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GROWTH PERFORMANCE AND BODY COMPOSITION OF *Clarias gariepinus* (Burchell 1822) FED GRADED LEVELS OF DETOXIFIED *Jatropha curcas* MEAL

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Abstract
This research investigated into the growth performance, survival and body composition of Clarias gariepinus fingerlings (4.30±0.01g) fed five diets containing 40% crude protein and varying inclusion levels of detoxified Jatropha curcas meal (DJCM) at 0%, 25%, 50%, 75% and 100% replacement for fishmeal (FM). The results obtained indicated significant differences (P<0.05) in the growth parameters, survival and biological values evaluated. Diet 1 (0% DJCM and 100% FM) gave the best growth parameters in terms of Mean weight gain (10.53±1.95), Feed Conversion Ratio (FCR) (2.73±0.55), Specific Growth Rate (2.19±0.23) and survival rate (73.33±10.41) this followed by diet 2 (25%DJCM and 75%FM) with MWG (0.88±0.33), FCR (12.00±4.67), SGR (0.33±0.11) and survival rate (56.67±16.07). The body crude protein was significantly high (P<0.05) for diet 1 (65.63%) and lowest for diet 5 (48.13%). The lipid content was also high for diet 1 (21.40%). and lowest for diet 3 (16.30%) while the ash content was found high in diet 1 (29.10%) and low in fish fed diet 5 (16.10%). The growth performances and survival rate became decreased with increment in the inclusion levels of detoxified Jatropha curcas meal. It can be concluded that detoxified Jatropha curcas meal can be included in the diet of Clarias gariepinus up to 25% beyond which there is detrimental effect on fish growth.

Key words: Detoxified, *Jatropha curcas* meal, *Clarias gariepinus*

INTRODUCTION

Fish has been reported to be a good source of food and means of livelihood to many African populace (Mustapha, 2013). However, this industry is constrained by availability of alternative nutritive protein source as replacement for fish meal (NCR, 1993); Naylor *et al.*, 2000; Mabahinzireki *et al.*, 2001). Several studies have revealed the use of some plant protein sources like Moringa leaf meal, Soybean meal and so on as fish meal replacement in fish diets (Hossain *et al.*, 2001; Dongmeza *et al.*, 2006; Kumar *et al.*, 2008, 2010a,b,c; Makkar *et al.*, 2009 and Yue and Zhou, 2009). Moreover, the inclusion level of these plant protein sources requires careful consideration for processing for fish to utilize its nutrients (Pillay, 1990; Francis *et al.*, 2001). Nutritional values of plant protein sources as supplement in animal diets have been studied and some of the reported studies were found with cotton seed meal replacing fish meal in tilapia ration at 50% inclusion rate (Ofojekwu and Ejike, 1984; Mbahinzireki *et al.*, 2001). *Jatropha curcas* is a plant protein source which is abundant in the tropics and subtropics (Becker and Makkar, 2008: Kumar *et al.*, 2008). It is useful in bio-diesel production (Makkar *et al.*, 2008: Parawira *et al.*, 2010), its oil extract is a good nutrient source for animal diet when properly treated to reduce the anti-nutritional factors (Reddy and Pierson, 1994: Aderibigbe *et al.*, 1997). The seed maintains its weight of 50% as press cake with crude protein between 58-62% and an excellent amino acid profile and carbohydrate (Becker and Makkar, 2008). Saturated and unsaturated fatty acids that includes the polyunsaturated fatty acid (PUFA) containing acid (18:2n-6) and alpha linoleic acid (18:3n-3) fatty acids (Becker and Makkar, 2008). However, *Jatropha curcas* has been posited as future important feed ingredient to replace fish meal and soya bean but the anti-nutritional substance such as (lectin, phytic acid, saponins and trypsin inhibitors) and the toxic substance (phorbol esters) would limits the protein content, amino acid profile and carbohydrate level and functionality in the feed (Makkar and Makkar, 2008). There is the need for further investigation into alternative plant protein sources for fish feed (FAO, 2012: Madalla, 2008) that will have no interference with human interest with regard to issue of food security (Tacon and Foster, 2000). This research thus, investigated the growth performance of *Clarias gariepinus* fed detoxified *Jatropha* curcas meal.

