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Growth performance of *Clarias gariepinus* fed locust bean meal (*Parkia biglobosa*) supplemented diets

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Abstract
Growth performance of *Clarias gariepinus* fed with locust bean (*Parkia biglobosa*) supplemented diets was carried out for 56days in a plastic tank. Locust beans were fermented. 40% crude protein diets were formulated using Pearson square method in which fermented locust bean meal was included at varying levels of D1-0%, D2-25%, D3-50%, D4-75% and D5-100%. 150 *Clarias gariepinus* fingerlings were acclimatized for 48hours and stocked in 25L circular plastic bowls; they were triplicated and labelled 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 twice day (morning and evening). Water quality was measured and experiment monitored for daily mortality. Raw data generated was subjected to descriptive analysis while mean was subjected to one-way analysis of variance (ANOVA), significance difference was compare at 5%. The result of the experiment shows that the best weight gains (17.31), specific growth rate, (0.99) and feed conversion ratio (2.55), protein efficiency ratio (0.13) and gross energy (531.80) were from fish fed with D2. The temperature, dissolved oxygen and pH were not significantly different ($p<0.05$) but there was significant difference ($p<0.05$) in the Ammonia concentration with the treatment. The highest gross profit, 434.28 and benefit cost ratio, 3.54, were recorded in D2. Based on findings from this research, 25% inclusion of locust bean meal can replace soybean without affecting the profit of the farmers. Proximate composition, growth and cost benefit analysis was determined.

Keywords: *Parkia biglobosa*, dietary supplement, growth performance, feed utilization, *Clarias gariepinus*

1. Introduction

In fish farming, nutrition is critical because fish feed represents 60% of the total production costs. Fish nutrition has advanced dramatically in recent years with the development of new balanced commercial diets which promote optimal fish growth and health. The development of new species-specific diet formulations support aquaculture i.e. fish farming industry as it expands to satisfy increasing demand for affordable, safe and high quality fish and sea food products (Kanazawa 2000) [1]. Aquaculture is the rational rearing of fish and other aquatic organisms in man-made ponds. As previously reported by Miles and Chapman (2006) [2] 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. 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 (Miles and Chapman, 2006) [2]. Fishmeal which serves as the main protein source for fish feed because of its high quality protein content, is not only expensive but also usually unavailable (Tacon and Barg, 1998) [3] particularly in developing countries. Fagbenro and Davies (2003) [4] and Ogunji *et al*. (2003) [5] reported the efforts to replace fishmeal with vegetable protein from more sustainable sources.

Plants proteins have been extensively studied for use in fish feed formulations for aquaculture (Gatlin *et al.,* 2007) [6]; these include various pulses and lupins in carnivorous fishes such as rainbow trout *Oncorhynchus mykiss* (Glencross *et al.,* 2004) [7]. Ordinarily, plants provide nearly two thirds of the world supply of food protein for human and animal in which 10-15% come from legumes. Among the leguminous plants used by man is the African locust bean tree (*Parkia biglobosa*). Since the primary objective of fish nutrition work is geared towards

reducing protein cost in fish feed, it is of interest to investigate and utilize the suitable abundant conventional and non-conventional feed resources available in Nigeria for feed formulation. Cook *et al*. (2000) [8] and Lockeett *et al*. (2000) [9] showed that *P. biglobosa* is a plant legume with an outstanding protein and amino acid composition. The most conventional protein source used in fish feed such as soya bean meals are becoming expensive especially to fish farmers in Nigeria. Also, the competing demand for fish feed stuff such as corn, soya bean and groundnut cake has made feed production expensive. This high demand for this feed stuff by man and consequently the high price has made other means such as *P. biglobosa* (African locust bean) inevitable.
This work is therefore intended to evaluate effects of locust beans in the feed of *Clarias gariepinus* as a protein source.

2. Materials and Methods

2.1 Seed collection and processing

The locust bean was obtained from Girei market, the locust beans were fermented according to the method of (Ann, 1988) [10] by first cooked the seeds for 24 hours at 100 ^{0}C, addition of water frequently to soften the seed coats. The cooked beans seed coats were removed by pounding in a mortar and washed severally to remove seed coats. The seeds were slowly boiled again for 3 hours at 30 ^{0}C until they become softer. The de-coated seeds were fermented by spreading them in a basket and covered with leaves for 72 hours at 32^{0}C. After then, the seeds were spread to dry under the sun for several hours. Five experimental feed varied percentage inclusion of locust bean meal (D1-0%, D2-25%, D3-50%, D4-75 and D5-100%).

