Production Economy of Bitter Leaf (Vernonia Amygdalina) as Dietary Additive Fed to Clarias Gariepinus

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Abstract

Antibiotic has been used to enhance physiological well-being in animal husbandry cum aquaculture; however, resistance of pathogenic microorganisms resulting from its use poses serious challenges to both animal and human being. Man has used nature’s resources to his benefit since creation; one of such resources is herbal additives that are readily available and effective with no residual effects, but there is little information on their utilization in fish farming in Nigeria. This study evaluated the utilization of powdered Bitter leaf (Vernonia amygdalina) on growth performance and production economy of Clarias gariepinus. Six isonitrogenous herbal diets (40% Crude protein), with the following inclusion levels (VAM1/Control; 0.00% - VAM6; 0.10%) were fed twice daily at 5% body weight to twenty Clarias gariepinus per treatment, in triplicates for 12 weeks. Mean Weight Gain (MWG), Specific Growth Rate (SGR), Protein Efficiency Ratio (PER), Mean Feed Intake (MFI), Feed Conversion Ratio (FCR) and Profit indices (PI), Cost Benefit Ratio (Ber) and water parameters were determined using standard methods. Results obtained showed that VAM4 diet gave the highest MWG (65.02±1.70g); SGR (0.87±0.01%/day); PER (0.96±0.01); and lowest FCR (2.57±0.04) but highest PI (6.4) and Ber (1.63) respectively as compared with others diets. However the highest MFI (138.25±1.57) was recorded from fish fed VAM5 diet and least from VAM1 (106.32±1.73). Values for DO, PO

INTRODUCTION

Vernonia amygdalina popularly known as bitter leaf a member of compositae family is widely distributed throughout Africa. It is locally abundant in sloughs, home gardens and even all over places in the Southern part of Nigeria (Bonsi et al., 1995 and Burkill, 1985). The plant leaves can be used as flavouring, seasoning accomplishment and garnishing of foods (Fayemi, 1999). Bitter leaf, is a well-known remedy for stomachaches, skin infections, diabetes, loss of memory prostate cancer, general weakness and other diseases (Adodo, 2004). The bitter leaf plant contains vernonine, vernodalin, venomygdin. It is known to be endowed with valuable biochemical properties, fixed oil, alkaloids, saponins, tannins and other glycosides (Bonsi et al., 1995). Medicinal plants have continued to attract attention in the global search for the effective methods of using plants ‘parts (e.g. seeds, stems, leaves, roots and bark etc.) for the treatment of many diseases affecting humans (Sofowora, 1993) and his animals (Babayemi et al., 2014).

Fish are considered one of the important food sources for human beings because their flesh contains a high percentage of protein, calcium, phosphorus and iodine that are vital to our health. Fish account for almost 17 percent of the global population intake of animal protein (FAO, 2014). The fisheries and aquaculture play a vital role in achieving the FAO’S strategic objective of eliminating hunger, food insecurity and malnutrition. People have never consumed fish so much fish or depend so greatly on the sector for their well-being as today. As the demand for fish increases, the sector is also striving to be more productive and sustainable and to enable more inclusive and efficient system while reducing rural poverty and enhancing the resilience of livelihood to disaster, crises and climate change (FAO, 2014).

The fisheries and aquaculture sector is also a source of employment and income, supporting the livelihoods of 10–12 percent of the world’s population. In 2012, employment in the sector grew faster than the world’s population, with almost 60 million people engaged in the primary sector, 90 percent small-scale fishers and 15 percent of them women. At global level, the contributions of small scale fisheries to poverty alleviation and food and nutrition security are being increasingly recognized, most notably in the Rio+20 outcome document (The

