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1 message

Samuel Bem Umma <umma@fuwukari.edu.ng> Wed, Sep 9, 2015 at 5:19 AM
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From: **John Cooksey** <admin@was.org>
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To: Mr. Samuel B. Umma Abstract ID# 251
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Re: Abstract submission for AQUACULTURE 2016 -- to be held in Las Vegas, Nevada, USA

This is your OFFICIAL NOTICE that the Program Committee of AQUACULTURE 2016 (to be held in Las Vegas, Nevada, USA) has ACCEPTED your abstract for presentation. The exact presentation assignment will be sent in December. You will be sent a notice of the session, day and time for your presentation after assignment has been made.

PLEASE PROOFREAD THE INFORMATION LISTED BELOW.

*If you find an error in the abstract title or author names, you must inform us if a correction is to be made. Conference Management will not be held responsible for errors or omissions made in the transmittal form or the abstract as submitted. Italics and special characters will appear in the final publication, as they do not always translate via email. Professional titles will not be used with author names.

*Abstract Title:
EVALUATION OF AFRICAN CATFISH Clarias gariepinus RESPONSES TO GRADED LEVELS OF ZINC PRACTICAL DIET

*Presenting Author: Samuel B. Umma

*Co-Authors (make certain ALL co-aurhors are listed here):
Oyin Olukunle

Presentation Method selected:
Poster Preferred

Abstract Topic selected:
Finfish Nutrition

LANGUAGE:
All abstracts must be presented in English - the official language of this conference.

CANCELLATION:
If you are not going to attend AQUACULTURE 2016, please contact this office to withdraw your abstract.

YOU CAN START PLANNING NOW TO ATTEND THE CONFERENCE

AQUACULTURE 2016 -- "All In For Aquaculture"
The International Triennial Meeting of World Aquaculture Society, National Shellfisheries Association, National Aquaculture Association and American Fisheries Society, Fish Culture Section

CONFERENCE LOCATION:
Paris Hotel and Convention Center, Las Vegas, Nevada USA
Registration opens: Monday, February 22
Conference dates: Tuesday, February 23 - Friday, February 26
Exhibition open: Tuesday, February 23 - Thursday, February 25

REGISTRATION:
All presenters are required to register and arrange their own funding to cover expenses. AQUACULTURE 2016 cannot subsidize registration fees, travel, hotel, or food costs. Register by January 11, 2016 to save money.

You can register online if paying with a credit card at: www.was.org or you can print out the registration form on the website and send it by fax or regular airmail to the AQUACULTURE 2016 Conference Management office. Registration confirmation will be sent to those who pre-register.

VISA MAY BE REQUIRED:
International attendees are responsible for obtaining a visa to enter USA, if required. Start the process early, as this can take some time. Check with the embassy in your country for visa requirement information: www.embassyworld.com

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Your destination is: Las Vegas McCarran International Airport (LAS), Las Vegas, Nevada USA

PROGRAM:
For information on the program, registration, accommodation, etc. please go to the website: www.was.org.

Thank you for your participation in AQUACULTURE 2016. Your contribution will help to make this a very interesting program.

Sincerely,
Mr. John Cooksey
Conference Management

AQUACULTURE 2016
CONFERENCE MANAGEMENT
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September 30, 2015

TO: Justina O. Oshoke

RE: INVITATION to **AQUACULTURE 2016**

On behalf of AQUACULTURE 2016, I am pleased to invite you to attend AQUACULTURE 2016 Conference and Exposition, which is to be held February 22-26, 2016, at Paris Hotel & Convention Center, Las Vegas, Nevada USA. AQUACULTURE 2016 has been certified under the U.S. Trade Fair Act of 1959.

AQUACULTURE 2016 will feature technical sessions and workshops covering nearly all aspects of aquaculture around the world. There will be international professionals in attendance to present the latest research and investigations on technical and practical aspects of aquaculture.

It is our sincere hope that you will be able to attend AQUACULTURE 2016. The paper you present, as well as your expertise and attendance, will benefit the conference. In addition, what you learn at the conference will provide benefits for aquaculture in your country.

OFFICIAL NOTICE OF ABSTRACT ACCEPTANCE - Thank you for your abstract submission:
GROWTH PERFORMANCE OF *clarias gariepinus* FRY FED THREE VARIETIES OF SWEET POTATO *Ipomoea batatas* AS A REPLACEMENT FOR YELLOW MAIZE.

The program committee of AQUACULTURE 2016, made of experts in aquaculture, has reviewed and accepted your abstract for presentation. The exact assignment will be sent by December 2015.

All AQUACULTURE 2016 attendees are responsible for their own travel expenses including airfare, lodging, ground transportation, meals, conference registration, and any other incidentals.

Check the **AQUACULTURE 2016 web page** (www.was.org) to register, for program updates, or to book your hotel reservation.

We look forward to seeing you in Las Vegas!

Sincerely,

John Cooksey

John Cooksey
Conference Manager
AQUACULTURE 2016

Abstract

Fisheries and aquaculture contribute significantly to food security and livelihood; therefore, fish and fish products are projected as being among the most widely traded foods. Fish like other animals, has requirement for essential nutrients in order to grow properly. Such essential foods are available in the wild for fish to forage extensively to meet their body needs. The variable factors such as climate change, environment, season of the year and location among others determines the abundance and search for these foods. These factors modifies aquatic environment and make it difficult for fish in the wild to forage adequately. Therefore, enough food in the form of artificial diet is required to furnish fish with the nutrients it need out of its natural environment for optimal growth. However, most of the challenges facing the formulation of feed are on the affordability, ready acceptability and bioavailability for fish optimal growth. Therefore, trace minerals which are needed in minute quantity at a time for the general health maintenance and growth of an animal offers a soft landing to this challenges; however, their deficiency perturbs the wellbeing of fish. Zinc has been recognized to play a vital role in almost every aspect of living system either directly or indirectly. The biochemical components of fish diet that needs varying in terms of percent inclusion to render the protein in feed more bioavailable should be encouraged. The objectives of this study includes determination of the; required dietary zinc inclusion that is essential for juvenile African catfish *Clarias gariepinus growth,* serum biochemical profile of African catfish juveniles post feeding response to growth, and haematological responses of African catfish (*Clarias gariepinus*) to graded levels of zinc nutrient.

