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APPARENT DIGESTIBILTY EXPERIMENT WITH NILE TILAPIA (*OREOCHROMIS NILOTICUS*) FED DIETS CONTAINING *CITRULLUS LANATUS* SEEDMEAL

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ABSTRACT
Apparent digestibility coefficients of nutrients in Citrullus lanatus based diets were determined for Nile tilapia (Oreochromis niloticus) using AIA as marker or indicator. 150 tilapia fingerlings of average weight 6.12±0.05g were acclimatized for a week, weighed and allotted into five dietary treatments; CTR, DT2, DT3, DT4 and DT5 containing 0, 15, 30, 45 and 60% Citrullus lanatus respectively. The diets were isonitrogenous, isocaloric 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. The results from the study indicated that there was no significant variation (p>0.05) in the apparent organic matter and gross energy digestibility coefficients of the diets; that there was significant (p<0.05) reduction in apparent digestibility coefficients of protein with increasing level of inclusion of Citrullus lanatus seed meal; that there was no significant difference (p>0.05) in the apparent digestibility coefficients of nutrients (protein, energy, lipid and carbohydrates) between the diets up to 30% replacement levels for tilapia.
KEYWORDS: *watermelon. tilapia, digestibility, acid insoluble ash, Citrullus lanatus*

INTRODUCTION

The current growth of aquaculture in Nigeria in the recent years needs to be sustained. Its sustainability largely depends on variety of factors, principal among which is feed being given to fish. Soybean which has been the plant protein source capable of replacing at least 50% of the fishmeal in the diet of fish species is fast on the increasing cost and not so much available in the market because of its competitive use as food by man and feed ingredients by other livestock feed producers (Siddhuraju & Becker, 2001) thus creating the need to search into alternative feed ingredients that would replace soybean meal. Recent research works focus on the use of alternative protein source feed ingredients prominent among which are watermelon (Jimoh *et al.,* 2013); sunflower and sesame as protein source feed ingredients for *Clarias gariepinus*; Fagbenro *et al,* 2010; Fagbenro *et al,* 2013; a, b); jackbean as protein source feed ingredients for *Oreochromis niloticus* (Fagbenro *et al,* 2007; Jimoh *et al,* 2010).

Watermelon belongs to the family Curcubitaceae. It is a tropical, semi tropical and arid region crop of the world (Razavi & Milani, 2006). It seeds have nutritional density comparable to other oilseed proteins including soybean and other conventional legumes (Mustapha & Alamin, 2012). Wani *et al* (2011) reported that watermelon seedmeal contains adequate amount of nutritional protein that could be used as nutritional ingredients in food products. More so, there is paucity of information on the use of *Citrullus lanatus* seeds as dietary protein source of fish feed especially its digestibility.

Borghesi *et al* (2008) reported that knowing nutrient digestibilities of feed ingredients show how possible feed ingredients can be interchanged without reducing animal performance. Apparent digestibility coefficient (ADC) results allow us to precisely estimate the contribution of a particular protein source to a complete fish feed (Koprucu & Ozdemer, 2005). The importance of knowing the digestibility of feed ingredients is well highlighted in the work of De Silva & Anderson (1995). Digestibility of nutrients in fish diets needs to be studied because it is the digested feed, which is absorbed, that is made available for cellular metabolism. The resultant of which will be tissue synthesis, and repair of worn-out tissues and various energy utilization channels.

Various methods have been used to study digestibility. The indirect method is chosen in this study which is based on the concentration of an indigestible marker (an indicator) in the feed and in the fecal samples. Various researchers have identified this indirect methods as being reliable in carrying out digestibility study for fish (Takeuchi *et al.,* 1979; Wilson & Poe, 1985; Satoh *et al.,* 1992) and in collecting the faecal sample, Smith (1989) reported that fish can be sacrificed and the faecal samples removed from the lower large intestine, faecal samples can also be gotten by gentle pressure in the abdomen of the fish, suction method has also been used. Faecal samples can also be periodically removed from the tank by siphoning or the use of settling column (Smith, 1989).

