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## GROWTH RESPONSE OF *Cyprinus carpio* FINGERLINGS FED DIETS CONTAINING HYDROTHERMALLY PROCESSED *Citrullus lanatus* SEED MEAL

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### Abstract:

The effect of incorporating hydrothermally processed watermelon whole seeds in the diet of fish was investigated on growth, feed utilization and body composition of carp (*Cyprinus carpio*) fingerlings. Fish diets (35% crude protein) were formulated using watermelon hydrothermally processed for 0 (DT1), 10 (DT2), 20(DT3), 30 (DT4) and 40 minutes (DT5) boiling time. Twenty fingerlings (1.50±0.00g each) were randomly allocated in triplicate to 70 liters plastic bowls, for each treatments, aeration was provided to culture bowls throughout the 12weeks feeding trial.

Result of the study reveals that fish fed DT<sub>4</sub> (30 minutes) had the best performance in terms of mean weight gain, feed conversion ratio, feed conversion efficiency, protein efficiency ratio, apparent net protein utilization and specific growth rate (P>0.05). Hence, hydrothermal processing of watermelon seeds for 30minutes is recommended for better growth in *C. carpio*.

**Keywords:** Watermelon seed, Proximate composition, Common carp, Unconventional feeds

## Introduction

Common carp (*Cyprinus carpio*) a benthic omnivore, is a native to Asia and Eastern Europe (Taylor, 1977). Carps is the most cultured freshwater fish species all over the world, (FAO, 2012), reputed as a popular food fish and a highly cultivable species with year round breeding under tropical and subtropical conditions. Common carp also plays an important role in polyculture system in seasonal reservoirs and ponds (Chakraborty 1982). It is the only exotic carp that is known to breed naturally in lakes, it has high fecundity and hatchability (Nathaniel, 2001), and can grow to a maximum length of 1.5m and a maximum weight of over 37.5kg (Panek, 1987). Today it remains the best choice for utilizing pond resources (FAO, 2011). Carp represent the species of choice due to their high growth rate, significant tolerance to environmental stresses, easy to reproduce and unquestionable market demand (FAO 2004).

Feed is the main operating cost in fish production and therefore adequate information on the nutritional requirements is necessary in order to formulate and produce economically, balanced and complete diet geared towards satisfying the need of different fish species (Ejidike, 2004). Feed accounts for the highest proportion of operational inputs in fish culture. Hence efforts are geared toward reducing production cost through the Utilization of unconventional feed stuff in animal nutrition.

Watermelon belongs to the genus *Citrullus* and family Cucurbitaceae (Huxley 1992). The watermelon fruit, loosely considered a type of melon, possesses a smooth exterior (green and yellow) and a juicy, sweet, usually red, yellow or orange interior flesh (Jeffrey, 2005). Moreover, they are used as domestic remedy for urinary tract infection, hepatic congestion, catarrh, (Deible, 2001; Amadi et al., 2003). Water melon is rich in minerals, protein, vitamins, carbohydrate and fibre (Duke and Ayensu, 1985; Tarek and Khaled, 2011).

Watermelon seeds are one among the underutilized fruit byproducts (FAO STAT, 2009) despite it presumed high nutrient level.. This study is attempt to investigate the nutritional potential of using different hydrothermally processed watermelon (*Citrullus lanatus*) seed meal as an unconventional and a byproduct protein supplement in the diet of *Cyprinus carpio*.

## Materials and Methods

### Experimental Site

The feeding trial was carried out at the fish farm of Bauchi State Agricultural Development Programme (BSADP) Bauchi, Nigeria. Circular plastic bowls system of 70 litres capacity were used. The experiment lasted for twelve weeks. Aeration was provided using air pumps and water in bowls was siphoned after every two days to avoid fouling, water was renewed weekly and their quality parameter monitored closely to ensure that each experimental unit remain within the acceptable limits for culture of the fish ( e.i. temperature at room temperature, oxygen  $>5\text{mgL}^{-1}$ , pH between 6.5-7.5).

### Experimental Fish

The *Cyprinus carpio* (common carp) fingerlings were obtained from the Fish Farm of Bauchi state Agricultural Development Programme (BSADP) along Dass Road Bauchi. 300 Fingerlings of mean weight  $1.50 \pm 0.00\text{g}$  were acclimated for two weeks. After the period of acclimatization, twenty fingerlings were randomly distributed into each plastic bowls.

### Diet Formulation

Raw watermelon seeds (6 kg) were cleaned, sun-dried and milled, raw meal was obtained and then stored for diets formulation. Soybean used for the study were toasted for 30 minutes in an electric oven set at  $100^{\circ}\text{C}$  and milled after cooling to get soybean meal (SBM). Yellow maize used for the experiment were milled to get yellow maize meal (YMM) all were stored in air tight and moisture free container.

The experimental diets of the feeding trial were formulated using Pearson square method. Iso-nitrogenous diet of 35% crude protein were formulated with Fishmeal included at 25.72, Maize meal at 27.07, Soybeans meal at 25.72, vitamin/mineral premises at 1, salt at 0.50 while watermelon seed meal at 20.00. The five diets formulated were included with hydrothermally processed watermelon seed meal boiling for 0 minutes (DT<sub>1</sub>) i.e. raw watermelon seed meal as control, diet 2 boiled for 10minutes (DT<sub>2</sub>), diet 3 boiled for 20minutes (DT<sub>3</sub>), diet 4 boiled for 30minutes (DT<sub>4</sub>) and diet 5 boiled for 40minutes(DT<sub>5</sub>). The feed ingredients for each of the treatment were weighed, ground, mixed thoroughly and warm water was added then stirred to

form consistent dough which was passed through a 2mm die pelleting machine. The pellets produced were collected on a flat sheet of plate for easy spread and sundried to constant weight; the dried pellets were micronized and stored for the feeding trail. Analysis was carried out to determine the nutrient composition of the raw watermelon seed meals soybeans, yellow maize, as well as the experimental fish before and after the experiments.