2.2 Diet formulation

After preparing the ingredients, they were weighed and mixed in appropriate proportions to give the desired 40% c p level required by the fish. The experimental diet was analyzed for proximate composition following the methods of Association of official analytical chemical (AOAC, 2000) [11] for crude protein, crude fiber, total ash, crude lipid and moisture content while gross energy was calculated.

2.3 Experimental fish

150 *Clarias gariepinus* fingerlings were obtained from a reputable fish farm and transported to the Department of Fisheries Research Farm, Modibbo Adama University of Technology Yola, Adamawa State.

2.4 Growth and nutrient utilization parameters

The growth and feed parameters were determined according to Aderolu *et al*. (2010) [12] method

2.5 Economic evaluation

The production cost in Naira of the experimental diets was calculated following the method of New (1989) [13] and modified by Sogbesan *et al* (2005) [14] based on the current market price of the Ingredients used for formulating the diets and fish cultured.

A. Estimated investment cost analysis

This was calculated as

Estimated value cost analysis = cost of feeding + cost of fingerlings stocked

B. 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

C. Gross Profit (GP)

This was taken as the difference between the net profit value and investment

GP = Net profit – Investment cost analysis

D. Profit Index (PI)

This was determined using this equation below:

Profit index = Net profit value /cost of feeding

E. Benefit Cost Ratio

This was determined as:

Benefit cost ratio = Net profit value / Investment cost analysis

2.6 Statistical analysis

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

3. Results

The proximate composition of both fermented raw locust bean is presented in Table 1. The analysis reveals that the raw locust bean has a moisture content of 6%, ash 4.02%, crude protein 34.98%, crude fibre 5.62%, crude lipid 28.10%, nitrogen free extract 21.38% while that of fermented has moisture 9.5%, ash 2.92%, crude protein 39%, crude fibre 3.4%, crude fat 34% and the nitrogen free extract 11.13%.
Table 2 shows the proximate analysis of the experimental diets. The crude protein ranges from 37.21 to 41.58%, crude lipid 0.21 to 1.97%, crude fibre 16.02 to 22.52%, ash 7.15 to 31.96%, moisture 9.03 to 15.5%2 and nitrogen free extract 13.51 to 28.74%.
Figure 1 shows the weekly length of *C. gariepinus* fed locust bean meal diets. The graphs reflected increase in the weekly length of all the fish fed experimental diets. D2 is the highest in length while D5 has the least.
Figure 2 shows a weekly change in weight of *C. gariepinus* fed locust bean diets. D2 is the highest in weight while D5 is the least.
Table3 shows the growth performance and nutrient utilization of *C. gariepinus* fingerling. Fish fed diet 2 and 1 gives better growth performance than others. Mean weight gain was highest with 5.77 in D2 and the least was 3.53 in D5. There was significant difference ($p<0.05$) between the mean weight gain of D2 and others.
The feed intake decreases as the inclusion of locust bean meal increases with the exception of the control diet. The gross energy was high in D2 (531.80) and least in D3 (434.41). The total protein in-take highest in D1 with 43.85 and lowest in D5 with 36.02. The best feed conversion ratio is in this sequence D2>D1>D3>D4>D5. Water quality conditions in the experimental tanks showed little variation throughout the duration of the experiment (Table 4). Temperature ranges from 26.8o to27.80°c, dissolved oxygen from 4.50 to 5.50mg/l, pH from 6.01 to 6.51 and ammonia from 0.53 to 0.71.
Table 5 shows the cost of feed which range between 183.81 to 186.21, D1 has the highest value of 186.21 and D5 had the lowest value of 183.81, cost of feeding was recorded highest in D2 with value of 136.59 and lowest value in D5 with value of 99.20. The gross profit in D2 was highest with value of

434.28 and lowest in D5 with 237.87, the profit index was recorded highest in D2 with 4.45 and lowest in D5 with the value of 3.76 and lastly Benefit Cost Ratio of 3.54 was recorded highest in D2 and lowest in D5 with 2.87 values.

