Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 23(5): 301 - 312 (2019)
www.ejabf.journals.ekb.eg

Growth and economic performance of *Clarias gariepinus* fed diets containing dry heat-treated *Luffa cylindrica* seedmeal

Wasiu A. Jimoh *[1], Mohammed O. Shittu[2], Ahmed A. Ayeloja [1] and Somrat A. Abdulsalami [3],

1- Department of Aquaculture and Fisheries, University of Ilorin, PMB 1515, Ilorin
2- Department of Fisheries Technology, Federal College of Animal Health and Production Technology, PMB 5029, Ibadan
3- Fisheries and Aquaculture Unit, Department of Biological Sciences, Crescent University, Abeokuta, Ogun State

*Corresponding author: jimoh.wa@unilorin.edu.ng

ARTICLE INFO

Article History:
Received: Feb.23, 2019
Accepted: Nov. 28, 2019
Online: Dec. 2019

Keywords:
Luffa cylindrical
Economic performance
Growth parameters
Net return
Clarias gariepinus

ABSTRACT

A 56-day feeding trial was carried out to determine the effect of processing time, inclusion level and/or interaction of *Luffa cylindrica* seedmeal on the growth and economic performance of *Clarias gariepinus*. The experiment was designed to include processing times (of 5- and 10- minutes toasting) and inclusion levels (of 15 and 30% *Luffa cylindrica*) making four test dietary treatments. A diet without *Luffa cylindrica* seedmeal served as control. A total of 225 *Clarias gariepinus* juveniles (4.30g average weight) were distributed equally into fifteen experimental 70-litre capacity aerated rectangular plastic tanks. Triplicate groups of each treatment were made. Fish were fed 5% body weight on two equal proportions per day for 56 days. The results of the experiment showed Distinct variations ($p<0.05$) existed on the effect of processing time on the growth performance parameters, the effect of 5-minutes toasted series on growth parameters were significantly different ($p<0.05$) from 10-minute toasted series. 15% replacement levels had significantly higher ($p<0.05$) effects on growth performance parameters than 30% replacement levels. The 10-minute toasted series had higher gross margin and net return but significantly ($p<0.05$) lesser than control. However, fish produced by D1030T yielded a significantly higher gross margin and net return than the other test diets.

INTRODUCTION

Nigeria remains giant in sub-Sahara African Aquaculture production (Machena and Moehl, 2001; Hecht, 2007; FAO 2010). This is because rapid expansion of urban aquaculture and high-density culture of Clariid catfishes is progressing rapidly in the country (Hecht 2007, Ayinla 2007, FAO 2016). However, the exorbitant cost of some fish feed input cum their availability question restrict their use in fish feed manufacture (Huntington, 2004; FAO 2016). In order to witness sustainable growth and development of fish feed manufacture, the need to look for alternative feed ingredients that would have nutrient density comparable to conventional feed becomes a priority. *Luffa cylindrica* has comparable nutrient profiles as the conventional legumes and pulses used as protein sources in fish feed (Oyetayo and Ojo 2012; Sanchez-Vioque *et al*., 1998; Oshodi *et al*., 1993).

Its protein content, mineral content, fatty acid and amino acid profile appear similar to most of the conventional feedstuffs (Olaofe, Okiribiti, and Aremu, 2008). The phytochemicals present in *Luffa cylindrica* seeds such as flavonoids, saponin and alkaloids are in concentrations that make the seed an important source of phytomedicine (Oyetayo and Ojo 2012). Bagchi *et al.* (1999) reported that flavonoids have antioxidant property that is far better than vitamin C and E. Okwu and Omodamiro (2005) reported that saponin has hypocholesteromic effect; they could regulate the blood lipid. *Luffa cylindrica* belongs to the family Curcubitacea that could grow well in tropical lowland (Adebisi and Ladipo, 2000). Ajiwe *et al*. (2005) describes *Luffa cylindrica* to be tropical vine or herbaceous plant with yellow flowers and round leaves. They flourish with twinning tendrils. The seeds of *Luffa cylindrica* are readily available at village level with little or no competitive use at little or no cost. It has potential to serve as a good alternative to conventional legumes and pulses used as protein sources in fish feed especially at village levels. Few studies exist on the use of *Luffa cylindrica* in fish feed especially for *Clarias gariepinus*; Jimoh *et al*. (2013) reported 15% soybean replacement level by *Luffa cylindrica* seedmeal supported optimum growth and nutrient utilization that was not significantly different from control; Tiamiyu *et al*., (2014) reported 25% inclusion level of *Luffa cylindrica* seedmeal supported growth and nutrient utilization of *Clarias gariepinus.* A major drawback is that most of these alternative feed ingredients especially from plant sources contain one form of anti-nutrients or the other which are easily removed by either wet or dry thermal processing (Francis *et al*., 2001). Heat treatments are effective in removing trypsin inhibitors (Norton, 1991); phytates (Hossain and Jauncey, 1990); tannins (Grifiths, 1991) glucosinolates (Burel *et al*., 2000). Designing optimum replacement level and treatment methods for this novel feed ingredient is a way of trying to reduce the inhibitory effect of anti-nutrients present in the plant and optimize its utilization. This is because thermal processing time has significant effect on the digestibility of nutrients in feed so also the replacement level (Adeparusi and Jimoh, 2002). Possible interaction of these two factors may yield a far better result than the effect either of these individual factors could have. This research aims at investigating the effect of heat treatment time, replacement levels and their interactions on the growth and economic performance of *Clarias gariepinus* fed diets containing dry heat-treated *Luffa cylindrica* seedmeal.

