Journal of Applied Life Sciences International

18(2): 1-13, 2018; Article no.JALSI.41643
ISSN: 2394-1103

Prospects of an Alternative Fish (*Clarias gariepinus*) Growth Booster, Based on Watermelon (*Citrillus lanatus*)

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Authors' contributions

This work was carried out in collaboration between all authors. Author GMS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JNO and GNI supervised and managed the analyses of the study. Authors ECN and SGO managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JALSI/2018/41643
Editor(s):
(1) Malakeh. Z. Malak, Community Health Nursing, Al-Zaytoonah University of Jordan, Jordan.
Reviewers:
(1) Folasade Majolagbe, Ekiti State University, Nigeria.
(2) Magdy Mohamed Aly Mohamed Gaber, National Institute of Oceanography and Fisheries, Egypt.
(3) Jesiel Mamedes Silva, Federal University of Mato Grosso do Sul, Brazil.
Complete Peer review History: http://www.sciencedomain.org/review-history/25978

Original Research Article

Received 24th April 2018
Accepted 21st July 2018
Published 23rd August 2018

ABSTRACT

Aims: The aim of this experiment was to evaluate the potentials of newly formulated watermelon syrup booster compared to a commercial syrup booster on growth performance, nutrient utilization and survival of *Clarias gariepinus* fingerlings.
Study Design: This study employs laboratory experimental design, statistical analysis and interpretation of data.
Place and Duration of Study: Newly formulated watermelon syrup booster was obtained from a private fish firm (ISitor Agromed), commercial syrup booster (LEE GROW) and fish feed (SKRETTING) were purchased in a commercial feed store at Rumuokoro in Port Harcourt. *Clarias gariepinus* fingerlings used in this study were obtained from a private fish farm (Sokari Integrated Farms and Services) in Port Harcourt and conveyed in a 10- liter rectangular plastic aquarium to the departmental laboratory of Animal and Environmental Biology, Rivers State University. The duration of study lasted for eight weeks (56 days) from November 1st to December 26th, 2017.

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Methodology: One hundred and eighty fingerlings of *Clarias gariepinus* were evenly allocated to nine rectangular aquaria, the fish were acclimated for one week after which initial weights and lengths were measured prior to commencement with treatment diets. The basal diet (commercial feed) were coated with the boosters at 2 ml kg^{-1}, air dried for twenty minutes according to commercial recommendation and fed to the fish for eight weeks at 10% body weight.
Results: Fish fed with both booster diets showed significantly improved growth performance and feed utilization compared to fish fed with only basal diet (control). The best growth was observed in the group fed with watermelon syrup booster diet with initial weights of 1.77 ± 0.17 g to final weight 38.23 ± 4.26 g and initial length of 4.9 ± 0.08 cm to final length of 16.63 ± 0.95 cm compared to the commercial syrup booster with initial weight 1.84 ± 0.51 g to final weight of 31.27 ± 13.43 g and initial length of 4.73 ± 0.26 cm to final length 16.16 ± 1.64 cm. The variables of PER 20.32 ± 0.08, FCE 9.53 ± 0.03 and Feed Intake 3.82 ± 0.42 were higher in group fed watermelon syrup booster diet compared to the commercial syrup booster diet and basal diet only (control). The condition factor, K, in group fed watermelon syrup booster diet (0.83 ± 0.07) and commercial syrup booster diet (0.70 ± 0.13) were not significantly different (P=0.05). Percentage survival was also higher in group fed watermelon syrup booster diet (56.66 ± 7.63) compare to commercial syrup booster diet (53.33 ± 7.63) with the least survival at commercial diet only (51.66 ± 2.88), however showing no significant difference at P=0.05.
Conclusion: This study established watermelon syrup booster as an alternative growth enhancer for *Clarias gariepinus.*

Keywords: Watermelon syrup booster diet (WBCF); Commercial syrup booster diet (CBCF); Commercial feed only (CF); Feed Conversion Efficiency (FCE); Protein Efficiency Ratio (PER); Daily Growth Rate (DGR); Relative Weight Gain (RWG); Clarias gariepinus.

1. INTRODUCTION

Clarias gariepinus also known as African catfish, is of high aquacultural importance in Nigeria [1,2]. It is widely used due its fast growth, ability to withstand low oxygen and pH in aquaculture systems and grow on wide range of low cost artificial feeds [3].

The use of chemical growth hormones and antibiotics by most aquaculturists in Nigeria is common to yield fast production which can be harmful to human health [4]. World Health Organization (WHO) encourages the use of medicinal herbs and plants as a measure to embrace nature which is safer. Wild fishing on industrial scale and artisanal level is not sufficient to meet human fish demand as World population increases on daily bases [5]. Pollution due to anthropogenic activities is greatly affecting the fishing industries as recent studies by [6] reveal traces (microns) of plastic and beads in the digestive tract and tissues of some marine food fish. Oil spill from pipeline vandalisms and artisanal refinery in the Niger Delta regions of Nigeria has also been a major source of pollution affecting wild fishing. Hence giving aquaculture an edge to thrive, though this is dependent on the availability of good quality and low cost material (ingredients) for feed formulations. Fish farmers should be more concerned to produce food fish with materials that are health friendly and also carry out safe aquaculture practices as such, the need to look inward for organic materials from plant such as watermelon.

