EFFECT OF DIFFERENT LEVELS OF ALPHA-TOCOPHEROL ACETATE ON GROWTH AND FAT COMPOSITION *CLARIAS GARIEPINUS* FINGERLINGS

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ABSTRACT

The effect of different levels of alpha-tocopherol acetate (Vitamin E) on growth performance, visceral fat and proximate composition of Clarias gariepinus fingerlings was investigated for 58 days. The results showed that final weight and total length was higher in fingerlings fed 300 mg/kg of vitamin E diet, while mean body weight gain, specific growth rate, relative growth rate, and average daily weight gain were higher in fish fed with 0 mg of vitamin E per kilogram of feed. Visceral fat escalated with an increase in the quantity of Vitamin E in the diet, though there was no significant difference (p>0.05) between the visceral fat among all the treatments. Similarly, crude protein of the fingerlings continues to increase with an increase in the quantity of vitamin E. However, there was a slight decrease in the muscle fat composition of the fingerlings with an increase in the quantity of vitamin E in the diet. Vitamin E has little or no effect on the reduction of visceral fat in fingerlings of Clarias gariepinus, though fish fed with 300 mg/kg of vitamin E diet have lower muscular fat content.

Key words: Alpha-tocopherol acetate, growth and fat composition, Clarias gariepinus, fingerlings

INTRODUCTION

African catfish *Clarias gariepinus* is an important food fish in Nigeria. They are widely cultured in Africa and Europe and lately in India, China, Brazil and some East European countries (Aluko and Ali 2001). *Clarias gariepinus* is generally considered to be one of the most important tropical catfish species for aquaculture in Nigeria. It is choice culturable species because, it is characterized by hardiness, rapid growth, resistance to diseases, high economic potential, ability to grow on wide range of food, ability to withstand low dissolved oxygen and adverse environment condition where other culturable fish species cannot survive (Aluko and Shaba 1999). They are also liked by the consumers because they are scaleless fish and possess few born compared to other culturable fish species.

Too much fat in reared fish predisposes the fish to stress which reduces the strength of the immune system. High fat in fish body may affect the quality and quantity of viable eggs and milt content of the brood fish. Eyo (1994) also noted that, too much fat is not desirable in fish feed because it can cause an imbalance of protein and binding of the feed components during pelleting. To avoid excessive oxidation of fats, antioxidant such as alpha-tocopherol has been recommended at optimum level during fish feeds formulation (Eyo 1994). Fish fed high fatted feed has been suggested to reduce fish growth, actual amount of fish flesh and

protein content of the fish (Eyo 1994).

Higher content of this lipid-soluble vitamin in fish feed has been suggested to increase egg size, which in turn has been correlated with larger larval size and better survival (Palace and Werner 2006). Tabachek (1992) reported that, a significantly higher proportion of male fish (Artic char) fed higher concentration of 600mg vitamin E/kg of feed produced milt in two successive spawning seasons. This higher concentration of vitamin E was also reported by the same author to produced higher fecundity (8305 eggs) in the second year.

Vitamins and other nutrients are essential for the proper function of the immune system. There is certainly a lot of attention given to the role of vitamins in the health of humans and other animals. However, according to Barim (2009), vitamin E is an indispensable nutrient required to maintain normal health and life functions, such as growth, development and reproduction in fish. Wilson *et al* (1984), also reported that vitamin E when incorporated into catfish feed at optimum level reduced mortality caused by certain bacterial diseases. It is usually supplemented in fish feed as alpha-tocopherol acetate with the aim of improving fish growth, survival rate and fish flesh quality, which consequently reduce fat composition (Yildiz 2004). There has been conflicting reports on the amount of alpha-tocopherol acetate that should be taken by fish to elicit a fat reduction response in fish (Robinson *et al.* 1997). Vitamin E, a fat-soluble vitamin is an antioxidant involved in the metabolism of all cells. According to Obikoya (2009), Vitamin E protects essential fatty acids from oxidation in the body cells as well as prevents breakdown of body tissues. Fish have built up extensive defense systems against this oxidation, consisting of antioxidant enzymes, endogenous antioxidant, and nutritional antioxidants such as alpha-tocopherol acetate and carotene oils (Barim 2009).