MATERIALS AND METHODS

1.5 kg *Luffa cylindrica* seeds were obtained from police post opposite Institute of Agricultural Research and Training Moor plantation Ibadan, Nigeria. The seeds were divided into two parts; one part was toasted at 150^0C for five minutes in an oven (Emel EOV20L) and the second part toasted at same temperature for 10 minutes. The two processed samples were milled to powder after cooling. Proximate analysis was done of each of these samples and other practical feedstuffs (Table 1) following the method described in Association of Official Analytical Chemists (AOAC) (1990).

Five experimental diets were formulated (Table 2). The control diet consists of soybean meal replacing 50% fishmeal. The 5- and 10 -minute toasted *Luffa cylindrica* seedmeal were used to replace soybean meal at 15 and 30% to produce four test diets. The five formulated dietary treatments were designated as CTR, D515T, D530T, D1015T and D1030T. All the feed ingredients in each dietary treatment were milled separately and sieved to a powdery form. They were thoroughly mixed with hot water to facilitate cohesion among the dietary ingredients.

Table 1: Proximate Composition of the some Feed Ingredients

	SBM	**5-Min TLCM**	**10-Min TLCM**	**Maize**
Moisture	9.00	8.00	9.44	10.48
Crude Protein	38.00	32.00	30.50	9.87
Crude Lipid	8.13	16.50	18.00	4.28
Crude Fibre	5.06	8.30	9.17	5.78
Ash	7.12	8.62	9.94	6.73
NFE	32.69	26.58	22.95	62.35
Total	**100.00**	**100.00**	**100.00**	**100.00**

NFE: Nitrogen Free Extract

Table 2: Gross Composition (g/100g Dry Matter) of Experimental Diets Containing Differently Timed Dry Heat Treated *Luffa cylindrica* Seedmeal fed to *Clarias gariepinus*

	Diet Treatments				
Gross Composition	**CTR**	**D515T**	**D530T**	**D1015T**	**D1030T**
Fishmeal	27.78	27.78	27.78	27.78	27.78
Soybean	50.00	42.50	35.00	42.50	35.00
5-min Toasted LCM	-	8.91	17.81	-	-
10-min toasted LCM	-	-	0	9.34	18.69
Cornmeal	10.00	10.00	10.00	10.00	10.00
Fish Premix	2.50	2.50	2.50	2.50	2.50
Fish Oil	5.00	5.00	5.00	5.00	5.00
Starch	4.72	3.31	1.91	2.88	1.03
Total	100.00	100.00	100.00	100.00	100.00
Proximate Composition					
Moisture	7.91	7.97	8.04	8.09	8.27
Crude Protein	40.19	40.22	40.25	40.22	40.25
Crude Lipid	19.69	19.59	19.48	19.80	19.91
Crude Fibre	2.13	2.68	3.23	2.79	3.46
Ash	6.57	6.9	7.24	7.06	7.55
NFE	23.51	22.64	21.76	22.04	20.56
Total	100	100	100	100	100
Amino Acid Composition					
Arginine%	3.16	3.83	4.50	3.87	4.59
Histidine%	1.00	1.13	1.26	1.14	1.28
Isoleucine%	1.95	2.13	2.32	2.15	2.35
Leucine%	3.21	3.48	3.74	3.50	3.79
Lysine%	2.95	3.24	3.52	3.26	3.57
Methionine%	0.90	1.05	1.20	1.06	1.22
M+C%	1.46	1.69	1.92	1.70	1.95
Phenylalanine%	1.88	2.12	2.36	2.14	2.40
P+T%	3.26	3.56	3.87	3.59	3.92
Threonine%	1.88	1.97	2.06	1.98	2.08
Tryptophan%	0.50	0.55	0.60	0.55	0.61
Valine%	2.12	2.35	2.59	2.37	2.63
Fatty Acid Composition					
LOA (18:2n-6)%	5.63	4.85	4.07	4.85	4.07
LNA (18:3n-3)%	0.80	0.69	0.58	0.69	0.58
ARA (20:4n-6)%	0.09	0.09	0.09	0.09	0.09
EPA (20:5n-3)%	0.54	0.54	0.54	0.54	0.54
DHA (22:6n-3)%	1.06	1.06	1.06	1.06	1.06
Total n-3%	2.41	2.30	2.19	2.30	2.19
Total n-6%	5.72	4.94	4.16	4.94	4.16
n3:n6	0.42	0.46	0.53	0.46	0.53
Total phospholipid%	3.08	2.93	2.78	2.93	2.78

Specification: each kg contains: Vitamin A , 4,000,000IU; Vitamin B, 800,000IU; Vitamin E, 40,000IU, Vitamin K_3, 1,600mg; Vitamin B_1, 4,000mg; Vitamin B_2, 3,000mg; Vitamin B_6, 3,800mg, Vitamin B_{12} 3 mcg; Nicotinic Acid 18000mg. Pantothenic Acid 8,000mg; Folic Acid 800mg Biotin, 100 mcg Choline Chloride 120,000mg; Iron 8,000mg; Copper 800mg; Manganese,6,000mg; Zinc 8,000mg; Iodine 400mg;; Selenium, 40 mcg,vit C Coated 60,000mg,Inositol 10,000mg; Cobalt,150m, Lysine 10,000mg; Methionine 10,000 mg, Antioxidant 25,000mg manufactured by Bi-mix Brrand, Corporate head office/factory: 1, Odo-Olowu Street, Ijesatedo, Lagos, Nigeria.

