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Cost Benefit of *Azanza garckeana* (Goron Tula) Seed Meal at Different Inclusion Levels in the Diet of *Clarias gariepinus* (Burchell, 1822) Juveniles

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Abstract
Five diets of different inclusion levels of *Azanza garckeana* seed meal 0%- Diet 1 (control),5%-Diet 11, 10%-Diet 111, 15%-Diet 1V and 20%-Diet V were fed to five triplicate groups of '*Clarias gariepinus'* juveniles to determine the cost benefit of the seed meal. The juveniles of mean weight 5.1g were stocked in fifteen plastic bowls of 300L for 56 days.Mean water quality parameters range between (25.4-25.73^{o}C) temperature, (5.96-6.15) pH, (5.50-5.88mg/l) DO_2, and (31.02-34.10uscm^{-1}) conductivity, (2.71-3.13mg/l)Carbon dioxide, (30.20-31.94mg/l) Alkalinity. The growth performance, survival rate and cost benefit ratio were estimated from the study. Fish fed Diet V has the best growth performance of 76.1%-RGR, 0.44%-SGR, 1.15-FCR. Fish fed Diet1had the least growth performance of RGR(24.7%), SGR(0.17%/day) and FCR(2.52). Although fish fed Diet 5 had the best profit index of 0.42 but fish fed Diet 3 had the highest Benefit:Cost ratio of 0.33, which is better than the remaining diets. Since the cost benefit analysis reveals that '*Clarias gariepinus*' juveniles fed Diet 5 (20% *Azanza garckeana* seed meal Diet) had comparatively lower incidence of cost (₦191.9/g) than those fed the control diet 1 (₦514.0/g). Hence , the inclusion of *Azanza garckeana* in the feed of *Clarias gariepinus* to about 20% gave both better growth performance and cost effectiveness,this is recommended to fish farmers for sustainable yield and profit.
Keywords: *Azanza garckeana*, Cost benefit, Growth performance, *Clarias* juveniles.

1.Introduction

The cost of investment is a driven tool for any viable venture, which is critically considered by any business investor before embarking on his investment (Sogbesan *el al.* 2005). The development of fish production in the semi intensive culture system is adversely affected by the current high cost of fish feed. Sogbesan *el al.,* (2005) reported that the use of commercial pelleted fish feed in Nigeria accounts for about 60% of the recurrent cost of fish farming venture. The major component in fish feed formulation is the fishmeal (that constituted about 50-70% by weight), which is limited by high cost, non availability and competition from poultry and livestock sectors (Misra *el al*., 2003). The production of cost effective, nutritionally balanced diets for fish requires effort in research, quality control and biological evaluation of the feed. An alternative based diets ingredients in aquafeed must be capable of acting as a partial or complete substitute or supplement for fish meal without compromising fish growth and health. In fish farming, nutrition is critical because fish feed represent 40 – 50% of the total production cost (sogbesan, *et al.,* 2006). Fish nutrition has advanced dramatically in recent years with the development of new balanced commercial diet which promote optimal fish growth and health. The development of new species specific diet formulation support aquaculture, that is, to satisfy increasing demand for affordable, safe and high quality fish as well as sea food products (Kanazawa, 2000). Mile and Chapman (2006) reported that aquaculture potential in Nigeria could be exploited through the availability of good quality and inexpensive ingredients for the formulation of fish feed. This therefore calls for the need to source locally available raw materials and in this particular case, *Azanza garckeana* seed for formulating fish feed.

According to Orwa *et al.,(*2009) *Azanza garckeana* is popularly known as morajwa (African chewing gum) in Botswana, while in English it is known as *Azanza*, tree hibiscus, snot apple, wild hibiscus, while is called Goron Tula by people in northern part of Nigeria.

