Effect of replacing soybean meal with water melon (*Citrullus lanatus*) seed meal on the growth, feed utilization and body composition of Nile tilapia (*Oreochromis niloticus*)

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Abstract

The nutritive potential of water melon (Citrullus lanatus) seed meal as dietary protein source in the diet of Nile tilapia (Oreochromis niloticus) using growth performance and nutrient utilization were evaluated in a 56 day feeding trial. One hundred and fifty tilapia fingerlings of average weight 6.12±0.05g were acclimatized for a week, weighed and allotted into five dietary treatments; containing 0, 15, 30, 45 and 60% Citrullus lanatus replacement levels with soybean meal respectively. The diets (35% crude protein and 10% lipid) were isonitrogenous and isolipidic. Each treatment was replicated three times with ten fish per replicate. Fish were fed 5% body weight on two equal proportions per day to determine weight gain, percentage weight gain, specific growth rate, food conversion ratio, protein efficiency ratio and net protein utilization. The result from the study indicated that there was no significant (p>0.05) differences in the FCR and PER between the fish fed control diets and the fish fed test diets.

Keywords: Water melon, tilapia, growth, alternative feed ingredients

Introduction

The growing demand to substitute soybean meal with less expensive and readily available plant protein sources in the practical diets of Nile tilapia and other fishes cannot be over emphasized due to the various uses to which it is put; as dietary ingredient for human consumption and feed ingredients by other animal feed industries (Siddhuraju and Becker, 2001). Such a less expensive plant protein sources being sought for must have no or low direct demand for human consumption so that they can contribute maximally towards satisfying the demand of aquaculture feed industries (Francis *et al*., 2001). Thus sourcing a less expensive, readily available plant protein sources of little or no significance for direct human consumption, that can successfully replace soybean meal without compromising the nutritional quality of the fish feed is a research priority. Wani *et al.* (2011) reported that watermelon seed meal contains adequate amount of nutritional protein that could be used as nutritional ingredients in food products. It seeds have nutritional density comparable to other oilseed proteins including soybean and other conventional legumes (Mustapha and Alamin, 2012). Watermelon belongs to the family Curcubitaceae. It is a tropical, semi tropical and arid region crop of the world (Razavi and Milani, 2006). Nile tilapia is reported to contribute greatly to the world food supply for human (Leveque, 2002) to such as extent that Fagbenro

(2002) named it as aquatic chicken owing to its importance in aquaculture industry. The success of Nile tilapia in African waters and other ecosystem outside Africa is well documented in the work of Leveque (1997, 2002).

Some studies have been conducted to explore the nutritive value of *Citrullus lanatus* in fish feed.Jimoh *et al.* (2013) fed diets containing water melon seed meal to *Clarias gariepinus;* and recorded no significant difference in the growth performance of fish fed control diet and that of test diet up to 60% replacement level with soybean. Tiamiyu *et al.* (2014) fed raw *Citrullus lanatus* seed meal to *Cyprinus carpio* fingerlings and recorded that 10% raw seed meal was ideal for enhancing growth performance of the fish. Tiamiyu *et al.* (2015) fed differently cooked *Citrullus lanatus* seed meal to *Clarias gariepinus* and found out that 40 minutes cooking of the seed meal improved the digestibility of *Clarias gariepinus. Citrullus lanatus*. Although Iheanacho *et al.* (2018) evaluated the effect of feeding different levels of *Citrullus lanatus* peel as energy source in the diet of *Oreochromis niloticus*, research on the use of watermelon seed meal in the practical diets of fish is still very low hence paucity of information exists on the use of watermelon seed meal in the practical diets of Nile tilapia. This study therefore seeks to investigate the effect of replacing soybean meal with watermelon (*Citrullus lanatus*) seedmeal on the growth, feed utilization and body composition of Nile tilapia (*Oreochromis niloticus*).