Growth performance, serum biochemistry and physiological response to graded levels of practical dietary zinc fed to African catfish (*Clarias gariepinus*) juvenile were investigated. Water quality was monitored throughout the period of the study and the results showed that all parameters were within the required and tolerable ranges for catfish. The mean weight of fish fed dietborne zinc nutrients revealed that there were no significant differences in growth responses to graded levels of dietary zinc inclusions of 0, 5.46, 10.96, 16.40, 21.86, and 27.33 mg Zn kg^{-1}.

The results for the mean weight revealed that there are no significant variations in mean weight since $P>0.05$. However the mean weight for the diet increased with respect to dietary zinc inclusion (Figure 1). The SGR, FCR, GFCE, F.I and RGR, also showed no significant variations among fish fed. The PCV revealed that there are no significant variations among the values for the fish fed with Diets 3, 4 and 5. The serum biochemistry revealed significant variations in the serum total protein (T.P) among fish fed on all the Diets, with the highest values in fish fed Diet 4 and the minimum values in fish fed Diet 2. Fish fed dietary zinc had slightly altered haematological and serum biochemistry in response to dietary zinc.

Key words: Food security, practical dietary zinc, bioavailability, African catfish

INTRODUCTION

Fisheries and aquaculture contribute significantly to food security and livelihood; therefore, fish and fish products are projected as being among the most widely traded foods, with more than 37% by volume of world production traded internationally (FAO 2011). Fish like other animals have a requirement for essential nutrients in order to grow properly. In the wild such essential foods are available and as the fish forage for food they are able to meet their body need by feeding extensively on these foods (Eyo, 2003). The variable factor such as the type of environment, season of the year and location among others determines the abundance of these foods and the distance to which the fish must migrate in search of food. Factors such as climate change and oil exploration has also become one among the major influence in the 21st century, apparently modifying aquatic environment and making it difficult for fish in the wild to forage extensively to support their body needs. Coastal countries dependent on fisheries are particularly vulnerable to climate change (Allison, *et al.,* 2009, 2005) and polluted runoff waters. Aquaculture is now been employed to have control over these renewable natural resource against aquatic modifiers that makes life difficult for aquatic biota. Therefore, enough food in the form of artificial diet to furnish all the nutrients requirement of the fish (Ugwu and Mgbenka, 2006) must be supplied to fish out of their natural environment in order to enable fish grow at an optimal rate (Eyo, 2003). However, most of the challenges facing the formulation of feed are on the affordability, ready acceptability and bioavailability to particular species of fish to grow optimally.

Therefore, trace minerals which are needed in minute quantity at a time for the general health maintenance, growth and other biochemical functions in the body of animal (Haruna, 2003) offers a soft landing to this challenges; however, their deficiency perturbs the general wellbeing of the body. The role of trace elements in biological systems has been well documented in virtually all husbanded animals and humans (Vakili and Rashidi, 2011; Watanabe *et al.,* 1997), but the knowledge in fish is however limited (Watanabe *et al.,*1997). Zinc has been recognized to play a vital role in almost every aspect of living system either directly or indirectly (Shukla *et al*., 2002). Normal zinc levels in freshwater and seawater are known to be insufficient to meet the requirement of growing aquatic species (Spry *et al*., 1988; Willis and Sunda, 1984). Gatlin and Wilson, (1983) reported that when catfish diets were low in zinc, appetite was reduced, resulting in low growth, low bone zinc and calcium levels and serum zinc concentration. Zinc is an important trace element in fish nutrition as it is involved in various metabolic pathways and serves as a specific cofactor of several enzymes. Watanabe *et al.,* (1997) reported that zinc may also have a structural role in nucleoproteins and research on zinc-gene interactions has also assigned a basic role for this element in controlling growth (Chesters, 1991). Fish feed is singled out as the most expensive operating cost in aquaculture (Nwanna, 2002). Therefore, any biochemical components of fish diet that needs varying in terms of proportion of inclusion, which will render the protein in feed more bioavailable and promote faster growth of a healthy fish that is relatively cheap should be considered and encouraged. The objectives of this study include the determination of Serum biochemical profile of African catfish juveniles after post feeding trials in response to growth, required dietary zinc inclusion that is essential for juvenile African catfish *Clarias gariepinus* growth and evaluation of haematological responses of African catfish (*Clarias gariepinus*) to graded levels of zinc nutrient.

LITERATURE REVIEW

Mineral Requirements of Fish/Catfish

The role of trace elements in biological systems has been described in several animals. However, the knowledge in fish is limited to a few as components of body fluids, cofactors in enzymatic reactions, structural units of non-enzymatic macromolecules (Watanabe *et al.,* 1997). Investigations in fish are comparatively complicated as both dietary intake and waterborne mineral uptake and this have to be considered in determining the mineral budgets. The importance of trace minerals as essential ingredients in diets however, in small quantities, is also evident in fish (Srisvastava and Srisvastava, 2008; Watanabe *et al*., 1997). Minerals are required for the normal life processes, and all animals, including fish, need these inorganic elements. The minerals are responsible for skeletal formation, maintenance of colloidal systems, regulation of acid-base equilibrium and for biologically important compounds such as hormones and enzymes. Mineral deficiencies can cause biochemical, structural and functional pathologies which depend on several factors, including the duration and degree of mineral deprivation (Watanabe *et al*., 1997). Nutritional requirements of fish for trace elements are also fragmentary, particularly because many are needed only in very small amounts (usually less than 100 mg kg^{-1} dry diet); they are absolutely required for normal growth.

