https://dx.doi.org/10.4314/ijs.v22i3.8

GROWTH PERFORMANCE AND FEED UTILISATION IN *Clarias gariepinus* FINGERLINGS FED GRADED LEVELS OF MELON (*Citrillus lanatus*) SEED PEEL MEAL-SUPPLEMENTED DIETS

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(Received: 1st June, 2020; Accepted: 29th September, 2020)

ABSTRACT

A fifty-six (56) day experiment was conducted to evaluate the growth performance and feed utilization in *Clarias gariepinus* fingerlings fed with six iso-nitrogenous diets in which oven-dried melon (*Citrillus lanatus*) seed peel meal (MSPM) was substituted for yellow maize at 0, 20, 40, 60, 80 and 100% inclusion levels. A total of 270 fingerlings of *C. gariepinus* (mean weight: 7.40 ± 0.02 g) were randomly allocated into eighteen plastic bowls (50-litre capacity) at 15 fish per bowl and fed the control and experimental diets twice daily at 5% of their body weight. Proximate composition of melon seed peel meal-supplemented diets and fish carcass was determined using standard procedures. Results showed that crude protein was highest (60.75%) in fish fed diet 2 (20% MSPM-supplemented diet) and least (58.21%) in fish fed diet 4 (60% MSPM-supplemented diet). Fish fed diet 2 (20% MSPM-supplemented diet) had statistically ($p < 0.05$) superior values of MWG (48.27 g), SGR (1.56%/day) and FCR (0.48) beyond which growth and feed utilization indices gradually declined with increased level of MSPM inclusion. This study demonstrated that 20% substitution level of oven-dried melon seed peel meal produced the best growth and feed utilization in *C. gariepinus*.

Keywords: Melon seed peel, *Clarias gariepinus*, Growth performance, Feed utilization

INTRODUCTION

Formulation and production of high quality feed which accounts for about 60% of the overall cost of fish production determines the viability and profitability of an aquaculture venture (Balogun *et al.*, 2016). Maize meal which is one of the major sources of metabolisable energy in most compounded catfish feeds is also extensively used for both human and livestock consumption (Aderolu *et al.*, 2011). Wider utilization of maize in formulated fish feeds is becoming increasingly unjustifiable in economic terms because it is expensive and not always supplied in sufficient quantities. This necessitated the need to search for cheaper and under-utilized energy-rich feed ingredients of high nutritional value such as melon seed peel. Earlier studies had attempted to increase the use of unconventional feedstuffs to replace conventional feed ingredients like maize and fishmeal in fish diets (Baruah *et al.*, 2003; Eyo and Ezechie, 2004; Aderolu *et al.,* 2011; Azaza *et al.*, 2015; Balogun *et al.*, 2016). Despite the availability of most seeds, their use as fish feedstuffs is usually restricted by the presence of one or more endogenous anti-nutritional compounds such as saponins, tannins, phytates, oxalates and hydrogen cyanide. Anti-nutritional factors decrease bio-availability of minerals and/or form complexes with digested food materials, thereby decreasing the absorption of nutrients in the gastro-intestinal tract and ultimately reducing growth in animals (Jimoh and Aroyehun, 2011). Several other studies have also been conducted on the use of agricultural by-product meals as dietary protein or energy sources in fish feed (Adekoya *et al.*, 2004; Bhatnagar *et al.*, 2004; Adeparusi and Agbede, 2005; Abdelhamid *et al.,* 2006; Adewolu*,* 2008; Olawepo *et al.*, 2014). Currently, these product meals are becoming more expensive because of the increasing utilisation by humans and as livestock feedstuffs. This current situation necessitates a continuous search for other alternative cheap feedstuffs from unconventional sources. Melon (*Citrillus lanatus*) seed peel or husk which is usually discarded as a waste after shelling of melon seeds is a typical agricultural by-product which has not been utilized as fish feed. This study was designed to assess the feasibility of utilising melon seed peel as an alternative dietary energy source on the growth performance and feed utilization in *Clarias gariepinus* fingerlings.

MATERIALS AND METHODS

Experimental diet formulation and preparation

Five (5) kilograms of melon seed peels were collected from a melon shelling and milling factory at Bodija Market, Ibadan, Oyo State, Nigeria. The peels sundried for 3 days were sieved using a hand sieve. The sundried peels were then dried at 50°C for 48 h in an electric oven (Fan Azma Gostar, BM 55 Model), ground into powdery form with the aid of a grinding machine and stored in an airtight container. The proximate composition of melon seed peel meal (MSPM) as determined in this study was: 14.65% crude protein; 4.27% crude lipid; 6.05% crude fibre; 8.56% ash; 7.83% moisture and 58.64% nitrogen-free extract. Six iso-nitrogenous (40% crude protein) experimental diets were formulated using Pearson's square method (Table 1). Oven-dried melon seed peel meal (MSPM) was substituted for yellow maize meal at graded levels of 0% (0.00 g = Diet 1), 20% (4.46 g = Diet 2), 40% (8.93 g = Diet 3), 60% (13.39 g = Diet 4), 80% (17.86 g = Diet 5) and 100% (22.32 g = Diet 6) (Table 1). The formulated diets were prepared by thoroughly mixing the dry ingredients using a mixer (Pars Electric Company, Tehran, Iran) after which palm oil and hot water were added to the dry mixture to form a homogenous paste. Each diet mixture was steam-pelleted through a 2-mm diameter disc aperture of Hobart pelleting machine (A-2007 Model, UK). The pellets were again sundried on clean concrete slabs, cooled to room temperature and packaged in separate airtight containers prior to experimental feeding.

