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Growth Performance and Body Compositions of *Clarias gariepinus* Fed Graded Levels of Detoxified *Jatropha curcas* meal

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Abstract

Protein source is the single most expensive ingredient in feed production. The limitation of this important resource necessitated the need for sourcing for alternative and non-competing protein source especially from *Jatropha curcas* plants. This research thus, investigated the growth performance, survival and body compositions 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 ($P<0.05$) for 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), Food Conversion Ratio (2.73±0.55), Specific Growth Rate (2.19±0.23) and survival rate (73.33±10.41) 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 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* provided it is free of growth inhibiting compounds.

Keywords: Detoxification; Jatropha; *Clarias gariepinus*

Introduction

Fish has been reported to be a good source of food and means of livelihood to many African populace [1]. However, this industry is constrained by availability of alternative nutritive protein source as replacement for fish meal [2,3] Naylor et al. Several studies conducted 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 [4-11]. Moreover, the inclusion level of these plant protein sources requires careful consideration for processing for fish to utilize its nutrients [12,13]. 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 [3,14]. *Jatropha curcas* is a plant protein source which is abundant in the tropics and subtropics [6,15]. It is useful in bio-diesel production [16,17], its oil extract is a good nutrient source for animal diet when properly treated to reduce the anti-nutritional factors [18,19]. The seed maintains its weight of 50% as press cake with crude protein between 58-62% and an excellent amino acid profile and carbohydrate [15,16]. 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 [15,16]. 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 [10,16]. This research thus, investigated into 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, GidanKwano 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. 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.

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	460.4	345.3	230.2	115.1	0
DJCM	0	115.1	230.2	345.3	460.4
Maize Meal	389.6	389.6	389.6	389.6	389.6
Soybean Meal	100	100	100	100	100
Vitamin premix	20	20	20	20	20
Vegetable Oil	30	30	30	30	30
Total	1000	1000	1000	1000	1000
Proximate Composition of Formulated Diets (%)					
Crude Protein	45.52	45.6	45.25	45.4.2	45.5
Crude Lipid	11.05	12.15	14.35	15.54	17.55
Crude Fibre	0.55	0.95	0.95	1.15	1.3
Ash	8.1	6.95	7.3	6.1	4.3
Moisture Content	36.28	34.64	26.2	33.62	38.18

Twenty (20) fishes were distributed randomly in triplicate of 15 tanks in a complete randomized design. The fishes were fed thrice daily starting with 3% body weight and adjusted fortnightly for the feeding trial period of 8weeks. The water quality parameters were measured for temperature with the aid of clinical thermometer while the dissolve oxygen was determined according to the method reported by Wrinker [20]. Hydrogen ion concentration (pH) was measured with pH meter at room temperature while conductivity was monitored with conductivity meter (µm) [21] (Table 2).

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 carcasses for initial and final treatments were analysed for their proximate compositions according to the method of AOAC [22]s.

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

$$SGR = \frac{Ln\ Mean\ Final\ Weight\ x\ Ln\ Mean\ Initial\ Weight}{Duration\ of\ experiment\ (Days)} X100$$

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

$$FCR = \frac{Weight\ of\ feed\ fed\ (Dry\ gram\ weight)}{Weight\ gain\ of\ fish\ (Wet\ gram\ weight)}$$

Protein Efficiency Ratio (PER): This is express as

$$PER = \frac{Weight\ gain\ of\ fish}{Protein\ fed}$$

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Apparent Net Protein Utilization (ANPU)

$$ANPU = \frac{Carcass\ Protein\ gain\ (g)}{Protein\ fed} X100$$

Mortality was evaluated as the expressed below;

$$\%Mortality = \frac{No\ of\ fish\ left}{No\ of\ fish\ stocked} X100$$

Statistical analysis

The result for the feeding trials were subjected to one-way Analysis of Variance (ANOVA) [23] 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 were plotted with Microsoft excel window 2010. Multiple parameters mean comparison of treatment was done according to Duncan multiple range tests [24].

Result

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

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±2.77c	1.89±2.16c	1.79±0.66c	1.82
Feed Fed (g)	26.23±3.84^a	9.52±1.12^b	8.84±0.29^b	3.64±1.41c	2.15±0.90c	1.94
Food Conversion Ratio	2.73±0.55a^b	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	1.1
ANPU (%)	88.59±0.52^a	-57.60±0.01^c	178.27±0.03^d	-45.50±0.08^c	-234.48±0.01^d	0.23
Survival Rate (%)	73.33^a+10.41	56.67a+16.07	16.67b+15.28	11.67b+10.41	6.67b+2.89	11.97

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

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 (DJCM)) gave the best performances in terms of mean weight gain 10.53g, this was followed by diets 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 diets 2 and 3 were significantly high (12.00g and 12.17g respectively) with no significant difference (P>0.05) between them while, diet 1 gave a significantly low (P<0.05) FCR value of 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). Diets 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% and 11.67% 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) indicated that diets 1 and 2 were significantly different (P<0.05) from other treatments with 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.

The Body compositions also significant differences (P<0.05) among treatments (Table 4). 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 crude lipid for diets 1 (20.09%) and 2 (21.40%) were not significantly different (P>0.05) from each other but are significantly different (P<0.05) from other treatments. Diet 1 gave a significantly high (P<0.05) 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 diet 5 and the initial fibre value. The 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 had a significantly high (P<0.05) moisture content (5.24%).

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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
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
Crude Fibre (CF)	1.29±0.00^{d}	4.00±0.00a	2.00±0.00c	2.8±0.00^{b}	1.20±0.00^{d}	1.40±0.00^{d}	0
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
Moisture Content (MC)	3.70±0.00^{c}	2.64±0.00d	3.62±0.00^{c}	3.92±0.00^{c}	4.64±0.00b	5.24±0.00a	0

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

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. 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. 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, feed utilization, growth performance and survival rate of the fish. 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 Ca2+ and Fe2+) and protein digestibility through complex formation and enzyme reactions [18]. 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 factor 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 [18,19,25,26] that, feed containing high concentration of anti-nutritional factor would decrease nutrient availabilityin the diet with attendant implication on reduction of growth performance of fish. It was observed that diets 1 and 2 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 [26]. 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 esters).

Conclusion

It can be concluded that, since inclusion level up to 25% detoxified *Jatropha curcas* meal can reduce 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 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 perchance high level inclusion of the meal will be tolerated by the fish.

Contribution of Authors

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

Ms. Amupitan OO was the mentee on the experiment.

Dr. Daniyan SY (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

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between Department of Water Resources, Aquaculture and Fisheries Technology and Department of Microbiology of the Federal University of Technology, Minna.

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