Zinc requirement and bioavailability for fish

Glover and Hogstrand (2003) reported that for aquatic organisms, zinc is both an essential nutrient and an environmental contaminant. Investigation on zinc-gene interactions has assigned a basic role for this element in controlling growth (Chesters, 1991). The zinc requirement of rainbow trout is normally met by dietary levels of 15-30 mg kg^{-1} diet (Ogino and Yang, 1978). The average range of zinc in salmon diets is 80-l18 mg kg^{-1} (Tacon and De Silva, 1983). Other signs of zinc deficiency are eye lens cataract and erosion of fins and skin (Ogino and Yang, 1979; Hughes, 1985). Appetite was reduced, resulting in low growth, low bone zinc and calcium levels and serum zinc concentration (Gatlin and Wilson, 1983). Zinc deficiency also has been found to impair immunological responses in rainbow trout (Kiron *et al*., 1993). The gills and gastrointestinal tract are involved in the uptake of this element. Spray *et al.* (1988) noted that uptake of zinc from water took place mainly through the gills, irrespective of dietary intake. The intestine is potentially the most important route of zinc absorption, yet little is known regarding this uptake pathway for zinc in fish (Glover and Hogstrand, 2003). The absorption and utilization of zinc may be affected by the chemical form of zinc in the diet, the source of protein and the presence of other dietary components such as calcium, phosphorus and phytic acid. Growth when compared among rainbow trout fed dietary zinc compounds at 20 mg Zn kg^{-1}dietary levels recorded highest with zinc sulphate and lowest in fish fed zinc chloride. The poor absorption of zinc is also associated with high amounts of hydroxyapatite mainly as tricalcium phosphate common in white fishmeal (Satoh *et al*., 1987). Gatlin and Wilson (1984) also made similar observations and had to supplement 150 mg Zn kg^{-1} in a practical catfish diet. Glover and Hogstrand (2003), Satoh *et al*. (1987) investigated the zinc antagonistic effect of tricalcium phosphate employing semi-purified diet and the high digestibility decreased markedly. Porn-Ngam *et al*., (1993), identified dicalcium phosphate containing diet performing better than the mono and tri calcium phosphate. Porn-Ngam *et al.* (1993) showed that a 1:1 ratio between calcium and phosphorus was best. Richardson *et al.* (1985) fed semi-purified diets containing various levels of calcium, phosphorus, zinc and sodium phytate to chinook salmon and noted that a high dietary phytic acid content (25.8 g kg^{-1}) depressed fish growth and feed performance. Satoh *et al*. (1989) observed a decreased weight gain and feed efficiency when phytic acid level elevated from 1.1

to 2.2% in channel catfish diets containing 50 mg Zn kg-^{1}. Gatlin and Wilson (1984) suggested that channel catfish required about 200 mg kg-^{1} when the diet contained about 1.1% phytic acid. In maintaining whole body zinc and serum zinc concentrations within the normal range, it was observed that the dietary zinc requirement of juvenile Atlantic salmon is between 37 and 67 mg Zn kg^{-1} dry diet (Maage and Julshamn, 1993). Differences exist in the zinc availability from feedstuffs of plant and animal origin (Lech and Reigh, 2012). When zinc occurs at higher levels than normal, it can act as a pollutant (Agrawal and Srisvastava, 2003; Gupta and Srisvastava, 2006).

MATERIALS AND METHODS

Experimental design

This study was conducted to determine the effect of dietary zinc on growth, haematology and serum biochemistry of African catfish (*Clarias gariepinus*) juvenile. This was performed by grading dietary zinc at 40% crude protein practical diets from the following ingredients (Table 1). African catfish (*Clarias gariepinus*) juvenile were obtained from Aquatech Fisheries Institute Ibadan. Fish of average weight between 10 and 15g respectively were placed under laboratory conditions in fish holding tanks and left unfed for 2 days to adapt to changes in the environment before feeding them with controlled diet. A total of 180 juvenile fish were sorted out on the third day and placed into 6 equal groups of 3 replicates each with 10 fish per tank at an average weight of 12.5g with 25 litres of water in each tank. They were fed control diet for 14 days in order to acclimatize them to the experimental conditions. Fish were fed graded levels of zinc nutrient (5.46, 10.93, 16.40, 21.86, and 27.33 mg Zn kg^{-1}) dry diets respectively for 10 weeks. Feeding of the experimental fish was at 5% of their body weight twice daily (morning and evening) while water exchange was twice in a week with freshwater from deep well. Zinc concentrations of the freshwater from the deep well before and after use were measured. Growth performance in the different treatments was measured bi-weekly throughout the duration of the study. Fish blood was pooled at the beginning of the experiment and from each treatment at the end of the experiment for haematology and serum biochemistry analysis.

Diet Preparation

The practical diet was formulated from: Fishmeal, groundnut cake, soybean meal, yellow maize, vegetable oil, vitamin premix, zinc free mineral premix and zinc mineral respectively (Table 1).