Experimental arrangement and fish feeding trial

Three hundred and twenty (320) *C. gariepinus* fingerlings (mean weight = 7.40 ± 0.08 g) were procured from a reputable fish farm in Okitipupa, Ondo State, Nigeria and transported in an open 50-litre water-filled plastic container to the Fish Nutrition laboratory, Department of Fisheries and Aquaculture Technology, Olusegun Agagu University of Science and Technology, Okitipupa, Ondo State, Nigeria. The fish were acclimatized in an open 2 m x 2 m plastic tank for 7 days and were fed twice daily (07.00 and 17.00 hours) with the control diet at 5% of their body weight. A total of 270 uniformly-sized *C. gariepinus* fingerlings were batch-weighed using a high-precision weighing balance (OHAUS LS, Model 2000, Bradford, Massachusetts, USA) and randomly distributed into eighteen plastic bowls at a stoking density of fifteen (15) fish per bowl. Six dietary treatments (arranged as three replicates per treatment) were randomly assigned to the experimental bowls making eighteen (18) treatment units. Each diet was fed to the experimental fish twice daily (07.00 and 17.00 hours) at 5% of their body weight for 56 days. Fish mortality was monitored daily while fish weight in each tank was determined weekly and diet quantity adjusted according to new weight gain. Eight (8) grams of each diet sample as well as six (6) fish per treatment sacrificed at the commencement and end of the feeding trial were proximately analyzed according to the methods of Association of Official Analytical Chemists (AOAC, 2011). Selected physico-chemical parameters of water in the fish culture bowls were measured initially and weekly throughout the experimental period. Temperature was measured with the aid of mercury-in-glass thermometer, dissolved oxygen values were measured using dissolved oxygen meter (YSI 55, Yellow Springs Incorporated, Ohio, USA) while pH values were determined by means of pH meter (LT-Lutron pH-207, Taiwan).

Table1: Gross ingredient composition (g/100 g diet) of experimental diets

Dietary ingredients	Diet 1 0% MSPM (control)	Diet 2 20% MSPM	Diet 3 40% MSPM	Diet 4 60% MSPM	Diet 5 80% MSPM	Diet 6 100% MSPM
Fishmeal	24.00	24.00	24.00	24.00	24.00	24.00
Groundnut cake	23.00	23.00	23.00	23.00	23.00	23.00
Soybean meal	20.68	20.68	20.68	20.68	20.68	20.68
Yellow maize	22.32	17.86	13.39	8.93	4.46	-------
Melon seed peel meal	-------	4.46	8.93	13.39	17.86	22.32
Wheat offal	3.00	3.00	3.00	3.00	3.00	3.00
Vit./mineral premix*	1.00	1.00	1.00	1.00	1.00	1.00
Salt	2.00	2.00	2.00	2.00	2.00	2.00
Palm oil	2.00	2.00	2.00	2.00	2.00	2.00
Cassava starch	2.00	2.00	2.00	2.00	2.00	2.00
Total (g)	100.00	100.00	100.00	100.00	100.00	100.00

MSPM = melon seed peel meal
*Each kilogram of vitamin/mineral premix contained the following:
Vit. A: 1,000,000 IU; Vit. B_1: 250 mg; Vit. B_2: 1750 mg; Vit. B_6: 875 mg; Vit. B_{12}: 2500 mg; Vit. C: 12,500 mg; Vit D_3: 600,000 IU; Vit. E: 12,000 IU; Vit. K_3: 15 mg; Calcium D-pantothenate: 5000 mg; Nicotinic acid: 3750 mg; Folic acid: 250 mg; Cobalt: 24,999 mg; Copper: 1999 mg; Iron: 11,249 mg; Selenium ($Na_2SeO_3 . 5H_2O$): 75 mg; Iodine (Potassium iodide): 106 mg; Anti-oxidant: 250 mg.

Manufacturer: DSM Nutritional Products Limited, Basle, Switzerland, Europe.

Determination of feed utilization and growth performance indices

Effects of the six dietary treatments on fish growth performance and feed utilization were evaluated according to the formulae of Sogbesan and Ugwumba (2008), Jimoh and Aroyehun (2011), Iheanacho *et al.* (2017) and Adesina and Ikuyeju (2019) as follows:

Mean weight gain (MWG) =

$$\{\text{Final weight (g) - initial weight (g)}\} \quad \text{Eq. (1)}$$

Percentage weight gain (PWG) (%) =

$$\frac{\text{Weight gain (g)}}{\text{Initial weight (g)}} \times 100 \quad \text{Eq. (2)}$$

Feed intake (g) = Summation of the quantities of feed supplied to fish in each treatment throughout the experimental period Eq. (3)