LOA: Linoleic Acid; LNA: Linolenic Acid; ARA: Arachidonic Acid; EPA: Eicosapentanoic Acid; DHA Docosahexanoic Acid

The mixed dietary ingredients were pelleted into 2mm pellets using meat mincer and oven dried at 45^0C for 24 hrs. They were thereafter kept frozen in a refrigerator at -20^0C. Fatty acid and amino acid profiles of the experimental diets were calculated using a software developed by Network of Aquaculture Centre in Asian-Pacific (NACA) (2008).

Experimental design

A 2 x 2 factorial treatment design in completely randomized design was employed adopting two replacement levels (15, 30% of toasted *Luffa cylindrica* seedmeal) and two processing time (5- and 10 minutes toasting).Juveniles of *Clarias gariepinus* were obtained from the hatchery of Department of Fisheries Technology, Federal College of Animal Health and Production Technology Ibadan Oyo state, Nigeria. The fish were allowed to acclimatize for 15 days. They were fed on commercial diet. Prior to the commencement of the feeding trial, all fish were starved for 24 hours. This practice was to prepare the gastrointestinal tract for the experimental diet while at the same time to increase the appetite of the fish.

Feeding trial

The feeding trial was carried out in the wet laboratory of Federal College of Animal Health and Production Technology, Ibadan. The experimental system contained a set of 15 aerated rectangular plastic tanks each with a capacity of 70 liters of water. Triplicate group of each treatment were made consisting of 15 fish per tank (4.30g average weight). All fish were group fed twice daily at a fixed feeding rate of 5% of their body weight per day. Periodic weighing was done at two weeks interval and the feed adjusted as required. Growth performance indices were estimated using the procedures explained in Jimoh and Aroyehun (2011). Water temperature and dissolved oxygen were measured using a combined digital YSI dissolved oxygen meter (YSI Model 57, Yellow Spring Ohio); pH was monitored weekly using pH meter (Mettler Toledo – 320, Jenway UK). Economic Analysis was done following the methods explained in Faturoti, (1989); Abu *et al*. (2010); Boateng *et al*. (2014) and Jimoh *et al*. (2015); Straight line method of depreciation was used to evaluate the cost of Aquaria tanks with the following properties.

$$\text{Depreciation} = \frac{\text{Cost Price} - \text{Salvage value}}{\text{Life Span}}$$

The following indices (equations 1 – 11) were used

$$\text{Incidence of Cost} = \frac{\text{Cost of Feed}}{\text{Weight of Fish}} \quad (1)$$

$$\text{Profit Index} = \frac{\text{Value of Fish}}{\text{Cost of Feed}} \quad (2)$$

$$\text{Profit/kg} = \text{Value of 1kg fish} - \text{Incidence of cost} \quad (3)$$

$$\text{Total Cost (TC)} = \text{TVC} + \text{TFC} \quad (4)$$

Where TVC = Total Variable Cost (Cost of fingerlings + Cost of Feeding)

TFC = Total Fixed Cost (Cost of Aquaria Tanks)

$$\text{Total Revenue(TR)} = \text{Price of Fish} \times \text{Biomass Output (kg)} \quad (5)$$

$$\text{Gross Margin (GM)} = \text{TR} - \text{TVC} \quad (6)$$

$$\text{Net Return (NR)} = \text{TR} - \text{TC} \quad (7)$$

$$\text{Expense Structure Ratio(ESR)} = \frac{\text{Fixed Cost}}{\text{Total Cost}} \quad (8)$$

$$\text{Benefit Cost Ratio (BCR)} = \frac{\text{Total Revenue}}{\text{Total Cost}} \quad (9)$$

$$\text{Gross Ratio (GR)} = \frac{\text{Total Cost}}{\text{Total Revenue}} \quad \text{.......(10)}$$

$$\text{Rate of Return (ROR)} = \frac{\text{Net Return}}{\text{Total Cost}} \quad \text{.......(11)}$$

Statistical Analysis

Data obtained from the experiment were expressed in mean with pooled standard error around the mean (SEM) and they were subjected to two-way analysis of variance (ANOVA) using SPSS 16.0 version for the source and level effect. The interactive effect was subjected to one-way ANOVA. Duncan multiple range test was used to compare differences among individual treatment means where the ANOVA reveals significant difference (P<0.05).

RESULTS

Table 3 shows the growth performance of *Clarias gariepinus* fed diets containing differently timed dry heat-treated *Luffa cylindrica* seedmeal. The results showed that there was significant difference (p<0.05) in the effect of processing time, inclusion levels and their interaction on the growth performance of *Clarias gariepinus* exposed to different dietary treatments. The weight gain of fish fed the control diet was highest which was significantly different (p<0.05) from the weight gain of fish exposed to other dietary treatments except diet D1015T. Fish fed D530T had the least weight gain. There was no significant difference (p>0.05) in the weight gain of fish fed diets D515T and Diet D1030T. Similar trends of results as obtained for weight gain was recorded for percentage weight gain and specific growth rate. However, a reverse trend of results was recorded for the feed conversion ratio of fish exposed to different dietary treatments.