Alpha-tocopherol acetate (ATA) reacts with the lipid peroxide radical produced by a cycle of auto oxidation preventing it from react with a new polyunsaturated fatty acid (PUFA) (Erisir *et al*. 2006). Vitamin E is also regarded as a stable antioxidant with respect to oxidation during feed processing and storage (Harlioglu and Barim 2004; Barim 2009).

Effects of high dietary alpha-tocopherol acetate on fat composition and flesh quality have been demonstrated by several authors (Chaiyapechara *et al*. 2003; Yildiz 2004; Barim 2009). Diverse authors have suggested different dosages of vitamin E to be incorporated into fish diet. Yildiz, (2004) suggested 370mg/kg for rainbow trout (*Oncorchynchus mykiss*), Wilson *et al*. (1984) recommended 100mg/kg for channel catfish (*Ictalurus punctatus*) (1984), Zhang *et al.* (2007) recommended 500mg/kg was recommended by for *Sparus macrocephalus,* while Huang and Huang (2004) 62.5 IU for *Oreochromis niloticus* x *Oreochromis aureus*. Wilson *et al*. (1984) observed that dietary vitamin E requirement of *Ictalurus punctatus* increased when they were fed diets containing higher level of polyunsaturated fatty acids. They also observed high mortality in channel catfish (*Ictalurus punctatus*) fed diets without supplements of vitamin E. The addition of 100mg/kg alpha-tocopherol acetate alone to the diets of the fish prevented disease deficiency syndromes in the presence of oxidized menhaden oil (Wilson *et al*. 1984).

The negative effects of vitamin E deficiency on the reproductive performance of higher vertebrates

have been demonstrated by (Palace and Werner 2006). Dietary vitamin E has shown to be an important nutrient for fish reproduction with its deficiency resulting in immature gonads in freshwater crayfish and reduced hatching rates and fry survival (Harlioglu and Barim 2004). However, vitamin E supplementation at 150mg/kg in freshwater crayfish feed improved percentages of buoyant eggs, hatching rates and percentage of normal larvae (Barim 2009). Fernandez-palacious *et al*. (1998) found that egg viability and percentage of abnormal eggs improved with increasing dietary α-tocopherol level in gilthead Sea bream (*Sparus auratus*). According to Emata *et al*. (2000) broodstock fed dietary supplementation of vitamin E resulted in higher percentage of egg viability (> 90%), hatching and cumulative survival rates in the reproduction of milkfish (*Chanos chanos*).

Harlioglu and Barim (2004) reported that bigger and more eggs and stage-1 juveniles in freshwater crayfish (*Astacus leptodactylus*) were improved when fed diets supplemented with vitamin E (150mg/kg feed) before spawning. However, Erisir *et al*. (2006) established that the presence of vitamin E higher than 150mg /kg in the ovigerous crayfish and 100mg/kg in the females with stage - 1 juvenile in diets negatively affected the connective tissue formation by decreasing the muscle arginase activity. Barim (2009) reported that the use of 150mg /kg vitamin E for 72 days before breeding period resulted in a significant increase in the ovarian eggs number of freshwater crayfish (*Astacus leptodactylus*).

Lipid oxidation which is one of most serious problems has led to the development of vitamin E in fish feed to reduce fat build-up. To avoid excessive oxidation of fat, antioxidant such as ATA could be used to fortify fish feed with the antioxidant to produce lean fish flesh. The objective of this study is to investigate the effects of vitamin E (Alpha tocopherol acetate) on growth performance and visceral fat of *Clarias gariepinus* fingerlings with the view to reduce fat deposition in species.

MATERIALS AND METHODS

The experiment was conducted at Department of Fisheries Alau, University of Maiduguri, Nigeria, between December 2009 to February 2010.

Experimental fish

Two hundred fingerlings of *Clarias gariepinus* (142.60 ± 16.33 g to 152.06 ± 4.26 g) were collected from fish hatchery complex of Department of Fisheries, and conditioned for two weeks in polythene lined nursery ponds (2m x 2m x 1.2m). During the acclimatization, fish were fed with commercial diet (42% crude protein) two times daily at 5% of their body weight.