The dietary treatments were in triplicates using completely randomized design (CRD). After 2weeks period the fish were weighed and randomly distributed in bowls, each treatment was in triplicate with 20 fingerlings of *C. carpio*. The experimental fish were fed twice daily (9.00am and 4.00pm) at 5% body weight for twelve weeks (Eyo, 1999 Ayinla, 2005 and Tiamiyu et. al., 2007).

The fingerlings were weighed every week to determine weight gain and feed quantity given was adjusted accordingly. The growth parameters determined include mean weight gain, specific growth rate, feed conversion ratio, protein efficiency ratio, and apparent net protein utilization and survival rate.

### Computation of the Growth Parameters

Calculation of the growth parameters were done following the formulae described by Osborne, *at. al.*, (1919), Brown, (1957) and Balfour, (1998).

**Mean Initial Weight:** Twenty (20) *C. carpio* fingerlings were counted and weighed, the total weight obtained was divided by 20, to obtain the mean initial weight of the fingerling.

$$MIW = N_w/N$$

Where MIW =Mean Initial Weight

N =Number of fingerlings

W = Weight of fingerling

**Mean Final Weight:** The surviving fingerlings were counted and weighed, the weigh obtained was divided by the number of the surviving fingerlings to obtain the mean final weight.

$$MFW = N_{sf}W/N_{sf}$$

Where MFW =Mean Final Weight (g)

N<sub>f</sub>=No. of surviving fish

W = Weight of the fish

**Mean Weight Gain =**

Mean Final Weight – Mean Initial Weight

**Survival Rate**

$$\text{Survival (\%)} = \frac{N_o - N_e}{N_o} \times 100$$

N<sub>o</sub> =Initial total number of fingerlings

N<sub>e</sub>=Total number of fish mortality at the end of feeding trial (12 wks)

**Specific Growth Rate (SGR)** This parameter was determined according to Brown (1957).

$$SGR = \frac{\ln W_2 - \ln W_1}{t_2 - t_1} \times 100$$

Where ln = natural logarithm

W<sub>2</sub> = final weight

W<sub>1</sub> = initial weight

T<sub>2</sub> - t<sub>1</sub> = time duration (in days)

**Feed Conversion Ratio (FCR)** According to Balfour (1998).

$$FCR = \frac{\text{Feed Intake}}{\text{Weight Gain}}$$

**Protein Efficiency Ratio (PER)** It was determined according to Osborne, *at. al.* (1919).

$$PER = \frac{\text{Weight Gain}}{\text{Protein Intake}}$$

Where protein

$$\text{Intake} = \frac{\% \text{ Protein in Diet} \times \text{Total Feed Consumed}}{100}$$

**Apparent Net Protein Utilization (ANPU)** According to Balfour (1998).

$$ANPU = \frac{\text{Protein Gained}}{\text{Protein Consumed}} \times 100$$

**Where protein gain=** Final Carcass-Initial Carcass Protein

The proximate composition of differently processed watermelon seed meal were carried out at Grand cereals Jos, according standard methods as stated by AOAC (2000).

**Data Analysis**

Data obtained from the feeding trials were subjected to analysis of variance (ANOVA) and where significant differences were observed be-

tween treatments, the means were compared using Fishers Least Significant Difference of the means (LSD). Genstat Discovery Edition 4 and Minitab 14 software were used for statistical analysis.

## Results and Discussion

The proximate composition of the experimental diets containing hydrothermally processed watermelon seed meal is presented in Table 1. The result shows that the contained approximately the same crude protein level of 35%CP. However, the reference diet coppens (DT<sub>6</sub>) differed significantly ( $P < 0.05$ ) with protein value of 52.24%. The ether extract of the formulated diets ranges from 11.24  $\pm$  0.07% to 13.74  $\pm$  0.13%. DT<sub>2</sub> (10mins) had the highest ether extract of 13.74  $\pm$  0.13% and ash content of 11.81  $\pm$  0.07% after DT<sub>6</sub> (reference diet). Conversely, DT<sub>1</sub> (control) contained the least values of 11.24  $\pm$  0.07% and 10.25  $\pm$  0.07% respectively. Moisture content of the diets differed significantly ( $P < 0.05$ ) with highest value in DT<sub>3</sub> (11.37  $\pm$  0.10%) while DT<sub>1</sub> (9.98  $\pm$  0.11%) had the lowest value. The highest value of crude fibre was found in DT<sub>4</sub> (9.95  $\pm$  0.14%), lowest in DT<sub>1</sub> (8.16  $\pm$  0.10) and DT<sub>6</sub> (2.01  $\pm$  0.01%) being the least. Nitrogen free extract (NFE) ranged from DT<sub>2</sub> (18.26  $\pm$  0.15%) to DT<sub>1</sub> (25.20  $\pm$  0.12%) among experimental diets.