Table 1: Proximate composition of fermented and raw locust bean on dry basis (%)

Parameters %	Raw	Fermented
Moisture	6.00	9.50
Ash	4.02	2.92
Crude protein	34.98	39.05
Crude lipid	28.10	34.00
Crude fibre	5.62	3.40
Nitrogen free extract	21.38	11.13

Table 2: Proximate composition of the experimental diets (%)

Experimental diets %	D1	D2	D3	D4	D5
Moisture	$9.01^{c}\pm0.01$	$9.03^{c}\pm0.03$	$15.50^{a}\pm0.01$	$13.00^{b}\pm0.01$	$8.51^{d}\pm0.01$
Ash	$14.29^{b}\pm0.01$	$7.14^{e}\pm0.01$	$31.94^{a}\pm0.01$	$9.20^{c}\pm0.01$	$7.66^{d}\pm0.01$
Crude protein	$39.81^{c}\pm0.01$	$37.20^{e}\pm0.01$	$38.07^{d}\pm0.01$	$40.70^{b}\pm0.01$	$41.57^{a}\pm0.01$
Crude lipid	$16.01^{d}\pm0.01$	$16.01^{d}\pm0.01$	$18.01^{c}\pm0.01$	$22.51^{a}\pm0.01$	$18.51^{b}\pm0.01$
Crude fibre	$1.29^{b}\pm0.01$	$1.96^{a}\pm0.01$	$O.20^{e}\pm0.01$	$1.14^{c}\pm0.01$	$0.64^{d}\pm0.01$
Nitrogen free extract	$19.64^{c}\pm0.01$	$28.73^{a}\pm0.01$	$16.60^{d}\pm0.010.01$	$13.5O^{e}\pm$	$23.17^{b}\pm0.01$

Mean of Data on the same row with different superscript are significantly difference ($p<0.05$)

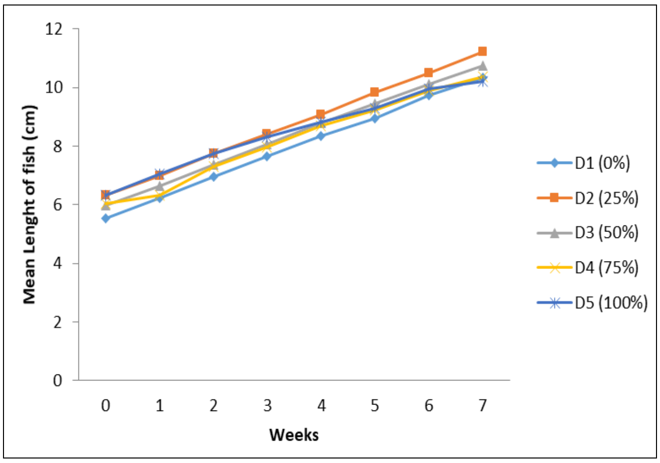

Fig 1: Weekly changes in weight of *C. gariepinus* fed locust bean meal supplemented diets for 56 days

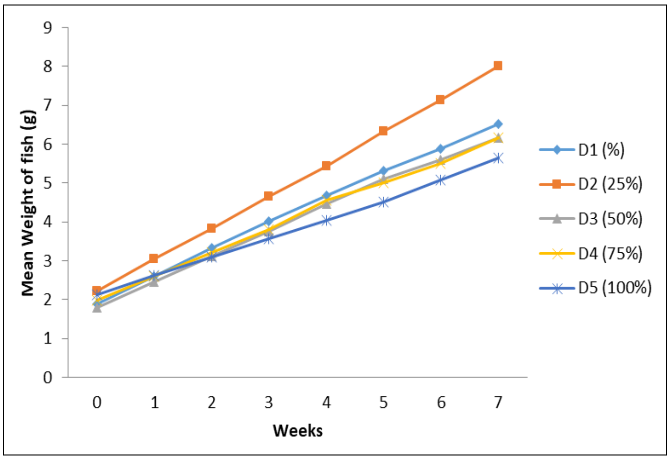

Fig 2: Weekly changes in length of *C. gariepinus* fed locust bean meal supplemented diets for 56 days

Table 3: Growth Performance and Feed Utilization of *C. gariepinus* Fed Experimental Diets for 56 days

