive feed ingredients for the formulation of compounded food since supplement feed brings greater yields in ponds than if the fish were left to depend on natural (aquatic) food. Various feeds are used in culturing fishes to enhance adequate fish growth, reproduction and survival [2].

Soybean meal is the most extensively used plant protein source in livestock diets as it has a high crude protein content and a well-balanced essential amino acids profile [3]. However, inclusion of soybean in practical fish rations is constrained by its competitive use as a dietary protein source for human, livestock nutrition, use in bio-fuel, decline in national production and increasing costs have encouraged the search for a substitute [4]. Hence, it is important to evaluate the nutritive value of other inexpensive under-utilized plant protein sources that would replace soybean meal such as mesquite seed.

Prosopis africana seed is among these abundant plants. It can be found growing wild in Nigeria and other parts of West Africa [5]. The fruits occur as pods which are dark brown cylindrical thick and hard shiny up to 15 x 3 cm with woody walls compartmented; about 10

loose rattling seeds per pod [5]. Its common names include African mesquite, Iron tree, while its local Nigerian names are Kiriya (Hausa), Ayan (Yoruba) and Ubwa (Ibo) [6]. This study therefore, assesses the replacement of soya bean meal with *Prosopis africana* in the diet of *Clarias gariepinus.*

Materials and methods

Experimental site

The experiment was carried out in the research farm of Fisheries Department School of Agriculture and Agricultural Technology, Modibbo Adama University of Technology Yola, Adamawa State Nigeria. Adamawa state is located within the semi-arid zone of northern guinea savannah and lies between latitude 9.01^0 North and Longitude 12.04^0 East [7]. The climate is tropical with two distinct dry and wet seasons. The wet season commence in April and end in late October, while the dry season starts in November and end in April.

Seed collection and processing

The mesquite seed was obtained within school of Agriculture premises. The seed was toasted by the use of gas cooker until the color changed and cracked.

Plate 1: *Prosopis africana* Pulp

Plate 2: *Prosopis africana* Seed

Proximate composition

The *P. africana* seed and the experimental diets was analyzed for proximate composition following the methods of Association of official analytical chemical [8] for crude protein, crude fiber, total ash, crude lipid and moisture content while gross energy was calculated.

Crude protein

Khjeldah method was used in determining the crude protein of the samples [9]. Each sample was digested with concentrated Tetraoxosulphate VI acid which converted the nitrogen to ammonium hydrogen to ammonium hydrogen sulphate. The digestion was accelerated by adding copper salt as khjeldah catalyst to increase the boiling point and activate digestion. Digestion of the sample was place in a fume cupboard for 2 hours and a clear solution was formed. The mixture was made alkaline by adding 50ml of 40% sodium hydroxide [NaOH] solution. The digested material produced was distilled into 25ml of 4% boric acid for 10 minutes. The extracted amount of ammonia indicating total nitrogen was determined by titration with 0.47M hydrochloric acid [HCl] until the initial color of the indicator [boric acid] obtained by multiplying the total nitrogen by a factor of 6.25.

Crude fibre

The crude fiber indicates the indigestible matter or roughage. Each sample was defatted with petroleum ether using soxhlet system as described for crude lipid. 2g of defatted sample was weighed into 600ml. 100ml of trichloroacetic acid digestion reagent was boiled and reflux for 40 minutes beginning from the time boiling started. The flask was removed and cooled slightly. The concentration was filtered and the residue was six times with hot distilled water and once with methylated spirit. The residue was transferred into a porcelain crucible. The porcelain crucible was dried in an oven at 100ºC for 3hours, cooled in a desiccator and weighed. The sample was then ashed in a muffle furnace at 550^0c for 6 hours, cooled in a desiccator and weighed. The crude fiber content was calculated as follows: Crude fiber [%] = WA-WB/WA × 100 Where WA= initial weight of sample, WB = final weight of sample