Materials and methods

Sources and processing of ingredients

Sample of dried water melon seeds were obtained in Bodija market, Ibadan, Oyo state. The water melon seed was rinsed with water and boiled for 15 minutes after which it was sundried for some days and then ground in a hammer mill and the oil therein was removed using the pressure generated from locally made screw press (cassava-presser type). The cakes therefore were analyzed for their proximate composition (AOAC 1990). Fish meal, soybean meal and other feedstuffs obtained from commercial sources in Nigeria were separately milled screened to fine particles size and triplicate samples were analyzed for their proximate composition (AOAC, 1990).

Table 1: Proximate composition of the protein feed ingredients

Parameter	Fish meal	Soybean Meal	**CLM
Moisture	9.75	10.70	9.69
Crude Protein	72.4	45.74	19.11
Crude Lipid	10.45	9.68	15.35
Crude Fibre	-	5.10	4.97
Ash	8.32	4.48	5.39
*NFE	-	30.00	45.49

***Nitrogen Free Extract**
**** *Citrullus lanatus* Meal**

Experimental Diets

Based on the nutrient composition of the protein feedstuffs (Table 1), the experimental diets were formulated (Table 2) containing soybean meal which was replaced by cooked water melon seed meal at the rate of 0, 15, 30, 45, and 60 designated as CTR, DT2, DT3, DT4 and DT5 respectively. The diets were isolipidic and isonitrogenous containing 35% crude protein and 10% lipid with fish meal (72%), soya bean meal (45%), fish oil, vitamin premix and starch serving as ingredients.

Table 2: Gross composition (g/100g) of experimental diets containing *Citrullus lanatus* seed meal fed to *Oreochromis niloticus*

Ingredients	CTR	DT2	DT3	DT4	DT5
Fishmeal	19.44	19.44	19.44	19.44	19.44
Soybean Meal	33.333	28.33	23.33	18.33	13.33
Watermelon	-	11.77	23.55	35.22	47.09
Corn	10.00	10.00	10.00	10.00	10.00
Fish Premix	2.50	2.50	2.50	2.50	2.50
Fish Oil	2.50	2.50	2.50	2.50	2.50
Starch	32.33	25.46	18.68	11.91	5.13
Total	100.00	100.00	100.00	100.00	100.00

***** Specification: each kg contains: Vitamin A , 4,000,000IU; Vitamin B, 800,000IU; Vitamin E, 16,000mg, Vitamin K $_3$,800mg; Vitamin B $_1$, 600mg; Vitamin B$_2$, 2,000mg; Vitamin B$_6$, 1,600mg, Vitamin B$_{12}$,8mg; Niacin,16,000mg; Caplan, 4,000mg; Folic Acid, 400mg; Biotin, 40mg; Antioxidant 40,000mg; Chlorine chloride, 120,000mg; Manganese, 32,000mg; Iron 16,000mg; Zinc, 24,000mg; Copper 32,000mg; Iodine 320mg; Cobalt,120mg; Selenium, 800mg manufactured by DSM Nutritional products Europe Limited, Basle, Switzerland*

The feedstuff were ground and water was added to aid binding after which it was introduced into a pelleting and mixing machine to obtain a homogenous mass and then passed through a mincer to produce 2mm size pellet which was immediately sundried at 30 - 32°C. After drying for three days, the diet was kept in a cool place.

Experimental fish and system

The experiment was conducted at the hatchery unit of the Federal College of Animal Health and Production Technology, Moor Plantation Ibadan. The tilapia fingerlings were obtained from Masopa fish farm, Ibadan, Oyo state and transported live to the project site in an aerated bag. The initial average weight of the fish was 6.12±0.05 and a total of 150 tilapia fingerlings were acclimated for seven days prior to the feeding trial while being fed on a commercial pelleted diet. 10 juveniles were allotted into each tank with three replicates per treatment. Experimental diet was assigned randomly to the tanks and each were fed 5% body weight per day in two equal proportions between 9.00 –10.00am and 5.00 – 6.00 pm for 56days.

Results

Proximate composition of experimental diets fed to Oreochromis niloticus

Table 3 reveals the proximate composition of experimental diets fed to *Oreochromis niloticus.* It shows that there was no significant ($P > 0.05$) difference in moisture, protein, lipid, fibre, ash and Nitrogen Free Extract (NFE). All the fish responded well to the dietary treatment given to them.