Watermelon (*Citrillus lanatus* Thunb) is a tender, warm season vegetable which belongs to the curcubitaceae family [7]. It is cultivated almost all year round in Nigeria, however the largest production of this crop comes from the North [8], where condition is more favorable for its growth and is further distributed to other parts of the country, generating a lot of waste after harvest, on landing sites as perishables and at sales points as seeds and rinds are wasted by consumers. Records have it that watermelon (*Citrillus lanatus*) contains proteins, carbohydrates, vitamins, minerals and fats [9,10]. Nutrients from watermelon waste can be used to formulate an alternative cost effective growth booster to facilitate the production of catfish such as *Clarias* and *Heterobranchus* species rather than depending on foreign expensive growth boosters and feed additives. Therefore, this study is geared towards the prospects of Watermelon product as an alternative fish growth booster.

2. MATERIALS AND METHODS

The materials used in this study are newly formulated watermelon syrup booster, commercial syrup booster (LEE GROW), commercial feed (SKRETTING), fingerlings of *Clarias gariepinus*, nine rectangular plastic 30-liter aquarium, meter rule (30 cm), triple beam balance (OHAUS 2610 g) and scoop net.

2.1 Sample Collections

Watermelon syrup booster was formulated at Isitor Agro med (Table 1). Commercial syrup booster and commercial feed were purchased at a commercial feed store at Rumuokoro in Port Harcourt. Fingerlings of *Clarias gariepinus* were obtained from a private fish farm (Sokari Integrated Farms and Services) in Port Harcourt and conveyed in a ten-liter rectangular plastic aquarium to the departmental laboratory of Animal and Environmental Biology, Rivers State University. Nine rectangular plastic 30-liter aquarium were purchased at mile one market in Port Harcourt.

Table 1. Percentage composition of newly formulated watermelon syrup growth booster

Ingredient	Composition (%)
Watermelon (seed, pulp, rind)	60
Sucrose base binder/feed enzyme	30
Vitamin/mineral premix	10

Vitamin/mineral pemix contains; Vitamin. A 22,000.00 i.u, D3 5,000.00 i.u, E 300.00 mg, K3 10.00 mg, B1 20.00 mg, B2 25.00 mg, C 300.00 mg, B6 10.00 mg, B12 0.05 mg, Niacin 120.00 mg, Calcium Pantothenate 60.00 mg Folic acid 5.00 mg, Biotin 1.00 mg, Choline Chloride 500.00 mg, Inositol 50.00 mg, Manganese 30.00 mg, Iron 35.00 mg, Zinc 45.00 mg, Copper 3.00 mg, Iodine 5.00 mg, Cobalt 2.00 mg, Lysine 85.00 mg, Selenium 5.00 mg, Anti-Oxidant 80.00 mg, Methionine 100.00 mg.

2.2 Methodology

One hundred and eighty (180) Catfish (*Clarias gariepinus*) fingerlings weighing between the range of 0.305 -1.065 g with total length ranging between 2.3 - 4.1 cm were stocked at the rate of 20 fish in 25 liters of water in a 30-liter rectangular plastic aquaria in triplicate and replicated twice. The fish were acclimated for one week during which they were placed on a maintenance diet at 3% of their body weight using 1.1 mm, extruded fish feed (Skretting), containing 52% crude protein. The choice of feed was based on its high crude protein content which is good for fish growth [11], and constant availability in the market. The initial weight after acclimation ranging between 1.22 -2.56 g and standard lengths ranging from 4.3-5.1 cm were recorded prior to commencement of feeding with booster diets. The aquaria tanks were labeled as treatment 1, 2 and 3. Treatment one were fed with basal diet commercial feed only (Cf) to serve as control, treatment two were fed with same commercial feed coated with watermelon syrup booster (WbCf) and treatment three were fed with the commercial feed coated with commercial syrup booster (CbCf). The boosters were administered at 2 ml per kilogram of feed and allowed to dry for 20 minutes after coating following commercial recommendation. All treatments were replicated twice and fed two times between 0800 and 1800-hour local time daily with ten percent (10%) of their body weight of feed. Complete water change was done every day by siphoning and replacing with clean water to aid good water quality.

Water quality parameters such as temperature and pH were determined every day throughout the experimental period. Temperature was taken using mercury in glass thermometer (0-100°c), pH was determined by a test kit. Other physico-chemical parameters such as Dissolved oxygen, Conductivity, Salinity and Total dissolved solids were measured using Extech instrument (DO 700).