Preparation of alpha-tocopherol

Alpha-tocopherol tablet (Teva pharmaceutical Industries limited, Petah – Tikva) obtained from a pharmaceutical Chemist in Maiduguri were grounded into powder and were added into diet of the fingerlings at the following levels: 0 mg/kg, 200 mg/kg, 300 mg/kg, and 400 mg/kg (table 1). Proximate composition of the diets (table 1) after addition of ATA was carried out following (AOAC 1999).

Fifteen *Clarias gariepinus* fingerlings (142.60 ± 16.33 g to 152.06 ± 4.26 g) were assigned to each of the treatment (ATA based diet). The treatments were allocated to twelve hapa (1.2m x 1.2m x 1.2m) installed in 11m x 10m x 1.2m concrete tank. The experiment was conducted in triplicates.

The fish were fed with the ATA base diets twice daily (morning 8.00am and evening 5.00pm local time) at 5% of their body weight. The quantity of feed was adjusted bi-weekly after each weighing. At each weighing time, the hapa were washed to allow proper aeration. The experiment lasted for 58 days. Weight were recorded using a top loading sensitive electric balance (Metler Tolardo - 500) as well along side final total length were measured using measuring board and survival. Weight gain (WG), survival rate (SR), specific growth rate (SGR), relative growth rates (RGR), average daily growth rate (ADGR) and condition factor (CF) were determined according to (Yildiz 2004):

Weight gain = $W_1 - W_0$

Where W_1 = final weight, W_0 = initial weight

% SR = No of fish survived/Initial number stocked x 100

FCR = Weight of feed intake (g)/Weight gain of fish (g).

SGR = $\log_1 W_1 - \log_o W_o / t$ X 100%, where W_1 = finial body weight (g), W_o = initial body weight (g), t = Time in days.

CF = 100 x w/L^3, Where: W = final mean weight (g), L = final mean total length of fish (cm)

RGR = $W_1 - W_0 / W_0$, Where W_1 = final mean weight of fish (g), W_0 = initial mean weight (g)

ADGR = $(W_1-W_0)/t$, Where: W_1 = final average weight at the end of the experiment, W_0 = initial average weight at the beginning of the experiment, t = cultured period.

Body-fat –ratio (%) =Visceral fat weight (g)/ Fish weight (g) x100.

Three fish from each treatment were also collected and proximate compositions were carried according to (AOAC 1999). Three fish from each treatment were randomly collected, killed and the visceral fat extracted and weighed. Visceral fat – body fat ratio was determined as follows:

Vt-Bf (%) = visceral fat weight (g)/ Fish final weight (g) x100.

Water quality parameters

Water quality parameters such as temperature, pH and dissolved oxygen (DO) were monitored throughout the experiment. Temperatures were recorded using mercury in-glass thermometer, dissolved oxygen were measured using dissolved oxygen analyzer (Model: JPB-607) and pH was recorded using digital pen pH/Temperature meter (Model: EC 500 meter).

Table 1 Proximate composition and calculated nutrient

Experimental Diet	Inclusion level of alpha-tocopherol acetate			
Ingredient	**0mg**	**200mg**	**300mg**	**400mg**
Fish meal	34.00	34.00	34.00	34.00
Soybean meal	21.00	21.00	21.00	21.00
Groundnut cake	18.00	18.00	18.00	18.00
Maize	21.00	21.00	21.00	21.00
Wheat bran	5.00	5.00	5.00	5.00
Vegetable oil	1.00	1.00	1.00	1.00
Premix	0.50	0.50	0.50	0.50
Vitamin C	0.01	0.01	0.01	0.01
Total	**100**	**100**	**100**	**100**
Proximate composition of the diet				
Percentage calculated crude protein	40.00			
Analyzed percentage crude protein	38.91			
Percentage Fat	12.00			
Percentage Ash	6.00			
Percentage Moisture	10.00			
Percentage Crude fiber	3.00			
Metabolizable Energy kcal/g	19.30			

Data analysis

Data obtained from the experiment were subjected to analysis of variance (ANOVA). Differences between the means were determined using Duncan's multiple range tests, Duncan (1955) using SPSS.15 for windows.