Zinc supplemented diets was formulated by dissolving the minerals in warm water thereafter mixing with prepared starch before mixing it homogenously to the feed ingredients respectively. To achieve the required graded levels of zinc nutrient in the diets, various milligrams of zinc sulphate (reagent grade) were weighed using the sensitive balance (PW 124 Æ Adams$^{(R)}$) from the University of Ibadan central laboratory at 15, 30, 45, 60, 75 mg respectively. The zinc contents of the practical diets were determined by Buck 211 Atomic Absorption Spectrophotometry at a wavelength of 232nm and a slope of 1.

Table 1: Gross and proximate composition of experimental diets

Ingredients	Diet $_1$ 0mg /kg	Diet $_2$ 5.46mg/kg	Diet $_3$ 10.93mg/kg	Diet $_4$ 16.40mg/kg	Diet$_5$ 21.86mg/kg	Diet $_6$ 27.33mg/kg
Fish meal	25.84	25.84	25.84	25.84	25.84	25.84
Soya bean meal	25.84	25.84	25.84	25.84	25.84	25.84
G/nut cake	12.92	12.92	12.92	12.92	12.92	12.92
Yellow Maize	25.41	25.41	25.41	25.41	25.41	25.41
Vegetable Oil	4.00	4.00	4.00	4.00	4.00	4.00
Dicalcium phosphate	0.50	0.50	0.50	0.50	0.50	0.50
Zinc-free mineral mix*	2.00	2.00	2.00	2.00	2.00	2.00
Vitamin mix*	2.00	2.00	2.00	2.00	2.00	2.00
Binder (Cassava)	1.50	**1.49454**	**1.48907**	**1.4836**	**1.47814**	**1.47267**
Zinc mineral	0.00	**0.00546**	**0.01093**	**0.0164**	**0.02186**	**0.02733**
Total%	100.00	100.00	100.00	100.00	100.00	100.00
Proximate composition (%)						
Protein	36.89	36.89	36.89	36.89	36.89	36.89
Fat	7.81	7.81	7.81	7.81	7.81	7.81
Ash	6.77	6.77	6.77	6.77	6.77	6.77
Fibre	6.49	6.49	6.49	6.49	6.49	6.49
M.C	9.67	9.67	9.67	9.67	9.67	9.67
NFE	32.40	32.40	32.40	32.40	32.40	32.40
Zn	1.18	6.64	12.11	17.58	23.04	28.51

Zn = mg kg-1

*Biovita fish vitamin and minerals providing per kg of diet: 20,000 i.u., Vitamin A, 300 i.u, Vit. E 800mg, Ascorbic acid 100mg, Vit. D3 200mg Vit. E 8 mg, Vit. K3 20mg, Vit. B3 60mg, Vit. B6 300mg, Biotin 15 mg, Vit. K 200mg, Cobalt 40mg, Iron 5.0mg, Iodine 30mg, Manganese 5mg, Copper 5mg, Lysine 10mg, Methionine 10 mg.

Growth and nutritional performance
The average weight, total length, standard length, and head length of fish from each tank was measured every 2 weeks throughout the 10 weeks duration of the experiment.

Haematology
Blood sample was pooled from fish at random at the beginning of the experiment and at the end from each group 20 hours after the final feeding. These samples were pooled to obtain one composite sample per treatment. Blood samples were collected into centrifuge tubes by cardiac puncture from the experime ntal fish using syringe fitted with needle (0.5mm diameter) and divided into two equal parts. To one part ethylene diamine tetraacetic acid (EDTA) was added to avoid the blood samples from clotting and the fol lowing were carried out; red blood cell (RBC) counts described by Schalm *et al.* (1975), white blood cell (WBC) counts, differential packed cell volume (% PCV) described by Jain (1986) and haemoglobin (Hb) concentration Mitruka and Rawnsley (1977). Using the above data, mean cell volume (MCV), mean cell haemoglobin (MCH) and mean cell haemoglobin concentration (MCHC) were calculated as described by Jain (1986).

To the second part serum biochemistry was determined as follows; Albumin was determined as described by Weis (1965), Alanine Aminotransferase (ALT) and AspartateAminotransferase (AST) was determine d as described by Reitman *et al.,* (1957), Creatinine was determined as described by Bartels and Bohmer (1964) and zinc concentration was determined by Buck 211 Atomic Absorption Spectrometry at a wavele ngth of 232nm, using hollow cathode and standardizing with zinc stock solution of 1ppm concentration.

Water quality assessment
The water quality parameters determined in the experiment were the DO, pH, Temperature, Zinc and Calcium ions in the water.

Statistical Analysis
Data obtained after the period of this study were the average weight and length of fish, differences in the amount and changes in blood cells concentration and was subjected to ANOVA and further comparison between pairs of means was determined using fisher s least significant difference (LSD).

RESULTS
Growth performance and physiological effect of graded levels of dietary zinc fed to African catfish (*Clarias gariepinus*) juvenile blood and serum biochemistry were investigated. Water quality was monitored throughout the period of the study and the results showed that all parameters were within the required and tolerable ranges for catfish.

Fish growth parameter
The results for the growth parameters for *Clarias gariepinus* juvenile fed graded levels of dietary Zinc are presented in Table 5. The results for the mean weight revealed that there are no significant variations in mean weight of the fish fed graded levels of dietary zinc since $P>0.05$. However the mean weight for the diet increased with respect to dietary Zinc inclusion (Figure 1). Fish fed with Diet 3 had the highest mean weight and this was followed by fish fed with Diet 2. The minimum mean weight was recorded from the fish fed with Diet 6. The results for the total length (TL) revealed that there are significant

variations in the mean total length of the fish fed with different diets and in different weeks as $P<0.05$ respectively. The results for the TL showed that the mean values for the fish fed with Diet 2, 3 and 6 had no significant variations among each other, but differ significantly from those fed on Diet 1. Similarly, the values for the fish fed with Diets 1, 4 and 5 had no significant variations among each other. The fish fed Diet 6 had the highest mean TL. The minimum value was recorded for fish fed with Diet 1. The SGR, FCR, GFCE, F.I and RGR, also showed no significant variations among fish fed graded levels of dietary zinc.