The experimental set up was monitored for eight weeks during which the fish were sampled weekly. Weight was measured with a triple beam balance (OHAUS 2610 g model) and standard lengths were measured using meter rule (30 cm). The data generated were used to estimate growth performance, nutrient utilization and survival. The variables used were namely; Mean weight (MW), Mean length (ML), Mean weight gain (MWG), Mean length gain (MLG), Daily growth rate (DGR), Relative weight gain (RWG), Specific growth rate (SGR), Protein efficiency ratio (PER), Feed conversion efficiency (FCE), Feed intake (FI), Condition factor and Survival of *Clarias gariepinus.* The variables were evaluated using the following formulars:

(a) Initial mean weight = (g/fish)
(b) Final mean weight of fish = (g/fish)
(c) Initial mean length = (cm/fish)
(d) Final length of fish =(cm/fish)

(e) Mean weight gain (g) = $W_1 - W_o$
(f) Mean length gain (cm) = $L_1 - L_0$

Where

W_1= Final weight, W_o = Initial weight
L_1 = Final length, L_o = Initial length

(g) Specific Growth Rate =

$$\frac{\text{Log e final weight} - \text{log e initial weight}}{\text{Culture period, t (days)}} \times 100$$

Where e is the base of natural logarithm and t, the culture period in days [12]

(h) Daily Growth Rate (g) = $\frac{\text{Mean weight gain}}{\text{Initial body weight}}$

(i) Relative weight gain (g) = $\frac{W_1 - W_o}{W_o}$

(j) Feed Intake = 10% Body Weight of fish

(k) Protein Efficiency Ratio =

$$\frac{\text{Weight Gain by fish`}}{100}$$ [4]

(l) Feed Conversion Efficiency (g) =

$$\frac{\text{Dry feed weight}}{\text{mean weight gain}}$$

(m) Condition factor K = $\frac{\text{Mean weight x 100}}{\text{Length}^3}$

(n) Survival Rate (%) =

$$\frac{\text{No. of survival after culture}}{\text{No. of fish stocked}} \times 100$$

2.3 Statistical Analysis

Data generated were subjected to one- way analysis of variance (ANOVA) with Duncan's Multiple Range Descriptive Test [13]. The results were further analyzed using Statistical Package for Social Sciences (SPSS) version 22. Differences among mean were separated with Turkey HSD at P = 0.05.

3. RESULTS AND DISCUSSION

The proximate analysis carried out to determine the mean ± SD on moisture, crude ash, crude protein, crude fat and carbohydrate contents on the newly formulated watermelon syrup booster and commercial syrup fish growth booster (Table 3) was significantly different when tested at *P* =0 .05 in all nutrient across the column. Digestible energy was calculated using crude protein 4.0 kcal/kg, fat 9.0 kcal/kg, carbohydrate 4.0 kcal/kg. [14]. The results of the physico-chemical parameter of water during the experiment were within the acceptable range for fish culture (Table 4).

Weekly growth variables measured for *Clarias gariepinus* fed CF (control diet) in Table 5, showed significant difference at *P* =0 .05 (Tukey HSD) from weeks one to weeks eight as the fish grows, the diet significantly impacted on the growth variables of MW, ML, MWG, MLG, DGR, RWG and SGR at the different durations. Weeks 1 to 5 showed no significant difference for the variables of MW, while week 6 and 7 also showed no significant difference except for week 8. ML showed significant difference across the durations except for weeks 7 and 8. The variables of MWG showed no significant difference *P* = 0.05 across the duration except for week 6, 7 and 8. DGR, RWG and SGR showed no significant difference during the durations. However, Weeks 6, 7 and 8 showed a significant difference among the entire variable.

Weekly growth performance of *Clarias gariepinus* fed WBCF showed significant difference at *P* = 0.05, (Table 6). However, some of the growth variables across the durations were not significantly different at *P* = 0.05. There was no significant difference on MW from weeks 1 to 4 while week 5 to 8 showed significant difference. Mean Length (ML) showed a significant difference across durations except at week 7 and 8 which showed no significant difference, MWG showed no significant difference from weeks 1 to 5 while weeks 6, 7 and 8 showed a significant difference. Weeks 1 and 2 as well as weeks 4 and 5 for MLG were not significantly different, weeks 3 and 6 were significantly different but 7 and 8 were also not significantly different. On the variables of DGR and RWG, weeks 1, 2, weeks 3 and 4 showed no significant difference but 5, 6, 7 and 8 showed a significant difference. Specific Growth Rate (SGR) showed no significant difference at weeks 1 and 2, weeks 3 and 4, weeks 6 and 7. However, there was a significant difference at weeks 5 and 8.

Table 2. Commercial feed of different size 1 mm, 1.8 mm, 2.5 mm, 3.2 mm and 4.5 mm (Company: Skretting, proximate composition) fed to *C. gariepinus* for eight weeks

Nutrients	Compositions (%)				
	1.1 mm	1.8 mm	2.5 mm	3.2 mm	4.5 mm
Crude protein	57	52	45	45	45
Crude fibre	0.4	0.9	2.6	2.6	2.8
Crude ash	9.5	9.5	7.5	7.5	7.0
Crude fats	0.9	15	14	14	14

Table 3. Proximate compositions of newly formulated watermelon syrup fish growth booster, and commercial syrup fish growth booster fed to *C. gariepinus* for eight weeks (56 days)