Feed safety is an essential factor to assure the productivity of those aquatic husbandries. Safety may be affected by many hazards of biological, physical and chemical origins (FAO, 2005). The greatest limitation of fish farming in Nigeria is lack of suitable fish feed both in quality and quantity. It accounts for about 60-80 percent of operational costs in intensive aquaculture (commercial) and semi-intensive (artisanal) production systems. Both systems involve inputs of supplementary and complete feed, which account for up to 40% and 60% of production costs, respectively (Fagbenro, 1987). Furthermore, feed and fertilizers represent about 40-60 percent of the total cost of aquaculture production in semi-intensive aquaculture systems (Adewumi and Fagbenro, 2009). Fertilizer and feed resources will therefore, continue to dominate aquaculture needs. While some countries in the world produce adequate quality commercial fish feeds for aquaculture, many depend on imports from countries within or outside the region. The evolution and development of fish feed manufacturing in aquaculture has made good progress in all regions, perhaps, except Africa (FAO, 2006). These feeds many/most are substandard in specific species feed formulation requirements. This situation led many farmers to use all kind of materials to formulate feeds or even feed their fish. (Areola, 2008; Kanu, 2008).

Synthetic antibiotics have been widely used in fish culture systems as performance enhancer and for stress control. These antibiotics are expensive and induce microbial resistance with consequent environmental effects. These products are now considered as human health factors for their possible role in the emergence of microbial resistance (Nollet, 2005; Michard, 2008). Now restriction on the use of antibiotics growth promoters has stimulated the search for alternative additives (Nasir and Gashorn, 2006). Natural medicinal products originating from fungi and herbs have been used as feed additives for farm animals in China, and show many bioactivities such as antimicrobial, immune enhancement and stress reduction (Wang et al., 1998). Several herbs have been tested for their growth promoting activities in aquatic animals (JayaPrakas and Euphorsia, 1996; Citarasu et al., 2002 and Sivaram et al., 2004) and pharmacological screening of some medicinal plants as antimicrobial and feed additives in poultry (Thakare, 2004). Catfish has been credited for being hardy, resistance to handling stress. It has better growth and feed conversion abilities, the high quality and better taste of its flesh makes it a highly demanded fish, hence there is need to increase local production of this species at cheaper production cost (Sogbesan, 2014).

Some phytogenic plants however, have been identified to have potential as antibiotics/phytobiotics, but there is little information on their utilization in fish nutrition. Owen and Amakiri (2011) suggested that any significant reduction in the cost of feeds will significantly reduce the overall cost of production and increase the profit margin of the farm. One way to achieve this is by the use of natural feed additive. Therefore the evaluation of Vernonia amygdalina a commonly available phytogenic plant as feed additive; its effect on growth performance and production economy of Clarias gariepinus (CG) were investigated.

MATERIALS AND METHODS
Experimental Site: The study was carried out at the Department of Aquaculture and Fisheries Management’s Teaching and Research Laboratory, University of Ibadan, Ibadan, Nigeria.

Identification, Preparation and Processing of Vernonia Amygdalina
Identification of the plant/botanicals was made by the Forest Taxonomist Dr. A.A. Adebisi from the Department of Forestry and Renewable Resources, Faculty of Agriculture and Forestry Resources, University of Ibadan, Ibadan Nigeria. The collection, preparation, processing and preservation of the plant were done practically as reported by (Fayemi, 1999 and Ogbeuwu et al., 2010).

Calculated Dosage Values For Bitter Leaf (Vernonia Amygdalina)
The dosage values for bitter leaf were based on the extrapolated dosage (Nwaoguikpe 2010) at 2% body weight of the dry powdered leaves of Vernonia amygdalina in rats. The final dosage/doses ranged from 0.00625% – 0.1%/100g.