Table 2: Growth and nutritional parameters of *Clarias gariepinus* fed graded levels of dietary zinc for 12weeks

Parameter	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	SEM
	0mg/kg	5.46mg/kg	10.96mg/kg	16.40mg/kg	21.86mg/kg	27.33mg/kg	
Initial weight	12.5	12.5	12.5	12.5	12.5	12.5	0.00
Mean weight	21.34^{a}	21.83^{a}	21.86^{a}	21.39^{a}	21.19^{a}	19.80^{a}	0.308
TL	14.83^{a}	15.73^{b}	15.74^{b}	15.45^{ab}	15.18^{ab}	15.78^{b}	0.156
SGR	0.471^{a}	0.511^{a}	0.500^{a}	0.480^{a}	0.495^{a}	0.531^{a}	0.008
FCR	3.3^{a}	2.9^{a}	7.4^{b}	1.7^{c}	1.8^{c}	2.1^{c}	0.088
GFCE	142^{a}	189^{a}	153^{a}	171^{a}	212^{a}	230^{a}	13.9
PER	0.0765^{a}	0.0816^{a}	0.0800^{a}	0.0770^{a}	0.0785^{a}	0.0878^{a}	0.002
P.I	39.03^{ab}	40.35^{ab}	40.92^{ab}	40.23^{ab}	39.25^{ab}	37.18^{a}	0.547
RGR	17.0^{a}	18.6^{a}	18.1^{a}	17.3^{a}	17.9^{a}	18.9^{a}	0.299
C.F	0.663^{a}	0.580^{b}	0.570^{b}	0.593^{b}	0.608^{b}	0.524^{c}	0.019
F.I	9.33^{a}	9.37^{a}	9.48^{a}	8.75^{a}	8.79^{a}	8.66^{a}	0.15
Weight gain	2.89^{a}	3.11^{a}	3.10^{a}	2.94^{a}	3.09^{a}	2.78^{a}	0.056

N.B: Means with the same alphabets as superscripts on the same row are not significantly different from each other ($P>0.05$)

Legend

TL = Total length
SGR =Specific growth rate
FCR = Feed conversion ratio
PER = Protein efficiency ratio
P.I =Protein intake
RGR = Relative growth rate
C.F = Condition factor
F.I = Feed intake

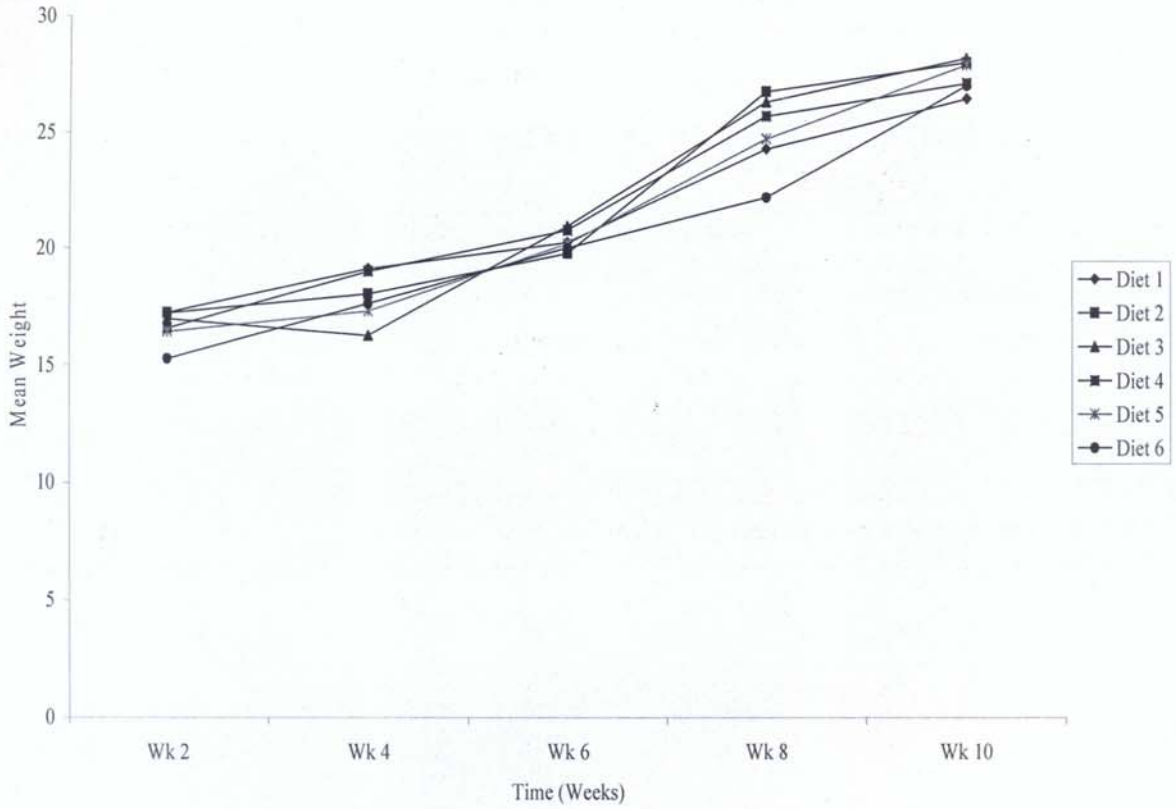

Figure 1: Trend in mean weight with respect to dietary zinc inclusion

Blood biochemistry

The PCV revealed that there are no significant variations among the values for the fish fed with Diets 3, 4 and 5. There are also no significant differences among the values for fish fed with Diets 1 and 6. However, there are significant differences among fish fed with Diets 1, 2 and 3. Fish fed with Diet 2. had the highest PCV value and the minimum PCV value was recorded in fish fed with Diet 1.

