
Nutritional evaluation of varying levels of cooked flamboyant seed meal (*Delonix regia*) on the growth performance and body composition of Nile tilapia (*Oreochromis niloticus*) fingerlings

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Abstract: A feeding trial was conducted to evaluate the effect of inclusion level of cooked *Delonix regia* seed meal (CDRM) in the practical diet of *Oreochromis niloticus* fingerlings through their growth performance and nutrient utilization for 56 days. Four iso-nitrogenous and iso-lipidic experimental diets were formulated to contain 35% crude protein and 9.5% lipid, CDRM was included at different varying inclusion levels viz: 0, 10, 15 and 20 and were designated as D1 (0 % inclusion), D2 (10 % inclusion), D3 (15 % inclusion) and D4 (20 % inclusion). Each treatment was allocated to three tanks of twenty *O. niloticus* per tank with initial mean weight of 1.18 ± 0.10 g. There was no significant difference ($P > 0.05$) in the survival rate of all the treatments, D2 has the highest value in percentage weight gain, specific growth rate, feed intake, protein efficiency and protein retention, while D4 (20% inclusion) had the lowest value in all the growth parameters and feed utilization measured. However, there is no significant difference ($P > 0.05$) between fish fed D3 (15% inclusion) and D1 (control: 0% inclusion). Proximate composition result revealed that increase in the inclusion level of cooked *Delonix regia* lead to an increase in carcass lipid content and a decrease in the moisture content of the fish fed experimental diet. The results indicate 10-15% inclusion of *Delonix regia* seed meal improved growth performance and nutrient utilization of Nile tilapia fingerlings.

Keywords: Delonix Regia Seed Meal, Nile Tilapia, Growth Performance

1. Introduction

In order to sustain the consistent expansion being witnessed in aquaculture sector worldwide, a matching increase in fish feed production is imperative (Francis et al., 2001). In finfish aquaculture aqua feed production accounts for between 40-65% of total operating costs, depending on the level of aquaculture intensification. (Jauncey and Ross, 1982; Hardy 1989 Lovell, 1989). Protein is the most critical and costly ingredient in aqua feed production feeds and usually protein sources represent about 60% or more in the cost of the feed. Traditionally, fishmeal is preferred dietary protein source for many farmed fish and is appreciated for its amino acid balance, vitamin content, palatability and unidentified growth factors (Tacon, 1993). However, limited

supply, increasing demand and high price of fish meal are challenges to the sustainable development of fish culture industry. Wider use of more economical plant or animal protein ingredients is needed for the formulation of cost-effective and eco friendly aquafeeds. Several studies focused on assessing the potential to reduce fish meal level in fish diets in the last two decades Bureau et al. 2000; Kureshy et al. 2000; Webster et al. 2000; Milliamena 2002; Gaylord & Rawles 2005; Wang et al. 2006; Guo et al. 2007). The magnitude of fish meal replacement by economical protein sources varies greatly in literatures because of great variability of fish meal and protein levels used in the basal (control) diets, as well as great variability of chemical composition and nutritive value of the alternate protein ingredients (Ali, et al., 2003; Bureau, et al. 2000;

Bake, et al 2009). Furthermore, considerable emphasis has been focused on the use of conventional plant protein sources, such as soybean (Nyirenda et al., 2000; Koumi et al., 2009), groundnut (Ovie and Ovie 2007), cotton seed (Mbahinzireki et al., 2001; El-Saidy and Gaber, 2003) and rapeseed meal (Burel et al. 2000a,b), however, their scarcity and competition from other sectors for these conventional crops for livestock and human consumption as well as industrial use make their costs too high and put them far beyond the reach of fish farmers or producers of aquafeeds (Fasakin et al., 1999). Therefore, in order to attain a more economically sustainable, environmentally friendly and viable production, research interest has been redirected towards the evaluation and use of unconventional protein sources, particularly from plant products such as seeds, leaves and other agricultural by-products (Siddhuraju and Becker, 2001; Olvera-Novoa et al., 2002; Ali, et al., 2003; Bake et al 2009).