Formulation and Preparation of Experimental Diets
The experimental diets were formulated using algebraic method along with least cost formulae of Falayi (2003) and prepared following the methods of (Adewole, 2014) as shown in (Table 1). The six different diets were isonitrogenous at 40% Crude Protein (CP): Vernonia amygdalina meal (VAM1) (control) diet at 0%, VAM2 (0.00625%), VAM3 (0.0125%) VAM4 (0.025%) VAM5 (0.05) and VAM6 (0.10%) respectively.
particulate wastes in the tanks through siphoning before feeding. Dissolved oxygen (DO) was determined using DO meter (EDT DiectUion) as recommended by Boyd, (1986). The quantity of feed was adjusted based on the weight attained by the fish for previous fortnight and were monitored for mortality daily and removed, whereas condition factor, survival rate and nutrient utilization were computed and analysed according to the standard methods (Aderolu et. al., 2009 and Adewole, 2014). Water quality standard was strictly adhered to by removing particulate wastes in the tanks through siphoning daily before feeding while the water in each tank was completely changed every other day and tanks were washed twice a week, to ensure optimum quality of the culture medium and healthy condition of the fish according to (Adewole and Owolabi, 2007). Dead fish were monitored for mortality daily and removed, counted and recorded for determination of mortality/survival rate (Sogbesan, 2007). The growth parameters, condition factor, survival rate and nutrient utilization were computed and analysed according to the standard methods (Aderolu et. al., 2009 and Adewole, 2014). Water quality of the rearing environment such as temperature was taken according to the standard methods (Aderolu et. al., 1997). Data collected were subjected to Analysis of Variance (ANOVA) at $\alpha = 0.05$. Comparisms among treatment means were carried out by one–way analysis of variance and Duncan’s Multiple Range Test was used to determine the level of significance among treatments, using Statistical Analysis System (SAS, 2008).

**RESULTS AND DISCUSSION**

The experimental fish did utilize the feed at the varying levels, and which brought about significant variations in some of the growth performances recorded. Total final weight attained ranged from 601.57 ± 21.23g to 1170.29 ± 30.57g. The highest total final weight value was from VAM4 diet, followed closely by 1127.92 ± 4.24g from VAM5 diet, while the lowest was from the control diet. The fish fed the VAM4, VAM5, VAM6, VAM3, VAM2 diets had significantly higher (p<0.05) total final weight than fish fed VAM1 the control diet (Table 2). The mean final weight, total weight gained, mean weight gain, specific growth rate, relative growth rate followed the same similar trend as in the total final weight (Table 2) in CG fed VAM’s diets. Final condition factor (K2) ranged from 0.69 ± 0.03 to 0.83 ±0.09. The highest final condition factor value was from VAM4 diet, followed closely by 0.80 ±0.03 from VAM2 diet, while the lowest value was from VAM5 diets respectively. There were no significant differences (p=0.05) within the treatments in the K2 of the fish fed the VAM’ diets (Table 2). The number of fish cropped ranged from 16.00 ± 0.00 to 19.00 ± 0.03. The highest value was from VAM2, followed

![Table 1: Percentage composition of ingredients (g/100g diets) in Vernonia amygdalina (Bitter leaf) meal diets for feeding trials](image)

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>VAM1 (Control)</th>
<th>VAM2</th>
<th>VAM3</th>
<th>VAM4</th>
<th>VAM5</th>
<th>VAM6</th>
</tr>
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<tbody>
<tr>
<td>Soybean meal</td>
<td>20.93</td>
<td>20.93</td>
<td>20.93</td>
<td>20.93</td>
<td>20.93</td>
<td>20.93</td>
</tr>
<tr>
<td>Groundnut cake</td>
<td>20.71</td>
<td>20.71</td>
<td>20.71</td>
<td>20.71</td>
<td>20.71</td>
<td>20.71</td>
</tr>
<tr>
<td>Yellow maize</td>
<td>20.76</td>
<td>20.754</td>
<td>20.7475</td>
<td>20.735</td>
<td>20.71</td>
<td>20.66</td>
</tr>
<tr>
<td>Vegetable oil</td>
<td>2.50</td>
<td>2.50</td>
<td>2.50</td>
<td>2.50</td>
<td>2.50</td>
<td>2.50</td>
</tr>
<tr>
<td>Vitamin/mineral premix</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
</tr>
<tr>
<td>Cassava starch (Binder)</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
</tr>
<tr>
<td>Common salt</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Bone meal</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Carboxyl/methylcellulose</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Chromic oxide</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Inclusion levels of Vernonia amygdalina (%)</td>
<td>0.00</td>
<td>0.00625</td>
<td>0.0125</td>
<td>0.025</td>
<td>0.05</td>
<td>0.10</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

**VAM**= **Vernonia amygdalina** meal

**Economic Evaluation in terms of Investment Cost Analysis (ICA), Net Profit Value (NPV), Gross Profit (GP), Profit Index (PI), Incidence of Cost and Benefit Cost Ratio (BCR) of comparative growth performance of the fingerlings of C. gariepinus to the natural products in sustainable fish production, was determined according to New (1989) and Mazid et al., (1997).