Azanza garckeana is produce locally and naturally in the woodland, it grow in semi-arid area receiving lowest annual rainfall of 26mm and highest rainfall of 127m (FAO, 1983). It is a good source of protein, vitamin, fat, carbohydrate and fibre (Legwaila *et al.,* 2011). *Azanza garckeana* is mostly found in East, South and West Africa (ICRAF, 1994). In Nigeria, it is found in northeast of the country, especially in Tula area in Kaltungo Local Government in Gombe State. Hausa people call it "Goron Tula" that is kola of Tula. They are available in Most markets in the northeast of Nigeria. The fruit is an almost spherical woody capsule 2.5 to 4cm in diameter, with dense short hairs. It is divided into 5 sections and when matured, it is yellowish to brownish green in colour, it opens slowly. The fleshy and sticky pulp inside contains 5 seeds, one in each chamber. The seed is hemispherical 7 – 10mm and covered in brownish woolly floss, which is thrown away, this can be collected and used for fish feed formulation (Orwa *et al.,* 2009).

The catfish, *C. gariepinus* is the most important fish species cultured in Nigeria (Ayinla, 2003). This species has shown considerable potential as a fish suitable for use in intensive culture and the fingerlings are widely produced in Nigeria. They have the ability to grow and develop on wide range of both artificial and natural feed. Anene *et al.* (2012) reported that they have high yield potential, tolerance to low oxygen and capacity to grow fast in both intensive and extensive culture system. They can also withstand diseases and many other adverse conditions that can kill some species of fish. Aluko (1998) reported that catfish hybrids generally exhibit intermediate phenotypic character of the parent and also the hybrids have advantageous qualities like fast growth, better food conversion, higher survival condition and disease resistance. This experiment focused on investigating the cost benefits of utilizing *Azanza garckeana* as based diet in the feed of *Clarias gariepinus* juveniles.

2. Materials and Methods

2.1 Experimental Site

The experiment was carried out in the Botanical garden, Department of Plant Science, Modibbo Adama University of Technology (Mautech) Yola, Adamawa State, Nigeria. Mautech is sited in Gerei local government area of Adamawa state. Mautech previously known as Federal University of Technology, Yola, located about 10 km north of the city on the road to Mubi. Adamawa state is located on latitude 9.14^0N, longitude 12.38^0E and an altitude of 185.9m (Adebayo, 1999).

2.2 Source of Plant Material

The plant materials *A. garckeana* fruits were obtained from a local market in Tula Kaltungo local government areas, Gombe State, Nigeria. Its headquarters are in the town of Kaltungo in the west of the area on the A345 highway at Latitude 9°48′51″N and Longitude 11°18′32″E.

2.2.1 Preparation of Azanza garckeana Seed Meal

The outer coats (pulp) were removed and the seed sun -dried and milled using pestle and mortar to give fine powder and sieved using a sieving material of 0.8mm size in diameter. Fish feed was prepared by mixing the powder with basal feed of 40% crude protein, based on formulation defined for African Catfish by Fagbenro and Adebayo (2005) to give 50, 100, 150, and 200 g kg-1 *A. garckeana* seed powder in the basal feed representing four dietary treatments and a control (0g kg-1 *A. garckeana* seed powder).

2.3 Formulation of Experimental Diets

Five diets was formulated from practical ingredients fish meal, maize, soybean meal, Groundnut cake GNC, vitamin premix, starch, sodium chloride, Dicalcium phosphate, vegetable oil. The control basal diet was without *A. garckeana* seed powder and others were supplemented with 50, 100, 150 and 200 g kg-1 *A. garckeana* seed powder respectively (Table 1). The experimental diets were formulated to contain 40% crude proteins. The ingredients were milled to give a fine particle size. Ingredients including vitamin premix and *A. garckeana* seed powder were thoroughly mix to obtain a homogenous mass, cassava starch was added as binder. The resultant mash was then been pressed without steam through a pelleting machine with 0.2mm diameter size. The pellets were sun dried at ambient temperature (27-30^{0}C) and stored in a refrigerator until the commencement of the experiment.