Specific growth rate (SGR) (%/day) =

$$\frac{(\text{Ln final weight} - \text{Ln initial weight})}{\text{Time (experimental period in days)}} \times 100 \quad \text{Eq. (4)}$$

Food Conversion Ratio (FCR) =

$$\frac{\text{Mean feed intake (g)}}{\text{Mean weight gain (g)}} \quad \text{Eq. (5)}$$

Protein intake (g of protein in 100g diet/fish) =

$$\frac{\text{Feed intake (g)} \times \text{\% crude protein in the diet}}{100} \quad \text{Eq. (6)}$$

Protein Efficiency Ratio (PER) =

$$\frac{\text{Weight gain (g)}}{\text{protein intake (g of protein in 100 g of diet/fish)}} \quad \text{Eq. (7)}$$

Nitrogen metabolism (NM) =

$$\frac{0.549 \times (\text{Initial mean weight} + \text{Final mean weight}) \times t}{2} \quad \text{Eq. (8)}$$

Where: t = experimental period in days
0.549 = metabolism factor.

Percentage Survival (PS) (%) =

$$\frac{\text{Total number of fish that survived}}{\text{Total number of fish stocked}} \times 100 \quad \text{Eq. (9)}$$

Data Analysis

Data obtained were analyzed using one-way analysis of variance (ANOVA). Duncan's multiple range test was used to separate the differences between mean values at $P < 0.05$. All analyses were computed using SPSS package version 20.0. Data were presented as mean value ± standard deviation.

RESULTS AND DISCUSSION

Proximate composition of experimental diets

The proximate composition of the experimental diets which varied significantly ($p < 0.05$) suggested that the substitution levels of melon seed peel meal affected the proximate composition of the diets (Table 2). The crude protein content was highest (41.40%) in Diet 1 (control) and lowest (39.40%) in Diet 2, though not significantly different ($p > 0.05$). Despite the variation, the protein requirements of *C. gariepinus* fingerlings were met by the quantity provided in the experimental diets. Adegbesan *et al.* (2018) reported that the best growth rate and feed conversion efficiency in *C. gariepinus* could be achieved with a diet containing 38 - 42% crude protein. The present values were also in harmony with 43.97 – 44.28% reported by Iheanacho *et al.* (2018) for melon seed peel meal-based diets fed to *Oreochromis niloticus* juveniles. The crude lipid content which was highest (6.50%) in Diets 1 and 5 and was least (5.50%) in Diet 4 however exceeded values ranging from 4.15 – 4.37% reported by Iheanacho *et al.* (2018) in similar melon seed peel meal-based diets. The crude fibre content of the experimental diets was lowest (4.80%) in Diet 1 (control) and highest (5.90%) in Diets 4 and 6. The crude fibre values recorded during the study were approximately twice 2.57 – 2.71% recorded by Iheanacho *et al.* (2018) for similar melon seed peel meal-based diets. Values of the ash content ranged from 7.80% in Diet 4 to 11.20% in Diet 6 and were comparable to 10.73 – 11.35% in melon seed peel meal-based diets reported by Iheanacho *et al.* (2018) while the moisture content (7.90 - 12.30%) however exceeded 5.37 – 6.08% reported by them. The NFE values (24.60 – 31.45%) in the experimental diets which were comparable with 31.56 – 32.86% documented by Iheanacho *et al.* (2018) therefore confirmed the dietary potential of melon seed peel meal as an unconventional energy feedstuff.

Table 2: Proximate composition of graded levels of melon seed peel meal-supplemented diets fed to *C. gariepinus* fingerlings

Proximate indices (%)	Diet 1 0% MSPM (Control)	Diet 2 20% MSPM	Diet 3 40% MSPM	Diet 4 60% MSPM	Diet 5 80% MSPM	Diet 6 100% MSPM
Dry matter	90.90±0.27^b	91.80±0.52^a	92.10±0.01^a	89.70±0.41^b	91.60±0.32^a	87.70±0.07^c
Moisture	9.10±0.56^c	8.20±0.27^d	7.90±0.11^d	10.30±0.24^b	8.40±0.35^d	12.30±0.16^a
Crude protein	41.40±0.01^a	39.40±0.21^a	39.90±0.31^a	39.80±0.01^a	40.15±0.13^a	40.30±0.51^a
Crude lipid	6.50±0.11^a	6.10±0.12^a	5.90±0.04^a	5.50±0.13^b	6.50±0.11^a	5.70±0.31^b
Crude fibre	4.80±0.22^b	5.40±0.41^a	5.60±0.15^a	5.90±0.32^a	5.60±0.22^a	5.90±0.32^a
Ash	10.50±0.34^a	10.90±0.32^a	9.60±0.15^b	7.80±0.72^c	7.90±0.34^c	11.20±0.16^a
Nitrogen-free extract	27.70±0.24^b	30.00±0.11^a	31.10±0.32^a	30.70±0.41^a	31.45±0.05^a	24.60±0.13^c

Mean values with different superscripts along the same row are significantly different ($p < 0.05$).
MSPM = melon seed peel meal