The proximate composition of the experimental diets showed that the various diets prepared were isonitrogenous, isocalorific and isolipidic as there was no significant difference ($P>0.05$) in the crude protein and crude lipid content of the diets. The protein and lipid requirement of *Oreochromis niloticus* was met by the 35 and 10% provided in the experimental diets (Jauncey and Ross, 1982; Luquet 1991).

Table 3: Proximate composition (g/100g) of experimental diets containing *Citrullus lanatus* seed meal fed to *Oreochromis niloticus*

Parameters	CTR	DT2	DT3	DT4	DT5
Moisture	9.66±0.51	9.59±0.59	9.56±0.50	9.88±0.33	9.52±0.52
Crude Protein	35.22±0.05	35.14±0.16	35.23±0.33	35.222±0.06	35.17±0.23
Crude Lipid	10.16±0.09	10.15±0.06	10.08±0.03	10.04±0.27	10.19±0.13
Crude Fibre	4.37±0.36	4.17±0.08	4.12±0.03	4.15±0.05	4.13±0.05
Ash	5.15±0.20	4.90±0.28	4.66±0.50	5.12±0.37	5.09±0.16
NFE	35.43±0.53	36.0±0.51	36.34±0.86	35.57±0.57	33.90±0.61
Total	100	100	100	100	100

Figures in each row with different superscripts are significantly different ($P<0.05$) from each other

Carcass composition

The carcass composition of *Orechromis niloticus* fed diets containing *Citrullus lanatus* seed meal is presented in Table 4. The highest value of carcass crude protein was found in fish fed CTR diet while the crude protein of fish stocked at the beginning of the experiment prior exposure to dietary treatment was the lowest indicating that there was significant ($p<0.05$) increase in carcass crude protein at the end of the experiment. There was no significant variation ($p>0.05$) in the carcass lipid of fish exposed to different dietary treatments and the initial carcass lipid prior to exposure to dietary treatments indicating that lipid change during the feeding trial was not significant ($p>0.05$).

Table 4: Carcass composition of *Oreochromis niloticus* fed diets containing *Citrullus lanatus* seed meal

Parameters	Initial	CTR	DT2	DT3	DT4	DT5
Moisture	79.13±0.64^{a}	76.40±0.08^{c}	76.93±0.27^{bc}	77.18±0.30^{b}	77.10±0.39^{b}	71.02±0.20^{bc}
Carcass Protein	13.15±0.16^{c}	15.66±0.09^{a}	15.40±0.07^{ab}	15.42±0.33^{ab}	15.35±0.06^{b}	15.29±0.03^{b}
Carcass Lipid	4.53±0.40^{a}	4.13±0.12^{a}	4.18±0.25^{a}	4.14±0.25^{a}	4.09±0.44^{a}	4.26±0.23^{a}
Carcass Ash	3.19±0.34^{a}	3.91±0.18^{a}	3.49±0.27^{b}	3.25±0.12^{b}	3.46±0.06^{b}	3.37±0.09^{b}

Row means with different superscripts are significantly different ($p<0.05$) from each other.

Growth and nutrient utilization of Oreochromis niloticus fed Citrullus lanatus seed meal

Table 5 revealed the growth and nutrient utilization of *O.niloticus* fed diets containing different replacement levels of *Citrullus lanatus* seed meal. The weight gain of fish fed control diet (CTR) was the highest which was significantly different ($p<0.05$) from the weight gain of fish fed test diets DT2, DT3, DT4 and DT5. There was significant ($p<0.05$) decline in weight gain of fish exposed to different dietary treatments with increasing levels of *Citrullus lanatus* seed meal in the diets. Same trend of results as explained above was obtained for the %WG and SGR of fish exposed to various dietary treatments. The PER of fish fed control diet was the highest while fish fed diet DT5 had the lowest PER. Although, there was no significant difference ($P>0.05$) in the PER and FCR of fish exposed to various dietary treatments.