Table 1: Fish Feed Ingredients Showing Percentage Inclusion of *A. garckeana* Seed Meal

Ingredients	D_1	D_2	D_3	D_4	D_5
Fish meal	25	25	25	25	25
Yellow maize	15	15	15	15	15
Groundnut cake	26	26	26	25	25
Soybean meal	22	22	22	22	22
Vegetable oil	8.0	8.0	8.0	8.0	8.0
Vitamin premix	1.0	1.0	1.0	1.0	1.0
Sodium chloride	1.0	1.0	1.0	1.0	1.0
Starch	1.0	1.0	1.0	1.0	1.0
Dicalcium phosphate	1.0	1.0	1.0	1.0	1.0
% inclusion levels of *A. garckeana*	0%	5%	10%	15%	20%
% Calculated Crude Protein	38.73	39.03	39.34	39.44	39.53

2.4 Collection and Acclimatization of Experimental Fish

One hundred and fifty (150) juvenile fish were obtained from Wisdom Farm in Yola, Adamawa State, Nigeria and was used for this investigation. The fish were kept to acclimates to the farm conditions for 24 hours before being randomly divided into five equal experimental groups [10 juvenile *C. gariepinus* in 3 replicates, of average weight and length(5.06g and 6.27cm)] representing five nutritional groups. Fifteen (15) plastic bowls, of 20 litres volume were used. One group serve as control and four groups representing the *A. garckeana* seed powder test. The initial weights and lengths of the experimental fish were taken after every 7 days in order to adjust the feeding rate of 5% total biomass at two times/day(0800 and 1800 hr.) for 56 days.

2.5 Water Quality Parameters

Water quality parameters such as Temperature, pH, Conductivity, Carbon dioxide, Alkalinity and Dissolved Oxygen concentration were monitored in the course of the feeding trial using mercury-in-glass thermometer, pH meter, Conductivity metre, Carbon dioxide metre, Alkalinity metre and Dissolved oxygen meter as described by APHA (1987).

2.6 Sample and Sampling Techniques

The initial weight and length of fish in each treatment were taken. The growth performance were measured weekly for 8wks. The quantity of feed to be fed was adjusted weekly based on the biomass.

2.7 Data Collection

The weekly weight and length of fish recorded was used to determine the growth performance of the fish. The feed supply was also used to determine the feed utilization following the methods of Aderolu *et al.* (2010).

2.8 Statistical Analysis

Data that were generated from the experiment were subjected to Analysis of Variance (ANOVA). Comparisons among treatment means were carried out by One way analysis of variance followed by Turkey's test (0.05).

2.9 Economics Analysis

The economic analysis was computed to estimate the cost of feed required to raise a kilogram of fish using the various experimental diets. The major assumption is that all other operating costs for commercial fish production will remain the same for all diets. Thus, cost of feed was the only economic criterion in this case. The cost was based on the current prices of the feed ingredients as at the time of purchase. The economic evaluations of the diets were calculated from the method of Sogbesan *et al*., 2005 as:

Investment Cost Analysis (ICA) = Cost of Feeding (#) + Cost of Fingerlings stocked (#)
Profit Index (PI) =Net profit value (#) / Cost of feeding (#)
Incidence of Cost (r) = Cost of feeding (#) / Weight of fish produce (g).
Benefit- Cost Ratio (BCR) =Net profit value (#) / Investment Cost Analysis (#)

3. Results

Water quality parameters during the experimental period are presented in Table 2. The values observed were within the tolerant range of *Clarias gariepinus*. The mean pH was between (5.96±0.02 – 6.15±0.02); Dissolved Oxygen (5.50±0.06 – 5.88±0.02) mg/litre; conductivity (31.02±0.03 – 34.10±0.05) uscm^{-1}; temperature (25.40±0.02 – 25.73±0.02) ˚C; Carbon dioxide (2.71±0.07 - 3.13±0.08) mg/litre; and Alkalinity (30.20±0.44 – 31.94±0.08)mg/litre.

Table 2: Mean Water Quality of Holding Facility of *Clarias gariepinus* Juveniles Fed Varying Inclusion Levels of *A. garkeana* Seed Meal.