Delonix regia a wild plant otherwise called flame of the forest originated from America (Madagascar) but found wild or as ornamental plants in various parts of the world including Nigeria (Purseglove 1994). It is an ornamental, leguminous plant, which produces tones of pods containing seed in the fruiting season (Keay and Stanfield, 1964). These seeds are left unutilized since they are neither consumed by any animal nor utilized for any other medical purposes. *Delonix regia* (Caesalpiniaceae) is a tree, which is about 12m high with a slightly flat or curving crown. Seeding is abundant and germination is free. The flowers are usually red but sometimes bear a paler orange red flower and flowering is spontaneous, it is one of the most spectacular flowering trees of the tropics. It is widely grown ornamental leguminous plant, which produces 25-40cm long pods containing seed which laboratory analysis has reported to contain crude protein 36.92%, crude lipid 4.17%, crude fiber 11.39% (Grant et al, 1991). Report also showed that the seed extracted exhibited low haemagglutinin activity and contains non-toxic lectins. Flamboyant seed meal compare favorably with mechanically extracted groundnut cake meal in term of crude protein content (NRC, 1993). Heat treatment is employed to dry certain plant product and to improve quality of pelletized feed. Hence, heat treatment can improve the nutritional value of *Delonix regia* by reducing the hydrocyanic acid and other anti-nutritional factor.

Tilapia is the second most culture fresh water finfish. It is also a common fish in tropical fish farms and its prolific breeding abilities makes it to dominate most ponds and water bodies where the population is not checked. Tilapias are voracious diurnal feeders. Currently, farmed tilapia represents more than 75% of world tilapia production (FAO, 2006). The high exponential growth of tilapia culture in recent years could be attributed to several factors such as their ability to be grown year round with some variability in fish yields depending upon seasonal differences related to the area (Green et al., 1990). It also effectively utilizes alternative feed ingredients such as rice,

cocoa, various flours, and soya-nut oil (Jackson et al., 1982 Brown, 1983). Intensification of tilapia culture requires development of suitable feeds for both complete and supplementary feeding in tanks and ponds (Koprucu and Ozdemir 2005). Therefore, this present study was carried out to evaluate the effect and suitability of cooked flamboyant seed meal (*Delonix regia*) inclusion in the practical diet of Nile tilapia fingerlings through their growth performance and nutrient utilization.

2. Materials and Methods Diet Formulation and Preparation

2.1. Soybean Meal

Soybean was obtained from the market and was toasted using a frying pan and allowed to cool before milling with the aid of a grinding machine. Cooking was done to remove the anti-nutritional factor present in the seed.

2.2. Cooked Flamboyant Seed Meal (*Delonix Regia*)

Mature and dried Flamboyant seedpods were collected from the ornamental garden of the Center for Preliminary and Extra Moral Studies (CPES) of the Federal University of Technology Minna; the seed were collected by manually opening the pods. The seeds were boiled at 100°C for 80mins to reduce the effect of hydrocyanic acid (anti-nutritional factor) and were allowed to cool by sun drying and were later grounded to homogeneous powder.

2.3. Fishmeal

The fishmeal used for these experiments was obtained from the market store. The crude protein and lipid content of fishmeal were 61.25% and 11.94%.

All the ingredients were separately milled and mixed with warm water to form consistent dough, which was then pelleted, sun-dried, packed in polyethylene bags and stored. The feed composition table is shown in Table 1

Table 1. Proximate composition of dietary ingredients diets.

Ingredients	Fish meal	Soybean meal	Raw <i>D.regia</i> meal	Cooked <i>D.regia</i> meal	Maize meal	Millet meal
Moisture (%) d.b	6.21	4.57	3.74	3.24	5.09	5.63
Crude protein(%) d.b	61.25	48.07	23.42	25.11	9.32	8.98
Lipid (%) d.b	10.70	7.04	4.60	7.30	4.20	3.56
Ash (%) d.b	6.69	4.35	8.79	6.48	3.84	3.60

*1 Dry basis

2.4. Experimental Diets

Based on the nutritional requirements of tilapia (NRC 1993), four isonitrogenous and isolipid diets were formulated at 35 % protein and 9.5 % lipids, containing 10-30% toasted flamboyant seed meal of different levels of

inclusion Table 2. The experimental diets were designated D1 (0 % inclusion), D2 (10 % inclusion), D3 (15% inclusion) and D4 (20 % inclusion).

Table 2. Formulation and proximate composition of the experimental diets for *Oreochromis niloticus* fingerlings.

Ingredients	D1	D2	D3	D4
Fishmeal	384.70	345.40	325.70	302.70
Soybean meal	220.00	220.00	220.00	220.00
Cooked <i>delonix regia</i> meal	0.00	100.00	150.00	200.00
Maize meal	47.00	47.00	47.00	47.00
Millet	47.00	47.00	47.00	47.00
Starch	107.90	55.00	55.00	55.00
Vitamin premix	25.50	25.50	25.50	25.50
Mineral	30.00	30.00	30.00	30.00
Soybean oil	30.00	30.00	30.00	30.00
Cellulose	107.90	100.10	69.80	42.80
Total	1000.00	1000.00	1000.00	1000.00
Moisture	5.25	5.00	4.92	4.81
Crude protein	34.35	36.78	36.11	34.34
Lipid	9.48	9.24	9.51	9.34
Ash	10.83	10.12	9.92	9.88