The growth parameters for common carp fingerlings in the treatments (T<sub>1</sub> – T<sub>5</sub>) in terms of mean initial weight (MIW), mean final weight (MFW), mean weight gain (MWG), feed conversion ratio, (FCR), feed conversion efficiency (FCE), protein efficiency ratio (PER), apparent net protein utilization (ANPU), specific growth rate (SGR) and survival rate (SR) are shown in Table 2. The result obtained from the feeding trial varied significantly ( $P < 0.05$ ) among the treatments. The mean final weight (MFW) and mean weight gain (MWG) were the highest in DT<sub>6</sub> (14.43  $\pm$  0.24g and 12.93  $\pm$  0.24g) and DT<sub>4</sub> (12.58  $\pm$  0.05g and 11.08  $\pm$  0.5g) respectively. DT<sub>5</sub> had least values of MFW 9.78  $\pm$  0.04g and MWG 8.28  $\pm$  0.04g. The feed conversion ratio (FCR) and feed conversion efficiency (FCE) followed similar pattern as observed in MFW and MWG. The best FCR (1.77  $\pm$  0.1) and FCE (56.40  $\pm$  0.25) were obtained in fish fed DT<sub>4</sub> after the reference (DT<sub>6</sub>) values of 1.74  $\pm$  0.02 and 57.57  $\pm$  0.75 respectively. The worst values of FCR 2.03  $\pm$  0.10 and FCE 49.35  $\pm$  0.30 were recorded with fish fed DT<sub>5</sub>. The protein efficiency ratio (PER), apparent net protein utilization (ANPU) and specific growth rate

(SGR) were highest in fish feed DT<sub>4</sub> with the following values 1.62  $\pm$  0.01%, 22.98  $\pm$  0.49% and 2.53  $\pm$  0.00% respectively. The least values were observed in fish fed DT<sub>5</sub> with values 1.39  $\pm$  0.01%, 19.03  $\pm$  0.32 and 2.23  $\pm$  0.00 respectively. All the values of these parameters differed significantly ( $P < 0.05$ ). The overall survival rate (SR) ranged from 95.00  $\pm$  2.89% to 100.00  $\pm$  0.00%. The fish fed DT<sub>2</sub> and DT<sub>5</sub> had the highest (SR) 100.00  $\pm$  0.00%. While fish fed DT<sub>3</sub> had the lowest value of 95.00  $\pm$  2.89%. This showed that the fish fed the experimental diet had good survival rate (SR) as there was no significant difference ( $p > 0.05$ ) in the percentage survival rate.

Figure 1 shows the weekly growth trend of common carp fingerlings fed at different period of hydrothermally processed watermelon seed meal diets. It was found that the common carp fingerling gained weight in all the weeks in response to the dietary treatments. Weight gain increased tremendously from week 4 to the end of the feeding trial (Week 12). Fish fed DT<sub>4</sub> picked up from the fifth week and became the best after DT<sub>6</sub> (reference diet). DT<sub>5</sub> progressed hand in hand with DT<sub>1</sub>, DT<sub>2</sub> and DT<sub>3</sub> but started declining from the 8<sup>th</sup> week and ended up with the least growth at the termination of the feeding trial.

The effect of the diets containing varying hydrothermally processed watermelon seed meal on the body composition of the common carp fingerlings at the end of the feeding trial (Table 3) reveals that crude protein, ether extract and ash increased, whereas moisture content, crude fibre and nitrogen free extract decreased at the end of the experiment when compared with their initial composition of the experimental fish ( $P < 0.05$ ).

Fish fed DT<sub>3</sub> (20mins) had the highest carcass moisture content of 79.82  $\pm$  0.54% while the lowest value of 78.81  $\pm$  0.42% was recorded for DT<sub>2</sub> (10mins) and differed significantly ( $P < 0.05$ ) among all the treatments. The crude protein in carcass of all the treatments differed significantly ( $P < 0.05$ ). The highest crude protein value of 13.92  $\pm$  0.19% was found in the carcass of fish fed DT<sub>4</sub> (30mins) followed by DT<sub>2</sub> (10mins) with the value of 13.70  $\pm$  0.10% whereas fish fed DT<sub>1</sub> (0min) had the least value of 12.38  $\pm$  0.09%, however, the protein content has improved when compared with the initial protein. There was no significant difference ( $P > 0.05$ ) in the carcass of fish fed DT<sub>1</sub>, DT<sub>2</sub>, DT<sub>3</sub>, DT<sub>4</sub> and DT<sub>5</sub>, however, fish fed DT<sub>6</sub> (reference diet) and initial carcass differed significantly ( $P < 0.05$ ) in terms of ether

extract. The highest ether extract was recorded in carcass of fish fed DT<sub>6</sub> (reference diet) with the value of  $4.02 \pm 0.06\%$  while the lowest value of  $1.87 \pm 0.06$  was recorded in the initial carcass. There was significant difference ( $p < 0.05$ ) in the crude fibre in the carcass of fish fed the experimental diets. The crude fibre varied from  $0.07 \pm 0.01\%$  to  $0.58 \pm 0.02\%$ . The highest crude fibre was observed for fish fed DT<sub>1</sub> while the least was observed in fish fed DT<sub>5</sub>. The initial carcass value was  $0.10 \pm 0.00\%$ . The highest ash content was recorded for fish fed DT<sub>1</sub> with value of  $3.35 \pm 0.05\%$  while the least ash content value of  $2.85 \pm 0.07\%$  was found in fish fed DT<sub>4</sub>. The nitrogen free extract (NFE) differed significantly ( $p < 0.05$ ), the least value of  $1.12 \pm 0.03\%$  was observed in fish fed DT<sub>5</sub> (40mins) whereas the highest value  $2.05 \pm 0.05\%$  was recorded in DT<sub>1</sub> (0min). However, the value of  $3.93 \pm 0.02\%$  of nitrogen free extract of the initial carcass was significantly higher than that found in all the treatments.