Ash content

2g of each sample was weighed into an empty porcelain crucible, which was later ignited, cooled in a desiccator and weighed. The sample was ignited in a fume cupboard to ash the organic matter. The crucible was placed in a muffle furnace maintained at 550^0c for 8 hours after which it was transferred immediately into a desiccator, cooled and weighed. The inorganic residue constituted the ash in the samples bellows: Ash content [%] = weight of crucible +ash-[weight of crucible]/sample weight

Crude lipid

The lipid in each sample was extracted with petroleum ether following automated method using soxhlet [Ht2 model]. 2g of each grounded sample was loaded into each thimble of the soxhlet system and stopped with cotton wool. The thimble was dried and inserted into the soxhlet system. Extraction cups [with boiling chips] was dried and weighed; then 50ml of the extraction oil was put into each cup. The cups were inserted into the soxhlet. Lipid was extracted for 15 minutes in boiling position. The solvent was evaporated. The cups was released and dried at 100^0c for 30 minutes, cooled in a desiccator and weighed. Crude lipid calculation was as follows: Crude lipid [%] = w_3-w_2/w_1 × 100 Where w_1 = weight of empty crucible
W_2= weight of empty cup+ processed meal
W_3 = weight of cup with the extraction oil

Moisture content

2g of each fresh sample was weighed into a clean pre-weighed porcelain crucible with a removable lid, to 0.1mhg. The uncovered dish was placed in a well- ventilated oven maintained at 103 ± 2^0c. The lid was placed for 30 minutes after which it was weigh as quickly as possible. The dish with the sample was replaced in the oven with lid for another two hours. The lid was then removed, cooled in a desiccator and re-weighed. They were repeated until a decreased in weight between successive weighing did not exceed 0.05mg of the sample [fresh wet basis]. Loss in weight was reported as moisture content as follows:
Moisture content [%] = m_1-m_2/m_1-m_2 × 100

Where m_0=weight of lid in g
m_1= weight of sample with lid before drying in g
m_2= weight of sample with lid after drying in g

Dry matter content
This was calculated as shown below: Dry matter content [%] = 100-% moisture content

Phytochemical screening
Both the qualitative and quantitative phytochemical were determined of both the raw and toasted *Prosopis africana* seed.

Tannins
Take 0.5g of the dried powder plant boil 0.5g sample in 20ml of water in the test tube. Filter the above mixture add few drops of 0.1% ferric chloride. Development of a brownish green or a blue –black coloration indicated the presence of tannins.

Flavonoids
The extract was treated with few drops of sodium hydroxide solution. Formation of intense yellow color, which becomes colorless on further addition of dilute acid, indicated the presence of flavonoids. Alkaline regent test to the extract few drops of lead acetate solution was added, formation of yellow coloration

Saponin
About 0.5g of the plant extract was shaken with water in test tube, frothing which persists on warming considered as preliminary evidence for the presence of saponins. Few drops of olive oil was also added and vigorously shaken, formation of soluble emulsion in the extract indicates the presence of saponins [10]

Steroid
100mg of the extract was dissolved in 2ml of chloroform and few of sulphuric acid was carefully added to form a lower layer. A reddish brown color at the interface indicates the presence of steroidal ring [11]

Glycoside
A total of 100mg of extract was dissolved in 1ml of glacial acetic acid containing one drop of ferric chloric solution, it was then under layered with 1ml of concentrated sulphuric acid and brown ring obtained at the interface indicate the presence of de-oxysugar characteristics of cardenolides. (keller killiani test)

Diet formulation
After preparing the ingredients, they were weighed and mixed in appropriate proportions to give 40%CP level required by the fish.