Booster	Crude composition (%)					
	Moisture	Ash	Protein	Fat	Carbohydrate	Digestible energy (Kcal/kg)
Wm. Booster	36.55 ± 0.64^{a}	0.09 ± 0.04^{b}	0.18 ± 0.11^{b}	0.53 ± 0.06^{a}	62.66 ± 0.24^{b}	256.10
C. Booster	20.37 ± 0.57^{b}	0.59 ± 0.00^{a}	0.59 ± 0.00^{a}	0.07 ± 0.03^{b}	77.32 ± 0.47^{a}	312.36

Mean ± SD in the same column with different superscript are significantly different (P =0 .05)

Table 4. Physico - chemical parameters of water used for culture of *Clarias gariepinus* for 56 days

Parameters	Range	Mean
Temperature (°C)	27 - 28.9	27.95
pH	6.0 - 7.0	6.5
Dissolved oxygen (mg/l)	3.2 - 5.9	4.55
Conductivity (µs/ cm)	112 - 120	116
Salinity ($^{0}/^{00}$)	0.03- 0.07	0.05
Total dissolved solid(mg/l)	35 - 85	60.0

Table 5. Growth performance of *C. gariepinus* fed commercial feed (CF) only for eight weeks (56 days)

Diet	Week	MW (g)	ML (cm)	MWG (g)	MLG (cm)	DGR	RWG(g)	SGR (%/day)
CF	**Start value**	2.04±0.72	4.76±0.41					
	1	3.02±0.04^{d}	6.26±0.11^{f}	0.97±0.72^{d}	1.50±0.34^{e}	0.64±0.72^{c}	2.02±0.04^{d}	-0.08±0.72^{b}
	2	3.37±1.12^{d}	6.80±0.26^{ef}	1.32±1.83^{d}	2.03±0.37^{e}	1.00±1.53^{c}	2.37±1.12^{d}	-0.01±1.04^{b}
	3	6.07±0.58^{d}	8.70±0.26^{de}	4.03±1.10^{d}	3.93±0.37^{d}	2.34±1.59^{bc}	5.07±0.58^{d}	0.61±0.77^{ab}
	4	8.30±1.10^{cd}	10.00±0.55^{cd}	6.25±0.93^{cd}	5.23±0.45^{cd}	3.41±1.54^{bc}	7.30±1.10^{cd}	0.92±0.65^{ab}
	5	10.88±2.29^{cd}	11.33±1.10^{bc}	8.83±1.93^{cd}	6.56±0.89^{bc}	4.68±1.68^{bc}	9.88±2.29^{cd}	1.18±0.60^{ab}
	6	15.97±3.57^{bc}	12.60±0.72^{b}	13.92±3.23^{bc}	7.83±0.61^{b}	7.35±2.57^{bc}	14.97±3.57^{bc}	1.56±0.61^{ab}
	7	20.89±4.58^{b}	14.93±1.25^{a}	18.85±4.10^{b}	10.16±1.00^{a}	9.83±2.88^{ab}	19.89±4.58^{b}	1.83±0.57^{ab}
	8	33.08±5.48^{a}	16.10±0.30^{a}	31.03±5.20^{a}	11.33±0.66^{a}	16.57±6.20^{a}	32.08±5.48^{a}	2.30±0.66^{a}

Means in the same columns with similar superscript are not significantly different at P > 0.05 (Tukey HSD)
Key: MW-Mean Weight; ML -Mean Length; MWG-Mean Weight Gain; MLG-Mean Length Gain; DGR-Daily Growth Rate; RWG-Relative Weight Gain; SGR-Specific Growth Rate

Table 6. Growth performance of *C. gariepinus* fed Watermelon booster diet (WBCF) for eight weeks (56 days)

Diet	Week	MW (g)	ML (cm)	MWG (g)	MLG (cm)	DGR	RWG(g)	SGR (%/day)
WBCF	**Start value**	1.77±0.20	4.90±0.10					
	1	2.83±0.16^{e}	6.00±0.30^{f}	1.06±0.03^{e}	1.10±0.26^{f}	0.60±0.08^{e}	1.83±0.16^{e}	0.02±0.14^{e}
	2	3.93±0.28^{e}	7.06±0.15^{ef}	2.16±0.44^{e}	2.16±0.25^{ef}	1.24±0.36^{e}	2.93±0.28^{e}	0.35±0.25^{de}
	3	6.27±1.35d^{e}	8.53±0.51^{de}	4.50±1.50^{de}	3.63±0.61^{de}	2.61±1.05^{de}	5.27±1.35^{de}	0.80±0.39^{cd}
	4	8.30±1.10d^{e}	10.00±0.55^{cd}	6.53±1.21^{de}	5.10±0.65^{cd}	3.74±0.95^{de}	7.30±1.10^{de}	1.09±0.28^{cd}
	5	12.76±2.77^{cd}	11.30±0.95^{bc}	10.99±2.94^{cd}	6.40±1.03^{bc}	6.36±2.17^{cd}	11.76±2.77^{cd}	1.51±0.41^{b}
	6	19.09±3.66^{c}	12.70±0.75^{b}	17.32±3.82^{c}	7.80±0.85^{b}	9.99±2.97^{bc}	18.09±3.66^{c}	1.92±0.37^{ab}
	7	27.13±3.78^{b}	15.56±1.35^{a}	25.36±3.58^{b}	10.66±1.30^{a}	14.30±0.35^{b}	26.13±3.78^{b}	2.28±0.06^{ab}
	8	38.23±4.26^{a}	16.63±0.95^{a}	36.46±4.12^{a}	11.73±0.90^{a}	20.64±1.85^{a}	37.23±4.26^{a}	2.62±0.14^{a}

Means in the same columns with similar superscript are not significantly different at P = 0.05 (Tukey HSD)
key: MW-Mean Weight; ML-Mean Length; MWG-Mean Weight Gain; MLG-Mean Length Gain;
DGR-Daily Growth Rate; RWG-Relative Weight Gain; SGR-Specific Growth Rate.