Materials and Methods

The experimental work was carried out in the Laboratory of Water Resources, Aquaculture and Fisheries Technology Department, Gidan Kwano Campus of School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State, Nigeria.

Experimental Protocol

Clarias gariepinus fingerlings (4.30±0.01g) were purchased and transported to the Laboratory from *Eco*-Rehab Environmental Service Limited (Fishery Section) Kuje, Federal Capital Territory,

Abuja. The fishes were acclimatized in plastic tank for one week before commencement of the experiment. The feedstuffs comprising detoxified *Jatropha* curcas meal which was obtained from the department of Microbiology, School of Life Sciences, Federal University of Technology, Minna, while, fishmeal, maize meal, soybean meal, vitamin-mineral premix and vegetable oil were purchased from Minna Central Market, Niger State. The feed ingredients were milled separately and their proximate compositions were analysed for Moisture, Crude protein, crude fat, Cride fibre and Ash according to the method of AOAC (2000). Five diets containing 40% crude protein at five different inclusion levels of 0%, 25%, 50%, 75% and 100% of detoxified *Jatropha curcas* meal were formulated and compounded as in Table 1.

Experimental Procedure

Twenty fishes were distributed randomly in triplicate of 15 tanks in a complete randomized design. The fish were fed thrice daily starting with 3% body weight and adjusted fortnightly for the feeding trial period of 8weeks. Water quality parameters were maintained by daily changing of water and monitored weekly for temperature, conductivity and pH using standard methods (Table 2).

Table 1: Formulated diets with their proximate compositions

Feedstuffs	Diet 1 (0%DJCM)	Diet 2 (25%DJCM)	Diet 3 (50%DJCM)	Diet 4 (75%DJCM)	Diet 5 (100%DJCM
Fish Meal	460.40	345.30	230.20	115.10	0.00
DJCM	0.00	115.10	230.20	345.30	460.40
Maize Meal	389.60	389.60	389.60	389.60	389.60
Soybean Meal	100.00	100.00	100.00	100.00	100.00
Vitamin premix	20.00	20.00	20.00	20.00	20.00
Vegetable Oil	30.00	30.00	30.00	30.00	30.00
Total	1000.00	1000.00	1000.00	1000.00	1000.00
Proximate Composition of Formulated Diets (%)					
Crude Protein	45.52	45.60	45.25	45.4.2	45.50
Crude Lipid	11.05	12.15	14.35	15.54	17.55
Crude Fibre	0.55	0.95	0.95	1.15	1.30
Ash	8.10	6.95	7.30	6.10	4.30
Moisture Content	36.28	34.64	26.20	33.62	38.18

Table 2: Water Quality Parameters for week 1-8

Parameters	Temp (°C)	pH	Conductivity (μM/cm)
T1	25.1-28.2	7.28-8.49	274-475
T2	25.1-28.4	7.30-8.48	275-464
T3	25.1-29.0	7.27-8.43	273-466
T4	25.1-28.3	7.30-8.50	275-465
T5	25.1-28.3	7.47-8.49	276-467

Chemical analysis

The carcass contents for initial and final treatments were analysed for their proximate compositions according to the method of AOAC (2000).