Parameters	D1	D2	D3	D4	D5
Total Initial Weight (g)	5.71±0.15	6.70±0.51	5.40± 0.40	5.94 ±0.42	6.36±0.25·
Mean Initial Weight (g/fish)	1.90±0.08	2.23±0.03	1.80±0.38	1.98±0.41	2.12±0.21
Total Final Weight (g)	$19.57^{b}\pm0.21$	$24.01^{a}\pm0.10$	$18.50^{bc}\pm0.09$	$18.48^{bc}\pm0.11$	$16.99^{bc}\pm0.15$
Mean Final Weight (g)	$6.52^{b}\pm0.15$	$8.00^{a}\pm0.53$	$6.16^{bc}\pm0.50$	$6.16^{bc}\pm0.42$	$5.66^{bc}\pm0.23$
Total Weight Gain (g)	$13.86^{b}\pm0.11$	$17.31^{a}\pm0.20$	$13.10^{b}\pm0.10$	$12.54^{b}\pm0.10$	$10.63^{c}\pm0.10$
Mean Weight Gain (g/fish)	$4.62^{b}\pm0.09$	$5.77^{a}\pm0.52$	$4.36^{b}\pm0.11$	$4.18^{b}\pm0.01$	$3.54^{c}\pm0.06$
Relative Weight Gain (%)	243.16±38.34	258.35±22.98	249.26±47.19	218.41±51.80	168.30±17.37
Specific Growth Rate (g/day)	$0.95^{a}\pm0.02$	$0.99^{a}\pm0.05$	$0.96^{a}\pm0.10$	$0.89^{ab}\pm0.12$	$0.76^{b}\pm0.05$
Initial Length	$5.54^{b}\pm0.10$	$6.32^{a}\pm0.06$	$5.98^{ab}\pm0.31$	$6.04^{ab}\pm0.61$	$6.34^{a}\pm0.39$
Final Length	$10.32^{b}\pm0.20$	$11.22^{a}\pm0.08$	$10.64^{b}\pm0.16$	$10.42^{b}\pm0.33$	$10.31^{b}\pm0.16$
Final Condition Factor	$0.63^{ab}\pm0.05$	$0.56^{ab}\pm0.03$	$0.41^{b}\pm0.18$	$0.54^{ab}\pm0.04$	$0.51^{ab}\pm0.00$
Initial Condition Factor	$1.11^{a}\pm0.01$	$0.88^{b}\pm0.01$	$0.83^{b}\pm0.07$	$0.89^{b}\pm0.08$	$0.83^{b}\pm0.06$
Survival (%)	53.33±5.77	56.66±5.77	56.66±5.77	46.66±5.77	46.66±5.77
Total Feed Intake (g)	96.64±4.76	117.70±4.49	93.28±9.93	89.95±7.60	86.69±6.00
Mean Feed Intake (g)	$12.06^{b}\pm0.60$	$14.71^{a}\pm0.55$	$11.66^{a}\pm1.24$	$11.24^{a}\pm0.94$	$10.83^{a}\pm0.77$
Total Protein Intake (g)	38.46±3.01.	43.85±1.72	35.50±3.78	36.60±3.09	36.022±2.59
Feed Conversion Ratio	2.61±0.12	2.55±0.14	2.66±0.21	2.69±0.21	3.10±0.24
Protein Efficiency Ratio	0.38±0.46	0.13±0.01	0.12±0.11	0.11±0.11	0.10±0.10
Gross Energy (kcal/g)	463.32	531.80	434.41	438.68	515.38

Mean of Data on the same row with different superscript are significantly difference ($p<0.05$)

Table 4: Water quality parameter of experimental setup

	D1	D2	D3	D4	D5
Temperature (°C)	28.36^a±0.37	28.53^a±0.05	28.30^a±0.10	28.80^a±0.05	27.80^b±0.10
Ammonia (mg/l)	0.53^d±0.01	0.68^{ab}±0.01	0.63^c±0.01	0.71^a±0.01	0.67^b±0.00
pH	6.21^c±0.01	6.51^a±0.01	6.01^d±0.01	6.31^b±0.01	6.31^b±0.01
Dissolved Oxygen (mg/l)	5.50^a±0.03	5.50^a±0.00	5.50^a±0.00	5.50^a±0.03	4.50^b±0.03