**Statistical Analysis:** Data collected were subjected to Analysis of Variance (ANOVA) at $\alpha = 0.05$. Comparisms among treatment means were carried out by one–way analysis of variance and Duncan’s Multiple Range Test was used to determine the level of significance among treatments, using Statistical Analysis System (SAS, 2008).
closely and jointly by 18.00±0.00 from VAM4, VAM5, VAM6 diets, and the lowest value was from the control diet respectively. The fish fed VAM2 diets had significantly higher (p<0.05) number of fish cropped than, VAM4, VAM5, VAM6 diets, which were significantly different from VAM3, VAM1 diets respectively. The percentage survival ranged from 80.00% to 90.00% and followed similar trend as the number of fish cropped for all the experimental VAM’s diets (Table 2).

Total Feed Intake (TFI) ranged from 1701.18 ± 27.69 to 2488.45 ± 28.30g within the treatments, the highest value was from VAM5 diet, followed closely by 2438.45±30.76g from VAM4 diet and the lowest value was from the control diet. The fish fed the VAM5, VAM4, VAM6, VAM3 diets had significantly higher (p<0.05) TFI than the VAM2 diet, which was significantly different from control diet (Table 2), while Total Protein Intake (TPI) ranged from 707.35 ± 11.51 to 999.11 ±11.36 within the treatments, the highest value was from VAM5 diet, followed closely by 990.75 ± 30.76 from VAM4 diet and the lowest value was from the control diet. The fish fed the control diet had significantly lower (p<0.05) TPI than the other diets (Table 2).

Protein Efficiency Ratio (PER) values ranged from 0.54 ± 0.01 to 0.96±0.01 across the treatments. The highest value was from the fish fed VAM4 diet followed closely jointly by 0.90 ± 0.02 from VAM5, VAM6 diets and the lowest was from control diet respectively. The fish fed the VAM4, VAM5, VAM6, VAM2 diets had significantly higher (p<0.05) PER than VAM3 diet which was significantly different from the control diet (Table 2). The Feed Conversion Ratio (FCR) values ranged from 2.57 ± 0.04 to 4.44±0.07 across the treatments. The highest value was from the fish fed the control diet, followed closely by 2.80±0.15 from VAM2 diet and the lowest was from VAM4 diet respectively. The fish fed the control diet had significantly higher (p<0.05) FCR ratio than the other diets (Table 2).

The result of the production cost of the experimental diet Vernonia amygdalina meals (Table 4) showed that the highest profit index (PI) 6.84 was from VAM4 diet, followed closely by VAM3 diet and the lowest value was the control VAM1 diet respectively. The highest net profit and best benefit cost ratio were from VAM4 diet, followed closely by VAM5 diet and the least was from VAM1 diet. Mean values for pH ranged from 6.67- 6.82. The highest was from VAM6 diet, followed closely by VAM5 diet and the least was from VAM1 diet. Mean values for dissolved oxygen ranged from and 5.56-6.74mg/l. The highest was from VAM6 diet, followed closely by VAM2 diet and the least was from VAM1 diet.