In conducting indirect method of digestibility study using marker, generally there are two types of markers; the exogenous and endogenous markers. Halver *et al* (1993) compared the efficacy of the two markers and concluded that endogenous marker especially Acid Insoluble Ash (AIA) was a more reliable indicator of digestibility coefficient since dietary ingredient (ash) is used and analysis of this component in feed and faeces uses simple gravimetry method. Goddard & McLean (2001) reported that there was no significant difference in apparent digestibility coefficients for nitrogen, dry matter or gross energy determined in a practical diet using naturally occurring AIA. This work therefore seeks to evaluate the apparent digestibility coefficients of nutrients in the diets containing *Citrullus lanatus* seedmeal fed to *Oreochromis niloticus* using AIA as an indicator.

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 analysed 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).

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. The diets were isolipidic and isonitrogenous containing 40% crude protein and 10% lipid with fish meal (72%), soya bean meal (45%), fish oil, vitamin premix and starch serving as ingredients. The feedstuffs 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 7 days prior to the feeding trial while being fed on a commercial pelleted diet. 10 juveniles were allotted into each tank with 3 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. Digestibility procedures followed the method described by Fagbenro *et al* (2013) and indices were estimated following the method of Jimoh *et al* (2010) using AIA as indicator. 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).

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

TABLE 2. Gross composition (g/100g) of experimental diets containing *Citrullus lanatus* seedmeal 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.*

Proximate Analyses.

The proximate analyses of feed ingredients, diets and faeces for crude protein, crude fibre, crude lipid, fat and ash were carried out in triplicate using the methods described by the AOAC, (1990). A factor of 6.25 was used to convert nitrogen to protein. The nitrogen free extract was estimated by difference. Energy content of faeces and diets were determined using the physiological value of 5.61kcal/g protein 4.11kcal/g carbohydrate and 9.50 kcal/g lipid.

AIA Analyses.

AIA analyses were carried out on test diets and faeces using the methods described in Halver (1997) and Adeparusi & Jimoh (2002).

Determination of Digestibility Coefficient.

This was calculated on the percentage of AIA in feed and in faeces and the percentage of nutrient on diets and feaces.

$$\text{Apparent Organic Matter Digestibility} = 100 - 100\frac{(\text{AIA in feed})}{(\text{AIA in faeces})}$$

$$\text{Digestibilty} = 100 - 100\frac{(\text{AIA in feed})}{(\text{AIA in faeces})} \times \frac{(\text{Nutrient in faeces})}{(\text{Nutrient in diets})}$$

Statistical Analysis. Data obtained from the experiment was expressed in mean ±SD and it was subjected to one way Analysis of Variance (ANOVA) using SPSS 16.0 version. Where the ANOVA reveals significant difference ($P<0.05$) Duncan multiple range test was used to compare differences among individual treatment means.

RESULTS AND DISCUSSIONS

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

The table of 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 & Ross, 1982; Luquet 1991).

Table 4 revealed the proximate composition of the faecal output of *Oreochromis niloticus* fed diets containing *Citrullus lanatus* seedmeal. Generally there was reduction in the parameters of the proximate composition of the faeces when compared with that of their corresponding diets and significant variation ($p<0.05$) existed in the parameters of the proximate composition. This indicates that certain fractions of the nutrients had been absorbed and made available for metabolism and eventual tissue synthesis. This agrees with the work of Jimoh *et al* (2010) who fed *Cannavalia ensiformis* to *Oreochromis niloticus* and Fagbenro *et al* (2013) who fed sunflower and sesame seedmeal to *Clarias gariepinus.* Adeparusi & Jimoh (2002) reported that there was reduction in the parameters of the proximate composition in the faeces compared to the diet when *Oreochromis niloticus* was fed lima bean (*Phaseolus lunatus*).

Table 5 showed the trend of Acid Insoluble Ash (AIA) as measured in the diets given to *Oreochromis niloticus* and faeces gotten therefrom. There was no significant difference ($p>0.05$) in the AIA of the various diets fed to *Oreochromis niloticus* though the quantity of the AIA was more in the faeces than in the feed. The AIA in the feacal output of *Oreochromis niloticus* exposed to various dietary treatment showed no significant variation ($p>0.05$). Fagbenro *et al.* (2013) made similar observation in their work earlier mentioned. In the work of Gul *et al* (2007) the quantity of the indicator (chromic oxide) was more in the faeces than in the feed.