Weekly growth performance measured for *Clarias gariepinus* fed CBCF (Table 7), show significant difference at *P* =0.05. Although some of the growth variables across the durations are not significantly different at *P* = 0.05. The diets impacted on the growth performance of all the variables across the durations (weeks) of experiment. The values of MW show no significant difference from weeks 1 to 5 as well as 6 to 8, ML show no significant difference between the values on weeks 1, 2 and 3 with week 6,7 and 8 while weeks 4 and 5 show a significant difference. The variables of MWG, DGR and RWG show no significant difference from week 1 to 5 as well as with the values of 6 to 8. MLG and SGR show a significant difference across the duration except for week 5, 6, 7 and 8.

Weekly performance on nutrient utilization and survivability of *Clarias gariepinus* fed CF only (control diet) on Table 8, showed significant difference at *P* =0 .05. However, some of these variables across the durations are not significantly different at *P* =0.05. Weeks 1 and 2, weeks 3 to 8 showed no significant difference on PER. Feed Conversion Efficiency (FCE) showed no significant difference between weeks 1 to 4, weeks 5 to 8 also showed no significant different, Feed Intake showed no significant difference between weeks 1 to 6 compared to weeks 7 and 8 which showed a significant difference. Condition Factor (K) showed no significant difference among the durations except for weeks 1 and 7. There was no significant difference between weeks 1 and 2 as well as weeks 3 to 8 on survivability of *Clarias gariepinus*

Weekly performance on nutrient utilization and survivability of *Clarias gariepinus* fed WBCF (Table 9), showed significant difference at *P* = 0.05. However, some of these variables across the durations are not significantly different at *P* =0.05. The variables of PER and FCE showed no significant difference between weeks 3 and 4, weeks 5 and 6. Feed Intake showed no significant difference from weeks 1 to 4 but weeks 5 to 8 showed significant difference. There was significant difference at the variables of Condition Factor (K) and survivability from weeks 1 and 2 compared to weeks 3 to 8 with no significant difference.

Weekly performance on nutrient utilization and survivability of *Clarias gariepinus* fed CBCF (Table 10), showed significant difference at *P* =0.05. However, some of these variables across the durations were not significantly different at *P* =0.05. The variables of Protein Efficiency Ratio (PER) and Feed Conversion Efficiency (FCE) showed a significant difference between weeks 1 to 3 to but showed no significant difference from weeks 4 to 8. Feed Intake showed no significant difference between weeks 1 to 6 as well as weeks 7 and 8. Condition Factor (K) showed no significant difference between weeks 1 to 4 as well as weeks 5 to 8 while survivability showed also showed no significant different in weeks 1 and 2 as well as 3 to 8.

Comparative performance of all the diets (Table 11), showed that the diets impacted on the fish though there is no significant difference (*P* = 0.05) in the performance *Clarias gariepinus* fed diets of CF (control diet), WBCF and CBCF for all the variables of MW, ML, MWG, MLG, DGR, RWG, SGR, PER, FCE, FI and Survival rate (%) except for Condition Factor (K) which show significant difference *P* =0.05 on fish fed commercial syrup fish growth booster diet with no significant difference *P* =0.05 on fish fed CF(control diet) and WBCF. However, WBCF shows a slightly better performance in all the variables compared to CBCF and CF (control diet).

3.1 Discussion

The comparative values of *Clarias gariepinus* fed the three experimental diets showed no significant difference at *P* =0.05 on the variables of Mean Weight, Mean Length, Mean Weight Gain, Mean Length Gain, Daily Growth Rate, Relative Weight Gain, Specific Growth Rate, Protein Efficiency Ratio, Feed Conversion Efficiency, Feed Intake. However, there was significant difference at *P* = 0.05 on the variables of condition factor and survivability.

From the result above, all treatment sample had a good growth performance due to high crude protein content of the basal diet (feed pellets) used to mix with the boosters which were between the range of 57% – 45% crude protein. Such high crude protein is good for better growth performance of *Clarias gariepinus*, [11]. However, in this study better growth performance and feed utilization of *Clarias gariepinus* were obtained with treatment diet of WBCF which showed higher variables compared to the other two diets between the 6^{th} and 8^{th} weeks of the experimental period (Tables 5, 6 and 7), the WBCF treatment groups showed a higher numeric values over the other two treatment groups. The values presented on Table 11 also clearly demonstrate the superiority in performance of WBCF treatment groups over the other two treatment groups. Condition factor (k) was also higher in group fed Watermelon syrup booster when compared to the other two treatment groups. Also, the Proximate analysis of both boosters showed that commercial booster was higher in crude protein, carbohydrate and digestible energy when compared to Watermelon syrup growth. However, Watermelon syrup growth booster was higher in fat.