Table 1: A diet of 40% CP was formulated using the following ingredients

Ingredients	Control	D1	D2	D3	D4
Inclusion level	0%	5%	10%	15%	20%
Fish meal (60%)	24.18	24.18	24.18	24.18	24.18
Soybean meal (48%)	24.18	22.97	21.76	20.55	19.34
Prosopis africana seed meal (23.88%)	0.00	1.21	2.42	3.63	4.84
Groundnut cake (40%)	24.18	24.18	24.18	24.18	24.18
Maize (10%)	22.56	22.56	22.56	22.56	22.56
Vitamin premix	1.00	1.00	1.00	1.00	1.00
Calcium	2.00	2.00	2.00	2.00	2.00
Salt	0.4	0.4	0.4	0.4	0.4
Palm oil	1.00	1.00	1.00	1.00	1.00
Starch	0.50	0.50	0.50	0.50	0.50
Total	100	100	100	100	100
Calculated crude protein	40	39.69	39.39	39.08	38.78

Experimental design
Five experimental feed with varying percentage inclusion of mesquite meal (Diet 1 - Control, Diet 2 - 5%, Diet 3 - 10%, Diet 4 - 15% and Diet 5 - 20%). They were fed 5% of their body weight twice daily 7.00-8.00am and 5.00-6.00pm. Excess feed were siphoned every morning and water increased to a preferred volume. Subsequently, the fish weights and length were taken at one-week interval and feed rations adjusted according to the new weight. Dead fish was monitored daily, removed, counted and recorded. 100 fingerlings were randomly divided into five experimental groups with varying inclusion levels 0, 5, 10, 15 and 20% (10 fingerlings *C. gariepinus* in replicates) in a completely randomized design

Water quality monitoring
Temperature, dissolved oxygen, ammonia and pH were monitored during the experiment.

Temperature
The water temperature was determined using thermometer. The instrument was inserted into the water with the mercury end in the water; the meter was allowed for stable reading and was recorded.

Dissolved oxygen
This was determined using Niffr indicator. Small quantity of water was fetched from the experimental tank using plastic container. Then, the indicator was dropped two times bearing Winkler solution 1 and 2. After the drop, it was checked to know the amount of dissolved oxygen in the water.

Ammonia
Using a bulb pipette, 10 mL aliquot of the cleaning solution sample was quantitatively transferred to a 100 mL volumetric flask. It was diluted to the mark with distilled water, and the stopper was replaced and mixes the contents by inverting and swirling the flask a number of times. Using a bulb pipette, quantitatively transfer a 25 mL aliquot of the diluted cleaning solution sample to a 250 mL Erlenmeyer flask. The inside of the flask was washed down with about 50 mL of distilled water delivered from a wash bottle. 2 drops of methyl red

indicator was added and mix well carefully. 50 mL burette with standard 0.05 M sulfuric acid solution, M (sulfuric) was filled. The diluted cleaning solution was then titrated to the first sign of a permanent pink end point (using a white tile beneath the Erlenmeyer flask during the titration). The titre to the nearest 0.01 mL was recorded [12]

$$C\ (ammonia) = \frac{2 \times M\ (sulfuric) \times T\ (sulfuric) \times Mr\ (ammonia)}{25}$$

Where Mr (ammonia) is the formula mass of ammonium hydroxide

pH
The pH values were determined using pH-meter. The electrode was dipped into the water and the values read on the pH meter.

Experimental procedure
100 *Clarias gariepinus* fingerlings were purchased from a reputable fish farm. They were acclimatized for 24 hours before the commencement of the experiment. The initial weight was taken and recorded using sensitive weighing balance and the length using meter ruler.

Growth and Nutrient Utilization Parameters
Weight gain = Final weight (Wf) – Intial weight (Wi)

$$\text{Mean weight gain (g)} = \frac{\text{final weight[g]} - \text{initial weight gains[g]}}{\text{n (no of weeks)}}$$

$$\text{Survival rate [\%]} = \frac{\text{Number of fish at the beginning}}{\text{Number of fish at the final}} \times 100$$