Table 5: Cost benefit evaluation of experimental diets

Parameters	D1 (0%)	D2 (25%)	D3 (50%)	D4 (75%)	D5 (100%)
Estimated Investment Cost (Naira)	147.48^b±0.01	171.59^a±0.01	142.88^c±0.01	138.68^d±0.01	146.96^e±0.01
Net Production Value (Naira)	485.11^b±0.01	605.11^a±0.01	458.51^c±0.01	438.91^d±0.01	372.06^e±0.01
Gross Profit (Naira)	337.64^b±0.01	434.28^a±0.01	315.68^c±0.01	300.87^d±0.01	237.87^e±0.01
Cost of Feeding (Naira)	112.48^b±0.01	136.59^a±0.01	107.88^c±0.01	103.68^d±0.01	99.20^e±0.01
Cost of Feed (Naira)	186.21^a±0.01	185.61^b±0.01	185.01^c±0.01	184.41^d±0.01	183.81^e±0.01
Protein Intake	4.32^b±0.01	4.45^a±0.01	4.26^c±0.01	4.24^d±0.01	3.76^e±0.01
Benefit Cost Ratio	3.29^b±0.00	3.54^a±0.01	3.22^c±0.01	3.18^d±0.01	2.78^e±0.01

Mean of Data on the same row with different superscript are significantly difference ($p<0.05$)

4. Discussion

The proximate composition of the fermented seed was higher with value of (39.05) than the raw one (34.98) this is similar to the work of (Emmanuel *et al.*, 2017) [15]. This trend may be due to the effect of hydrolysis during the fermentation with increase in the content of the crude protein, a process often associated with microbial activities. Yashim *et al.* (2009) [16] and Tamburawa (2010) [17] reported that crude protein increased progressively with increase in the duration of *Crotalaria retusa* and *Parkia* seed respectively.

It has also been reported that locust bean is rich in essential amino acids necessary for growth and development. Also present are other amino acids such as arginine and histidine as previously reported by (Hassan and Umar, 2005) [18]. 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 (Lovell, 1989) [19]; (NRC, 1993) [20].

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 (Balogun *et al.*, 2004) [21]. The highest growth response is recorded in Diet 2 inclusion of locust bean meal which support the growth of fish in replacement of soybean. There were significantly different ($p>0.05$) in the Diet 2 and Diet 3 which reflected that the feed is palatable to the fish. This result is in agreement with the work of (Oso *et al.*, 2011) [22], (Olukunle, 1996) [23], (Olukunle and Falaye, 1998) [24].

The high specific growth rate, high feed efficiency rate, high protein efficiency ratio and low feed conversion rate value of fish D2 (25% locust bean and 75% 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 (2009) [25] who stated that the higher the specific growth rate and the smaller the feed conversion ratio, the better the feed quality. Adiku (2003) [26] also reported that a lower feed conversion ratio value implies efficient feed utilization by fish.

The physico chemical parameters of water were within the acceptable range recommended for rearing and culture of most tropical fish, including the African catfish (Fafioye *et al.*, 2005) [27], *C. gariepinus* like any other fish species require optimum level of these water parameters for optimum survival, growth and production. Boyd and Lichotkopler (1979) [28] reported that pH of 6.5-9.0 and temperature of 22-27 °C gives the best growth for cultured tropical fishes. Adesulu (2001) [29] 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 reduction in cost of production of the experimental diets from 186.21 in D1 (control) to 183.81 in the locust bean inclusion diets (D2, 3, 4 and 5) is an indication of the cost effectiveness of using locust bean meal as a conventional feedstuff in fish feed formulation (Table 3). This is dissimilar to the report that non-conventional feedstuffs (NCFRs) are cheap byproducts or waste from agriculture, farm made feeds and processing industries (Sogbesan, 2014) [30].

5. Conclusion

In conclusion, 25% inclusion level of locust bean meal diets recorded best weight gain and benefit cost ratio than other inclusions level. It is recommended, 25% inclusion level of locust bean meal can be used in the diet of *C. gariepinus* fingerlings without reducing the weight. Also more works should be done on different locust bean seed processing techniques for anti- nutritional factors reduction which could maximize its utilization. More days of fermentation should be increased also.

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