Table 5: Growth and nutrient utilization of *Oreochromis niloticus* fed *Citrullus lanatus* seed meal

Parameters	CTR	DT2	DT3	DT4	DT5
Initial weight	6.11±0.00	6.11± 0.00	6.18± 0.64	6.07± 0.64	6.11± 0.00
Final Weight	23.85±0.11^{a}	22.52±0.09^{b}	20.71±0.19^{c}	18.85±0.08^{d}	17.86±0.08^{e}
[1]M.W.G	17.74±0.11^{a}	16.41±0.09^{b}	14.53±0.24^{c}	12.78±0.13^{d}	11.75±0.08^{e}
[2]% Wt Gain	290.22±1.72^{a}	268.46±1.47^{b}	234.93±6.21^{c}	210.37±4.28^{d}	192.20±1.32^{e}
[3]SGR	2.43±0.01^{a}	2.33±0.01^{b}	2.16±0.03^{c}	2.02±0.03^{d}	1.92±0.01^{e}
[4]FCR	1.16±0.10^{a}	1.21±0.11^{a}	1.25±0.12^{a}	1.26±0.12^{a}	1.24±0.08^{a}
[5]PER	2.47±0.21^{a}	2.37±0.23^{a}	2.31±0.23^{a}	2.28±0.23^{a}	2.31±0.14^{a}
[6]NPU	33.62±2.87^{b}	32.74±4.09^{b}	36.18±3.26^{b}	39.22±3.35^{ab}	43.54±3.18^{a}
[7]%Survival	100±0.00^{a}	92.59±6.41^{a}	96.30±6.41^{a}	100±0.00^{a}	96.30±6.41^{a}

Row means with different superscripts are significantly different ($p<0.05$) from each other.
[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] Net protein utilization= [protein gain/protein fed] X 100
[7] Percentage survival = {(total number of fish- mortality)/total number of fish] X 100

Fish fed diet DT5 had the highest PPV which was significantly ($p<0.05$) different from fish fed CTR, DT2 and DT3. However, the PPV of fish DT4 and DT5 were not significantly ($p>0.05$) different. Similarly, there was no significant ($p>0.05$) difference in the PPV of fish exposed to diets CTR, DT2 and DT3. Percentage Survival of fish fed various dietary treatments was above 92 and there was no significant ($p>0.05$) difference in the percentage survival of fish exposed to different dietary treatments. Figure 1 shows the growth curve of *O. niloticus* fed diets containing *Citrulus lanatus* seed meal. Figure 2 shows the polynomial regression of weight gain by of *O. niloticus* fed diets containing *Citrulus lanatus* seed meal against inclusion level. A downward trend in weight gain was observed as we increased the level of *Citrulus lanatus.* The R^2 value of 99.34% showed that greater percentage of the variation in weight is explained by inclusion level.