Condition factor [K]: This expresses the health status of fish as a result of the experimental treatment was computed at the beginning and end of the experiment using the Fulton's Condition Factor Formula:
$K=100W/L^3$ where W is the weight of the fish and L is the length of fish

$$\text{Specific growth rate [g/day]: this was determined as: } = \frac{log\ final\ weight - log\ initial\ weight}{Experimental\ period(in\ days)} \times 100$$

$$\text{Relative growth rate (\%)} = \frac{\text{Final weight (Wf)} - \text{Initial weight (Wi)}}{\text{Final weight (Wf)}} \times 100$$

Protein Intake (g/kg) = Total feed consumed [g] × crude protein in feed

Feed Intake (g) = this was the amount of feed fed throughout the period of the experiment

Mean feed intake (g) = feed intake/experimental period
Feed Conversion ratio = Feed intake(g)/weight gain (g)
Protein efficiency ratio = mean weight gain of the fish (g) /protein intake (g)

Economic Evaluation
The production cost in Naira of the experimental diets was calculated following the method of New 1989, and modified [13] based on the current market price of the ingredients used for formulating the diets and fish cultured.

Estimated Investment Cost Analysis
This was calculated as:
Investment cost analysis (ICA) = cost of feeding (₦) + cost of fingerlings stocked (₦)

Net Production Value (NPV)
This was taken as the cost of all fish harvested at the end of the experiment as: NPV = Total weight gain× cost /kg

Gross Profit (GP)
This was taken as the difference between the net profit value and investment. GP = Net profit – Investment cost analysis

Profit Index (PI)
This was determined using this equation below: Profit index = Net profit value (₦) /cost of feeding (₦)

Benefit Cost Ratio
This was determined as: Benefit cost ratio = Net profit value (₦) / Investment cost analysis (₦)

Statistical Analysis
Raw data generated was subjected to descriptive statistics while mean was subjected to one-way analysis of variance (ANOVA), significance difference was compared at 5%. Ducan multiple range test was used to separate the means.

Results
The proximate composition of both raw and toasted African mesquite seed is presented in Table 2. The proximate analysis shows that the raw Africana mesquite seed has a moisture content of 6%, ash 2.20%, crude protein 18.75%, crude fibre 5.10%, crude lipid 4%, nitrogen free extract 63.95% while the toasted African mesquite seed has moisture content of 2%, ash 3.6%, crude protein 23.88%, crude fibre 5.0%, crude lipid 9.5% and the nitrogen free extract 56.02%.
The proximate analysis of the experimental diets is presented in Table 3. The crude protein ranges from 38.75 to 39.94%, crude lipid 19.5 to 21%, crude fibre 4.8 to 4.9%, ash 6 to 10%, moisture 8 to 13.46% and nitrogen free extract 13.16 to 21.2%
The quantitative phytochemical analysis in table 5 shows that the raw African mesquite seed has saponin 3.55, tannin 2.35, flavonoids 1.35 and glycoside 0.62 while the toasted has saponin 3.45, tannin 2.40, flavonoids 1.40 and glycoside 0.41. Steroid was not available in both raw and toasted *Prosopis africana* seed.
Table 6 shows the growth performance and nutrient utilization of *C. gariepinus* fingerlings. Fish fed diet 5 gives better growth performance than others. Mean weight gain was highest with 4.70 in Diet 5 and the least was 1.71 in Diet 2. There was significant difference ($p \leq 0.05$) between the mean weight gain of Diet 5 and others.
The feed conversion ratio decreases as the inclusion of the *Prosopis africana* seed meal increases with the exception of Diet 2 that is the highest. The gross energy was high in Diet 4 (4.78) and least in Diet 1 (4.27). The protein intake was highest in Diet 5 and lowest in Diet 2. The best feed conversion ratio is in this sequence Diet 2>Diet 1>Diet 3>Diet 4>Diet 5
Water quality conditions in the experimental tanks showed little variation throughout the duration of the experiment (Table 7). Temperature ranges from 27.37 to 28.00°c, dissolved oxygen from 4.95 to 5.40mg/l, pH from 6.49 to 6.52 and ammonia from 0.61 to 0.66