The astringent taste associated with the consumption of V. amygdalina affects its intake as food/feed (Bonsi et al., 1995; Coop and Kyriazakis, 2001). The feed intake in this study dropped at the highest concentration of VAM6 within the tested groups for C. gariepinus fed V. amygdalina, although significantly higher than the control while the feed acceptability index did not vary significantly within the tested groups indicating that the presence of astringent tastes of V. amygdalina did not deter the fish from consuming the various diets. It may be suggested that the concentrations used here did not affect the palatability of the feeds given to the fish. The results obtained here are in agreement with (Ibrahim et al., 2000) that consumption of V. amygdalina Del leaves, especially at very high concentration requires caution, since there were reduction in the total and mean weight gain from ≥VAM5, although better than the control. Also the results obtained here are similar to (Yilmaz et al., 2009) who reported that the increase in Genesis (contains naturally occurring
mixture of plant substances (Soy concentrate, wild yam, vitex, black cohosh, licorice root gentian root) that are recognized to have varying degrees of estrogenic activity) concentration enhanced weight gain up to a definite level (420mgG30l) for female C. gariepinus, but after this level specific growth rates decreased significantly. Similarly, (Ekeocha, 2011) reported that the average final body weight decreased as the levels of VALMs increased in the diet with the highest value of (784.21g) from the control diet and those on the 10%VALMs diet had the least value of 561.83g in birds.

The Feed Conversion Ratio (FCR) and Protein Efficiency Ratio (PER) showed that the fish utilized the tested diets better than the control. The feed conversion ratio decreased from (4.44±0.07 to 2.57±0.04), while the PER increased from (0.54±0.01 to 0.96±0.01). The feed efficiency ratio and PER are used as quality indicator for fish diet and amino acid balance. So these parameters are used to assess protein utilization and turnover. The feed conversion ratios of (2.57- 4.44) reported from the study are better than those reported by ElUBlock (1975) that food conversion ratio for Clarias ranged from (3.2-6.7) according to the quality of the food/feed given. Since De silva and Anderson (1995) and Adikwu, (2003) documented that lower the feed conversion ratio, the better the feed utilization. The results from this study are also similar to those obtained by (Khattab et. al., 2001; Adewole, 2014; Adewole and Awosusi, 2015; Shalaby et. al., 2006; Oleiforuh-Okoleh et al., 2015; Olobatoke and Oloniruha, 2009) who reported that the increased feed intake, FCR and PER in O. niloticus, Clarias gareipinus, broiler birds and cockerels fed black seed cake (Nigella sativa L.), rosselle (Hibiscus sabdariffa), honeybee propolis and ag-zyme (organic enzyme), garlic (Allium sativum) and Chloramphenicol, bitter leaf (Vernonia amygdalina) extract and powdered meal as dietary additives/supplements respectively. However, the result obtained here were not in agreement with (Teguia et. al., 1993 and Ekeocha, 2011), who reported that V. amygdalina leaf meal supplement did not improve performance characteristics over basal diets but significantly (p<0.05) decreased feed intake, feed conversion ratio and growth rate in birds. However, boiling prior to use has been shown to decrease the contents of secondary plant compounds, making it more palatable (Teguia et. al., 1993; Bonsi et. al., 1995).

The PER of a diet is its “growth promoting value” and is a good indication of the quality of the feed and the response of the animals to it (Adejumo,2004). The relationship between rate of growth and productive life is also well established (Maynard and Loosli, 1956). Higher growth rates promote better feed efficiency and carcass quality. The PER also increased significantly within the tested groups when compared with the control. De Silva and Anderson (1995) reported that the protein efficiency ratio is a measurement of protein effectiveness to provide the essential amino acids needed by the fish muscle. It means that higher protein efficiency ratio is an indication of diet that produces fatty fish. The authors also reported that this index has been associated with fat deposition in the fish muscle, although fat deposit index was significantly lower than the control in these studies.