The proximate composition of the experimental diets of this study revealed that all the diets met the targeted crude protein requirement for common carp. According to Craig and Helfrich (2002) crude protein level in aquaculture feeds generally average 18-20% for marine shrimps 30-40% for catfish, 20-30% for tilapia and 38-42% for hybrid striped bass but protein requirements are usually lower for herbivorous and omnivorous fish species (e.g carp) than carnivorous fish. The protein requirement of carp varies between 25-35%, depending upon age reported by Hossain *et al.* (1997). However, providing excessive levels of dietary protein is both economically and environmentally wasteful because protein is the most expensive dietary component and excess protein increases the excretion of nitrogenous waste (Hossain *et al.*, 1997).

Crude fibre in each of the diets exceeded the recommended level of 4% as suggested by Cowey (2007) in the present study. According to Gatlin (2010) the quantity of crude fibre in fish diet is usually less than 7% of the fish diet to limit the amount of undigested materials entering the culture medium. A high fibre and ash content reduces the digestibility of other ingredients in the diets resulting in poor growth of the fish (Abowei *et al.*, 2011). Despite the higher levels of the crude fibre in the diets than what were reported by the authors mentioned, the growth of the experimental fish was not adversely affected. This might be due to the heat treatment given to the watermelon seed before inclusion into the

diets. This is in agreement with the report of Bell, *et al.*, (1980) that cooking renders feedstuff more palatable, digestible and destroy bacteria, at the same time the fibre shrinks and become softer and looser. In addition Udensi *et al.*, (2007), reported that boiling cowpea seeds in water for 15 to 45 min reduced antinutritional factors. Similarly, Wang *et al.*, (2009) reported that boiling and soaking resulted in reductions of antinutritional factors in flours made from different lentil varieties. Khattab *et al.*, (2009) concluded that there can be a complete removal of trypsin inhibitor activity for pea seeds through roasting or boiling.

The result of the study revealed that the percentage lipid and the carbohydrate that is nitrogen free extract (NFE) differed significantly, however the values fall within the recommended range as stated by Craig and Helfrich (2002) that the lipid content of fish diet is between 10-25%, as well up to about 20% of dietary carbohydrate can be used by fish. Lipid content of diet is important as a sources of dietary energy, but is also fundamental for supplying adequate amount of essential fatty acid (Sargent, *et al.*, 2002). It was also observed in the result that the moisture contents of the experimental diets were higher than 10%, except in DT<sub>1</sub> ( $9.98 \pm 0.11\%$ ) this is contrary to the recommendation of Craig and Helfrich (2002) that the moisture content of fish feed must not exceed 10% dry diet. Andras *et al.*, (2011) reported that moisture content is very critical for fish feed to avoid mould; higher moisture content in diet promote mould and other microbial agent, mould carries risk of contamination and disease factors and may also cause toxicological problems.

In the present study it was observed that the mean weight gain (MWG) of the experimental fish increased with increasing hydrothermal processing duration of the watermelon seed in all the treatment except in DT<sub>5</sub>, which might be due longer boiling period. This agrees with the report of Kaankula (1998) who reported that the nutritive value of legume seeds is improved when subjected to heating.

**Table 1.** Proximate Composition of hydrothermally processed watermelon seed meal diets

Treatment	Moisture %	Crude Protein %	Ether Extract %	Crude Fibre %	Ash %	NFE %
Diet 1	9.98±0.11 <sup>c</sup>	35.16±0.08 <sup>b</sup>	11.24±0.07 <sup>c</sup>	8.16±0.10 <sup>d</sup>	10.25±0.07 <sup>c</sup>	25.20±0.12 <sup>a</sup>
Diet 2	11.02±0.28 <sup>ab</sup>	35.08±0.10 <sup>b</sup>	13.74±0.13 <sup>b</sup>	9.09±0.05 <sup>c</sup>	11.81±0.07 <sup>b</sup>	19.26±0.15 <sup>c</sup>
Diet 3	11.37±0.10 <sup>a</sup>	35.29±0.08 <sup>b</sup>	11.84±0.10 <sup>d</sup>	9.32±0.09 <sup>bc</sup>	11.50±0.10 <sup>c</sup>	20.68±0.24 <sup>b</sup>
Diet 4	10.72±0.10 <sup>b</sup>	34.89±0.08 <sup>b</sup>	12.14±0.07 <sup>cd</sup>	9.95±0.14 <sup>a</sup>	11.39±0.08 <sup>c</sup>	20.93±0.12 <sup>b</sup>
Diet 5	11.23±0.12 <sup>a</sup>	35.41±0.08 <sup>b</sup>	12.34±0.11 <sup>c</sup>	9.38±0.04 <sup>b</sup>	10.63±0.09 <sup>d</sup>	21.01±0.11 <sup>b</sup>
Diet 6	10.97±0.13 <sup>ab</sup>	52.24±0.20 <sup>a</sup>	16.55±0.13 <sup>a</sup>	2.01±0.01 <sup>e</sup>	14.80±0.10 <sup>a</sup>	3.43±0.12 <sup>d</sup>