Physico-chemical parameters of fish culture water medium

Selected water quality parameters in the fish culture medium are presented in Table 3. The mean weekly values of pH (7.57 ± 0.06 - 7.81 ± 0.04) significantly ($p < 0.05$) exceeded the initial value (6.35 ± 0.15). Likewise, temperature readings across the treatments (27.49 ± 0.07°C - 28.63 ± 0.15°C) were significantly higher ($p < 0.05$) than the initial value (26.15 ± 0.07°C) while the initial (5.43 ± 0.01 mg/l) and subsequent weekly values (5.32 ± 0.61 mg/l - 5.60 ± 0.42 mg/l) of dissolved oxygen concentration exhibited no significant variation. Physicochemical parameters of water recorded in this study fell within the range reported by Devi (2013) for ideal growth of cultured tropical fishes. The recorded values for temperature, DO and pH also fell within the optimal requirements for freshwater fish production (Ochang *et al.*, 2007; Anyanwu *et al.*, 2012). The values recorded for the three parameters were within the tolerance limits for *C. gariepinus* reported by Adekoya *et al.* (2004) and Bhatnagar *et al.* (2004). The authors reported 25 - 30°C temperature range and dissolved oxygen concentration of 4 – 8 mg/L as being ideal for *C. gariepinus* culture. Adekoya *et al.* (2004) and Santhosh and Singh (2007) also recommended pH values between 7.5 and 8.5 which overlapped with the values recorded to be ideal for *C. gariepinus* culture.

Table 3: Selected physico-chemical parameters measured during the experimental period

Dietary Treatment	Water Temperature (°C)	DO (mg/l)	pH
Initial values	26.15 ± 0.20^{b}	5.43 ± 0.01^{a}	6.35 ± 0.15^{b}
Mean weekly values			
0% MSPM	28.60 ± 0.32^{a}	5.51 ± 0.31^{a}	7.59 ± 0.17^{a}
20% MSPM	28.63 ± 0.15^{a}	5.39 ± 0.17^{a}	7.68 ± 0.05^{a}
40% MSPM	27.78 ± 0.21^{a}	5.60 ± 0.42^{a}	7.76 ± 0.23^{a}
60% MSPM	27.49 ± 0.07^{a}	5.48 ± 0.07^{a}	7.57 ± 0.06^{a}
80% MSPM	28.41 ± 0.18^{a}	5.32 ± 0.61^{a}	7.73 ± 0.15^{a}
100% MSPM	27.83 ± 0.20^{a}	5.45 ± 0.13^{a}	7.81 ± 0.04^{a}

Mean values along the same column with different superscripts are significantly different ($P<0.05$).
MSPM = melon seed peel meal

Carcass proximate composition of *C. gariepinus* fingerlings

Table 4 which shows significant variations ($p < 0.05$) in the carcass proximate composition of *C. gariepinus* fingerlings fed the graded levels of melon seed peel meal-based diets suggested that the varied substitution levels of melon seed peel meal in the diets affected fish body composition. The moisture content was significantly higher ($p < 0.05$) in the fish fed the control diet (diet 1) than in the fish fed the experimental melon seed peel-substituted diets which was probably due to the variation recorded in the other proximate components of the fish carcass. The carcass crude protein levels (58.21 – 60.75%) in the post-treatment fish significantly ($p < 0.05$) exceeded the initial pre-treatment value (57.80%). The result could be attributed to increase in the synthesis of tissue protein in the experimental fish as suggested by Tiamiyu *et al.* (2015) and corroborated by Fountoulaki *et al.* (2003) that fish growth was not due to weight gain alone. The results obtained also possibly indicated that melon seed peel meal contains some essential nutrients which aided new protein formation when compared to the fish fed the control diet. The initial carcass crude lipid content (8.40%) was not significantly different ($p > 0.05$) from the final values which ranged from 7.50% (in the fish fed Diet 4) to 8.40% (in the fish fed Diet 2). Moreover, the moderately high level of carcass lipid content in the experimental fish probably suggested an enhanced lipid production in the fish (Fountoulaki *et al.*, 2003). The initial ash content (9.01%) was significantly ($p < 0.05$) lower than the ash content values in the fish fed Diets 4 and 6. NFE values ranged from 2.64% in the fish fed Diet 2 to 3.88% in the fish fed Diet 5 and were significantly ($p < 0.05$) lower than the initial value (6.49%).

Table 4: Carcass composition (%) of *C. gariepinus* fingerlings fed graded levels of melon seed peel meal diets