Economic evaluation of feeding C. gariepinus fingerlings on graded levels of Vernonia amydalina (VAM’s) diets showed that higher net gain, better cost benefit ratio reported for all the inclusion levels of VAM’s diet when compared to the control, indicated that the C. gariepinus was able to maximize the utilization of the feed for muscle development as reflected by the superior mean weight gains of the fish. Production and benefits positively favoured the utilization of VAM2-VAM5 diets, since the values are more than 1.0 indicating an increase in the fish value above the amount invested (Sogbesan et. al., 2006). Considering the profit index (PI), the fish fed VAM4 had the highest profit index coupled with the highest mean weight gain of the fish compared to others and lowest feed conversion ratio. There is no doubt that this assertion is in support of the findings of (Sotolu, 2008 and Omitoyin, 1995) and similar to the observations of Kyvsgard (2002) and Oleiforuh-Okoleh et al., (2015) that broiler fed bitter leaf performed better in term of cost of feed per kg than those on the control. Also the result in this study is in accordance to the revelation of Oleiforuh-Okoleh et al., (2015) that the cost /kg feed consumed /bird as well as cost of production increased with increase in the quantity of bitter leaf in the drinking water, thus, the highest cost of feeding was from the fish fed the highest inclusion level: VAM6 diet.

The development of new diet formulation supports the aquaculture industry to increase demand for affordable, safe, and high quality fish and sea food products. Food is a major requirement for all living organisms including fish for reproduction, growth and maintenance of the body as a whole (Soloman, 2012). Given the engagement of a considerable high proportion of the Nigerian population in agriculture and widespread poverty among rural populace in agriculture, positive intervention in agriculture through varieties developed by conventional breeding and biotechnological (Adetimirin,2010) and nutritional techniques (Adewole, 2014) remain a veritable tool for addressing poverty and socio-economic problems in Nigeria. Without an increase in the productivity of more nutritionally adequate food and a reduction in poverty, the increase in population is bound to be accompanied with high level of food insecurity (Adetimirin, 2010).
Thus the recent increases in feed ingredients cost have motivated the fisheries industry to identify technologies that will improve feed utilization and reduce the cost per pound gain. Furthermore, inclusion of bitter leaf in the diet of *Clarias gariepinus* had no detrimental effects on growth performance and production economy of the fish. This paper has contributed to knowledge through the establishment of the best supplementation level with respect to the utilisation of *Vernonia amygdalina* as alternative to synthetic antibiotic as growth promoter in the production of *Clarias gariepinus* was 0.025g/100g (VAM4) diet. Since the aim of this conference is to promote National Capacity Building Strategy for Sustainable Development and Poverty Alleviation: the adoption of aqua feed with the incorporation of herbal additive will contribute immensely to the manpower development/empowerment in aquaculture/agriculture and economy in general, thus, improving sustainable livelihood, alleviating poverty and enhance the fish farmers’ capacity building strategy and productivity.

Table 1. Proximate and energy composition (% dry matter) of the *Vernonia amygdalina* meal diets

<table>
<thead>
<tr>
<th>Parameter</th>
<th>VAM1</th>
<th>VAM2</th>
<th>VAM3</th>
<th>VAM4</th>
<th>VAM5</th>
<th>VAM6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein (%)</td>
<td>41.58</td>
<td>40.66</td>
<td>40.85</td>
<td>40.63</td>
<td>40.15</td>
<td>40.17</td>
</tr>
<tr>
<td>Crude fat (%)</td>
<td>3.47</td>
<td>3.81</td>
<td>3.69</td>
<td>3.65</td>
<td>3.91</td>
<td>3.92</td>
</tr>
<tr>
<td>Crude fiber (%)</td>
<td>2.76</td>
<td>2.93</td>
<td>2.97</td>
<td>2.87</td>
<td>2.81</td>
<td>3.03</td>
</tr>
<tr>
<td>Dry matter (%)</td>
<td>92.04</td>
<td>91.67</td>
<td>91.37</td>
<td>93.02</td>
<td>91.41</td>
<td>90.97</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>7.96</td>
<td>8.33</td>
<td>8.63</td>
<td>6.98</td>
<td>6.98</td>
<td>8.59</td>
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<tr>
<td>Nitrogen free extract (%)</td>
<td>30.85</td>
<td>30.48</td>
<td>29.68</td>
<td>32.32</td>
<td>29.56</td>
<td>29.56</td>
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<tr>
<td>Gross energy</td>
<td>3115</td>
<td>3110</td>
<td>3132</td>
<td>3125</td>
<td>3115</td>
<td>3171</td>
</tr>
<tr>
<td>Digestible energy</td>
<td>422.50±5.58</td>
<td>422.50±5.58</td>
<td>422.50±5.58</td>
<td>422.50±5.58</td>
<td>422.50±5.58</td>
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</tr>
</tbody>
</table>