Means in the same column followed by different superscripts differed significantly (P<0.05)

Diet 1 (DT<sub>1</sub>): 0% Minutes

Diet 2 (DT<sub>2</sub>): 10% Minutes

Diet 3 (DT<sub>3</sub>): 20% Minutes

Diet 4 (DT<sub>4</sub>): 30% Minutes

Diet 5 (DT<sub>5</sub>): 40% Minutes

Diet 6 (DT<sub>6</sub>): Coppens as reference diet

**Table 2.** Growth and Nutrient Utilization of the *C. carpio* Fingerlings Fed hydrothermally processed watermelon seed meal diets

Treatment	MIW	MFW	MWG	FCR	FCE	PER	ANPU	SGR	Survival
Diet 1	1.50±0.00	10.99±0.05 <sup>d</sup>	9.49±0.05 <sup>d</sup>	1.80±0.00 <sup>b</sup>	55.60±0.15 <sup>b</sup>	1.58±0.01 <sup>b</sup>	19.73±0.10 <sup>cd</sup>	2.37±0.01 <sup>d</sup>	96.67±3.33 <sup>ns</sup>
Diet 2	1.50±0.00	11.56±0.07 <sup>c</sup>	10.06±0.07 <sup>c</sup>	1.80±0.02 <sup>b</sup>	55.52±0.58 <sup>b</sup>	1.54±0.02 <sup>c</sup>	21.53±0.18 <sup>b</sup>	2.43±0.01 <sup>c</sup>	100.00±0.00 <sup>ns</sup>
Diet 3	1.50±0.00	11.68±0.03 <sup>c</sup>	10.18±0.03 <sup>c</sup>	1.78±0.01 <sup>b</sup>	56.11±0.18 <sup>b</sup>	1.59±0.00 <sup>a</sup>	20.31±0.15 <sup>c</sup>	2.44±0.00 <sup>c</sup>	95.00±2.89 <sup>ns</sup>
Diet 4	1.50±0.00	12.58±0.05 <sup>b</sup>	11.08±0.05 <sup>b</sup>	1.77±0.01 <sup>bc</sup>	56.40±0.25 <sup>ab</sup>	1.62±0.01 <sup>a</sup>	22.98±0.49 <sup>a</sup>	2.53±0.00 <sup>b</sup>	96.67±3.33 <sup>ns</sup>
Diet 5	1.50±0.00	9.78±0.04 <sup>c</sup>	8.28±0.04 <sup>c</sup>	2.03±0.01 <sup>a</sup>	49.35±0.30 <sup>c</sup>	1.39±0.01 <sup>d</sup>	19.03±0.32 <sup>d</sup>	2.23±0.00 <sup>e</sup>	100.00±0.00 <sup>ns</sup>
Diet 6	1.50±0.00	14.43±0.24 <sup>a</sup>	12.93±0.24 <sup>a</sup>	1.74±0.02 <sup>c</sup>	57.57±0.75 <sup>a</sup>	1.10±0.02 <sup>e</sup>	16.42±0.37 <sup>e</sup>	2.69±0.02 <sup>a</sup>	98.33±1.67 <sup>ns</sup>

Means in the same column followed by different superscripts differed significantly (P<0.05)

MIW: Mean Initial Weight

MFW: Mean Final Weight

MWG: Mean Weight Gain

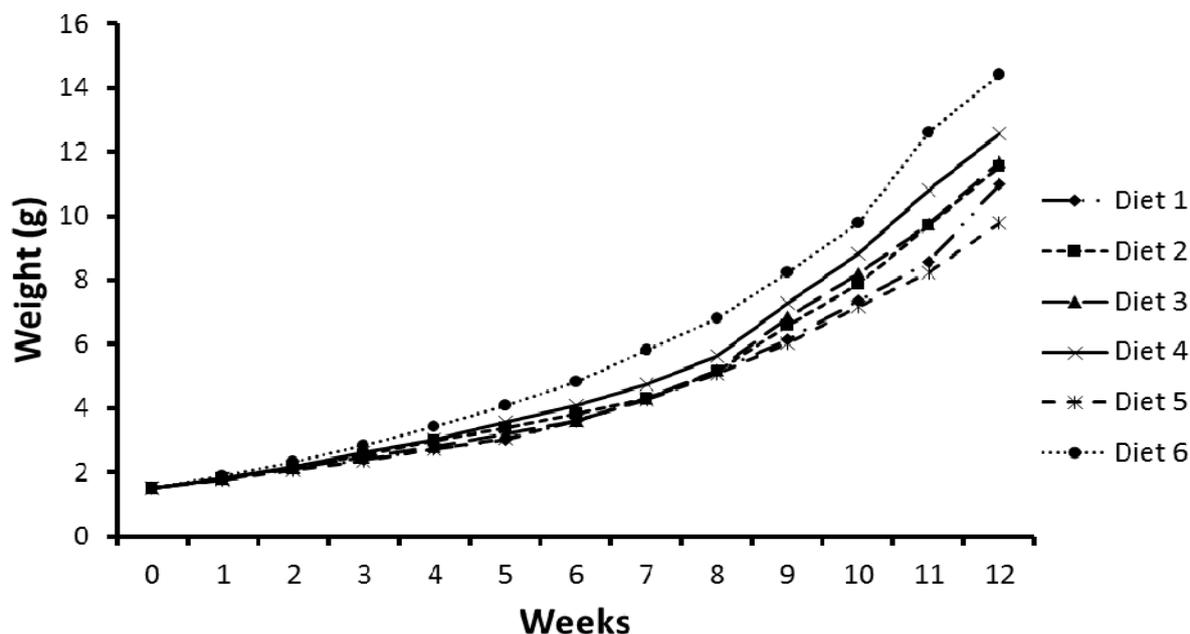
FCR: Feed Conversion Ratio

FCE: Feed Conversion Efficiency

PER: Protein Efficiency Ratio

ANPU: Apparent Net Protein Utilization

SGR: Specific Growth Rate



**Figure 1.** Weekly Weight Gain of *C. carpio* Fed different period of hydrothermally processed watermelon seed meal diets

**Table 3.** Carcass proximate Composition of *C. carpio* Fingerlings Fed hydrothermally processed watermelon seed meal diets (%).