Table 8 shows the following results obtained which are the cost of feed which has the range between 20.95 to 23.04 in which Diet 1 has the highest value of 23.04 and Diet 5 had the lowest value of 20.55, cost of feeding was recorded highest in Diet 1 with value of 29.94 and lowest value in Diet 5 with value of 26.55 The gross profit in Diet 5 was highest and lowest in Diet 2, the profit index was recorded highest in Diet 5 with 768.89 and lowest in Diet 2 with the value of 450.43 and lastly Benefit Cost Ratio of 521.36.44 was recorded highest in Diet 5 and lowest in Diet 2 with 229.19 values.

Table 2: Proximate composition of raw and toasted African mesquite seed on dry basis (%)

Parameters	Raw	Toasted
Moisture	6.00	2.00
Ash	2.20	3.60
Crude protein	18.75	23.88
Crude lipid	4.00	9.50
Crude fibre	5.10	5.00
Nitrogen free extract	63.95	56.02

Table 3: Proximate composition of the experimental diets (%)

Experimental diets	D1	D2	D3	D4	D5
Moisture	12.00	13.46	10.00	8.00	8.00
Ash	10.00	6.00	6.00	6.00	10.00
Crude protein	39.94	39.63	39.31	39.00	38.75
Crude lipid	20.00	21.00	19.50	21.00	21.00
Crude fibre	4.90	4.80	4.80	4.80	4.90
Nitrogen free extract	13.16	15.11	20.39	21.20	17.35

Keys: D1-Control diet, D2-5% *Prosopis africana* meal diet, D3-10% *Prosopis africana* meal diet, D4-15% *Prosopis africana* meal diet, D5-20% *Prosopis africana* meal diet

Table 4: Qualitative phytochemical present in raw and toasted African mesquite seed

	Raw	Toasted
Saponins	***	**
Tannins	**	***
Flavanoids	*	**
Glycoside	NA	*
Steroid	NA	NA

Keys
*** High present, ** Moderate, * Low, NA Not available

Table 5: Quantitative phytochemical present in raw and toasted *Prosopis africana* seed

	Raw	Toasted
Saponins	3.55±1.34	3.45±1.62
Tannins	2.35±0.63	2.40±0.84
Flavanoids	1.35±0.63	1.40±0.84
Glycoside	0.62±0.10	0.41±0.12

Table 6: Growth Performance and Feed Utilization of *C. gariepinus* Fed Experimental Diets for 40 days