Biological evaluation

The biological parameters which included mean weight gain, feed conversion ratio, specific growth rate and protein efficiency ratio were evaluated according to the method of Maynald, 1979, and Halver 1989, as describe below;

Weight gain: Weight gain = Final body weight - initial body weight

Specific Growth Rate (SGR): According to Brown 1957 was measure with the formula

SGR = Ln Mean Final Weight x Ln Mean Initial Weight x 100 /Duration of experiment (Days)

Feed Conversion Ratio (FCR): This is measure with the formula

FCR = Weight of feed fed (gram) / Weight gain of fish (gram)

Protein Efficiency Ratio (PER): This is express as:

PER = Weight gain of fish / Protein fed

Apparent Net Protein Utilization (ANPU) = Carcass Protein gain (g) x 100 / Protein fed

Mortality was evaluated as the expressed as

%Mortality = No of fish left in the tank x 100 / No of fish stocked

Statistical Analysis

The result for the feeding trials were subjected to one-way Analysis of Variance (ANOVA) (Steel and Torrie, 1980) and the average means for the treatments were compared with each other for

significance difference (P<0.05) with the aid of a statistical software package Minitab release 14. The graphical analysis was plotted with Microsoft excel window 2007. Multiple parameters mean comparison of treatment was done according to Duncan multiple tests (Duncan, 1995).

RESULT

The initial mean weight among the fishes were not significantly different (P>0.05) from each other at the commencement of the feeding trial. Table 3 showed the performance of *Clarias gariepinus* fed detoxified *Jatropha* curcas meal which indicated significant differences (P<0.05) among treatments. It was observed that diet 1 (0% detoxified *Jatropha* curcas meal) gave the best performances in terms mean weight gain 10.53g, this was followed by diet 2 (25% DJCM) with 0.88g while diets 3, 4 and 5 were significantly low (P<0.05) -1.11g, -1.89g and -1.79g respectively with no significant differences (p>0.05) among them. The feed conversion ratio for diet 2 and 3 showed the highest mean value of 12.00g and 12.17g which were not significantly different (P>0.05) from each other but significantly different (P<0.05) from diet 1 (2.73). However, diets 4 and 5 exhibited negative FCR (-7.18g and -0.99g respectively) P>0.05. The specific growth rate (SGR) was significantly high (P<0.05) for diet 1 (2.19) followed by diets 2, 3 and 5 (0.33; 0.13 and 0.13 respectively) while diet 4 gave a significantly low (P<0.05) SGR value (-0.21). The percentage survival of fishes fed detoxified *Jatropha curcas* meal was also significant (P<0.05). Diet 1 and 2 had the highest mean survival rate of 73.33% and 56.67% with no significant difference (P>0.05) between them while diet 3 and 4 recorded significantly low (P<0.05) mean survival rate of 16.67%, 11.67% and 6.67% with no significant (P>0.05) difference between them but were significantly different from diet 5 with lowest survival rate of 6.67%. On the tissue protein analysis, the protein efficiency ratio (PER) evaluated indicated that diets 1 and 2 were significantly different (P<0.05) from other treatments which had negative protein efficiency ratios. Similarly, the apparent net protein utilization (ANPU) expressed significant difference (P<0.005) among treatments. Diet 3 had the best ANPU value (178.27%) followed by diet 1 (88.59%) while other diets gave a significantly low ANPU values.

Body compositions: Table 4 showed the body composition of initial and final carcass with significant differences (P<0.05) among treatments. Diets 1 and 3 were significantly higher (P<0.05) in carcass crude protein values (65.63% and 62.13% respectively) than the initial value (55.00%) while diet 5 gave a significantly low crude protein value (48.13%). However, the body crude lipid for diets 1 (20.09%) and 2 (21.40%) were not significantly different (P>0.05) from each other but are significantly (P<0.05) different from other treatments. Diet 1 gave a significantly high (P<0.05) body crude fibre content (4.00%) while diet 4 (1.20%) was significantly low (P<0.05) however, with no significant difference (P>0.05) to diets 5 and the initial fibre value of 1.29% and 1.40% respectively. The carcass ash content for all treatments were significantly higher (P<0.05) than the initial, moreover, diet 3 gave a significantly high (P<0.05) ash content (29.10%) than other treatments while diet 5 was significantly low (P<0.05) in ash with 16.10%. The moisture content was significantly low for diets 2 (2.64%) and 3 (3.92%) with no significant difference (P>0.05) while diet 5 was significantly different from other diets with high moisture content (5.24%) (Table 4).