RESULTS

Growth performance

Table 2 shows the growth performance of *Clarias gariepinus* fingerlings fed with different levels of ATA (vitamin E). Final mean weight (252.49 ± 0.30 g) obtained in fingerlings fed with 300mg/kg of ATA was significantly higher ($p<0.05$) the entire treatments. However, mean final weight values (234.76 ±15.34g) obtained from fingerling fed 0 mg/kg ATA was significantly different ($p<0.05$) from fish fed 300 mg/kg ATA. Similarly, there was no significant difference ($p>0.05$) between final mean weight of fingerlings fed 200 mg/kg ATA compared to those fed 400 mg/kg ATA.

The highest mean body weight gain was recorded in control (93.83 ± 2.99), followed by 75.30 ± 0.00 g observed in fingerlings fed 300 mg/kg of ATA. Mean body weight recorded in fish fed 400 mg/kg was negatively significantly lower than the rest of the treatment.

Table 2: Mean (±SEM) growth and survival of *Clarias gariepinus* fingerlings fed with various levels of alpha-tocopherol acetate (Vitamin E).

Growth parameters	Alpha-tocopherol inclusion levels			
	0mg/kg	**200mg/kg**	**300mg/kg**	**400mg/kg**
Initial weight (g)	142.60±16.33^{a}	146.03±14.28^{a}	145.03±16.00^{a}	152.06 ± 4.26^{a}
Final weight (g)	234.77±15.34^{ab}	161.74± 0.32^{bc}	252.49±0.30^{a}	119.80±46.38^{c}
Fish total length (cm)	17.96±0.53^{a}	16.13±0.08^{a}	18.30±0.00^{a}	17.23±1.16^{a}
Mean body wt. gain (g)	93.83±32.99^{a}	22.76±0.13^{c}	75.90±0.00^{ab}	-23.40±0.00^{b}
Specific growth rate (% /g)	0.89±0.33^{a}	0.26 ± 0.00^{b}	0.60±0.00^{ab}	0.24±0.00^{b}
Relative growth rate (%/day)	74.58±32.19^{a}	16.10±0.11^{b}	42.90±0.00^{ab}	15.03±0.00^{b}
Condition factor	0.56 ± 0.07^{a}	0.74 ± 0.01^{a}	0.71 ± 0.14^{a}	0.72 ± 0.05^{a}
Feed conversion ratio (%)	7.17 ± 3.78^{b}	14.25 ± 0.00^{a}	2.08 ± 0.00^{b}	15.10 ± 0.00^{a}
Survival rate (%)	48.86 ± 4.43^{a}	33.29 ± 0.00^{b}	46.70 ± 0.00^{a}	20.03 ± 6.66^{c}
Average daily weight gain(g)	1.4 1± 0.72^{a}	0.39 ± 0.00^{a}	1.11 ± 0.06^{a}	0.40 ± 0.00^{a}

Values in the same row bearing different super script are significantly different ($p<0.05$).

Average weight gain was higher in the control treatment, followed by those fed 300, 400 and 200 mg/kg ATA, respectively. The individual average weight gain and the average daily weight gain of *C. gariepinus* fingerlings fed diets with 0mg/kg, 200mg/kg, 300mg/kg and 400mg/kg ATA did not differ significantly ($p>0.05$) from one another (Table 2).

The highest specific growth rate (SGR) of 0.89 ± 0.33 was observed in fingerlings fed 0mg/kg ATA, followed by fingerlings fed 300 mg/kg ATA (0.60 ± 0.00) while lower (0.24 ± 0.00) value SGR was observed in fingerlings fed 400 mg/kg and 200mg/kg ATA (0.26 ± 0.00%/g). There was no significant difference ($p>0.05$) between SGR of fish fed 0 mg/kg of ATA compared to those in 300 mg/kg ATA. RGR was also higher (74.58 ± 32.19) in fingerlings fed 0mg/kg ATA followed by 42.90 ± 0.00 in fingerlings fed 300mg/kg ATA and 200mg/kg ATA (16.10±0.11) and the lowest value

(15.03±0.00%/g) was observed in fingerlings fed 400mg/kg.