Table 6 showed the apparent digestibility coefficient of nutrients in the diets containing *Citrullus lanatus* seedmeal fed to *Oreochromis niloticus*. There was no significant variation (p>0.05) in the apparent organic matter digestibility coefficients of the diets fed to *Oreochromis niloticus.* The apparent organic matter digestibility coefficient reported in this study was slightly higher than the value reported by Fagbenro (1998a and b) the variation may be attributed to processing methods applied and or experimental methodology; different seed meal and fish species was used as it is known that digestibility of nutrients are species specific however the result closely related to that reported in Martinez – Palacois *et al.*(1988) and Yue & Zhou (2008) for juvenile hybrid tilapia fed cottonseed meal.

TABLE 3. Proximate composition (g/100g) of experimental diets containing *Citrullus lanatus* seedmeal fed to *Oreochromis niloticus*

Parameters	CTR	DT2	DT3	DT4	DT5	SEM
Moisture	9.66±0.51	9.59±0.59	9.56±0.50	9.88±0.33	9.52±0.52	0.12
Crude Protein	35.22±0.05	35.14±0.16	35.23±0.33	35.222±0.06	35.17±0.23	0.04
Crude Lipid	10.16±0.09	10.15±0.06	10.08±0.03	10.04±0.27	10.19±0.13	0.22
Crude Fibre	4.37±0.36	4.17±0.08	4.12±0.03	4.15±0.05	4.13±0.05	0.04
Ash	5.15±0.20	4.90±0.28	4.66±0.50	5.12±0.37	5.09±0.16	0.09
NFE	35.43±0.53	36.0±0.51	36.34±0.86	35.57±0.57	33.90±0.61	0.26
Total	100	100	100	100	100	
Energy (Kcal/g)	5.18±0.01	5.18±0.01	5.18±0.01	5.18±0.02	5.19±0.01	0.01

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

TABLE 4. Proximate composition (g/100g) of faecal output of *Oreochromis niloticus* fed diets containing *Citrullus lanatus* seedmeal

Parameters	CTR	DT2	DT3	DT4	DT5	SEM
Moisture	$10.70±0.71^{a}$	$10.77±1.18^{a}$	$11.19±0.97^{a}$	$11.25±0.95^{a}$	$11.13±0.93^{a}$	0.21
Crude Protein	$10.35±0.25^{b}$	$10.84±0.10^{ab}$	$11.29±0.59^{a}$	$11.63±0.44^{a}$	$11.67±0.72^{a}$	0.17
Crude Lipid	$3.42±0.35^{d}$	$3.57±0.08^{cd}$	$3.73±0.456^{bc}$	$3.78±0.11^{b}$	$3.97±0.12^{a}$	0.05
Crude Fibre	$3.69±0.30^{b}$	$3.66±0.08^{b}$	$3.77±0.26^{b}$	$3.80±0.13^{b}$	$4.52±0.06^{a}$	0.95
Ash	$3.68±0.49^{b}$	$4.43±0.53^{ab}$	$4.45±0.17^{ab}$	$4.90±0.22^{a}$	$4.69±0.50^{a}$	0.14
NFE	$68.15±0.56^{a}$	$66.73±0.89^{ab}$	$65.56±0.62^{bc}$	$64.61±1.15^{c}$	$64.02±1.16^{c}$	0.44
Total	100	100	100	100	100	
Energy (Kcal/g)	$3.56±0.01^{c}$	$3.57±0.01^{bc}$	$3.59±0.02^{ab}$	$3.60±0.01^{a}$	$3.59±0.01^{ab}$	0.04

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

TABLE 5. Acid insoluble ash content (AIA in %) in experimental diets containing *Citrullus lanatus* seedmeal fed to *Oreochromis niloticus* and its faecal output

	CTR	DT2	DT3	DT4	DT5	SEM
AIA in Feed	2.83±0.67	2.89±0.02	2.83±0.45	2.85±0.03	2.87±0.06	0.01
AIA in Faeces	7.84±0.11	7.84±0.12	7.86±0.08	7.68±0.16	7.82±0.11	0.03

Figures in each row without superscripts are not significantly different (P<0.05) from each other

TABLE 6. Apparent digestibility coefficent of nutrients in the diets containing *Citrullus lanatus* seedmeal fed to *Oreochromis niloticus*