Discussion

The experimental fish feeding behavior and the feed palatability were observed during the period of the experiment and was noticed that fish fed the control diet (0% Detoxified *Jatropha* curcas meal, 100% Fishmeal) and Diet 2 (25% Detoxified *Jatropha* curcas meal 75% Fishmeal) were more active in feeding behavior than those fed other diets as evident in the feed fed (Table 1). Therefore, the variation recorded in all treatments with reference to biological values measured indicated that, *Clarias gariepinus* performances were affected by the dietary inclusion of *Jatropha* meal (Table 1). The results from the study also indicated that, inclusion of *Jatropha* meal at various levels in the diet of *Clarias gariepinus* fingerlings impacted negatively on the diet palatability, feeding behavior, growth performance, feed utilization and survival rate of the fish (Tables 1, 3 and 4). The acceptability of diets 1 and 2 (0% detoxified *Jatropha* curcas meal,100% Fishmeal) and (25% detoxified *Jatropha* curcas meal 75% Fishmeal) respectively can be as a result of low level of anti-nutritional factors that might have effect on the palatability of the diets and its utilization. However, high phytate level in the Jatropha kernel has been reported to have ability to decrease the bio-availability of mineral (especially Ca^{2+} and Fe^{2+}) and protein digestibility through complex formation and enzyme reactions (Reddy and Pierson, 1994). The experimental fish fed diet 1 (0% detoxified *Jatropha* curcas meal,100% Fishmeal) had superior growth performance in term of mean weight gain and specific growth rate, body crude protein and body lipid followed by fishes fed diet (25% detoxified *Jatropha* curcas meal 75% Fishmeal) and were significantly (P<0.05) different from other treatments which could be as a result of high levels of toxin (Phorbol ester) and anti-nutritional compounds in the detoxified *Jatropha* curcas meal as the inclusion levels increases in the diets which confirms the report of Azzaza *et al.*, 2011; Reddy and Pierson, 1994; Hajos *et al.*, 1995; Aderibigbe *et al.*, 1997) that, feed containing high

concentration of anti-nutritional factor would decrease nutrient available in the diet with attendant implication on reduction of growth performance of fish. It was observed that diet 1 and 2 fed diet containing (0% detoxified *Jatropha* curcas meal/100% Fishmeal) and (25% detoxified *Jatropha* curcas meal/ 75% Fishmeal) respectively achieved the highest survival rate (73.33% and 56.67%) than those fed high inclusion of detoxified Jatropha curcas meal. This could be as a result of increased level of anti-nutritional factors such as phytates, trypsin inhibitor, lectin and the toxic substance (phorbol esters) as reported by (Hajos *et al.*, 1995). He further explained that reduction in metabolic activities of the fish and growth performance can be affected by increased level of anti-nutritional factors and toxic substances (phorbol ester).

CONCLUSION

It can be concluded that, since inclusion level up to 25% detoxified *Jatropha* curcas meal can reduced survival rate by about 50%, a lower inclusion level might be adopted for fishmeal replacement in the diet of *Clarias gariepinus* fingerlings.

Recommendation

From this study, it is therefore recommended that detoxified *Jatropha* curcas meal can be included in the diet of *Clarias gariepinus* fingerlings up to 25% beyond which there would decline in growth as well as survival rate. Further research should be conducted on the detoxification of the kernel to ensure high inclusion level in the diets of fishes.

Contribution of authors

Dr. A.M. Orire (Aquaculture Nutritionist), was the major supervisor of the research on the use of *Jatropha curcas* oil in the diets of *Clarias gariepinus*.

Ms. Amupitan O.O. was the mentee on the experiment.

Dr. S.Y. Daniyan (Microbilogist) assisted with the detoxification of *Jatropha curcas* kernels used for the experiment.