Parameters	D1	D2	D3	D4	D5
Mean initial weight (g)	5.35±0.49	5.50±0.14	6.00±0.56	4.45±1.62	5.90±0.56
Mean final weight(g)	20.2 ± 0.50^{bc}	15.8 ± 0.23^{c}	24.8 ± 2.58^{b}	20.80 ± 1.47^{bc}	34.1 ± 4.6^{a}
Mean initial length(cm)	8.53±0.66	8.36±0.63	8.85±0.49	8.43±1.23	8.75±0.06
Mean final length(cm)	10.95 ± 0.63^{b}	10.66 ± 0.41^{b}	11.07 ± 0.31^{b}	10.82 ± 1.23^{b}	14.1 ± 0.63^{a}
Weight Gain(g)	14.85 ± 0.01^{bc}	10.33 ± 0.37^{c}	18.83 ± 2.02^{b}	16.35 ± 0.14^{bc}	28.22 ± 5.23^{a}
Mean Weight Gain (g/fish)	2.47 ± 0.00^{bc}	1.71 ± 0.06^{c}	3.13 ± 0.33^{b}	2.72 ± 0.02^{bc}	4.70 ± 0.87^{a}
Survival Rate (%)	100.00 ± 0.00^{a}	100.00 ± 0.00^{a}	95.00 ± 7.07^{ab}	90.00 ± 0.00^{b}	90.00 ± 0.00^{b}
Initial Condition Factor	0.86±0.12	0.95±0.19	0.86±0.06	0.72±0.04	0.87±0.10
Final Condition Factor	1.54±0.23	1.31±0.16	1.82±0.02	1.68±0.45	1.21±0.00
Specific Growth Rate	1.44 ± 0.07^{ab}	1.14 ± 0.04^{b}	1.53 ± 0.01^{ab}	1.70 ± 0.33^{a}	1.90 ± 0.25^{a}
Relative Growth Rate (%)	73.54 ± 1.79^{ab}	65.25 ± 1.40^{b}	75.82 ± 0.24^{a}	78.83 ± 6.30^{a}	82.42 ± 4.06^{a}
Protein Intake(g)	783.96 ± 74.5^{ab}	565.1 ± 36.8^{b}	844.2 ± 83.1^{ab}	698.1 ± 184.2^{ab}	959.5 ± 85.6^{a}
Feed Intake(g)	19.6 ± 1.86^{ab}	14.2 ± 0.92^{b}	21.95 ± 2.14^{a}	17.9 ± 4.72^{ab}	24.7 ± 2.20^{a}
Mean Feed Intake (g)	0.48 ± 0.04^{ab}	0.35 ± 0.02^{b}	0.53 ± 0.05^{ab}	0.44 ± 0.12^{ab}	0.61 ± 0.04^{a}
Feed Conversion Ratio	1.31 ± 0.12^{a}	1.37 ± 0.03^{a}	1.13 ± 0.01^{ab}	1.09 ± 0.29^{ab}	0.88 ± 0.08^{b}
Protein Efficiency Ratio	0.0025 ± 0.00^{b}	0.0025 ± 0.00^{b}	0.0030 ± 0.00^{ab}	0.0035 ± 0.00^{ab}	0.0045 ± 0.00^{a}
Gross Energy(kcal/g)	4.27±0.00	4.46±0.00	4.60±0.00	4.78±0.00	4.55±0.00

Mean of Data on the same row with different superscript are significantly difference ($p\leq0.05$)

Table 7: Water Quality Parameter of Water used for Experiment for 6 weeks

	D1	D2	D3	D4	D5
Temperature(°C)	28.00±0.70	27.37±0.53	27.75±0.35	27.87±0.88	27.87±0.53
Ammonia(mg/l)	0.61±0.01	0.63±0.31	0.65±0.03	0.64±0.03	0.66±0.02
pH	6.49±0.04	6.49±0.03	6.52±0.00	6.49±0.00	6.49±0.00
Dissolved Oxygen (mg/l)	5.21±0.02	5.34±0.15	5.40±0.13	4.95±0.38	5.13±0.20

Table 8: Cost Benefit Evaluation of Experimental Diets

Parameters	D1 (0%)	D2 (5%)	D3 (10%)	D4 (15%)	D5 (20%)
Estimated Investment Cost(Naira)	49.63 ± 1.57^{ab}	45.08 ± 0.78^{b}	51.22 ± 1.81^{a}	48.17 ± 4.00^{ab}	43.99 ± 1.87^{b}
Net Production Value(Naira)	14855.00 ± 7.07^{bc}	10335.00 ± 374.66^{c}	18830.00 ± 2022.32^{b}	16355.00 ± 148.49^{bc}	28225.00 ± 529.66^{a}
Gross Profit(Naira)	14805.36 ± 5.49^{bc}	10289.91 ± 373.98^{c}	18778.77 ± 2020.50^{b}	16306.82 ± 152.50^{bc}	28171.00 ± 5237.78^{a}
Cost of Feeding(Naira)	29.04 ± 1.76^{b}	29.94 ± 0.85^{c}	31.59 ± 2.59^{a}	27.15 ± 4.40^{bc}	26.55 ± 3.19^{bc}
Cost of Feed(Naira)	23.04 ± 1.76^{b}	20.94 ± 0.85^{c}	25.59 ± 2.59^{a}	21.15 ± 4.40^{bc}	20.55 ± 3.19^{bc}
Profit Index	512.38 ± 30.81^{b}	450.43 ± 0.46^{b}	595.35 ± 15.11^{b}	610.76 ± 104.55^{b}	768.89 ± 76.12^{a}
Benefit Cost Ratio	299.42 ± 9.36^{bc}	229.19 ± 4.32^{c}	367.12 ± 26.45^{b}	340.79 ± 31.44^{b}	521.36 ± 78.94^{a}