The haemoglobin (Hb) values for fish fed with Diets 1, 2, 3, 4 and 6 showed significant differences among each other, while Diets 4 and 5 showed no significant differences among each other. Fish fed with Diet 2 had the highest Hb value and the minimum value was recorded in fish fed with Diet 1.

For Red Blood Cell (RBC), fish fed with Diet 3 and 4 showed no significant differences, and Diet 4 and 5 also showed no significant differences. However, the values for fish fed with Diets 1, 2, and 3 showed significant differences among each other. The highest value was recorded in Diet1 followed by 3 and 6 with the same values, while the minimum value was recorded in Diet 2.

The Mean Cell Volume (MCV) showed that fish fed with Diet 4 and 5 had no significant differences, while fish fed with Diets 1, 2, 3 and 6 showed significant differences, with Diet 2 showing the highest value, followed by Diet 5 and while the minimum value was recorded in Diet 1.

The Mean Cell Haemoglobin Concentration (MCHC) showed that there are significant differences amon g all the fish fed different Diets with the highest value in Diet 2 and the minimum value in fish fed with

Diet 1.The results for mean cell haemoglobin (MCH) showed that there are no significant differences am ong fish fed with Diets 3, 4 and 5, while fish fed diets 1, 2 and 6 showed significant differences among each other.

Table 3: Blood biochemistry parameters of *Clarias gariepinus* fed graded levels of zinc diet for 12 weeks

Parameter	Initial	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	SEM
		0mg/kg	5.46mg/kg	10.96mg/kg	16.40mg/kg	21.86mg/kg	27.33mg/kg	
PCV (%)	25.00	27.00^{a}	31.00^{b}	30.00^{c}	30.00^{c}	30.00^{c}	27.00^{a}	0.703
HB (g/dl)	8.30	8.26^{a}	10.37^{b}	9.67^{c}	9.40^{d}	9.47^{d}	8.67^{e}	0.297
RBC ($10^{6}/mm^{3}$)	2.21	3.72^{a}	3.44^{b}	3.62^{c}	3.54^{cd}	3.53^{d}	3.62^{c}	0.0394
MCV (fl)	1131.22	725.77^{a}	890.77^{b}	828.69^{c}	847.42^{d}	849.82^{d}	737.37^{e}	27.2
MCHC (%)	33.20	30.59^{a}	33.54^{b}	32.30^{c}	31.30^{d}	31.63^{e}	32.19^{f}	0.411
MCH (Pg)	3.76	2.18^{a}	2.95^{b}	2.64^{c}	2.62^{c}	2.65^{c}	2.34^{d}	0.110
WBC ($10^{3}/mm^{3}$)	32.40	15.17^{a}	10.61^{b}	18.77^{c}	15.17^{a}	23.27^{d}	11.27^{e}	1.94
Hetro. (%)	27.00	31.00^{a}	28.00^{b}	29.00^{c}	24.00^{a}	31.00^{d}	32.00^{e}	1.19
Lymph.(%)	71.00	62.00^{a}	65.00^{b}	65.00^{b}	72.00^{c}	63.00^{d}	62.00^{a}	1.54
Mono.	1.00	2.00^{a}	3.00^{b}	3.00^{b}	2.00^{a}	3.00^{b}	2.00^{a}	0.224
Eosi	1.00	4.00^{a}	3.00^{b}	3.00^{b}	2.00^{c}	3.00^{b}	4.00^{a}	0.307
Baso	0.00	1.00^{a}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.167
Platelet	110,000	$94,000^{a}$	$100,000^{b}$	$153,000^{c}$	$98,000^{a}$	$110,000^{d}$	$103,000^{e}$	8939

N.B: Means with the same alphabets as superscripts on the same row are not significantly different from each other (P>0.05)

Legend

Hb = Haemoglobin
RBC = Red blood cell
MCV = Mean cell volume
MCHC = Mean cell haemoglobin concentration
MCH = Mean cell haemoglobin
WBC = White blood cell

The results for white blood cell (WBC) showed that fish fed with Diet1 and 4 had no significant differences but fish fed with Diets 2, 3, 5 and 6 showed significant differences. The highest values were recorded in those fed on Diet 3 and the minimum value in those fed with Diet 2.

The Neutrophil showed no significant differences among fish fed with Diets 1 and 4, while those fed with Diets 2, 3, 5, and 6 showed significant differences. The highest value was recorded in fish fed with Diet 6 and the minimum value in fish on Diet 4.
The Lymphocyte values showed no significant differences among fish fed on Diets 1 and 6, also fish fed on Diets 2 and 3 were not significant differences. The highest value was recorded in fish fed Diet 4 while the minimum values were in fish fed with Diets 1 and 6 respectively.

Serum biochemistry
As presented in Table 7, the serum biochemistry revealed that there are significant variations in the serum total protein (T.P) among fish fed on all the Diets, with the highest values in fish fed Diet 4 and the minimum values in fish fed Diet 2.