Table 3: Growth performance of *Clarias gariepinus* fed diets containing varying replacement levels of differently timed dry heat treated *Luffa cylindrica*

	Dietary Treatments						p-value		
	CTR	**D515T**	**D530T**	**D1015T**	**D1030T**	**SEM**	**PT**	**IL**	**PTxIL**
Initial Weight	4.30[a]	4.30[a]	4.30[a]	4.30[a]	4.30[a]	0.00	P<0.001	P<0.001	P<0.001
Final Weight	17.23[a]	16.50[b]	12.81[c]	16.97[a]	16.30[b]	0.11	P<0.001	P<0.001	P<0.001
MWG[1]	12.93[a]	12.20[b]	8.51[c]	12.67[a]	12.00[b]	0.11	P<0.001	P<0.001	P<0.001
PWG[2]	300.70[a]	283.80[b]	197.91[c]	294.65[a]	279.07[b]	2.59	P<0.001	P<0.001	P<0.001
SGR[3]	2.82[a]	2.78[b]	2.52[c]	2.81[a]	2.77[b]	0.01	P<0.001	P<0.001	P<0.001
DFI[6]	3.51[c]	3.63[b]	3.24[d]	3.71[b]	3.92[a]	0,27	P<0.001	P<0.001	P<0.001
FCR[4]	1.13[c]	1.30[b]	1.53[a]	1.31[b]	1.49[a]	0.02	P<0.001	P<0.001	P<0.001
PER[5]	22.09[a]	19.23[b]	16.38[c]	19.08[b]	16.81[c]	0.30	P<0.001	P<0.001	P<0.001

Row means with different superscripts are significantly different (p<0.05) from one another.
SEM: Standard Error of Mean PT: Processing Time IL: Inclusion Level
[1] Mean weight gain= final mean weight –initial mean weight
[2] Percentage weight gain= [final weight-initial weight /initial weight] X 100
[3] Specific growth rate= [In final weight-In initial weight] X 100
[4] Feed conversion ratio=dry weight of feed fed /Weight gain (g)
[5] Protein efficiency ratio=fish body weight (g)/ Protein fed
[6]Daily Feed Intake (%day^{-1})=feed intakex100/(initial weight + final weight)/2x56

Fish fed D530T had the highest value of FCR while the lowest value of FCR was recorded in fish fed diet CTR. There was no significant difference (p>0.05) in the value of FCR recorded for fish fed D515T and D1015T. So also, there was no significant difference (p>0.05) in the value of FCR recorded for fish fed D530T and D1030T implying that irrespective of the processing time, the results of replacement levels is comparable with one another. Distinct variations (p<0.05) existed on the effect of processing time on the growth performance parameters, the effect of 5 minutes toasted series on growth parameters were significantly different (p<0.05) from 10 minute toasted series. 15% replacement levels had significantly higher (p<0.05) effects on growth performance parameters than 30% replacement levels. Fish fed CTR had the highest PER which was significantly different (p<0.05) from the PER of fish fed test dietary treatments. There was no significant difference (p>0.05) in the effect of processing time on PER of fish exposed to different dietary treatments. However, significant variation (p<0.05) existed on the on the effect replacement level on the PER. The effect interaction of processing time and replacement level on PER were not significant (p>0.05) on level to level comparison.

The growth curve of the of *Clarias gariepinus* fed diets containing differently timed dry heat treated *Luffa cylindrica* Seedmeal for 56 days is as presented in Figure 1.

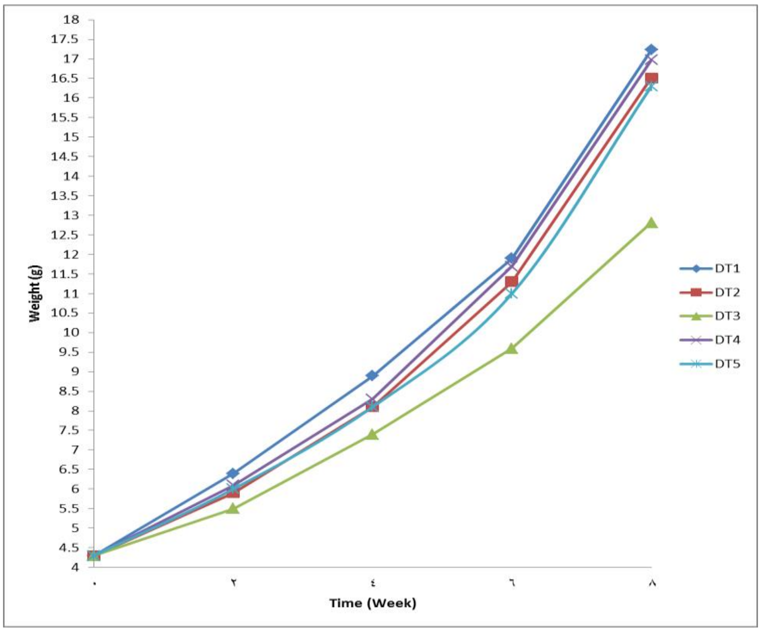

Fig. 1:Growth curve of *Clarias gariepinus* fed diets containing differently timed dry heat treated *Luffa cylindrica* Seedmeal for 56 days.

Table 4 presents the cost of production (N) of the experimental diets containing differently timed dry heat-treated Luffa cylindrica seedmeal fed to Clarias gariepinus. The cost per kg diet was highest in control diets and lowest in dietary treatments.