Mean of Data on the same row with different superscript are significantly difference ($p\leq0.05$)

Discussion

The protein content of the toasted seed was higher with value of (23.88) than the raw one (18.75) this is similar to the work of Aremu *et al.,* [14]. Crude protein value of raw *Prosopis africana* which was 18.75 is low when compared with some selected legumes such as wild jack bean (*Canavelia ensiformis*) which is 28.9 – 35.0% [15] and *Baulinia nonander* which is 33.0% [16]. Processing method such as toasting enhances crude protein of *Prosopis africana* seed. Processed *Prosopis africana* seed meal could therefore be used as an alternative source of protein in the diet/protein supplement especially in nation like Nigeria where the majority of the populace lives on starchy food and cereals. Protein requirement is given high priority in any nutritional study because it is the single nutrient that is required in the largest quantity for growth and development and also the most expensive ingredient in diet formulation [17, 18].

Dietary lipids function as a ready source of energy for fish and also provide essential fatty acids which are needed for fish growth and survival. Fish generally require omega-3 fatty acids rather than omega-6 fatty acids in contrast to terrestrial animals which require omega-6 fatty acids [19]. Previous works of Oso *et al.,* [20] showed the need to use plant meal in combined form to produce the cheapest and required nutrient for fish and this formed the basis of this research work.

The crude proteins from the five diets are within the requirements recommended for catfish *C. gariepinus* fingerlings in tropics which agreed with the work of Oso *et al.*; Eyo and Falayi [20, 21]. The results obtained in these studies agreed with Fasakin *et al.*; Ugwumba, *et al*., [22, 23] that relatively low fibres and high protein contents as revealed in the fish growth and better utilization by fish growth and feed conversion ratio in this studies. Fibre has been documented to support or promote digestion when is low in feed.

It was found that moisture content of the experimental diets including control was below 20% and this corresponds with the theoretical range of moisture content in all low moisture food [24]. All the diets, however, did not exceed 75% any feed sample that does not exceed 75% moisture content is/are suitable to be utilized as foodstuff for animals. Therefore, *Prosopis africana* bean meal diets can be classified as low moisture, biological material; hence it is safe for biological spoilage.

The phytochemicals screening of *Prosopis africana* seed confirmed the presence of saponin, tannin, glycoside and flavonoids, while steroid is absent. The absent of steroid is an indication that *Prosopis africana* seed cannot be used to boost reproductive performance in fish. Similar report has been observed in *Azadirachta indica* by Akiwande and Sogbesan [25] this agrees with the report of Samuelsson *et al.,* [26]. Saponins foam can coat fish gill epithelia, this coherent with the report of Adeogun [27] that saponins are present in *R. hookeri* and it cause hyperventilation, rapid opercula movement, and mortality in mud-catfish. Emad *et al.,* [28] Reported that plants such various phytochemical constituents present have the tendency of poisoning fish most especially tannin.