This implies that the watermelon growth booster is very promising and can be improved upon by adding more seed meal to increase protein content since the seed of watermelon has been shown to be rich in protein and oil [15]. Uniformity in growth of *Clarias gariepinus* was also observed in treatment group fed with WBCF which might also have contributed to a better growth performance and nutrient utilization. The rationale behind the greater growth by the watermelon booster in comparison with the commercial booster, in spite of the fact that the latter had the higher crude protein, fat and carbohydrate content may be attributed to the greater palatability of the watermelon booster in view of its high content of its sucrose base sweetener, which eventually translated into higher Feed intake by WBCF treatment group during the last two weeks of experimental period. This trend of greater growth boost by the watermelon booster may have continued if the experimental period had extended beyond eight weeks. On the other hand, the inability to demonstrate significant differences in performance between any of the groups within the first 6 weeks of the experimental period may be explained on the basis of adequate nutrient content of smaller feed pellets (1.1 mm, 1.8 mm, 2.5 mm) which were initially fed to *clarias gariepinus* fingerlings within the first 6 weeks prior to changing to 3.2 mm and 4mm feed pellets that is usually cheaper and overall lower in nutrient composition. This implies that during the initial slow growing phase (first 6 weeks), both boosters had no effect on the growth performance of the fishes since their nutrient requirements was adequately met by the highly nutritious but more expensive smaller pellets. Beyond the initial 6 weeks, the effect of the growth boosters became noticeable as the nutrient composition of the bigger but cheaper pellets were used to replace the smaller-sized pellets. Final Mean Weights were also higher for *Clarias gariepinus* fed with WBCF at 38.23±4.26 g, while diets of CBCF showed 31.27±13.43 g and 33.08 ± 5.48 g for CF (control diet), these values are higher than the values of the growth promoters; Aqua pro (26.79 g) and Aqua booster (25.20 g) used as reported by [4]. And the weight values obtained for watermelon seed meal fed to *Orechromis niloticus* (Nile tilapia) 17.7±0.1 g and 16.4±0.09 g recorded by [16] which may be as a result of feeding at 10% body weight of feed mixed with the boosters.

The Mean±S.D for growth performance nutrient utilization and survival of *Clarias gariepinus* in all the variables across the diets were higher at group fed WBCF diet. This may be as a result of feed intake of *Clarias gariepinus* is maximum at treatment with WBCF with 3.82±0.42 g, followed by CF (control diet) at 3.30±0.54 g and CBCF at 3.12±1.34 g, this explains why all the variables evaluated were higher on WBCF compare to CF (control diet) and CBCF.

The degree of well-being and robustness of a fish expressed by the Condition Factor is important in the study of fish biology. Variations in fish Condition Factor reflects the sex, age and degree of nourishment. Fish Condition Factor may vary as a result of age, sex and diseased condition [17,18,19,20]. In this study, the Condition Factors of *Clarias gariepinus* fed WBCF, CBCF and CF (control diet) is slightly less than 1 which may be as a result of the age of the fish.

Survivability were higher at *Clarias gariepinus* fed with WBCF and CBCF which agree with the reports of [4], that survival of C. *gariepinus* can be improved by feed additives supplementation. The least survival was observed at the diet of CF only (control), this implies that mortality was highest in group fed with controlled diet which may be as a result of irregular growth size of fish that has led to more mortality by cannibalism. However, there was general mortality in all treatment as a result of both cannibalism and handling stress during measurements but consumption of leafs that fell out of water lettuce (*Pistia stratiotes*) accounted for major increase in mortality as seen in gut content.

Water quality parameters were significantly within the recommended values for culture of *Clarias gariepinus* [21]. This research suggests that dietary feed of watermelon syrup fish booster coated with commercial feed (WBCF), showed better growth performance of *Clarias gariepinus.* This implied that watermelon syrup

Table 7. Growth performance of *Clarias gariepinus* fed commercial booster diet (CBCF) for eight weeks (56 days)