Proximate Parameters (%)	Pre-treatment carcass values	Experimental Dietary Treatments					
		Diet 1 0% MSPM (control)	Diet 2 20% MSPM	Diet 3 40% MSPM	Diet 4 60% MSPM	Diet 5 80% MSPM	Diet 6 100% MSPM
Moisture	11.98 ± 0.41^{a}	8.87 ± 0.34^{d}	9.71 ± 0.17^{b}	9.44 ± 0.33^{c}	9.91 ± 0.41^{b}	10.06 ± 0.27^{b}	9.41 ± 0.42^{c}
Crude protein	57.80 ± 0.07^{c}	58.45 ± 0.41^{b}	60.75 ± 0.52^{a}	60.50 ± 0.01^{a}	58.21 ± 0.41^{b}	59.12 ± 0.01^{ab}	59.40 ± 0.51^{ab}
Crude lipid	8.40 ± 0.02^{a}	8.10 ± 0.01^{a}	8.40 ± 0.01^{a}	7.90 ± 0.31^{a}	7.50 ± 0.06^{a}	8.10 ± 0.41^{a}	7.80 ± 0.11^{a}
Ash	9.01 ± 0.60^{b}	10.40 ± 0.04^{ab}	10.60 ± 0.01^{ab}	9.60 ± 0.48^{b}	11.00 ± 0.06^{a}	10.10 ± 0.50^{ab}	11.10 ± 0.03^{a}
Nitrogen-free extract	6.49 ± 0.01^{a}	3.64 ± 0.02^{b}	2.64 ± 0.31^{c}	3.15 ± 0.34^{b}	3.47 ± 0.52^{b}	3.88 ± 0.31^{b}	3.40 ± 0.61^{b}

Mean values with different superscripts along the same row are significantly different ($p < 0.05$).
MSPM = melon seed peel meal

Growth performance and feed utilization in *C. gariepinus* fingerlings

The growth performance and feed utilization efficiencies in the experimental fish during the period of study exhibited significant variations ($p < 0.05$) as shown by increase in weight (Table 5). Mean weight gain (48.27 g) was significantly higher ($p < 0.05$) in the fish fed 20% melon seed peel meal (MSPM)-based diet, followed by the fish fed 40% and 60% MSPM-based diets while the least MWG (37.38 g) recorded in the fish fed 100% MSPM-based diet was not significantly different ($p > 0.05$) from the values recorded in the fish fed the control and 80% MSPM-based diets. This implied that MSPM as an energy source improved fish growth as reported by Orire and Ricketts (2013) in *O. niloticus* juveniles fed melon seed peel meal-incorporated diets. By contrast, the higher MWG values recorded reflected superior growth when compared to the values reported by Iheanacho *et al.* (2018) in *O. niloticus* juveniles fed similar melon seed peel meal-based diets. Similarly, fish fed 20% MSPM-based diet had the highest specific growth rate (SGR) value (1.56%/day)) while those fed 0%, 80% and 100% MSPM-based diets had the least SGR (1.40%/day). The SGR value in the fish fed 20% MSPM-based diet was not significantly different ($p > 0.05$) from the SGR in the fish fed 40% and 60% MSPM-based diets but was significantly different ($p < 0.05$) from the SGR in the fish fed 0%, 80% and 100% MSPM-based diets. The higher SGR in the fish fed 20% MSPM-based diet indicated that it best converted dietary nutrients to flesh when compared to the fish fed with the other diets. These higher SGR values reflected better growth when compared to the values reported by Iheanacho *et al.* (2018) in *O. niloticus* juveniles fed similar melon seed peel meal-based diets.

The progressive reduction in growth with higher MSPM substitution above 20% level probably resulted from poor utilisation of diets at higher levels which could probably be linked to high levels of fibre content and residual anti-nutrients in the diets (Adewolu, 2008). Similarly, Gatlin (2010) pointed out that increasing fibre content beyond the basal level in certain fish species could reduce fish growth owing to poor digestion of cellulose. Fakunle *et al.* (2013) also reported that toxic components or anti-nutritional factors in most agricultural by-products might irritate the digestive tract and cause reduced feed intake and growth. Aderolu *et al.* (2011) stated that high fibre content in the diets of *C. gariepinus* reduces the rate of nutrient absorption and thereby causes poor growth. Oyelere *et al.* (2016) also reported that *C. gariepinus* manifested poor handling of high fibre in its diets. This probably accounted for the progressively reduced growth performance of the fish fed MSPM substitutions above 20% level. Earlier, Nwanna *et al.* (2009) stated that very high substitution levels of unconventional dietary carbohydrate sources often result in poor fish performance. Similar findings in *C. gariepinus* fed diets containing *Moringa oleifera* leaf meal, toasted *Senna obtusifolia* seed meal and soaked *Bauhinia monandra* seed meal respectively were reported by Dienye and Olumuji (2014), Bake *et al.* (2016) and Balogun *et al.* (2016). The decreased trend in growth performance and feed utilization of the experimental fish with increased substitution levels of MSPM suggested that it has the potential of replacing yellow maize provided it is incorporated at low levels of substitution in the diet of *C. gariepinus* and thereby reduce the cost of fish feed.

Feed conversion ratio (FCR) values recorded in the fish fed 0%, 80% and 100% MSPM-based diets was significantly higher ($p < 0.05$) than the value in the fish fed 20% MSPM-based diet. The lowest FCR suggested that *C. gariepinus* fingerlings effectively utilized MSPM at 20% substitution and efficiently converted the feed to flesh. The low FCR showed a better feed utilization when compared with the values reported by Iheanacho *et al.* (2018) in *O. niloticus* juveniles as well as values reported for *C. gariepinus* fingerlings by Dienye and Olumuji (2014) and Oyelere *et al.* (2016) respectively.