Treatment	Moisture	Crude Protein	Ether		Ash	NFE
			Extract	Crude Fibre		
Initial	80.20±0.06 <sup>a</sup>	11.75±0.06 <sup>c</sup>	1.87±0.06 <sup>c</sup>	0.10±0.00 <sup>b</sup>	2.15±0.01 <sup>e</sup>	3.93±0.02 <sup>a</sup>
Diet 1	78.94±0.60 <sup>bc</sup>	12.38±0.09 <sup>d</sup>	2.70±0.08 <sup>b</sup>	0.58±0.02 <sup>a</sup>	3.35±0.05 <sup>a</sup>	2.05±0.05 <sup>b</sup>
Diet 2	78.81±0.42 <sup>b</sup>	13.70±0.10 <sup>bc</sup>	2.68±0.09 <sup>b</sup>	0.08±0.01 <sup>bc</sup>	2.93±0.06 <sup>c</sup>	1.80±0.01 <sup>c</sup>
Diet 3	79.82±0.54 <sup>ab</sup>	12.64±0.08 <sup>d</sup>	2.68±0.08 <sup>b</sup>	0.09±0.01 <sup>bc</sup>	2.97±0.08 <sup>bc</sup>	1.80±0.01 <sup>c</sup>
Diet 4	78.90±0.06 <sup>bc</sup>	13.92±0.19 <sup>b</sup>	2.62±0.09 <sup>b</sup>	0.09±0.01 <sup>bc</sup>	2.85±0.07 <sup>c</sup>	1.62±0.01 <sup>d</sup>
Diet 5	79.55±0.23 <sup>abc</sup>	13.36±0.11 <sup>c</sup>	2.70±0.08 <sup>b</sup>	0.07±0.01 <sup>c</sup>	3.20±0.15 <sup>ab</sup>	1.12±0.03 <sup>e</sup>
Diet 6	78.58±0.22 <sup>c</sup>	14.57±0.16 <sup>a</sup>	4.02±0.06 <sup>a</sup>	0.04±0.01 <sup>d</sup>	2.56±0.06 <sup>d</sup>	0.23±0.01 <sup>f</sup>

Means in the same column followed by different superscripts differed significantly ( $P < 0.05$ )

FCR, FCE, PER, ANPU and SGR followed the same trend with MWG which increased with increasing period of heat treatment of the seeds; however, the increase in heat treatment duration beyond 30 minutes was not able to bring further improvement in the growth parameters of the fish, thus a decline in the performance of the experimental fish fed DT<sub>5</sub>. This could be due to overheating of the seed which might have reduced or destroyed the amino acids and the micro nutrients content of the watermelon seeds. Tamminga *et al.*, (2004) reported that if boiling of protein supplement fails to improve or results in

decreased animal's performance the reasons might be that boiling condition may not be optimal the feed ingredient being either under boiled or over boiled. Ullah,(1982) reported that heat treatment will affect the nutritional value of legumes through destruction or inactivation of present factors as well as some impairment in the protein value, because over heating may result in damaging the protein quality by lowering digestibility (denaturation) and causing the loss of sulphur amino acids. According to the report of Buyukcapar and Kamalak, (2007) several factors depress growth, including reduced nutrients and

energy digestibility and efficiency of energy utilization.

The result shows an excellent survival rate in all the treatments, which ranged from 95.00  $\pm$  2.89 to 100.00  $\pm$  0.00% indicating that *C. carp* has high survival rate. Abba (2007) pointed out that a survival rate of 98.30 to 100% can be achieved with *C. carp*. Similarly, Manjappa et al., (2011) reported survival rate of 96.26 to 98.14%.

Furthermore, EL Adawy and Taha (2001) reported that watermelon seeds are rich in growth and health promoting nutrients which might be the reason for good nutrient utilization and survival rate attained in this feeding trial, in addition the present study revealed that the proximate analysis of the carcass fish fed the experimental diets were affected in terms of crude protein and fat content by the hydrothermally processed watermelon seed meal. Both the crude protein and lipid content of the initial fish carcass were lower compared with carcass of fish fed the trial diets at the end of experiment. This is an indication of protein addition and true growth involving an increase in the structural tissues such as muscles and various organisms (Fafioye et al., 2005). Reinitz and Hitzel (1980) reported that the type of feed ingested and their nutritional quality is known to be one of the main factors affecting fish carcass composition.