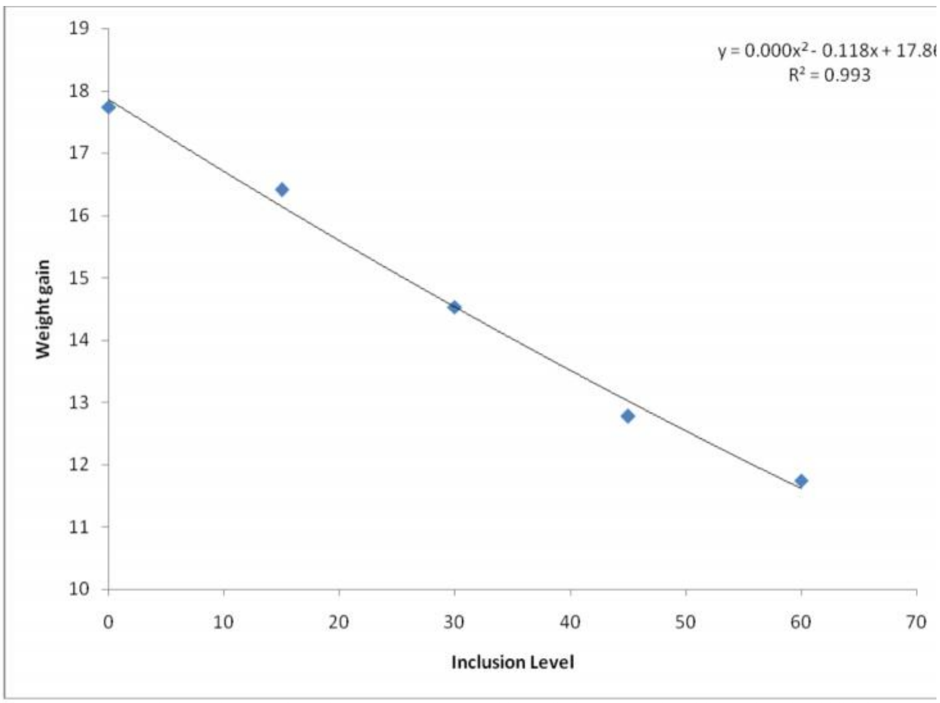

Figure 2 shows the polynomial regression of weight gain by of *O. niloticus* fed diets containing *Citrulus lanatus* seed meal against inclusion level

Discussion

The growth performance results obtained in this study showed a reduction in growth performance parameters with increasing inclusion of *Citrullus lanatus* arising from reduced feed intake by the fish caused by reduced palatability of the feed ingredients with increasing inclusion of *Citrullus lanatus* in their diets as explained in Glencross *et al.* (2007). Domingues *et al.* (2003) reported that acceptance of alternative sources of feedstuffs are used in fish diets is one of the major challenges faced in fish feeding. Higher levels of inclusion *Citrullus lanatus* in the diets of *O. niloticus* was responsible for the reduced palatability as well as bioavailability of nutrients plausibly caused by incomplete inactivation of anti-nutritional factors in the seed meal; or imbalance amino acid profile of the diets or increased fibre content of the diets. Similar observation was made by Jimoh and Aroyehun (2011) when cooked sesame seed meal was fed to *Clarias gariepinus*, Jimoh *et al.* (2013) when the *Citrullus lanatus* seed meal was fed to *Clarias gariepinus* and Jimoh *et al.* (2014) when *Chrysophyllum albidum* seed meal was fed to *Clarias gariepinus.* Davies *et al.* (2000) reported that higher inclusion of certain oilseed recorded poor growth and nutrient utilization by *O. niloticus.* Aderolu and Oyedokun (2009) reported that the rate of digestion and nutrient absorption are restricted by high fibre in diets. Keembiyeethy and Desilva (1993) stated that it could result in increased weight of excreta and reduced nutrient absorption. Processes that reduce fibre content of oilseed meal could improve growth rate and weight gain of fish (Maina *et al*., 2002). The effectiveness of cooking as a process of inactivating of anti-nutritional factors in *Citrullus lanatus* seed meal was not established in this study. The poorer growth performance of fish fed higher inclusion of this seed meal could be due to the presence of these anti nutritional factors which were not completely inactivated by cooking procedure. Our submission is in tandem with the report of Tiamiyu *et al.* (2015) that the best cooking levels that could support growth performance in fish should be 40 minutes. Jimoh *et al.* (2014) gave similar explanation when *Chrysophyllum albidum* seed meal was fed to *Clarias gariepinus.* The fact that the protein accretion in all the fish exposed to different dietary treatments was not significant and no significant difference was recorded in FCR and PER of *O. niloticus* fed various replacement levels of *Citrullus lanatus* seed meal indicated that it is feasible to replace soybean meal with *Citrullus lanatus* up to 60% replacement level. However, lower nutrient utilization will be recorded and growth will be retarded at higher levels of inclusion. Francis *et al.* (2001) explained why at lower replacement levels, better growth and nutrient utilization by fish is recorded by reporting that a compensatory physiological mechanism in fish could cope with the presence of these lowered levels of anti-nutritional factors in seed meal.

Conclusion

The study showed that soybean replacement by *Citrulus lanatus* in the diet of *O. niloticus* is feasible up to 60% replacement level except that lower nutrient utilization will be recorded and growth will be retarded at higher levels. Appropriate processing techniques should be employed in not only removing the antinutrients in the seed meal but also reducing the fibre content of the seed meal and ensuring supplementation of amino acids so that its full nutritional potentials can be exploited.

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