Total length was slightly higher in fish fed 300 mg/kg, followed closely by fingerling fed 0 mg/kg, 400 mg/kg and 200 mg/kg ATA. All the treatment were statistically ($p>0.05$) the same in terms of total length.

Condition factor

Condition factor was observed to be higher in fish fed 200 mg/kg ATA, 400, 300 and 0 mg/kg ATA, respectively. No significant difference ($p>0.05$) was observed in the condition factors among all treatments.

Survival rate

Survival was significantly higher in fingerling fed 0 mg/kg ATA compared to those observed in fingerlings fed 200 and 400 mg/kg. There was no significant difference ($p>0.05$) between percentage survival rates in fish fed 0 mg/kg compared to fingerlings fed 300 mg/kg. However, survival rates of fingerlings fed 200 mg/kg were significantly higher than those fed 400 mg/kg of ATA.

Visceral fat and body-fat ratio

Fig. 1 shows the visceral fat and body-fat ratio of *C. gariepinus* fed different levels of alpha-tocopherol acetate (58 days). The visceral fat and body-fat ratio did not differ significantly from one another ($p>0.05$), it increased with an increase in the dosage of alpha-tocopherol acetate levels in the diets.

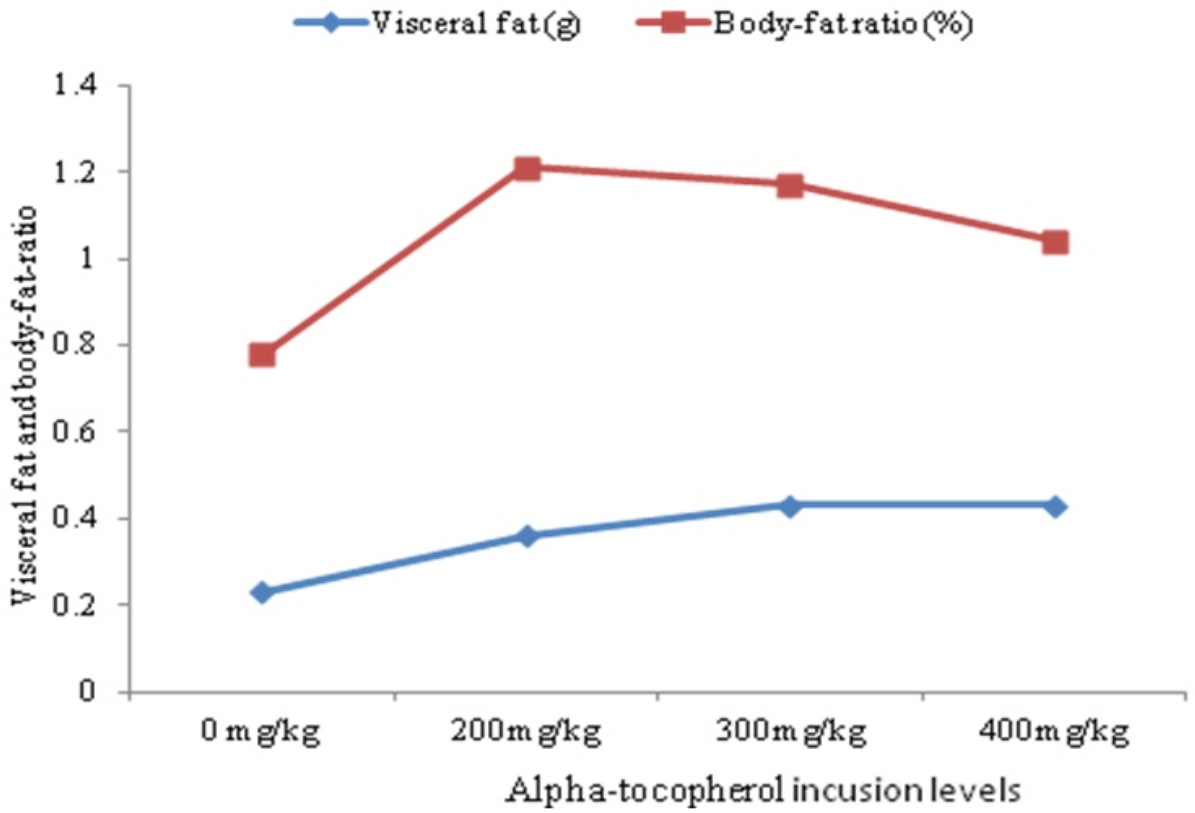

Fig. 1 Visceral fat and body-fat ratio of *C. gariepinus* fingerling fed with various levels of alpha-tocopherol acetate.