Despite the observed differences in the initial compared to final experimental fish fed different hydrothermally processed diet did not show difference in fat content of carcass. This could mean that high lipid of the diets did not affect fat content of the fish carcass. Thus conforming to the report of Izquierdo et al., (2003), that dietary lipid source do not affect lipids deposition in either liver or muscle of Seabass or Seabream. Also according to El- Marakby (2006) no change in total lipid and ash content was observed in fish fed different oil sources. This is contrary to the report of Chou and Shiau (1996); Ahmadi (2004) and Pei et al. (2004), who reported that increase of dietary levels herein is usually associated with an increase in whole-body lipid content, while crude protein decreased.

It was also observed in the result, the fish fed with higher lipid diets (DT<sub>2</sub> and DT<sub>3</sub>) contained higher ash content in their carcasses. This agrees with the report of Abbas (2007), that dietary lipid affect ash content slightly.

## Conclusion

It is established that feeding Carp hydrothermally processed watermelon seed meal at 30minutes boiling performed better than all the diets. However, all the diets show excellent survival rate ranging from 96.67 $\pm$ 3.33% to 100 $\pm$ 0.00, which is indicative that the experimental diets were not harmful to the fish and can support their growth. Hydrothermal processing of watermelon seeds for 30minutes is therefore recommended for better growth and cost effective rearing of Carp.

## References

- Abbas, E.F. (2007): Effect of dietary oil sources and levels on growth, feed utilization and whole-body chemical composition of common carp, *Cyprinus carpio* L. Fingerlings. *Journal of Fisheries and Aquaculture Science*, 2(2): 140-148.
- Abowei J.F.N., Ekubo A.T. (2011): A Review of Conventional and Unconventional Feed in Fish Nutrition. *British Journal of Pharmacology and Toxicology*, 40: 179-191.
- Amadi, E.N., Barimala, I.S., Blankson, C.D., Achienuwhu, S.C. (2003): Melon seeds (*Citrullus vulgaris*) as a possible substrate for production of temper. *Journal of Plant Foods for Human Nutrition*, 53: 3-11.
- Amadi Ali, S. (2004): Evaluation of different sources of lipid and lipid levels in the diet of pearlspot *Etroplus suratensis* (Teleostei: Perciformes). *India Journal of Marine Science*, 33: 281-286.
- Andras W., Bueno, P.B., Altan, O., Jeney, Z., Reantoso, M., Xinhua, Z., Anrooy, R.V. (2011): Better Management practices for Carp Production in Central and East Europe, the Caucasus and Central Asia. *FAO Fisheries and Aquaculture Technical Paper, Ankara*. 566: 62-63.
- AOAC (Association of Official Analytical Chemists), (2000): Official methods of analysis AOAC international methods 934.01, 988.05, 920.39 and 942.05. Arlington, VA, USA: AOAC International.
- Ayinla, O.A. (2005): Final Technical Report on Study and Analysis of Feed and nutrients (including fertilizer) for sustainable agriculture in Nigeria for food and Agriculture Organization.

- Balfour, H.E. (1998): Nutrition of pond Fish and Aquaculture Research station, Dor Isreal. Combridge University press New York. *New Rockhelle Melourne Sydney* pp 162, 179 and 180.
- Bell, G.H., Erushe, D., Peterson, C.R. (1980): Textbook Physiology, 10<sup>th</sup> edition.
- Brown, M.E. (1957): Experimental studies on growth. *The Physiology of Fishes*, 1: 360-400.
- Buyukcapar, H.M., Kamalak, A. (2007): partial replacement of fish and soyabean meal protein in mirror carp (*Cyprinus carpio*) diets by protein in hazelnut meal. *South African Journal of Animal Science*, 37(1): 35-44.
- Chakrabarty, R.D. (1982): Polyculture Principles and Practices. *Journal of Inland Fisheries*, 1: 30-40.
- Chou, C.Y., Shiau, S.Y. (1996): Optimal dietary lipid level for growth juvenile hybrid Tilapia, *Oreochromis niloticus* × *Oreochromis aureus*. *Aquaculture*, 143: 185-195.
- Collins, J.K., Wu, G., Perkins-Veazie, P., Spears, K., Claypool, P.L., Baker, R.A., Clevidence, B.A. (2007): Watermelon consumption increases plasma arginine concentrations in adults. *Nutrition*, 23(3): 261-266.
- Cowey, C.B. (2007) Nutrient Requirements of Fish. Collin B. Cowey C. Young Cho Proceeding of the Nutrition Society 52:0303, 417 – 426 Cambridge University Press.
- Craig, S., Helfrich, I.A. (2002): Understanding fish nutrition, feeds and feeding. Department of Fisheries and Wild Life Science, Virginia Tech., 420 (256).
- Deible, K.E., Swanson, K.M.J. (2001): Cereals and cereal products, In: compendium of methods for the microbiological examination of foods. Downes, F.P.O and Ito, K. (eds) Academic Press. New York.
- Duke, J.A., Ayensu, E.S. (1985): Medicinal plants of China. Reference publication vol. 1 p. 131.
- Ejidike, B.N. (2004): Growth performance and Nutrient utilization of African Giant catfish hatchlings fed different protein diets pp 5-9.
- El-Adawy, T.A., Taha, K.M. (2001): Characteristics and composition of different oil seeds and flours. *Food Chemistry*, 74: 47-54.
- EL-Marakby, M. (2006): Effect of dietary sources and levels of lipids on growth performance and feed utilization of fry Nile tilapia, *Oreochromis niloticus* (L) (Teleostei: perciformes). *Journal of Fisheries and Aquatic Science*, 1: 117-125.
- Eyo, A.A. (1999): The effect of different methods of soybean processing on the growth and food utilization of African mud fish clarias anguilarus fingerlings, Nigeria. *Journal of Biotechnology*, 10(1): 9-10.
- Fafioye, O.O., Fagade, S.O., Adebisi, A.A., Jenyo, O., Omoyinmi, G.A.K. (2005): Effects of dietary soybeans (*Glycine max* (L.) Merr.) on growth and body composition of African catfish (*Clarias gariepinus*, Burchell) Fingerlings. *Turkish Journal of Fisheries and Aquatic Sciences*, 5(1): 11-15.
- FAO (2012): The state of world fisheries and Aquaculture. <http://www.fao.org/docrep/016/i2727e/i2727e.pdf>
- FAO (2011): Better Management Practices for Carp Production in Central Asia and Eastern Europe, the Caucasus and Central Asia. *FAO Fisheries and Aquaculture Technical Paper* 556.
- FAOSTAT (2009): (Food and Agriculture Organization of The United Nations), available online at <http://faostat.fao.org/site/567/default.aspx#ancor>
- Gatlin, D.M. (2010): Principles of fish nutrition. Southern regional aquaculture centre, New York. Publication no. 5003.
- Gopalan, C., Sastri, B.V.R., Balasubramanian, S.C., Rao, N.B., Deosthale, Y.G., Pant, K.C. (1989): Nutritive value of Indian foods. Hyderabad, India: National Institute of Nutrition. Indian Council of Medical Research.
- Hossain, M.A., Naher, N., Kamal, M. (1997): Nutrient digestibility coefficients of some plant and animal proteins for rohu (*Labeo rohita*). *Aquaculture*, 151: 37-45.
- Huxley, A. (1992): The New RHS Dictionary of Gardening. Macmillan Press. Long Island New York p. 5-8.
- Izquierdo, M.S., Obach, A., Arantzamedi, L., Mentorol, D., Robaina, L., Rosenwind, G. (2003): Dietary Lipid Sources for Seabream