Protein intake (PI) was highest (9.26 g/100g diet/fish) in the fish fed 40% MSPM-based diet but was not significantly different ($p > 0.05$) from the values in the fish fed the control diet and 20% MSPM-based diet. However, it was significantly higher ($p < 0.05$) than the values recorded for fish fed 60% - 100% MSPM-based diets which probably suggested optimal intake of dietary protein by the fish fed 20% and 40% MSPM-based diets. The PI values recorded indicated better dietary protein utilization when compared with 0.84 – 1.33 g/100g diet/fish reported by Adesina and Ikuyeju (2019) in *C. gariepinus* fingerlings fed pawpaw leaf meal-based diets. Protein efficiency ratio (PER) was significantly higher ($p < 0.05$) in the fish fed 20% MSPM-based diet than in the control and other experimental diets. The lowest (4.08) PER value which was recorded in the control group was not significantly different ($p > 0.05$) from the values recorded in the fingerlings fed 80% and 100% MSPM-based diets. The higher PER values reflected better dietary protein utilization compared to the values reported by Iheanacho *et al.* (2018) in *O. niloticus* juveniles fed similar melon seed peel meal-based diets.

The percentage survival (86.67%) recorded for fish fed 0%, 20%, 60%, 80% and 100% MSPM-based diets was significantly higher ($p < 0.05$) than 82.22% recorded in the fish fed 40% MSPM-based diet. The fish survival rate observed in this study compared favourably with 86.67 - 100% reported by Iheanacho *et al.* (2018) in *O. niloticus* juveniles fed similar MSPM-supplemented diet. The result, however, contradicted 48.00 - 86.00% rate recorded by Anyanwu *et al.* (2015) in *C. gariepinus* fingerlings fed *Azadirachta indica* leaf meal-based diets. The relatively high survival rates recorded in this study probably reflected high acceptability of the MSPM-based diets by fish coupled with good handling, adequate water quality management, proper feed processing and suitability of oven-dried MSPM substitutions in the diet of *C. gariepinus*. Survival of fish has been shown to strongly depend on the tolerance level of the fish species as well as the nature and level of anti-nutrients in the feedstuff (Oyelere *et al.*, 2016). The acceptance of the oven-dried MSPM-based diets in this study as reflected by the growth, feed utilization and survival indices has established the elasticity of *C. gariepinus* fingerlings to efficiently utilize a wide range of unconventional feed ingredients.

Table 5: Feed utilization and growth performance indices of *C. gariepinus* fingerlings fed melon seed peel meal-based diets for 56 days

Growth and feed utilization parameters	Diet 1 0% MSPM (Control)	Diet 2 20% MSPM	Diet 3 40% MSPM	Diet 4 60% MSPM	Diet 5 80% MSPM	Diet 6 100% MSPM
Initial mean weight (g)	7.40 ± 0.21^a	7.41 ± 0.01^a	7.39 ± 0.05^a	7.38 ± 0.12^a	7.40 ± 0.03^a	7.41 ± 0.04^a
Final mean weight (g)	44.97 ± 0.14^c	55.68 ± 0.08^a	50.13 ± 0.08^b	49.15 ± 0.24^b	45.23 ± 0.11^c	44.79 ± 0.11^c
Mean weight gain (g)	37.57 ± 0.15^c	48.27 ± 0.08^a	42.74 ± 0.01^b	41.77 ± 0.26^b	37.83 ± 0.39^c	37.38 ± 0.04^c
Percentage weight gain (%)	507.70 ± 0.06^e	651.42 ± 0.16^a	578.35 ± 0.03^b	566.00 ± 0.40^c	511.22 ± 0.09^d	504.45 ± 0.19^e
Total feed intake (g)	1000.23 ± 0.41^c	1040.12 ± 012^a	1044.42 ± 0.32^a	1015.76 ± 0.04^b	1000.90 ± 0.32^c	998.45 ± 0.25^c
Mean feed intake (g)	22.23 ± 0.02^b	23.11 ± 0.12^a	23.21 ± 0.21^a	22.57 ± 0.12^a	22.24 ± 0.03^b	22.19 ± 0.11^a
Feed conversion ratio	0.59 ± 0.10^a	0.48 ± 0.03^b	0.54 ± 0.13^a	0.54 ± 0.27^a	0.59 ± 0.04^a	0.59 ± 0.13^a
Specific growth rate (%/ day)	1.40 ± 0.12^b	1.56 ± 0.02^a	1.49 ± 0.01^{ab}	1.47 ± 0.01^{ab}	1.40 ± 0.01^b	1.40 ± 0.03^b
Nitrogen metabolism	805.03 ± 0.23^d	969.82 ± 0.15^a	884.20 ± 0.35^b	869.00 ± 0.20^c	809.03 ± 1.32^d	802.42 ± 1.13^d
Protein intake	9.21 ± 0.03^a	9.11 ± 0.13^a	9.26 ± 0.04^a	8.98 ± 0.02^b	8.93 ± 0.21^b	8.94 ± 0.14^b
Protein efficiency ratio	4.08 ± 0.23^c	5.30 ± 0.15^a	4.62 ± 0.35^b	4.65 ± 0.20^b	4.24 ± 1.32^c	4.18 ± 1.13^c
Percentage survival (%)	86.67 ± 0.31^a	86.67 ± 0.24^a	82.22 ± 0.41^b	84.44 ± 1.23^{ab}	86.67 ± 0.25^a	86.67 ± 1.03^a

Mean values with different superscripts along the same row are significantly different ($p < 0.05$).
MSPM = melon seed peel meal

CONCLUSION

The study demonstrated that 20% level of substitution of melon seed peel meal for yellow maize meal component of the diet produced the best feed utilization and growth performance in *C. gariepinus* fingerlings. Utilization of melon seed peel which is a cheap and readily available unconventional feed ingredient is therefore recommended to replace yellow maize meal component. However, a study of the anti-nutrients present in melon seed peel is essential in order to fully exploit its nutritional potentials.