Table 4: Cost of production (₦) of the experimental diets containing differently timed dry heat-treated *Luffa cylindrica* seedmeal fed to *Clarias gariepinus*

Ingredients	**Price/kg**	**CTR**	**D515T**	**D530T**	**D1015T**	**D1030T**
Fishmeal	750	208.35	208.35	208.35	208.35	208.35
Soybean	148	74.00	62.90	51.80	62.90	51.80
5-min Toasted LCM	15	-	1.34	2.67	-	-
10-min Toasted LCM	15	-	-	-	1.40	2.80
Cornmeal	145	14.50	14.50	14.50	14.50	14.50
Fish Premix	700	17.50	17.50	17.50	17.50	17.50
Fish Oil	300	15.00	15.00	15.00	15.00	15.00
Starch	50	2.36	1.66	0.96	1.44	0.52
Cost/kg		**331.71**	**321.24**	**310.78**	**321.09**	**310.47**

Table 5 depicts the gross profit analysis of producing *Clarias gariepinus* with diets containing differently timed dry heat-treated Luffa cylindrica seedmeal. Processing time, inclusion level and their interaction had significant effect (p<0.05) on the profit index and gross profit of producing Clarias gariepinus. Fish produced by control diet (CTR) had the highest profit index and gross profit. No significant variation (p>0.05) existed in the profit index and gross profit of fish produced by 15% replacement level and the different processing time; fish produced by D515T and D1015T had similar effect on the profit index and gross profit. Similarly, there was no significant variation in the profit index and gross profit of producing fish with diet D530T and D1030T.

Table 5: Gross Profit analysis of producing *Clarias gariepinus* with diets containing varying replacement levels of differently dry heat-treated *Luffa cylindrica* seedmeal.

	Treatments						p-value		
	CTR	**D515T**	**D530T**	**D1015T**	**D1030T**	**SEM**	**PT**	**IL**	**PT x IL**
Weight Gain (kg x10^{-2})	1.29^{a}	1.22^{b}	0.85^{c}	1.27^{a}	1.20^{b}	0.00	P<0.001	P<0.001	P<0.001
Cost of feed fed(₦)	4.86^{c}	5.10^{bc}	4.04^{d}	5.33^{ab}	5.54^{a}	0.09	P<0.001	P<0.001	P<0.001
Feed fed(kg x10^{-2})	1.47^{c}	1.59^{b}	1.30^{d}	1.66^{b}	1.78^{a}	0.00	P<0.001	P<0.001	P<0.001
Incidence of cost (₦)	375.94^{c}	417.61^{b}	474.45^{a}	420.63^{b}	461.56^{a}	5.72	P<0.001	P<0.001	P<0.001
Value of fish(₦)	9.70^{a}	9.15^{b}	6.38^{c}	9.50^{a}	9.00^{a}	0.08	P<0.001	P<0.001	P<0.001
Profit index	2.00^{a}	1.80^{b}	1.58^{c}	1.78^{b}	1.63^{c}	0.03	P<0.001	P<0.001	P<0.001
Gross profit (₦)	374.06^{a}	332.39^{b}	275.55^{c}	329.37^{b}	288.44^{c}	5.72	P<0.001	P<0.001	P<0.001

Row means with different superscripts are significantly different (p<0.05) from one another.
SEM: Standard Error of Mean PT: Processing Time IL: Inclusion Level
Current Value of 1kg fish= ₦750 1 USD=305. 85

Table 6 shows the cost and return analysis of producing Clarias gariepinus with diets containing differently timed dry heat treated Luffa cylindrica seedmeal. Processing time, inclusion level and their interaction had significant effect (p<0.05) on the gross margin and net return of producing *Clarias gariepinus* as there existed a significant difference (p<0.05) between the effect of 5-minute and 10-minute toasted dietary treatments series; the 10-minute toasted series had higher gross margin and net return but significantly (p<0.05) lesser than control. However fish produced by D1030T yielded a significantly higher gross margin and net return the rest test diets.

Table 6: Cost and return analysis of producing *Clarias gariepinus* with diets containing differently timed dry heat treated *Luffa cylindrical*.

	Dietary Treatments						p-value		
	CTR	**D515T**	**D530T**	**D1015T**	**D1030T**	**SEM**	**PT**	**IL**	**PT X IL**
Biomass	12.93^{a}	12.20^{b}	8.51^{c}	12.67^{a}	12.00^{b}	0.11	P<0.001	P<0.001	P<0.001
Feed Fed	14.65^{C}	15.86^{b}	13.00^{d}	16.70^{b}	7.84^{a}	0.27	P<0.001	P<0.001	P<0.001
CoF (₦)	4860.7^{c}	5096.3^{bc}	4038.7^{d}	5329.8^{ab}	5537.8^{a}	87.05	P<0.001	P<0.001	P<0.001
Total Variable Cost (₦)	5010.7^{c}	5246.3^{bc}	4188.7^{d}	5479.8^{ab}	5687.8^{a}	87.05	P<0.001	P<0.001	P<0.001
Total Cost (₦)	6720.7^{c}	6956.3^{bc}	5898.7^{d}	7189.8^{ab}	7397.8^{a}	87.05	P<0.001	P<0.001	P<0.001
Total Revenue (₦)	9697.5^{a}	9152.5^{b}	6382.5^{c}	9502.5^{a}	9000.0^{b}	83.52	P<0.001	P<0.001	P<0.001
Gross Margin (₦)	4686.8^{a}	3906.2^{b}	2193.8^{d}	4022.7^{b}	3312.2^{c}	77.04	P<0.001	P<0.001	P<0.001
Net Return (₦)	2976.8^{a}	2196.2^{b}	483.77^{d}	2312.7^{b}	1602.2^{c}	77.40	P<0.001	P<0.001	P<0.001

Row means with different superscripts are significantly different (p<0.05) from one another.
CoF: Cost of Feeding SEM: Standard Error of Mean PT: Processing Time
IL: Inclusion Level Current Value of 1kg fish= ₦750 1 USD=305.85

Cost of Aquaria tank	57,000
Less 10% Savage Value	5,700
Depreciation	10,260
Depreciation (2 months)	1,710

Table 7 shows the profitability analysis of producing Clarias gariepinus with diets containing differently timed dry heat treated Luffa cylindrica seedmeal. Processing time, replacement level and their interaction had significant effect ($p<0.05$) on the profitability analysis parameters. BCR and ROR of fish produced by control diet were significantly ($p<0.05$) higher than those produced by test diets. Fish produced by 5-minute toasted series recorded the lowest value of BCR and ROR. Contrast was the case of gross margin and ESR.