Parameters	CTR	DT2	DT3	DT4	DT5	SEM
AOMD	63.87±0.36[a]	63.14±0.65[a]	63.92±0.91[a]	62.93±0.74[a]	63.28±1.01[a]	0.20
APD	89..39±0.15[a]	88.63±0.28[ab]	88.63±0.69[ab]	87.76±0.24[b]	87.81±1.01[b]	0.20
ALP	87.31±1.01[ab]	87.03±0.06[abc]	86.63±0.49[bc]	86.01±0.45[c]	88.04±0.27[a]	0.22
AFD	69.43±1.41[a]	67.67±1.35[a]	66.95±3.02[a]	66.06±1.13[a]	59.08±1.60[b]	0.96
AAD	74.06±4.43[a]	66.713.35[b]	65.26±3.88[b]	64.39±2.61[b]	66.21±2.83[b]	1.20
ACD	30.52±0.80[b]	31.76±0.25[b]	34.89±2.47[a]	32.64±1.86[ab]	30.66±0.53[b]	0.53
AED	75.18±0.20[a]	74.55±0.43[a]	74.96±0.61[a]	74.20±0.39[a]	75.07±0.75[a]	0.14

Figures in each row with different superscripts are significantly different ($P<0.05$) from each other
AOMD: Apparent organic matter digestibility; APD: Apparent Protein Digestibility; ALP: Apparent Lipid Digestibility; AFD: Apparent Fibre Digestibility; AAD: Apparent Ash Digestibility; ACD: Apparent Carbohydrate Digestibility; AED: Apparent Energy Digestibility

Control diet CTR had the highest apparent protein digestibility coefficient while diet DT5 had the lowest apparent protein digestibility coefficient. There was significant ($p>0.05$) reduction trend in the apparent protein digestibility coefficient with increasing inclusion of *Citrullus lanatus*. However, there was no significant difference ($p>0.05$) in the apparent protein digestibility coefficient up to 30% replacement level when compared to that of control diet. This agrees with the work of Hossain & Jauncey (1989), Muckhopadyay (2001), Jimoh *et al* (2010), Fagbenro *et al* (2013). Hossain *et al* (1992) reported apparent protein digestibility coefficients of 84.7% for soybean meal based diets by *Oreochromis mossambicus*; a result closely related to what was reported in this study.

Same trends of results as recorded above were recorded for apparent lipid digestibility coefficient for Nile Tilapia fed control diets and test diets containing *Citrullus lanatus* seedmeal. Up to 30% replacement level, there was no significant variation ($p>0.05$) in the apparent lipid digestibility coefficient of the diets. There was significant ($p<0.05$) reduction in apparent digestibility of lipid with increasing level of inclusion of *Citrullus lanatus* seed meal; a similar observation were made by Fagbenro *et al* (2013); Muckopadlyay (2001), Hossain & Jauncey (1989).

There was no significant difference ($p>0.05$) in the apparent energy digestibility coefficient between the control diets and test diets containing *Citrullus lanatus* seedmeal. The values of apparent energy digestibility coefficients reported in this study agree with earler work by Fagbenro (1998 a, b). Fagbenro (1998a) reported the apparent energy digestibility coefficients value of 60.2 to 78.6% for different legumes seedmeal fed to *Oreochromis niloticus* while Fagbenro (1998b) reported apparent energy digestibility coefficients value of 77.4 to 75.6% for different oilseed cakes/meals fed to African catfish.

The lower digestibility coefficient recorded for crude fibre and carbohydrate in *Oreochromis niloticus* fed *Citrullus lanatus* based diets might not be unconnected to the physiological requirement of *Oreochromis niloticus*. It is an omnivorous fish feeding primarily on zooplankton and phytoplanktons. The low carbohydrate digestibility recorded in this study was similar to that reported by Adeparusi & Jimoh (2002) for *Oreochromis niloticus* fed lima bean diets (*Phaseolus lunatus*).The values of apparent carbohydrate digestibility coefficients reported in this study was lower than the values reported by Jimoh *et al* (2010) who fed diets containing *Cannavalia ensiformis* seedmeal to *Oreochromis niloticus.* Lovell (1988) reported that the tilapias has ability to digest carbohydrates relatively well in feedstuff but not as well as protein or lipid. The experiment was conducted under optimum environmental condition for the growth of warm water fish species; the physico-chemical conditions were within the optimum range (Boyd, 1990)..

CONCLUSIONS

From the foregoing, it can be concluded that up to 30% replacement level of soybean meal by *Citrullus lanatus* seedmeal, no significant difference existed in their apparent protein, lipid, and energy digestibility coefficients.

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