Table 2: Growth performance of *Clarias gariepinus* fed *Vernonia amygdalina* additive meal for 84 days

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>VAM1</th>
<th>VAM2</th>
<th>VAM3</th>
<th>VAM4</th>
<th>VAM5</th>
<th>VAM6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial total weight (g)</td>
<td>218.67±0.44</td>
<td>219.33±0.17</td>
<td>218.67±0.44</td>
<td>218.67±0.44</td>
<td>218.67±0.44</td>
<td>218.67±0.17</td>
</tr>
<tr>
<td>Mean initial weight (g/fish)</td>
<td>10.94±0.02</td>
<td>10.97±0.01</td>
<td>10.94±0.02</td>
<td>10.94±0.02</td>
<td>10.94±0.02</td>
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</tr>
<tr>
<td>Total final weight (g)</td>
<td>912.83±34.71</td>
<td>912.83±34.71</td>
<td>912.83±34.71</td>
<td>912.83±34.71</td>
<td>912.83±34.71</td>
<td>912.83±34.71</td>
</tr>
<tr>
<td>Total weight gain (g)</td>
<td>365.69±48.34</td>
<td>365.69±48.34</td>
<td>365.69±48.34</td>
<td>365.69±48.34</td>
<td>365.69±48.34</td>
<td>365.69±48.34</td>
</tr>
<tr>
<td>Specific growth rate (%)</td>
<td>0.52±0.02</td>
<td>0.79±0.06</td>
<td>0.80±0.04</td>
<td>0.87±0.01</td>
<td>0.85±0.01</td>
<td>0.82±0.05</td>
</tr>
<tr>
<td>Relative growth rate (%/fish)</td>
<td>175.07±9.18</td>
<td>370.37±35.91</td>
<td>435.14±12.94</td>
<td>415.82±1.90</td>
<td>399.82±49.36</td>
<td>399.82±49.36</td>
</tr>
<tr>
<td>Total feed intake</td>
<td>2101.42±106.10</td>
<td>1181.16±6.22</td>
<td>1317.0±1.72</td>
<td>1354.7±1.71</td>
<td>1382.5±1.57</td>
<td>1342.9±1.88</td>
</tr>
<tr>
<td>Total protein intake</td>
<td>912.83±48.04</td>
<td>912.83±48.04</td>
<td>912.83±48.04</td>
<td>912.83±48.04</td>
<td>912.83±48.04</td>
<td>912.83±48.04</td>
</tr>
<tr>
<td>Feed conversion ratio</td>
<td>4.44±0.07</td>
<td>2.80±0.15</td>
<td>2.85±0.10</td>
<td>2.57±0.04</td>
<td>2.73±0.03</td>
<td>2.76±0.04</td>
</tr>
<tr>
<td>Protein efficiency ratio</td>
<td>0.54±0.01</td>
<td>0.88±0.05</td>
<td>0.86±0.03</td>
<td>0.96±0.01</td>
<td>0.90±0.02</td>
<td>0.90±0.01</td>
</tr>
<tr>
<td>Feed acceptability index</td>
<td>0.31±0.08</td>
<td>0.76±0.11</td>
<td>0.44±0.14</td>
<td>0.48±0.15</td>
<td>0.18±0.10</td>
<td>0.88±0.11</td>
</tr>
<tr>
<td>Initial condition factor</td>
<td>0.48±0.01</td>
<td>0.59±0.01</td>
<td>0.55±0.03</td>
<td>0.62±0.03</td>
<td>0.50±0.04</td>
<td>0.56±0.01</td>
</tr>
<tr>
<td>Final condition factor</td>
<td>0.69±0.03</td>
<td>0.80±0.03</td>
<td>0.77±0.06</td>
<td>0.83±0.03</td>
<td>0.71±0.08</td>
<td>0.73±0.03</td>
</tr>
<tr>
<td>Number cropped</td>
<td>16.00±0.00</td>
<td>19.00±0.00</td>
<td>17.00±0.00</td>
<td>18.00±0.00</td>
<td>18.00±0.00</td>
<td>18.00±0.00</td>
</tr>
<tr>
<td>Survival (%)</td>
<td>80.00±0.00</td>
<td>95.00±0.00</td>
<td>85.00±0.00</td>
<td>90.00±0.00</td>
<td>90.00±0.00</td>
<td>90.00±0.00</td>
</tr>
</tbody>
</table>