2.5. Experimental System and Fish

The experimental fish, pure- bred *O. niloticus* fingerlings, with a initial mean weight of (1.19±0.03) were purchased from Tagwai Fisheries hatchery, Ministry of Livestock and Fisheries, Minna, Niger state. The fish were transferred in a well-oxygenated water plastic container from hatchery to the Department of Water Resources, Aquaculture and Fisheries Technology laboratory, Federal University of Technology, Minna where the feeding trial was conducted. Upon arrival they were acclimatized in a transitional tank in the laboratory for four days and were fed commercial feed (coppense feed) at 35% crude protein once a day before the experiment commenced.

Fresh filtered dechlorinated tap water was supplied to the flow-through system, which consisted of 15-rounded plastic tank, each with an approximate capacity of 45 liter at the flow rate of 250-300 ml/min. The water quality parameters in the system were monitored weekly, and the ranges were dissolved oxygen 6.8-7.4 mg/l, total ammonia 0.1-0.27 mgN/l, and pH 6.9-7.5. No critical values were detected for nitrite and nitrate.

Three replicates of each treatment using 20 fish per plastic tank were reared on each of the four experimental diets. Feed was manually administered. The fish were fed three times daily at 5% of body weight at 0900, 1200 and 1600 hours. Feeding rate were subsequently adjusted according to their growth rates per plastic tank.

The uneaten and faecal matters were siphoned out of tank every morning before feeding, and 45 minutes after the fish have been fed. The fish were denied feed 24 h prior to sampling. Ten fish were randomly sampled on weekly basis, and weights were measured using a digital electronic weighing balance.

2.6. Biochemical Analysis

About 15 g initial sample and 10 g of final samples from each plastic tank were pooled separately and then homogenized using laboratory mortal and pestle. The major ingredient used for the diet; the formulated diet and the fish body samples were subjected to chemical analysis. Proximate composition analyses were performed according to AOAC procedures (AOAC, 2000). Moisture content was determined by drying samples at 105±2°C until a constant weight was obtained. Dried samples were used for determination of crude fat, protein and Ash contents. Crude fat was measured by solvent extraction method in a soxhlet system where n-hexane was used as solvent. Crude protein content was calculated by using nitrogen content obtained by Kjeldahl method. A conversion factor of 6.25 was used for calculation of protein content (AOAC, 2000).

2.7. Evaluation of Growth Parameters

Growth performance and nutrient utilization were analyzed in terms of weight gain (WG), feed efficiency (FE), specific growth rate (SGR), feed intake (FI), protein efficiency (PER) and protein retention (PR). The following formulas were used as described by Takeuchi, (1988) as the following equation:

Weight gain (%) = (final weight (g) – initial weight (g) x 100 / initial weight (g)

Feed efficiency (%) = (weight gained (g) / feed fed (g)) x 100

Specific growth rate (%)= (In final weight (g) – In initial weight (g) / feeding period (day) x 100

Feed intake (mg/fish/day) = dry feed (mg) given / number of fish / feeding period (day)

Protein efficiency ratio = wet body gain x 100 / protein intake (g)

Protein retention (%) = protein gain x 100 / protein fed.

2.8. Statistical Analyses

Data were analyzed using one – way analysis of variance (ANOVA) using Statistica 6.0 (Stat-Soft, Inc., USA). Differences between treatments were compared by Tukey's test. Level of significance was tested at P<0.05.

3. Results

The proximate composition of the major ingredients used in the formulation of the experimental diet is shown in Table 1. Fishmeal had the highest crude protein and lipid contents (61.25 and 10.70%) followed by soybean meal (43.07 and 7.0%) while cooked *Delonix regia* meal had 25.11 and 8.30% of crude protein and lipid contents, respectively. Though all the experimental diets were similar in terms of their proximate composition among the experimental diets, D2 had the highest crude protein content of 36.93% while diet 4 had the lowest crude protein content of 34.34%. The total lipid was highest in diet 3 (9.51%) while diet 2 had the lowest total lipid content

(9.24%). Ash content was highest in diet 1(10.83%) and lowest in diet 4 (9.88. %) among the test diets (table 2).