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Conflict of interest

There was not any form of conflict of interest during the experimental work, rather it was a collaborative research between Department of Water Resources, Aquaculture and Fisheries Technology and Department of Microbiology

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Table 3: Growth Performance of *Clarias gariepinus* fed graded inclusion levels of Detoxified *Jatropha curcas* meal for 56days

Growth Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SD±
Mean Initial Weight (g)	4.33 ± 0.01^{a}	4.31 ± 0.02^{a}	4.33 ± 0.02^{a}	4.33 ± 0.03^{a}	4.34 ± 0.03^{a}	0.26
Mean Final Weight (g)	14.85 ± 1.94^{a}	5.19 ± 0.34^{b}	3.22 ± 2.79^{b}	2.44 ± 2.15^{b}	2.55 ± 0.63^{b}	1.83
Mean Weight Gain (g)	10.53 ± 1.95^{a}	0.88 ± 0.33^{b}	-1.11 ± 2.77^{c}	-1.89 ± 2.16^{c}	-1.79 ± 0.66^{c}	1.82
Feed Fed (g)	26.23 ± 3.84^{a}	9.52 ± 1.12^{b}	8.84 ± 0.29^{b}	3.64 ± 1.41^{c}	2.15 ± 0.90^{c}	1.94
Feed Conversion Ratio	2.73 ± 0.55^{ab}	12.00 ± 4.67^{a}	12.17 ± 11.84^{a}	-7.18 ± 9.21^{b}	-0.99 ± 1.05^{b}	7.05
Specific Growth Rate (SGR, %/day)	2.19 ± 0.23^{a}	0.33 ± 0.11^{a}	0.13 ± 0.11^{b}	-0.21 ± 0.26^{b}	0.13 ± 0.44^{b}	0.26
Protein Efficiency Ratio (PER)	0.88 ± 0.08^{a}	0.21 ± 0.10^{b}	-0.28 ± 0.68^{c}	-1.62 ± 2.15^{c}	-2.08 ± 0.10^{c}	1.10
ANPU (%)	88.59 ± 0.52^{a}	-57.60 ± 0.01^{c}	178.27 ± 0.03^{b}	-45.50 ± 0.08^{c}	-234.48 ± 0.01^{d}	0.23
Survival Rate (%)	$73.33^{a}\pm10.41$	$56.67^{a}\pm16.07$	$16.67^{b}\pm15.28$	$11.67^{b}\pm10.41$	$6.67^{b}\pm2.89$	11.97

Mean data on the same raw carrying different superscripts differ significantly from each other ($P<0.05$)

Table 4: Body Composition of *Clarias gariepinus* fed graded inclusion levels of Detoxified *Jatropha curcas* meal for 56days

Body Composition (%)	Initial	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SD±
Crude protein (CP)	55.00 ± 0.00^{c}	65.63 ± 0.00^{a}	52.50 ± 0.00^{c}	62.13 ± 0.00^{b}	54.25 ± 0.00^{c}	48.13 ± 0.00^{d}	0.00
Lipid	20.09 ± 0.00^{a}	21.40 ± 0.00^{a}	17.50 ± 0.00^{b}	14.30 ± 0.00^{d}	15.60 ± 0.00^{c}	15.90 ± 0.00^{c}	0.00
Crude Fibre (CF)	1.29 ± 0.00^{d}	4.00 ± 0.00^{a}	2.00 ± 0.00^{c}	2.8 ± 0.00^{b}	1.20 ± 0.00^{d}	1.40 ± 0.00^{d}	0.00
Ash	11.11 ± 0.00^{d}	16.80 ± 0.00^{c}	23.90 ± 0.00^{b}	29.10 ± 0.00^{a}	23.91 ± 0.00^{b}	16.10 ± 0.00^{c}	0.00
Moisture Content (MC)	3.70 ± 0.00^{c}	2.64 ± 0.00^{d}	3.62 ± 0.00^{c}	3.92 ± 0.00^{c}	4.64 ± 0.00^{b}	5.24 ± 0.00^{a}	0.00

Mean data on the same raw carrying different superscripts differ significantly from each other ($P<0.05$)

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