Data mean values with different superscripts in each row are significantly different P<0.05, while without data are insignificantly different P>0.05

Table 3: Production Economics of *Vernonia amygdalina* fed *Clarias gariepinus*

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>VAM1</th>
<th>VAM2</th>
<th>VAM3</th>
<th>VAM4</th>
<th>VAM5</th>
<th>VAM6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of feeding</td>
<td>65.67</td>
<td>86.64</td>
<td>86.98</td>
<td>94.14</td>
<td>93.34</td>
<td>96.08</td>
</tr>
<tr>
<td>Cost of fingerling</td>
<td>300.00</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Expenditure</td>
<td>365.67</td>
<td>386.64</td>
<td>388.98</td>
<td>394.14</td>
<td>396.08</td>
<td>393.34</td>
</tr>
<tr>
<td>Value of fish</td>
<td>330.80</td>
<td>561.78</td>
<td>565.38</td>
<td>643.66</td>
<td>620.36</td>
<td>601.66</td>
</tr>
<tr>
<td>Incidence of cost</td>
<td>2.35</td>
<td>2.02</td>
<td>1.80</td>
<td>1.74</td>
<td>1.86</td>
<td>1.87</td>
</tr>
<tr>
<td>Profit index</td>
<td>5.04</td>
<td>6.48</td>
<td>6.50</td>
<td>6.84</td>
<td>6.46</td>
<td>6.45</td>
</tr>
<tr>
<td>Net profit</td>
<td>-34.81</td>
<td>175.14</td>
<td>176.60</td>
<td>249.52</td>
<td>224.28</td>
<td>208.32</td>
</tr>
<tr>
<td>Cost benefit ratio (Ber)</td>
<td>0.91</td>
<td>1.453</td>
<td>1.45</td>
<td>1.63</td>
<td>1.57</td>
<td>1.53</td>
</tr>
</tbody>
</table>

Values given are mean of three replicates.
Table 4: Physico-chemical parameters of water used for culturing *Clarias gariepinus* fed different levels of propolis and ag-zyme for 84 days

<table>
<thead>
<tr>
<th>Parameters</th>
<th>VAM1</th>
<th>VAM2</th>
<th>VAM3</th>
<th>VAM4</th>
<th>VAM5</th>
<th>VAM6</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>5.56</td>
<td>6.87</td>
<td>6.67</td>
<td>6.51</td>
<td>6.72</td>
<td>6.74</td>
</tr>
<tr>
<td>DO (mg/L)</td>
<td>6.67</td>
<td>6.79</td>
<td>6.77</td>
<td>6.76</td>
<td>6.79</td>
<td>6.82</td>
</tr>
<tr>
<td>Temp (°C)</td>
<td>26.81</td>
<td>26.67</td>
<td>26.71</td>
<td>26.75</td>
<td>26.68</td>
<td>26.72</td>
</tr>
</tbody>
</table>

Value given is mean of three replicates

REFERENCES


Adetimirin, V. O. 2010. Employing biotechnology for food security in Nigeria: Hope or hype? 2009/2010 Faculty lecture, Faculty of Agriculture and Forestry, University of Ibadan, Ibadan, Nigeria.


Sofowora, A. 1993. Medicinal Plants and Traditional Medicine in Africa. 2nd ed. Spectrum Book limited, Ibadan.6-188.