The highest growth response is recorded in Diet 5 inclusion of African mesquite seed meal which supports the growth of fish at 20% inclusion level. There were significantly different ($p \leq 0.05$) in the Diet 5 and Diet 4 which reflected that the feed is palatable to the fish. This result is in agreement with the work of Oso *et al.;* Olukunle; olukunle and Falaye [20, 29; 30]. In Table5, the increase in the weight gain recorded in all the treatment also indicated that the fish responded positively to all the diet and that the protein content of african mesquite seed meal diet enhanced the growth of fish. This observation is in agreement with the report of Fagbenro [31] as well as Oso *et al.,* [20]

The high specific growth rate, high feed efficiency rate, high protein efficiency ratio and low feed conversion rate value of fish Diet 5 (20% African mesquite seed meal and 80% soybean meal) confers it with better advantages for growth and efficiency of feed utilization over the rest of the experimental formulated diets. This result agrees with the assentation of Olaniyi [32] who stated that the higher the specific growth rate and the smaller the feed conversion ratio, the better the feed quality. Adiku [33] also reported that a lower feed conversion ratio value implies efficient feed utilization by fish. The ability of an organism to utilize nutrient especially protein will positively influence its growth performance. This is justified by the best PER at 20% inclusion of African mesquite seed meal diet when fed to *C. gariepinus* fingerlings. Lower feed conversion ratio indicates better feed utilization consumed by the fish. The ability of an organism *to* utilize nutrient especially protein will positively influence its growth performance. Weight gain and length increase are known to be the most important indices for measuring fish responses to experimental diets and very reliable indicators of growth [34].

The physic-chemical parameters of water were within the acceptable range recommended for rearing and culture of most tropical fish, including the African catfish [35, 36] *C. gariepinus* like any other fish species require optimum level of these water parameters for optimum survival, growth and production. Boyd and Lichotkopler [37] reported that pH of 6.5-9.0 and temperature of 22-27°C gives the best growth for cultured tropical fishes. Adesulu [38] indicated that any dissolved oxygen value below 4mg/l begins to stress fishes and pH kills fish due to corrosive effect, such acidic water diminishes the appetites of fish and thus reduces their growth rate, at pH of 9, water becomes unproductive because carbon dioxide becomes unavailable in such water and at pH 11, fish dies. The hydrogen ion concentration (pH) in this study ranged between 6.01-6.51.

The aim of every fish farmer is to make profit at the end of the culture period. Since the cost of feed has been one of the major constraints to the development of aquaculture sector, provisions of alternative ingredient that will be able to reduce certain percentage of the cost incurred by feeding overhead should be embraced. The reduction in cost of production of the experimental diets from Diet 1 (control) to the African mesquite seed inclusion diets (Diet 2, 3, 4 and 5) is an indication of the cost effectiveness of using African mesquite seed meal as a conventional feedstuff in fish feed formulation (Table 1). This is dissimilar to the report that non-conventional feedstuffs (NCFRs) are cheap byproducts or waste from agriculture, farm made feeds and processing industries [39] the feed cost per kilogram weight was highest ($p \leq 0.05$) in control which is justified by high cost of soybean meal. Least cost supplemented diet is expected to affect the skilled and un-skilled labor market, land, water, environmental resources required for its processing, investment needs for its utilization on both small and large scale basis and socio-economic impact of its utilization. The estimated investment cost ratio revealed that Diet 5 is the most least expensive and also has the best benefit cost ratio which remains the diet that farmers can gain most. The

estimated investment cost ratio revealed that Diet 1 is the most expensive while benefit cost ratio reveals Diet 5 as the diet that farmers can gain most.

Conclusion

In conclusion, 20% inclusion level of African mesquite seed meal diets recorded best weight gain and benefit cost ratio than other inclusions level. Therefore, toasted mesquite seed meal could be exploited by the small holder farmer at 20% inclusion level in production of fish feeds to reduce the cost of production of C. *gariepinus* diets.

Recommendation

- It is recommended, 20% inclusion level of African mesquite seed meal can be used in the diet of *C. gariepinus* fingerlings without reducing the weight.
- It is also recommended that more research be done on different African mesquite seed processing techniques for anti- nutritional factors reduction which could maximize its utilization since toasting alone seems not to be effective in removing crude fibre content.
- It is recommended that more works be done on increased inclusion level of African mesquite seed meal in the diet of C. *gariepinus* fingerlings

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