Table 7: Profitability analysis of producing *Clarias gariepinus* with diets containing differently timed dry heat-treated *Luffa cylindrica* seedmeal.

	Dietary Treatments						p-value		
	CTR	D515T	D530T	D1015T	D1030T	**SEM**	PT	IL	PT x IL
Benefit Cost Ratio	1.44^{a}	1.32^{b}	1.08^{d}	1.32^{b}	1.22^{c}	0.02	P<0.001	P<0.001	P<0.001
Gross Ratio	0.69^{d}	0.76^{c}	0.92^{a}	0.76^{c}	0.82^{b}	0.01	P<0.001	P<0.001	P<0.001
Expense Structure Ratio	0.26^{b}	0.25^{bc}	0.29^{a}	0.24^{cd}	0.23^{d}	0.00	P<0.001	P<0.001	P<0.001
Rate of Return	0.44^{a}	0.32^{b}	0.08^{d}	0.32^{b}	0.22^{c}	0.02	P<0.001	P<0.001	P<0.001

Row means with different superscripts are significantly different ($p<0.05$) from one another.

DISCUSSION

Higher processing time of *Luffa cylindrica* had a significant effect on growth performance of *Clarias gariepinus* plausibly due to higher effect of heat on anti-nutrient composition of *Luffa cylindrica*. Davies and Gouveia (2008) reported that dry heat treatment improved feed utilization. Okomoda *et al*. (2016) reported that hydrothermal heat treatment of 30-40 minutes improved the utilization of *Canavalia ensiformis* by *Clarias gariepinus*. The lower replacement level of 15% had a significantly improved effect on growth performance than higher level of 30%. This is because at lower level of inclusion body mechanism of fish could cope with anti-metabolite in the dietary treatments. Francis *et al*. (2001) reported fish have compensatory mechanism in their body system that could mitigate the negative effect of anti-nutrients when the quantity is below certain threshold levels. Tiamiyu *et al*. (2014) reported an inclusion level of 25% of the same seed meal in the diet of *Clarias gariepinus* had a comparable performance with control. Gouveia *et al*. (1993) reported rainbow trout fed on 20% plant protein of faba. lupin and pea seedmeal performed relatively well with growth and nutrient utilization being better with partial inclusion level. A reduction in growth performance was also observed by Jimoh *et al*. (2013) when *Luffa cylindrica* was fed to the same fish beyond 25% replacement level. The interactive effect of processing time and inclusion level revealed that D1015T had a comparable performance with control using mean weight gain as index of assessment,. However, the effect of dietary treatment D1015T was similar to D515T suggestive of the fact that irrespective of the processing time; lower inclusion level performs better than higher inclusion level. The level to level comparison in terms of FCR and PER attested to this. Jimoh *et al*. (2013) reported a replacement level of 15% of the same seedmeal for soybean meal had a comparable performance with control when fed to *Clarias gariepinus*. Higher inclusion levels of certain oilseed meals have been reported to result in poor growth and nutrient utilization by *Oreochromis niloticus* (Davies *et al*., 1999; 2000). Reduced cost per kg of producing the test dietary treatments relative to control was also reported by Jimoh *et al*. (2015) for watermelon seedmeal in the diet of Nile tilapia (*Oreochromis niloticus*) fingerlings. Processing time, replacement level of *L. cylindrica* or their interaction had a significant impact on the economic performance of producing *Clarias gariepinus* with dry heat treated *Luffa cylindrica* seedmeal. Reduced incidence of cost among the fish produced with test dietary treatments relative to control was reported by Jimoh *et al*. (2016) when *Jatropha curcas* was fed to *Oreochromis niloticus* fingerlings. Jimoh *et al*. (2015) evaluated the profitability of replacing soybean meal with watermelon seedmeal in the diet of *Oreochromis niloticus* and reported a reduced cost per kg which was also called incidence of cost in the watermelon dietary treatments. Feeding each of the dietary treatments left a profit index above 1 which indicated that it is profitable to feed *Clarias gariepinus* with dry heat treated *Luffa cylindrica* seedmeal. Our results agree with submission of Abu *et al*. (2010); Jimoh *et al*. (2015) and (2016) that using relatively cheaper, non-conventional legume left profit index above 1.

The reduced gross margin and net return in the test dietary treatments relative to control was due to poorer growth performance recorded. Jimoh *et al*. (2015) and (2016) reported similar trends of results when watermelon and *Jatropha curcass* seedmeal was fed to *O. niloticus*. Boateng *et al*. (2013) reported a positive gross margin as an index of profitability of all male tilapia aquaculture enterprise in Ghana. When variable cost of production is covered by gross revenue, the profit margin will be positive. The benefit cost ratio (BCR) and rate of returns determine the extent of the profit BCR above 1 implies profitability, the farther away from 1, the more the profitability. Fish produced by all the dietary treatments left a BCR above 1. Gross Ratio is a contrast to BCR. It relates how much is expended for every ₦1 revenue obtained from the production of certain items. Fish produced from our test dietary treatments had a relative higher gross ratio than control. The ESR shows how much of the fixed cost is represented in the total cost of producing a certain item. An average of 0.25 ESR recorded in this study means that for every ₦100 cost of production of *Clarias gariepinus* using diets containing *Luffa cylindrica* seed meal, ₦25 is expended as the fixed cost implying that the variable cost of production of *Clarias gariepinus* across the dietary treatments accounted for not less than 75%.