Treatment	Temperature (^oC)	pH	DO_2 (mg/L)	Conductivity ($uscm^{-1}$)	Co_2 (mg/L)	Alkalinity (mg/L)
D_1	25.4±0.02	5.96±0.02	5.88±0.01	31.02±0.03	2.71±0.07	30.20±0.44
D_2	25.7±0.01	6.15±0.02	5.87±0.03	32.05±0.02	2.85±0.19	30.89±0.66
D_3	25.63±0.02	6.09±0.03	5.50±0.06	33.06±0.01	2.89±0.05	31.13±0.21
D_4	25.73±0.02	6.14±0.03	5.73±0.01	34.10±0.05	2.95±0.17	30.99±0.71
D_5	25.66±0.02	6.15±0.02	5.81±0.02	31.10±0.01	3.13±0.08	31.94±0.08

D1-0%, D2-5%, D3-10%, D4-15% and D5- 20% *Azanza garckeana* seed inclusion levels**.**

DO_2 – Dissolved Oxygen

Growth responses of fish fed *Azanza* garckeana seed meal diets were generally high among treatments, indicating positive response of fish to the diets as presented in Table 3. The initial weight of the fish ranged between (5.06g - 5.12g). Mean weight gain (MWG) increased from 1.25g in D_1 to 3.85g in D_5. Relative growth rate (RGR) also followed a similar trend, with an increase observed with increase in inclusion level of *Azanza garckeana* seed meal in the diets from 24.7% in D_1 to 76.1% in D_5. Fish fed D_5 had the highest Weight gain value of 3.85g and the lowest value of Weight gain was recorded for D_1 1.25g. Fish fed D_5 had the highest SGR value of 0.44% while the lowest value was recorded for D_1 0.17%. The results of the nutrient utilization of *Clarias gariepinus* juveniles expressed as food conversion ratio (FCR) and protein efficiency ratio, (PER) are also presented in Table 3. FCR ranged between 1.15 in fish fed diet D_5 and 2.52 in fish fed diet D_1. Fish Survival rate ranged between 50% in fish fed D_1 and 80% in fish fed D_3.

Table 3: Growth Parameters of *Clarias gariepinus* juveniles fed *Azanza garckeana* Seed Meal

Parameters	D_1 (0%)	D_2 (5%)	D3 $_3$ D_3(10%)	D_4 (15%)	D_5 (20%)	SEM
Initial Weight (g)	5.06	5.12	5.08	5.07	5.06	
Final Weight (g)	6.31^c	6.5^c	7.47^b	7.64^b	8.91^a	0.47
Weight gain (g)	1.25^e	1.38^d	2.39^c	2.57^b	3.85^a	0.47
Initial Length (cm)	6.27	6.20	7.93	6.27	6.77	
Final Length (cm)	7.68^b	8.37^{ab}	9.70^a	9.93^a	10.40^a	0.51
Length gain (cm)	1.41^d	2.17^b	1.77^c	3.66^a	3.63^a	0.47
Relative growth rate (%/fish)	24.7^e	26.9^d	47.0^c	50.7^b	76.1^a	0.22
Specific growth rate (%/day)	0.17^d	0.19^d	0.30^c	0.32^b	0.44^a	0.05
Mean feed intake (g)	3.16^e	3.25^d	3.73^c	3.82^b	4.45^a	0.23
Feed conversion rate	2.52^a	2.35^b	1.56^c	1.48^c	1.15^d	0.26
Protein efficiency ratio	0.032^d	0.035^d	0.061^c	0.065^b	0.097^a	0.01
Survival rate (%)	50.0	73.0	80.0	77.0	67.0	
Condition factor (k)	44.6^a	13.5^c	43.1^b	5.24^e	8.05^d	8.66
Protein intake	122.4^e	126.8^d	146.7^c	150.6^b	175.9^a	9.56

Means with different superscripts are significantly different ($p<0.05$)

The economic Analysis is presented in Table 4.The cost of the juveniles are N50/fish; Cost of feed was recorded highest in D5 (742.5) and lowest D1 (642.5); Cost of feeding ranges from D1-D3 (87.8-128.5); Estimated investment Cost D3-D1 (137.8-178.5); profit index D1-D5 (0.28-0.42); Incidence of Cost D5-D1 (191.9-514.0); and Benefit cost ratio D1-D3 (0.21-0.33).