There was no feed rejection among the fish fed experimental diets; however the acceptability of the diets differed considerably among the treatments. Table 3 showed that Tilapia fed with 10% inclusion of cooked *Delonix regia* meal (D2) had the highest final body weight gain, specific growth rate, and total feed intake and was significantly higher than the rest of the treatments ($P < 0.05$) while tilapia fed with 20% inclusion of cooked *Delonix regia* meal (D4) had the lowest significant value in all the growth parameters measured. The growth parameter values measured for tilapia fed D1 and D3 were not significantly different from each other but were significantly higher than tilapia fed D4 ($P < 0.05$).

Fish fed with D2 had the highest significant value ($P < 0.05$) feed efficiency, Protein efficiency ratio and protein retention. Although fish fed D4 had the lowest feed efficiency and protein efficiency ration, it was not significantly different from fish fed D1 and D3 ($P > 0.05$) however the protein retention of tilapia fed D1 and D3 was significantly higher ($P < 0.05$) than those fed D4.

Variations in the tilapia body composition among fish fed experimental diets at the end of the feeding trial are shown in Table 4. The result of the body composition revealed that except for lipid and moisture fish fed cooked *Delonix regia* meal displayed a marginal increase in the carcass protein and ash at the end of the experiment and were significantly higher than the initial body composition at the start of the experiment. There was no significant

differences in the carcass ash contents among all the treatments fed experimental diets, fish fed D2 having the highest crude protein content value and was significantly higher than the other fish fed other experimental diet ($P < 0.05$), however fish fed D1, D3 and D4 do not show any significant difference ($P > 0.05$) from each other. Fish fed D4 had the highest significant lipid composition ($P < 0.05$) while D1 had the lowest value but was not significantly different from fish fed D2. Fish fed D1 showed the highest moisture among the experimental diets although not significantly different from D2 ($P < 0.05$) but were significantly different from D3 and D4.

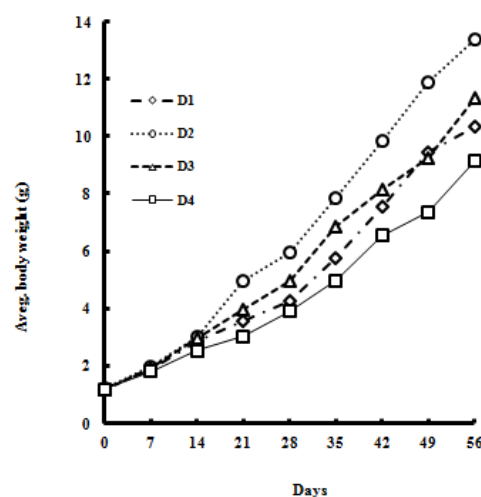


Fig 1. Growth of *O. niloticus* fingerlings fed the experimental diets for 56 days.

Table 3. Growth performances of *O. niloticus* fry fed experimental diets for 56 days.

Diet code	Body weight (g)		Weight gain (%)	Survival rate (%)	Specific growth rate (%)	Total feed intake (g)	Feed efficiency	Protein efficiency ratio	Protein retention (%)
	Initial	Final							
D1	1.21±0.04	10.32±0.01 ^b	932.00±12.00 ^b	97.30±0.74 ^a	3.83±0.01 ^{bc}	11.56±0.10 ^b	0.79±0.01 ^c	2.28±0.03 ^b	35.93±0.44 ^b
D2	1.20±0.07	13.40±0.43 ^a	1240.00±43.59 ^a	98.22±0.42 ^a	4.31±0.04 ^a	12.63±0.10 ^a	0.97±0.04 ^a	2.60±0.06 ^a	41.97±0.91 ^a
D3	1.17±0.06	11.32±0.54 ^b	1032.67±54.72 ^b	97.68±0.57 ^a	4.05±0.06 ^b	11.65±0.72 ^b	0.87±0.01 ^{bc}	2.39±0.03 ^b	36.70±0.51 ^b
D4	1.18±0.02	9.13±0.64 ^c	812.33±64.33 ^c	97.12±1.05 ^a	3.41±0.08 ^c	10.47±0.84 ^c	0.75±0.01 ^c	2.14±0.04 ^b	33.33±0.69 ^c

*1 Values in the same column with different superscript letters are significantly different ($p < 0.05$) from each other.

Table 4. Proximate composition analyses of whole body *O. niloticus* (wet basis) fed experimental diets for 56 days

Component (%)	Initial	Final ^{*1}			
		D1	D2	D3	D4
Moisture	75.64	74.25±1.5 ^a	73.56±1.3 ^{ab}	72.75±0.3 ^c	72.62±1.4 ^c
Protein	14.94	15.39±1.3 ^{bc}	16.09±1.7 ^a	15.67±1.1 ^b	15.46±1.5 ^b
Lipid	5.19	5.08±0.4 ^c	5.03±0.6 ^c	6.28±0.5 ^b	6.68±0.2 ^a
Ash	4.63	5.15±0.6 ^a	5.05±0.4 ^a	5.22±0.1 ^a	5.16±0.4 ^a

*1 Values in the same row with different superscript letters are significantly different ($p < 0.05$) from each other ($n = 3$).