Crude protein content

Table 3 shows the proximate composition of *C. gariepinus* fed different level of Vitamin E. The highest crude protein (CP) was obtained in fingerlings fed with 400mg/kg (66.18%) ATA followed by fingerlings fed 300mg/kg (50.16%) ATA and 200mg/kg ATA (42.19%), while the lowest CP was observed in fingerlings fed with 0mg/kg ATA (39.39%). The percentage crude fat (CF) was higher (7.00%) in fingerlings fed with 0mg/kg ATA, followed by 6.00% recorded in both 200mg/kg and 400 mg/kg ATA, while the lowest was observed in fingerlings fed with 300mg/kg ATA (5.00%).

Table 3: Proximate composition of *C. gariepinus* fingerling fed with various level of alpha-tocopherol acetate (Vitamin E).

Parameter	Alpha-tocopherol inclusion levels			
	0mg/kg	200mg/kg	300mg/kg	400mg/kg
Crude protein (%)	39.39	42.19	50.16	66.18
Crude fat (%)	7.00	6.00	5.00	6.00
Crude fiber (%)	17.00	16.00	28.00	25.00
Dry matter (%)	95.20	86.80	76.60	57.50
Ash (%)	1.00	2.00	2.00	2.00
Moisture (%)	4.80	13.20	23.40	42.50

Dry matter

Dry matter was higher in fingerlings fed with 0mg/kg ATA (95.20%) followed by 200mg/kg and 300mg/kg ATA with 86.80% and 76.60%, respectively. The lowest dry matter value was observed in fingerlings fed with 400mg/kg ATA (57.50%).

Crude fiber

Fingerlings fed with 300mg/kg have the highest crude fiber value (28.00%) followed by 25.00%, 17.00% and 16.00% recorded in fish fed with 400mg/kg, 0mg/kg and 200mg/kg ATA respectively.

Ash content

The fingerlings fed with 200mg/kg, 300mg/kg and 400mg/kg ATA have the same percentage ash values of 2.00% each, while 0mg/kg ATA had lower ash content (1.0%).

Moisture content

Higher moisture content (42.50%) was observed in fingerlings fed with 400mg/kg ATA followed by (23.40%) 300mg/kg ATA and (13.20%) in those 200mg/kg ATA respectively, while the lowest were observed in fingerlings fed 0mg/kg ATA (4.80%).

Physico-chemical parameters

Water quality parameters recorded during the experiment is shown in table 5. The water temperature ranged from 23^{0}C to 27^{0}C with mean temperature of 25^{0}C. Dissolved oxygen concentration recorded ranged from 5mg/L to 6mg/L with mean value of 5.5mg/L. while pH values ranged from 6.5 – 7.5 with mean value of 7.0.

Table 4: The water quality parameters during the experiment

Parameters	Ranges	Mean
Temperature (^{0}C)	23 - 27	25^{0}C
Dissolved Oxygen (mg/l)	5mg - 6mg/l	5.5 mg/l
pH	6.5 - 7.5	7.0

DISCUSSION

Growth performance

The present study showed that final weight was enhanced by increasing ATA 300mg/kg of diet fed to *C. gariepinus* fingerling which agrees with the finding of (Yildiz 2004). Similarly, the trial diet did not affect the mean body weight gain, but fingerlings fed with 0mg/kg ATA had increased mean body weight gain at the end of the experiment. However, Juvenile Korean rockfish fed diet without vitamin E showed a significantly lower weight gain (Bai and Lee 1998). In this study fingerlings fed up to 400mg/kg showed negative mean body weight gain. This was due to high mortality recorded in these groups of fingerlings.

The higher specific growth rate observed from fingerlings fed with 300mg/kg of vitamin E is at variance Chaiyapechara *et al.* (2003) finding. They observed no significant differences in the SGR of rainbow trout fish fed three different amounts of dietary vitamin E.