Diet	Week	MW (g)	ML (cm)	MWG (cm)	MLG (cm)	DGR	RWG(g)	SGR (%/Day)
CBCF	**Start value**	**1.84±0.61**	**4.73±0.32**					
	1	2.72±0.53^{c}	5.93±0.55^{f}	0.88±0.31^{c}	1.20±0.40^{f}	0.52±0.29^{c}	1.72±0.53^{c}	-0.03±0.41^{e}
	2	3.96±0.71^{c}	6.86±0.56^{ef}	2.12±0.11^{c}	2.13±0.25^{f}	1.21±0.29^{c}	2.96±0.71^{c}	0.33±0.38^{de}
	3	6.38±1.79^{bc}	8.40±0.70d^{ef}	4.54±1.21^{bc}	3.66±0.37^{ef}	2.51±0.38^{c}	5.38±1.79^{bc}	0.80±0.31^{cde}
	4	8.57±3.13^{bc}	9.70±1.08^{cd}	6.73±2.56^{bc}	4.96±0.76^{de}	3.65±0.73^{bc}	7.57±3.13^{bc}	1.07±0.28^{bcd}
	5	12.32±4.03^{bc}	11.33±1.64^{bc}	10.48±3.48^{bc}	6.60±1.34^{cd}	5.75±1.14^{bc}	11.32±4.03^{bc}	1.44±0.32^{abc}
	6	17.80±6.54^{ab}	12.70±1.22^{ab}	15.96±6.03^{ab}	7.96±0.90^{bc}	8.73±2.41^{abc}	16.80±6.54^{abc}	1.80±0.36^{abc}
	7	23.15±7.94^{ab}	14.70±1.70^{ab}	21.31±7.45^{ab}	9.96±1.38^{ab}	11.73±3.24^{ab}	22.15±7.94^{ab}	2.07±0.37^{ab}
	8	31.27±13.43^{a}	16.16±1.64^{a}	29.43±13.09^{a}	11.43±1.41^{a}	16.33±7.62^{a}	30.27±13.43^{a}	2.33±0.52^{a}

Means in the same columns with similar superscript are not significantly different at P = .05 (Tukey HSD)

Key: MW-Mean Weight; ML-Mean Length; MWG-Mean Weight Gain; MLG-Mean Length Gain; DGR-Daily Growth Rate; RWG-Relative Weight Gain; SGR-Specific Growth Rate

Table 8. Nutrient utilization and survival of *C. gariepinus* fed commercial feed only (CF) for eight weeks (56 days)

Diet	Week	PER	FCE	F intakes	K. factor	Survival
CF						
	1	6.88±5.11^{b}	3.22±2.39^{c}	0.30±0.00^{d}	1.22±0.05^{a}	95.00±5.00^{a}
	2	6.46±8.71^{b}	3.02±4.07^{bc}	0.33±0.11^{d}	1.08±0.44^{ab}	80.00±13.22^{ab}
	3	14.06±2.98^{ab}	6.57±1.39^{abc}	0.60±0.05^{d}	0.92±0.08^{ab}	65.00±5.00^{bc}
	4	16.14±1.72^{a}	7.54±0.80^{abc}	0.83±0.11^{cd}	0.82±0.03^{ab}	61.66±2.88^{c}
	5	17.38±1.24^{a}	8.12±0.58^{ab}	1.08±0.22^{cd}	0.74±0.06^{ab}	56.66±2.88^{c}
	6	18.64±0.90^{a}	8.71±0.42^{a}	1.59±0.35^{bc}	0.78±0.03^{ab}	53.33±2.88^{c}
	7	19.31±0.58^{a}	9.02 ±0.27^{a}	2.08±0.45^{b}	0.62±0.02^{b}	53.33±2.88^{c}
	8	20.06±0.46^{a}	9.38±0.21^{a}	3.30±0.54^{a}	0.79±0.17^{ab}	51.66±2.88^{c}

Means in the same columns with similar superscript are not significantly different at P > 0.05 (Tukey HSD)

Key: PER- Protein Efficiency Ratio; FCE-Feed Conversion Efficiency; F. Intake-Feed Intake; K. Factor-Condition Factor; Survival-Survival

Table 9. Nutrient utilization and survival of *Clarias gariepinus* fed Watermelon booster diet (WBCF) for eight weeks (56 days)

Diet WBCF	Week	PER	FCE	F. intake	K. factor	Survival
	1	8.01±0.72^{e}	3.75±0.34^{e}	0.28±0.01^{e}	1.32±0.21^{a}	98.33±2.88^{a}
	2	11.64±1.71^{d}	5.46±0.80^{d}	0.39±0.02^{e}	1.11±0.01^{ab}	81.66±2.88^{ab}
	3	15.01±2.08^{c}	7.04±0.97^{c}	0.62±0.13d^{e}	0.99±0.06^{bc}	70.00±5.00^{bc}
	4	16.69±0.98^{bc}	7.83±0.46^{bc}	0.83±0.11d^{e}	0.82±0.03^{bc}	66.66±7.63^{bc}
	5	18.20±1.09^{ab}	8.54±0.51^{ab}	1.27±0.27^{cd}	0.88±0.17^{bc}	65.00±10.00^{bc}
	6	19.25±0.64^{ab}	9.03±0.30^{ab}	1.90±0.36^{c}	0.92±0.04^{bc}	61.66±7.63^{c}
	7	19.91±0.03^{a}	9.34±0.01^{a}	2.71±0.37^{b}	0.72±0.10^{c}	60.00±5.00^{c}
	8	20.32±0.08^{a}	9.53±0.03^{a}	3.82±0.42^{a}	0.83±0.07^{bc}	56.66±7.63^{c}

Means in the same columns with similar superscript are not significantly different at P > 0.05 (Tukey HSD)
Key: PER-Protein Efficiency Ratio; FCE-Feed Conversion Efficiency; F. Intake-Feed Intake; K. Factor-Condition Factor; Survival