REFERENCES

Abdelhamid, A. M., Salem, M. F. I. and Khalafalla, M. M. (2006). Substitution of soybean meal by water hyacinth hay in the diets of Nile tilapia. *The 2nd International Scientific Congress for Environment, Recent Environmental Problems and Solutions*. 28 - 30 March, South Valley University, pp. 114 - 125.

Adegbesan, S. I., Obasa, S. O. and Abdulraheem, I. (2018). Growth performance, haematology and histopathology of African catfish (*Clarias gariepinus*) fed varying levels of *Aloe barbadensis* leaves. *Journal of Fisheries,* 6 (1): 553 – 562.

Adekoya, R. A., Awojobi, H. A., Taiwo, B. B. A. (2004). The effect of partial replacement of maize with full-fat palm kernel on the performance of laying hens. *Journal of Agriculture, Forestry and Social Sciences,* 2 (2): 89 - 94.

Adeparusi, E. O. and Agbede, J. O. (2005). Evaluation of leucaena and gliricidia leaf protein concentrate as supplements to Bambara groundnut (*Vignas subterranean* (L. verdc.) in the diet of *Oreochromis niloticus*. *Aquaculture Nutrition,* 12 (2): 335 - 342.

Aderolu, A. Z., Aarode, O. O., Akonu, A. A. and Jimoh, W. A. (2011). The effect of substituting maize with graded level of biscuit waste on growth, nutrient utilisation, carcass composition, haematological parameters and economic performance of African catfish (*Clarias gariepinus*). *Journal of Natural Science, Engineering and Technology,* 10 (2): 111 - 120.

Adesina, S. A. and Ikuyeju, M. F. (2019). Effects of replacing soybean meal with graded levels of pawpaw (*Carica papaya*) leaf meal in the diets of *Clarias gariepinus* fingerlings. *Coast Journal of Faculty of Science,* 1 (1): 130 – 142.

Adewolu, M. A. (2008). Potentials of sweet potato (*Ipomoea batatas*) leaf meal as dietary ingredient for *Tilapia zillii* fingerlings. *Pakistan Journal of Nutrition,* 7 (3): 444 - 449.

Anyanwu, D. C., Umeh, O. I., Maduka, B. C. and Mbchu, M. U. (2012). Nutrient utilization and growth of catfish (*Clarias gariepinus*) fed dietary levels of cassava leaf meal. *Pakistan Journal of Nutrition,* 11 (11): 1037 - 1040.

Anyanwu D. C., Offor J. I. and Nkulo U. U. (2015). Product quality assessment of *Clarias gariepinus* fed on varying dietary levels of *Azadirachta indica* leaf meal. *American Journal of Experimental Agriculture*, 9 (6): 1 - 6.

A.O.A.C. (2011). Association of Official Analytical Chemists. Official Methods of Analysis (18th edition), Arlington, Virginia. pp. 1-XX.

Azaza, M. S., Khiari, N., Dhraief, M. N., Alonui, N., Kratem, M. M. and Elfeki, A. (2015). Growth performance, oxidative stress indices and hepatic carbohydrate metabolic enzyme activities of juvenile Nile tilapia (*Oreochromis niloticus* L) in response to dietary starch-to-protein ratios. *Aquaculture Research*, 46:14 - 27.

Bake, G. G., Atoyebi, O. A., Abdulkarim, I. A., Adam, A., Sadiku, S. O. E. (2016). Evaluation of varying inclusion levels of toasted sickle pod (*Senna obtusifolia*) seed meal in the practical diet of catfish (*Clarias gariepinus*) fingerlings in concrete tanks. *International Journal of Fisheries and Aquatic Studies,* 4: 458 - 463.

Balogun, B. I., Oniye, S. J., Auta, J., Lakpini, C. A. M. and Abeke, F. O. (2016). Growth performance and feed utilization of *Clarias gariepinus* (Teugels) fed different dietary levels of soaked *Bauhinia monandra* (Kutz) seed meal. *Journal of Food Research,* 5: 1 - 10.

Baruah, K., Sahu, N. P. and Denath, D. (2003). Dietary phytase: an ideal approach for a cost- effective and low-polluting aquafeed. *NAGA, World Fish Center Quarterly*, 27 (3 - 4):15 -19.

Bhatnagar, A., Jana, S. N., Garg, S. K., Patra, B. C., Singh, G. and Barman, U. K. (2004). Water quality management in aquaculture. In: Course manual of summer school on development of sustainable aquaculture technology in fresh and saline waters. CCS Haryana Agricultural, Hisar (India), 203 - 210 pp.