4. Discussion

This study investigated the possibility of utilizing cooked *Delonix regia* meal in the diet of *O. niloticus* fingerlings. Fish mortality was low and relatively uniform in all the treatments, furthermore all the experimental fish remaining

in the tanks were morphologically normal at the end of the feed trial. In our study, the water temperature which ranged between $25 \pm 0.5^\circ\text{C}$ - $29 \pm 0.4^\circ\text{C}$ and the dissolved oxygen $6.6\text{--}8.3\text{mg/L}$ were within the acceptable range for tilapia culture (Balarin and Halton, 1979).

The proximate composition of cooked *Delonix regia* meal in this present study revealed that the crude protein content was 25.11% (Table 2). This value was higher than the values reported earlier by Balogun *et al.* (2004). The differences might be attributed to differences in environmental conditions such as soil types, harvesting time and the processing conditions. Fagbenro (1999), Francis *et al.* (2001) and Solomon *et al.* (2007) reported that heat treatment substantially reduces and inactivates levels of secondary compounds in the seed meals. Our results tend to agree with their report.

The suitability of inclusion of alternative ingredient in a fish diet in terms of growth performance has been reported to vary highly among fish species and experimental conditions (El-Sayed 1999, Bake *et al.* 2009). The percentage survival was excellent throughout the experimental period. This could be attributed to good handling, good water quality management and proper processing and the suitability of cooked *Delonix regia* meal inclusion in the diet of *O. niloticus*. However within the conditions of this experiment, cooked flamboyant seed meal (*Delonix regia*) was acceptable source of protein in the diets of *O. niloticus* fingerlings. The fishes adapted to the diets within 3-4 days of commencement of feeding trial, however the acceptability of the diet varied significantly. Table 3 and Figure 1 showed that acceptability of the diet reduced with the increase in the inclusion level of cooked flamboyant seed meal. The slight lower growth response by tilapia fed 20% cooked *Delonix regia* meal (D4) inclusion can be attributed to reduced palatability of the diet, which could be as a result of low feed intake. The best growth responses were obtained with tilapia fed (D2) 10% inclusion of cooked *Delonix regia*. Although, there was no significant difference between fish fed D1 and D4. Proper processing of ingredients has been reported to have effect on the texture, palatability and taste of experimental diets and are related to the level of plant material incorporated, hence can affect the acceptability of feed and may consequently retard growth of the fish when in high quantity (Fagbenro, 1999; Francis *et al.* 2001 and Solomon *et al.* 2007). The high FI obtained in this study may also be ascribed to the cooking processing technique employed in processing of the flamboyant seed. This may have reduced the effect of anti-nutritive factors and other secondary compound activities in the seed. Akinmutimi (2006) reported decrease in crude protein content of *Mucuna Pruriens* when cooked for 60 minutes; Balogun (2009) reported that boiled *Delonix regia* seed meal has higher potential of being utilized by *O. niloticus* when boiled for 80 minutes. In our present study cooking of *Delonix regia* seed meal for 120 minutes at 100°C and including it in the diet of Nile tilapia fingerlings at 10-15% significantly improve their growth performance and nutrient utilization.

Olvera-nova *et al.* 2002 reported that when plant proteins are included in the diet of Nile tilapia at 10-20% they do have better feeding efficiency. Result from our study revealed that the FE, PER and PR decreases with

increase in the inclusion level of the cooked *delonix regia* meal. Although there was no much significant difference between D1, D3 and D4, D1 and D3 were better than D4. This indicates that D4 has high nutritive content and its low intake may be responsible for low in WG and SGR.

From the result of the proximate composition in Table 4, the total lipid of the fish fed experimental diets is related to the body moisture content and also showed that higher-level inclusion of cooked *Delonix regia* seed meal in the diet of Nile tilapia fingerlings as the potential in increasing lipid deposition in its carcass. This result agrees with the findings of Abd El-Hakim *et al.* (2003) that plant protein in the diet of fish has the potential to increase its lipid deposition in the carcass of the fish fed plant protein.

The present study has demonstrated that the cooking processing method of *Delonix regia* seed meal has significant effect on the tilapia diet hence can partially inactivate some of the secondary compound in *Delonix regia* seed meal thereby improve its growth performance and feed efficiency. Furthermore, *Delonix regia* seed meal can be suitable as an ingredient in Nile tilapia diet.

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