CONCLUSION

It is evident from this study that processing time, inclusion levels of *Liffa cylindrica* seedmeal and their interactions had significant effect on the growth and economic performance of *Clarias gariepinus*

REFERENCES

Abu, O.M.G.; Sanni, L.O.; Erondu, E.S. and Akinrotimi, O.A. (2010). Economic viability of replacing maize with whole cassava root meal in the diet of Hybrid catfish. Agricultural Journal 5 (1): 1-5. https://doi.org/10.3923/aj.2010.1.5

Adebisi, A.A and Ladipo, D.O. (2000). Evaluation of the utilization spectrum of some cucurbits in South West Nigeria.CENRAD Development, Series 07 CENRAD, Ibadan, Nigeria. 14pp

Adeparusi, E.O. and Jimoh, W.A. (2002). Digestibility coefficients of raw and processed Lima bean diet for Nile Tilapia, *Oreochromis niloticus*, Journal of Applied Aquaculture, 12(3): 89-98. https://doi.org/10.1300/J028v12n03_09.

Ajiwe, V.I.E.; Ndukwe, G.I. and Anyadiegwu, I.E. (2005): Vegetable diesel fuels from *Luffa cylindrica* oil, its methylester and ester-diesel blends. Chem Class Journal, 2:1–4

Association of Official Analytical Chemists (AOAC) (1990). Official method of analysis K. Helrich (ed). 15th edn, vol 1, AOAC, Arlington, VA, 684PP.

Ayinla, O.A. (2007). Analysis of feeds and fertilizers for sustainable aquaculture development in Nigeria. In M.R. Hasan, T. Hecht, S.S. De Silva and A.G.J. Tacon (eds). Study and analysis of feeds and fertilizers for sustainable aquaculture development.FAO Fisheries Technical Paper. No. 497. Rome: FAO. 453–470pp.

Bagchi, M.; Mark, M.; Casey, W.; Jaya, B.; Xumei, Y.; Sidney, S. and Debasis, B.(1999). Acute and chronic stress-induced oxidative gastrointestinal injury in rats, and the protective ability of a novel grape seed proanthocyanidin extract. Nutrition Research 19:1189–1199. https://doi.org/10.1016/S0271-5317(99)00080-9.

Boateng, V.F.; Alhassan, E.H.; Yaw, S.; Nensom, E. and Abarike, E. D. (2013). Profitability Analysis of all-male Tilapia Farming in Sekyere South and Bosomtwe Districts of Ashanti Region. Agriculture and Biology Journal of North America 4(5): 568-575.

Burel, C.; Boujard, T.; Escaffre, A.-M.; Kaushik, S.J.; Boeuf, G.; Mol, K.A.; Geyten, S.V.D. and Kuhn, E.R. (2000). Dietary low glucosinolate rapeseed meal affects thyroid status and nutrient utilization in rainbow trout *Oncorhynchus mykiss*. Brit. J. Nutr. 83: 653–664.https://doi.org/10.1017/S0007114500000830

Norton, G. (1991). Proteinase inhibitors. In: D'Mello, F.J.P., Duffus, C.M., Duffus, J.H. (Eds.) Toxic Substances in Crop Plants. The Royal Society of Chemistry, Thomas Graham House, Science Park, Cambridge CB4 4WF, Cambridge, 68–106pp. https://doi.org/10.1533/9781845698454.68.

Davies, S.J. and Gouveia, A. (2008). Enhancing the nutritional value of pea seed meals (*Pisum sativum*) by thermal treatment or specific isogenic selection with comparison to soybean meal for African catfish, *Clarias gariepinus*. Aquaculture 283:116–122. https://doi.org/10.1016/j.aquaculture.2008.06.022.

Davies, S.J.; Fagbenro, O.A.; Abdel-Waritho, A.A. and Diller, I. (1999). Use of soybean products as fish meal substitute in African catfish, *Clarias gariepinus*, diets. Applied Tropical Agriculture 4: 10-19.

Davies, S.J.; Fagbenro, O. A.; Abdel-Waritho, A. A. and Diller, I. (2000). Use of oilseed residues as fish meal replacer in diets fed to Nile tilapia, *Oreochromis niloticus* (L.). Applied Tropical Agriculture 5: 1-10.

Food Agriculture and Organization (FAO). (2016). The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Rome. 200pp

Food Agriculture and Organization (FAO) (2010). Cultured Aquatic Species Information Programme. *Clarias gariepinus*.Text by Pouomogne, V. In: FAO Fisheries and Aquaculture Department [online]. Rome. Updated 1 January2010. (Cited 18 November 2019) at http://www.fao.org/fishery/cultured species/*Clarias gariepinus*.