Devi, A. B. P. (2013). Water quality guidelines for the management of pond fish culture. *International Journal of Environmental Sciences,* 3: 1980 - 2009.

Dienye, H. E., Olumuji, O. K. (2014). Growth performance and haematological responses of African mud catfish *Clarias gariepinus* fed dietary levels of *Moringa oleifera* leaf meal. *Net Journal of Agricultural Science,* 2: 79 - 88.

Eyo, J. E., and Ezechie, C. V. (2004). The effects of rubber (*Hevea brasiliensis*) seed meal-based diets on diet acceptability and growth performance of *Heterobranchus bidorsalis* (male) x C*larias gariepinus* (female) hybrid. *Journal of Sustainable Tropical Agricultural Research,* 10: 20 - 25.

Fakunle, J. O., Alatise, S. P., Effiong B. N. and Tiamiyu, K. (2013). Effects of replacing soybean meal with graded levels of boiled Jatropha kernel meal in the diets of *Clarias gariepinus* fingerlings. *Bulletin of Environment, Pharmacology and Life Science*, 2 (9): 112-117.

Fountoulaki, E, Alexis, M. N., Nengas, I. and Venon, B. (2003). Effects of dietary arachidonic acid (20: 4n - 6) on growth, body composition and tissue fatty acid profile of gilthead bream (*Sparus aurata* L.) fingerlings. *Aquaculture,* 225: 309 - 323.

Gatlin, D. M. (2010). Principles of Fish Nutrition. Southern Regional Aquaculture Centre, New York. Publication no. 5003.

Iheanacho, S. C., Ogunji, J. O., Ogueji, E. O., Nwuba, L. A., Nnatuanya, I. O., Ochang, S. N., Mbah, C. E., Usman, I. B. and Haruna, M. (2017). Comparative assessment of ampicillin antibiotic and ginger (*Zingiber officinale*) effects on growth, haematology and biochemical enzymes of *Clarias gariepinus* juveniles. *Journal of Pharmacognosy and Phytochemistry,* 6 (3): 761 - 767.

Iheanacho, S. C., Ikwo, N., Igweze, N. O., Chukwuidha, C., Ogueji, E. O. and Onyeneke, R. (2018). Effect of different dietary inclusion levels of melon (*Citrullus lanatus*) seed peel on growth, haematology and histology of *Oreochromis niloticus* juveniles. *Turkish Journal of Fisheries and Aquatic Sciences,* 18: 377 – 384.

Jimoh, W. A. and Aroyehun, H. T. (2011). Evaluation of cooked and mechanically defatted sesame (*Sesamum indicum*) seed meal as a replacer for soybean meal in the diet of African catfish (*Clarias gariepinus*). *Turkish Journal of Fisheries and Aquatic Sciences,* 11: 185-190.

Nwanna, L. C., Falaye, A. E., Olarewaju, O. J. and Oludapo, B. V. (2009). Evaluation of Nile Tilapia *(Oreochromis niloticus* L) fed dietary potato peels as replacement for yellow maize. FISON Conference proceedings: 156-159.

Ochang, S. N, Fagbenro, O. A. and Adebayo, O. T. (2007). Growth performance, body composition, haematology and product quality of the African catfish (*Clarias gariepinus*) fed diets with palm oil. *Pakistan Journal of Nutrition,* 6: 452 - 459.

Olawepo, K. D., Banjo, O. T., Jimoh, W. A., Fawole, W. O., Orisasona, O. and Ojo-Daniel, A. H. (2014). Effect of cooking and roasting on nutritional and anti-nutritional factors in kenaf (*Hibiscus cannabinus* L.) seed meal. *Food Science and Quality Management USA,* 24: 1 - 5.

Orire, A. M, and Ricketts, O. A. (2013). Utilisation of melon shell as dietary energy source in the diet of Nile Tilapia (*Oreochromis niloticus*). *International Journal of Engineering and Science*, 2 (4): 5 - 11.

Oyelere, E. A., Balogun, J. K. and Abubakar, B. Y. (2016). Growth and nutrient utilization of African catfish (*Clarias gariepinus* Burchell, 1822) fed varying levels of *Albizia lebbeck* (Benth) leaf meal. *Agrosearch,* 16 (1): 15 – 24.

Santhosh, B. and Singh, N. P. (2007). Guidelines for water quality management for fish culture in Tripura, ICAR Research Complex for NEH Region, Tripura

Center, Publication no. 29.

Sogbesan, A. O. and Ugwumba, A. A. A. (2008). Nutritional evaluation of termite (*Macrotermes subhyalinus)* meal as animal protein supplements in the diets of *Heterobranchus longifilis* (Valenciennes, 1840) fingerlings. *Turkish Journal of Fisheries and Aquatic Sciences,* 8: 149 - 157.

Tiamiyu, O. L., Okomoda, T. V. and Agbese, E. V. (2015). Growth performance of *Clarias gariepinus* fingerlings fed *Citrullus lanatus* seed meal as a replacement for soybean meal. *Journal of Aquaculture Engineering and Fisheries Research,* 1: 49 - 56.