The fingerlings fed with 300mg/kg ATA had a better feed conversion ratio (FCR) than other experimental diets, this result agreed with Yildiz (2004) who reported that addition of vitamin E to fish diet more than 370.5mg per kilogram of diet improved feed conversion ratio.

Condition factor

The condition factor revealed that individual average weight gain and average daily weight gain were not affected by increasing ATA level. This also agreed with Haung and Haung (2004) who reported that hybrid tilapia were not affected when diets containing different amount of ATA were given to the fish. A higher relative growth rate (RGR) was obtained in fingerlings fed with 0mg/kg ATA. Wilson *et al*. (1984) earlier reported that channel catfish fingerlings fed with diet containing 300 mg/kg ATA had better relative growth rate which contradict the present study.

Survival rate

In this study, higher survival rate was recorded in fingerlings that had 0mg/kg of vitamin E which deviated from the report of Wilson *et al.*(1984) who postulated that an increase in vitamin E in fish diet consequently increase their survival rate. The low survival rate recorded in this study was could be related to the harsh weather condition of the study area (semi acidity).

Visceral and body-fat ration

This study shows that the diets containing various amounts of ATA led to increase in physical body a fat which is contrary to the findings of Chaiyapechara *et al.* (2003) who reported that increased in ATA levels significantly decreased lipid in fish liver. The present study also observed increased in physical body fat ratio which disagreed with Yildiz (2004) who reported decreased in fish fat content fed with increasing levels of ATA diets.

It is well established that fish tissue ATA has a protective role against lipid peroxidation (Bia and Lee 1998). Baker (1997) stated that alpha – tocopherol acetate is the most important factor in maintaining the post mortem membrane stability of fish flesh. Similarly, Yildiz (2004) reported that increasing vitamin E (ATA) in the fish flesh led to higher quality in the flesh of fish. This study shows that fingerlings fed vitamin E at 300mg/kg had a good flesh quality, because the amount of percentage crude fat (5.00%) were significantly lower while the percentage crude protein (50.16%) was significantly higher. This is in

agreement with the report of (Yildiz 2004) who reported that rainbow trout flesh quality was improved when diets supplemented with 370.5mg/kg ATA was fed to the fish.

Moisture content

Percentage moisture content in fish flesh increases with increased in ATA levels in fish diets while the percentage dry matter decreased with increase in ATA levels in fingerlings diets.

Crude protein

The crude protein levels escalated with increased quantity of Vitamin E in the diet. However Lygren *et al*. (2000) reported that adding different levels of ATA to the diets of Atlantic salmon did not affect their proximate composition which disagreed with the present study. Generally, lipid accumulation in fish increased with higher level of dietary lipid in fish feed (Chaiyapechara *et al.*, 2003). Eyo (1994) stated that high level of fat in fish flesh reduces the actual amount of real flesh of the fish.

As reported in several fish species such as rainbow trout Chaiyapechara *et al.* (2003), Sea bass (Gatta *et al*. 2000), the present study results did not show dietary ATA to have significantly influenced on the fat composition of *Clarias gariepinus* fingerlings. This could be attributed to short period of experimental research (58days).

Physico-chemical properties of water

The water quality parameters recorded during the study (Temperature 23°C – 27°C, dissolved oxygen 5mg/L – 6mg/L and pH of 65 – 7.5) were within the recommended water quality for rearing *Clarias gariepinus* fingerlings (Adigun 2005).

CONCLUSION AND RECOMMENDATION

The present Study demonstrated that diets containing different levels of alpha-tocopherol acetate slightly affect the growth performance of *Clarias gariepinus* fingerlings significantly. Although Vitamin E at 300mg/kg in fish diet slightly reduced muscle fat content and improved protein composition in the fingerlings muscle. However, increase in protein content and decrease in lipid content may be an indication of the quality flesh. This result suggests that feeding fingerlings with diets containing 300mg ATA per kilogram of diet gave in higher flesh quality. The effect of ATA on growth and fat composition of *C. gariepinus* fingerlings to adult (broodstock) fish should be investigated to ascertain the effect of alpha-tocopherol acetate on eggs and milt quality of the fish species.

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