Francis, G.; Makkar H.P.S. and Becker K. (2001). Antinutritional factors present in plant-derived alternate fish feed ingredients and their effects in fish. Aquaculture 199:197–227. https://doi.org/10.1016/S0044-8486(01)00526-9

Gouveia, A.; Oliva Teles, A.; Gomes, E. and Rema, P. (1993). Effect of cooking expansion of three legume seeds on growth and food utilization by rainbow trout. In: Kaushik, S.J., Luquet, P. _Eds.., Fish Nutrition in Practice. 24–27 June 1991, Biarritz France, INRA Special Publication, Les Colloques, 6: .933–938.

Griffiths, D.W. (1991). Condensed tannins. In: D'Mello, F.J.P., Duffus, C.M., Duffus, J.H. (Eds), Toxic Substances in Crop Plants. The Royal Society of Chemistry, Thomas Graham House, Science Park,Cambridge CB4 4WF, Cambridge, 180–201pp. https://doi.org/10.1533/9781845698454.180.

Hecht, T. (2007). Review of feeds and fertilizers for sustainable aquaculture development in sub-Saharan Africa. In M.R. Hasan, T. Hecht, S.S. De Silva and A.G.J. Tacon (eds). Study and analysis of feeds and fertilizers for sustainable aquaculture development. FAO Fisheries Technical Paper. No. 497. Rome, FAO, 77–109pp.

Hossain, M.A., and Jauncey, K. (1990). Detoxification of linseed and sesame meal and evaluation of their nutritive value in the diet of carp *Cyprinus carpio* L. Asian Fish. Sci. 3: 169–183.

Huntington, T.; Frid, C.; Banks, R.; Scott, C. and Paramor, O. (2004). Assessment of the sustainability of industrial fisheries producing fishmeal and fish oil. Final Report to Royal Society for Protection of Bird (RSPB). Poseidon Aquatic Resource Management Ltd, 2 Fox Pond Lane, Lymington, Hampshire SO41 8FW, UK. (http://www.rspb.org.uk/Images/fishmeal_ tcm5-58613.pdf).

Jimoh, W.A.; Aderolu, Z.A.; Ayeloja, A.A. and Shodamola, M.O. (2013), Use of *Luffah cylindrica* seedmeal as a soybean meal replacer in diet for fingerlings of African catfish, *Clarias gariepinus* (Burchell 1822). International Journal of Applied Agricultural and Apicultural Research 9(1&2): 98-105.

Jimoh, W. A.; Shittu, M. O.; Owolade, E. O.; Ojutalayo, S. T.; Arilesere, J. I.; Bernard, A. M and Ayeloja A. A. (2015). Production economics of using watermelon seedmeal in the diet of Nile tilapia (*Oreochromis niloticus*) fingerlings. Applied Tropical Agriculture 20(1): 96-101.

Jimoh, W.A.; Aderolu, Z.A.; Oladele-Bukola, M.O.; Abdulsalami, S.A. and Okemakin, F.Y. (2016). Growth performance of *Clarias gariepinus* fingerlings fed graded levels of dietary cooked *Jatropha curcas* seed meal-based diets. The Egyptian Journal of Experimental Biology (Zoology) 12(1): 87 – 91.

Machena, C. and Moehl, J. (2001). Sub-Saharan African aquaculture: regional summary. In R. P. Subasinghe, P. Bueno, M. J. Phillips, C. Hough, S.E. McGladdery & J. R. Arthur, eds. Aquaculture in the Third Millennium. Technical Proceedings of the Conference on Aquaculture in the Third Millennium, Bangkok, Thailand, 20-25 February 2000. 341-355pp. NACA, Bangkok and FAO, Rome

Network of Aquaculture Centre in Asian-Pacific (NACA) (2008). Diet Formulator Program (Excel). Retrieved from http://www.enaca.org/modules/library/publication.php?publication_id=952

Okomoda, V.T.; Tiamiyu, L.O. and Uma, S.G. (2016). Effects of hydrothermal processing on nutritional value of *Canavalia ensiformis* and its utilization by *Clarias gariepinus* (Burchell, 1822) fingerlings. Aquaculture Reports 3: 214–219. https://doi.org/10.1016/j.aqrep.2016.04.003

Okwu, D.E and Omodamiro, O.D. (2005). Effects of hexane extract and phytochemical content of *Xylopia aethiopica* and *Ocimum gratissimum* on the uterus of guinea pig. Bioresearch, 3(2):40 – 44.

Olaofe, O; Okiribiti, B. Y. and Aremu, M. O. (2008). Chemical evaluation of the nutritive value of smooth luffa *(Luffa cylindrica*) seed's kernel. Electronic Journal of Environmental Agricultural and Food Chemistry. 7(10):3444-3452

Oshodi, A.A.; Olaofe, O. and Hall, G.M. (1993). Amino acid, fatty acid, mineral composition of pigeon pea (*Cajnus cajan*). International Journal of Food Nutrition 43: 178-191

Oyetayo, F. L. and Ojo, B. A. (2012). Food value and phytochemical composition of *Luffa cylindrica* seed flour. American Journal of Biochemistry, 2(6): 98-103. https://doi.org/10.5923/j.ajb.20120206.02 .

Sanchez-Vioque, R.; Clement, A.; Vioque, J.; Bautista, J. and Millan, F. (1998). Polar lipids of defatted chickpea (*Cicer arietinum* L) flour and protein isolates. Food Chemistry 63: 357-855. https://doi.org/10.1016/S0308-8146(98)00015-6

Tiamiyu, L. O.; Solomon, S. G. and Satimehin, S. P. D. (2001). Growth performance of *Clarias gariepinus* fingerlings fed varying levels of the seed of *Luffa cylindrica* meal in outdoor hapas. Octa. J. Biosci., 2(1):8-12