Table 4: Cost Analysis of *C. gariepinus* juveniles fed varying inclusion levels of *A. garckeana* seed meal

Parameters	D1(Control)	D2 (5% inclusion)	D3 (10% inclusion)	D4 (15% inclusion)	D5 (20% inclusion)
Cost of juveniles	50	50	50	50	50
Survival %	50	70	80	70	60
Cost of feed(₦)/kg	642.5	682.5	702.5	722.5	742.5
Cost of feeding juveniles (₦)	128.5	97.5	87.8	103.2	123.8
Estimated investment cost (₦)/fish	178.5	147.5	137.8	153.2	173.8
Profit index	0.28	0.31	0.35	0.39	0.42
Incidence of cost	514.0	494.6	293.9	281.1	191.9
Benefit : Cost ratio	0.21	0.26	0.33	0.30	0.31

4. Discussion

The optimum aim of every agricultural investor is to make profit at the end of the cultural season. This same phenomenon is as well applicable to fisheries. Since cost of feed has been one of the major constrain to the development of aquaculture sector; provision of an alternative ingredient that will be able to reduce certain percentage incurred by feeding overhead cost should be embraced.

The observed water quality parameters were due to constant water change of the culture system. The range in the average temperature recorded during the experimental period was probably due to the fact that all the treatments were outdoors faced with environmental factor variations. (Adekoya *et al*. 2004 and Omotayo *et al*.2011) recommended Dissolved oxygen, DO level of between 4-8mg/ litre in the pond and DO values observed during the experimental period fall within these values, 4.8-6.5mg/litre were recorded. The pH value recorded (5.96±0.02 – 6.15±0.02) tend towards acidity which is as a result of acidic nature of *A. garckeana* as reported by Saka *et al*, (1994). High concentrations of CO_2 kill fish (Lee *et al*. 2003, Hayashi *et al*. 2004b, and Ishimatsu *et al*. 2004). The values of physico-chemical parameters observed in the culture system were within the range recommended for fresh water fish (Erondu, 1993, Adigun, 2005 and Adekoya *et al*. 2004).

Clarias juveniles fed on higher combined protein feed did better in weight gain, daily growth index, relative weight gain and specific growth rate than those fed on single protein source feed as in diet 1 and V. the higher growth performance observed in combined feeding can explain by synergetic effect of combining two biological compounds to have a single and superior effect than when individually applied. This observation is in agreement with suggestions by previous authors that combined protein source is better than single protein source for fish diets (sogbesan, *et al.,* 2006). *Clarias* juveniles fed Diet 1 wound have been expected to show the best growth performance since it's contains fish which is a high level of protein that has been known as the best for fish (Lovell, 1994 and Massumotu, *et al*., 1996), but this was not so. However, Lovell (1994) reported that the biological value of protein source does not only depend on its amino acid profile but also on its digestibility. Fibre content of feed has been documented to enhance growth performance in fish (Steffen, 1989), the low fibre content of diet 1 might has been one of the factors for low growth performance.

The economic evaluation of feeding *Clarias* juveniles on experimental diets shows that D3 recorded the highest Benefit: Cost ratio. The positive Benefit: Cost ratio recorded in all the diets indicate that *Clarias* juveniles can be economically reared on all diets. However, the result further indicated that inclusion of *Azanza garckeana* seed meal to 10% in the diet of *Clarias* can result into a better Benefit: Cost ratio than when fed with fishmeal diet alone, which shows an increase in the fish value above the amount invested (Sogbesan *et al*., 2006)

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