Table 10. Nutrient utilization and survival of *Clarias gariepinus* fed commercial syrup booster diet (CBCF) for eight weeks (56 days)

Diet CBCF	Week	PER	FCE	F intake	K. factor	Survival
	1	7.06±2.60^{d}	3.30±1.21^{d}	0.27±0.05^{c}	1.30±0.17^{a}	98.33±2.88^{a}
	2	11.62±1.41^{c}	5.43±0.66^{c}	0.39±0.07^{c}	1.22±0.11^{ab}	91.66±2.88^{ab}
	3	15.25±0.62^{b}	7.13±0.29^{b}	0.63±0.17^{bc}	1.05±0.04^{abc}	71.66±5.77^{bc}
	4	16.71±0.75^{ab}	7.81±0.35^{ab}	0.85±0.31^{bc}	0.91±0.04^{abc}	66.66±10.40^{c}
	5	18.16±0.52^{ab}	8.49±0.24^{ab}	1.23±0.40^{bc}	0.85±0.24^{bc}	63.33±7.63^{c}
	6	19.10±0.56^{a}	8.92±0.26^{a}	1.78±0.65^{abc}	0.84±0.15^{bc}	61.66±10.40^{c}
	7	19.63±0.42^{a}	9.18±0.19^{a}	2.31±0.79^{ab}	0.71±0.10^{c}	61.66±10.40^{c}
	8	19.98±0.60^{a}	9.34±0.28^{a}	3.12±1.34^{a}	0.70±0.13^{c}	53.33±7.63^{c}

Means in the same columns with similar superscript are not significantly different at P > 0.05 (Tukey HSD)
Key: PER-Protein Efficiency Ratio; FCE-Feed Conversion Efficiency; F. Intake-Feed Intake; K. Factor-Condition Factor; Survival

Table 11. Comparative growth performance, feed utilization and survival of *Clarias gariepinus* fed with different diets for eight weeks (56 days)

Variables	CF	WBCF	CBCF
Initial Mean Weight (g)	2.04±0.6[a]	1.77±0.17[a]	1.84±0.51[a]
Final Mean Weight (g)	33.08±5.48[a]	38.23±4.26[a]	31.27±13.43[a]
Initial Mean length (cm)	4.76±0.34[a]	4.90± 0.08[a]	4.73± 0.26[a]
Final Mean length (cm)	16.10±0.30[a]	16.63±0.95[a]	16.16±1.64[a]
Mean weight gain (g/fish)	31.03±5.20[a]	36.46±4.12[a]	29.43±13.09[a]
Mean length gain (cm/fish)	11.33±0.66[a]	11.73±0.90[a]	11.43±1.41[a]
Daily Growth Rate	16.57±6.20[a]	20.64±1.85[a]	16.33±7.62[a]
Relative Weight Gain (g)	32.08±5.48[a]	37.23±4.26[a]	30.27±13.43[a]
Specific growth rate (% day-1)	2.30±0.66[a]	2.62±0.14[a]	2.33±0.52[a]
Protein Efficiency Ratio	20.06±0.46[a]	20.32±0.08[a]	19.98±0.60[a]
Feed Conversion Efficiency	9.38±0.21[a]	9.53±0.03[a]	9.34±0.28[a]
Feed intake (g feed/fish)	3.30±0.54[a]	3.82±0.42[a]	3.12±1.34[a]
Condition Factor K.	0.79±0.17[ab]	0.83±0.07[bc]	0.70±0.13[c]
Survival rate (%)	51.66±2.88[c]	56.66±7.63[c]	53.33±7.63[c]

Variables having same superscript across each row are not significantly difference at P> 0.05

fish growth booster enhanced nutrient utilization, which is reflected in the improved length gain, weight gain, specific growth rate (SGR), feed conversion efficiency (FCE), daily growth rate (DGR), relative weight gain (RWG) and protein efficiency ratio (PER).

However, better feed FCE values were obtained in all treatment diet but the least value occurred in fish fed the CBCF. There was no significant difference *(P* = 0.05) in the FCE of WBCF diet compared with those of CF diet only (control) and CBCF diet. Other growth booster additives such as Aqua superliv in diets also promote good growth and FCE in Nile tilapia fingerlings [22]. Similar results were reported on two different commercial feed additives for Nile tilapia fingerlings [23]. [24], recorded feeding African catfish with diets supplemented by commercial feed additives [4], also reported the effect of two commercial diatery feed additives (Aqua booster and Aquapro) on *Clarias gariepinus.*

4. CONCLUSION

This research established the potentials of the formulated watermelon syrup booster as a good alternative growth promoter on *Clarias gariepinus,* as such fish farmer can look forward to alternative and better feed additives from plant sources instead of chemical sources, such as hormones and antibiotics, with their inherent drug resistant issues. It is also concluded that the growth boosting effect of the newly formulated watermelon booster takes effect from 6 weeks' period of introduction of *Clarias gariepinus*, during which the nutrient content of the initial smaller-sized feed pellets are replaced with lower nutrient large-sized but cheapest feed pellet.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/25978