The results for the Albumen showed that there are no significant variations among fish fed Diet 2 and 5, while fish fed Diet 1, 3, 4 and 6 shows significant difference among each other. The highest value is recorded in fish fed Diet 1, followed by fish fed diet 5 with the minimum value in fish fed Diet 3.

The values for Urea showed no significant difference among fish fed diet 1 and 2, also fish fed diet 4 and 5 showed no significant difference. There are significant variations in fish fed Diet 3 and 6. The highest value recorded is in fish fed Diet 6 and the minimum in fish fed Diet 3.

The values for Aspartate aminotransferase (AST) revealed that there are significant variations among all t he fishes fed graded levels of zinc Diet with the highest value recorded in fish fed Diet 1 and the minimu m in fish fed Diet 2. The values for Alanine aminotransferase (ALT) also revealed that there are significa nt differences among all the fishes fed graded levels of zinc Diet, with the highest value recorded in fish f ed Diet 1 and the minimum value in fish fed Diet 5 followed by fish fed Diet 6.
The values recorded for Cholesterol showed that there is no significant variations among fish fed diet 1 and 3 while diet 2, 4, 5 and 6 showed significant variations. The highest value is shown in fish fed diet 1 while the minimum value was recorded in fish diet 2. The result for serum Glucose showed that there are no significant variations among fish fed Diet 1 and 2, while fish fed Diet 3, 4, 5 and 6 showed significant variations, with the highest values in fish fed Diet 4 followed by Diet 3 and the minimum values in fish fed Diet 5 followed by Diet 6.

The results for Serum Zinc and Calcium revealed that there are significant variations among all the Diets with highest values in fish fed Diet 6 and the minimum values in the fish fed Diet 1.

Table 4: Serum parameters of *Clarias gariepinus* juvenile fed graded levels of zinc diet for 12weeks

Parameter	Initial	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	SEM
		0mg/kg	5.46mg/kg	10.96mg/kg	16.40mg/kg	21.86m/kg	27.33mg/kg	
T.P (g/dl)	3.18	3.51^{a}	3.06^{b}	3.17^{c}	3.55^{d}	3.26^{e}	3.48^{f}	0.083
Alb. (g/dl)	1.17	1.36^{a}	1.27^{b}	1.13^{c}	1.33^{d}	1.28^{b}	1.32^{e}	0.033
Urea (mg/dl)	1.25	4.16^{a}	4.16^{a}	3.67^{b}	4.62^{c}	4.62^{c}	5.09^{d}	0.202
Creat.(mg/d)	0.75	4.62^{a}	4.52^{b}	5.16^{c}	5.47^{d}	4.63^{a}	4.32^{e}	0.178
AST. (U.I/I)	229.31	151.82^{a}	94.24^{b}	120.41^{c}	89.52^{d}	116.22^{e}	96.85^{f}	9.53
ALT. (U.I/I)	58.4	16.83^{a}	16.48^{b}	15.27^{c}	14.91^{d}	9.92^{e}	10.29^{f}	1.25
Chol.(mg/dl)	144.94	139.02^{a}	117.38^{b}	139.67^{a}	133.77^{c}	131.77^{d}	136.39^{e}	3.36
Gluc.(mg/dl)	39.24	40.65^{a}	41.46^{a}	44.99^{b}	55.28^{c}	19.51^{d}	37.13^{e}	4.79
Ca (mg/dl)	11.29	9.22^{a}	8.77^{b}	9.67^{c}	10.25^{d}	10.04^{e}	10.29^{f}	0.249
Zn (mg/ml)		14.00^{a}	13.00^{b}	16.00^{c}	21.00^{d}	18.00^{e}	23.00^{f}	1.61

N.B: Means with the same alphabets on a row as superscripts are not significantly different from each other (P>0.05)

Legend

T.P = Total protein
Alb. = Albumin
Creat. = Creatinine
AST = Aspartate aminotransferase
ALT. =Alanine aminotransferase
Chol. = Cholesterol
Gluc. = Glucose
Ca = Calcium
Zn = Zinc

DISCUSSION

Growth and Nutritional performance

Dietary zinc supplementation has been associated with many benefits both as a growth promoter (Tan and Mai, 2001), chemotherapy (John *et al*., 2012), reproductive enhancer and disease resistance (Chhorn *et al*., 2011) in animals and its uses cut across human, terrestrial and aquaculture nutrition. This study attempted to investigate the African catfish *Clarias gariepinus* juvenile's growth, haematology and

serum biochemistry response to fed graded levels of practical dietary zinc. The mean weight of fish fed dietborne zinc nutrients revealed that there were no significant differences in growth responses of *Clarias gariepinus* juvenile fed practical diet with graded levels of zinc inclusions of 0, 5.46, 10.96, 16.40, 21.86, and 27.33 mg Zn kg^{-1}. This result agrees with the results of Huang *et al.* (2010) that showed no significant differences ($P > 0.05$) in weight gain, feed conversion ratio (FCR) and protein efficiency ratio (PER) among the dietary treatments. It also showed a relationship with other research works on zinc requirements for feeding channel catfish, blue tilapia (*Oreochromis aureus*), Japanese eels (*Anguilla japonica*) or Atlantic salmon with practical diets of approximately 100–200 mg Zn kg^{-1} dry diet.