- and Seabass: Growth Performance, Tissue Composition and Flesh Quality. *Agriculture Nutrition*, 9: 397-407.
- Jeffery, C. (2005): Appendix: an outline classification of the cucurbitaceae. Biology and utilization of the cucurbitaceae. Ithaca, New York Cornell University p. 449-463.
- Kaankula, F.G. (1998): Effect of Cooking time on the level of anti-nutritional factors and nutritive value of full fat soyabean for pigs. Ph.D Thesis, Department of Animal Sci. Ahmadu Bello University, Zaria, Nigeria.
- Manjappa, K., Keshavanath, P., Gangadhara, B. (2011): Influence of Sardine oil supplemented fish meal free diets on common carp (*Cyprinus carpio*) Growth, Carcass composition and digestive enzyme activity. *Journal of Fisheries and Aquaculture Science*, 6: 1-10.
- Nathaniel, S., Edirisinghe, U. (2001): Abundance and aspects of the reproductive biology of common carp (*Cyprinus carpio*) in an upland reservoir in Srilanka. *Asian Fisheries Science* 14: 343-351.
- Osborne, T.B., Mendel, L.B., Ferry, E.L. (1919): A method for expressing numerically the growth promoting value of proteins. *Journal of Biological Chemistry*, 37: 223-224.
- Panek F.M. (1987): Biology and Ecology of carp page 1-16 in cooper, E.L. (editor) *Carp in North America*.
- Pei, Z., Xie, S., Lei, W., Zhu, X., Yang, Y. (2004): Comparative study on the effect of dietary lipid level on growth and feed utilization for Gibel carp (*Carassius auratus gibelio*) and Chanis longsnout catfish (*Leiocassis longirostris* Gunther). *Aquaculture Nutrition*, 10: 209-216.
- Reinitz, G., Hitzel, F. (1980): Formulation of practical diets for rainbow trout based on desired performance and body composition. *Aquaculture*, 19: 243-252.
- Sargent, R.J., Tocher, D.R., Bell, J.G. (2002): The lipids. In: *Fish Nutrition* (Ed. J. E. Halver and R. W. Hardy) 3rd ed. pp. 181-257. Academic Press, San Diego, CA, USA.
- Steven, C. (2001): *Understanding Fish Nutrition, Feeds and Feeding* 420-456. Halver and R. W. Hardy) 3rd ed. pp. 181-257. Academic Press, San Diego, CA, USA.
- Tarek, A.E., Khaled, M.T. (2001): Characteristic and composition of watermelon, pumpkin and paprika seed oils and flurs. *Journal Agricultural Food Chemistry*, 49(3): 1253-1259.
- Taylor, J., Mahon, R. (1977): Hybridisation of *Cyprinus carpio* and *Carassius auratus*, the first two exotic species in the lower Laurentian Great lakes. *Environmental Biology Fishes Give*, 1: 205-208.
- Tiamiyu, L.O., Solomon, G.S., Sham, A.R. (2007): Growth performance of clarias gariepinus fingerlings fed cooked Breadfruit (*Artocarpus altilis*) seed meals as replacement for maize in outdoor pond. *Journal of Aquaculture Science*, 5: 191-193.
- Ullah, M. (1982): Processing Effect on Protein Quality of Different Legumes Seeds. *Pakistan Journal of Agricultural Resources*, 3(4): 252-258.
- Vandermark, T. (2011): The Health Benefits of Watermelon Seeds. Retrieved Dec. 09, 2011 from <http://www.livestrong.com/article/24243-healthbenefits-watermelon-seeds/>