For a wide range of fish species, dietborne zinc concentrations approximately 20 mg Zn kg^{-1} diets were sufficient in a semi purified diet as long as the daily ration provided zinc doses of approximately 0.3–4 mg kg^{-1} body $weight^{-1}$ (Clearwater *et al.*, 2002). Ayyat *et al.*, (2012) reported an average daily weight gain of 22.52, 54.95 and 38.74% respectively in fish fed practical diets supplemented with 25, 50 and 100 mg Zn kg^{-1} of diet, with the highest weight gain in Nile tilapia fed practical diet at 50mg Zn kg^{-1} dry diet. The reasons for the high dietary zinc inclusions in fish feed by some of the researchers as mentioned above were because of the high percentage of Phytic acid in plant ingredients which had the tendency of inhibiting the bioavailability of zinc in the diets. A typical Catfish diets is said to constitute more than 90% of plant ingredients (Reigh and Yan, 2001). This could actual be one of the major reasons why no significant differences in weight gain were recorded in the fishes fed practical diets in this study. As a result, much of the zinc research has been focused on factor that influences dietborne zinc bioavailability which is strongly affected by diet composition especially at low concentrations (Clearwater *et al.*, 2002). Some forms of dietborne phosphates have also been associated with reducing the bioavailability of dietborne zinc (Clearwater *et al.*, 2002) and this also suggests why higher levels of zinc inclusion for better results are desired. To support the reason for the no significant differences in the weight gain with incremental levels of dietary zinc in this present study, zinc content of the water quality result indicated that, there was an increased in the levels of zinc in the water from 0.027mg/l to 0.046mg/l after period of water exchange. This was a clear indication that the fishes were not optimally utilizing the zinc from the diets as required due to some factors that are capable of inhibiting the bioavailability of zinc such as phytic acid from plant ingredients (Lech and Reigh, 2012), dietborne calcium-phosphate ratio (Glover and Hogstrand, 2003; Porn-Ngam *et al.*, 1993) and perhaps the intestinal lining of the experimental catfish (Glover and Hogstrand, 2003). This result shows similar trend with the result of Porn-Ngam *et al.* (1993), where dietary phosphorus unbalanced the calcium-phosphorus ratio by depressing growth, affecting the availability of zinc and manganese.

Fish blood biochemistry

Dietary zinc inclusions altered the haematological parameters of the fish in this present study, and this is as observed by Ekrem *et al.* (2013). In this study, *Clarias gariepinus* juveniles fed graded levels of dietborne zinc showed an increase in values for Hematocrit and RBC with significant differences to the initial values and diet 1(control), while values for the other dietary inclusions were slightly not different from each other. On the contrary, Ekrem *et al.* (2013) reported a decrease in the values of Hematocrits with high concentrations of zinc and an increase with low and medium zinc concentrations.

The values for the lymphocytes and heterophil in this study reflected a relative decline with increase in the levels of dietary zinc inclusion. This was perhaps an indication that neither was the dietary zinc sufficient to boost growth nor bioavailable for the fishes, and this is supported by some research works on Tilapia and African catfish *Clarias gariepinus* (Osman *et al., 2010*). Contrary to the above report, a

short term exposure to low concentrations of heavy metals mostly induces an increase of haematological indices (Olurin *et al*., 2012). Generally the values for fish fed zinc diets in this study were higher than the initial values. The white blood cell (WBC) values showed a slight decline with increasing dietary zinc inclusion. This indicated that the dietary zinc in this study did not reach any levels adverse to fish health. This was anticipated with the low bioavailability of zinc in the diets and is supported by previous research works on dietborne trace elements (Glover and Bury, 2004).

Fish serum biochemistry

The values for the serum total protein (T.P) and Albumin in this study were significantly different among the diets with slight increases with incremental levels of dietborne zinc. Urea and Creatinine values were significantly different among the diets with slight increase with incremental levels of dietary inclusions. This perhaps was as a result of some stress among the fish fed diets in the course of the experiment, and it is in line with the findings of Mona *et al*. (2013). Cholesterol and Glucose levels among fish fed graded levels of dietborne zinc were significantly different among the diets with cholesterol decreasing in values as dietary zinc inclusion increases. The lowering of cholesterol may be attributed to an increase in lipid utilization for meeting additional energy requirements to mediate stress as suggested by Srisvastava *et al*. (2002) in *Channa punctatus*, Sindhe *et al.* (2002) in *N. notopterus*. AST and ALT values decreased along the diets with the highest values in the control diet. This result did not align with the reported result of Mona *et al.* (2013) where African catfish *Clarias gariepinus* fed 15 mg kg^{-1} zinc oxide showed a significant increase in AST, ALT and Choleleterol levels in the blood of *Clarias gariepinus.* This could be due to the form of zinc used which influences the bioavailability of dietary zinc for fish. The values for Calcium and Zinc levels in the serum increased with increased zinc inclusions and this was indicated in the level of zinc deposition in the fish blood. However, Lange and Ausseil, (2002) reported that exposure of trout to zinc did not result in significant elevation in the tissue levels of zinc.

CONCLUSION AND RECOMMENDATION

African catfish *Clarias gariepinus* fed graded levels of dietborne zinc in a practical diet at concentrations ranging from 0 to 27 mg Zn kg^{-1} showed no significant variations in growth responses. However, there were growth responses with respect to dietary zinc inclusions along the weeks in the fish fed graded levels of dietary zinc with optimum values recorded in diet 5 (21.86mg Zn kg^{-1}), while minimum value recorded in diet 1 (control) and 6 (27.33 mg Zn kg^{-1}). Fish fed dietary zinc had slightly altered haematology and serum biochemistry among the fish fed practical diets in response to dietary zinc. The gradual increase in the levels of serum zinc as dietary zinc increases with a corresponding rise in zinc levels of the culture water after water exchange raises concern about the possible low bioavailability of the dietary zinc in the practical diets. Therefore, it should be recommended that research work be focus on the factors that arrest the bioavailability of micronutrients that would be required by catfish in a plant based diet to reduce the effect of anti-nutritional factors in fish diets for optimum growth.

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