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RESEARCH

Evaluation of *Chromolaena odorata* as Growth Promoter in the African Catfish (*Clarias gariepinus*, Burchell 1822)

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ABSTRACT

The effect of different concentrations of *Chromolaena odorata* (Siam weed) supplementation in fish feed on *Clarias gariepinus* fingerling growth characteristics was examined. Fish were randomly assigned to one of the four experimental groups: 0.0 percent (controls), 0.5 percent, 1.0 percent, and 3.0 percent concentrations of *Chromolaena odorata* in feed. Fish was fed at 5 percent body weight (g) per day for 70 days. Results showed that fish-fed the treatment diet had no significant effect on weight gain. The final body lengths (cm) of all treated groups were marginally ($P > 0.05$) different from the control group after 70 days. When the growth parameters were considered, the fish fed the diet containing 1.0 percent *Chromolaena odorata* had the best growth response (2.4±0.04g) while the fish fed the control diet had the slowest growth (1.2±0.13g). In comparison with the control fish fed the diet containing 1.0 percent *Chromolaena odorata* had the best feed conversion ratio (FCR), specific growth rate (SGR), and condition factor (K) This study showed that the inclusion of *Chromolaena odorata* in fish food at 0.5 – 3.0 percent level did not significantly increase the weight and length of catfish.

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INTRODUCTION

Feeding fish, especially in the early stages, is crucial in fish culture. Various studies have identified low survival rates and poor growth performance as important barriers to supplying fish demand; particularly in developing nations such as Nigeria. Fish nutritionists' worldwide aim to develop the most cost-effective diet that provides the nutrients required for fish for development and productivity. The high cost of fish feed has been identified as one of the issues impeding the growth of the aquaculture sector in developing nations, including Nigeria (Gabriel et al., 2007). Gabriel et al., (2007) pointed out that fish feed accounts for not less than 60% of the total cost of production. Fish nutrition has advanced dramatically in recent years due to the development of new balanced commercial diets capable of promoting optimal fish growth and health. Specific diets have been developed for specific species expanding the fish feed industry to meet the rising demand for affordable, safe, and high-quality aqua products (Craig & Helfrich, 2002). However, the use of chemicals like antibiotics and hormones as feed additives in these diets to promote growth and prevent illness has also resulted in several issues, such as toxicity, antibiotic resistance, and antibiotic residue (Mccartney, 2002; Talpur & Ikhwanuddin, 2013). Antibiotic resistance in aquaculture environments, and antibiotic residue in the fish products can be harmful to human health (Wu et al., 2013). As a result, animal nutritionists and health specialists are researching various medicinal plants that may be utilized as feed additives in the livestock and aquaculture sectors worldwide. Greens (green plants from various sources) have long been used by animal nutritionists, particularly in developing countries, as the cheapest and most abundant potential source of proteins due to their ability to synthesize amino acids from a wide range of virtually unlimited and readily available primary materials such as water, CO_2, and atmospheric N_2 (as in legumes) (Fasuyi & Aletor, 2005). These greens have been shown to contain bioactive components such as alkaloids, tannins, flavonoids, and other phenolic compounds that have a distinct physiological function on the human and animal body (Anyasor, 2011)including the promotion of growth in *Clarias gariepinus* (Tiamiyu et al., 2017). *Chromolaena odorata* is known as one such green.

Chromolaena odorata, also known as Awolowo, Akintola, or Queen Elizabeth weed in Nigeria, is a perennial weedy shrub native to the American continent, ranging from Southern Florida to Northern Argentina, including the Caribbean Islands (Uyi et al., 2014). *Chromolaena odorata* has been utilized for medicinal and nutritional purposes in many regions of the world. The use of *C. odorata* by cattle in its fresh state is limited by its disagreeable odor and concerns about its toxicity (Jiggins, 2017). When the *C. odorata* leaf meal was compared with the cassava leaf meal in terms of mineral content, it was shown that the *C. odorata* leaf meal had better nutritional qualities than the cassava leaf meal (Thamaga et al., 2021). Fasuyi et al., (2005) showed that incorporating *C. odorata* into the diet up to 7.5 percent did not result in mortality among the experimental birds. *Chromolaena odorata* has not been studied as a replacement leaf meal or feed additive in fish diets, despite being studied as a replacement leaf meal for cattle and fowl.

Fish aquaculture continues to contribute significantly to Nigeria's animal protein needs. Tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*) are the most cultivated species in Nigeria. Consumers enjoy the African catfish (*Clarias gariepinus*) for the quality of its meat (Adewumi & Olaleye, 2011), which is primarily smoked and used in soups. In urban centers all over Nigeria, catfish pepper soup is a delicacy that people enjoy at event centers and evening clubs. The African catfish has lengthy dorsal and anal fins that give it an eel-like look. The catfish has a long, slender body, a flat, bony head, and a terminal mouth with four pairs of barbells. Its large barbells give it the appearance of cat whiskers. Normally, the fish are raised in earthen ponds. It can, however, be cultured in different systems, such as tanks, ponds, and hapas. Although African catfish breed naturally in the wild and in river systems, great effort has been made to artificially stimulate spawning. According to Akinrotimi et al. (2014), the African catfish is an ideal aquaculture species since it is omnivorous, grows quickly, and tolerates relatively low water quality.

African catfish (*Clarias gariepinus*) is the most culturable and commercially important fin fish species in Nigeria (Adewumi & Olaleye, 2011; Akinrotimi et al., 2014). *Clarias gariepinus* is believed to be more resistant to severe environmental conditions than other cultivated species such as tilapia (Khan et al., 2021). Nevertheless, its rapid development rate has made catfish farming in Nigeria appealing to farming activity over the past two decades. This work evaluated the effect of incorporating dried leaf powder of *C. odorata* as a feed additive to promote the growth of *Clarias gariepinus*

MATERIALS AND METHODS

Collection of Plant and Preparation of Plant Powder

Fresh *Chromolaena odorata* (Figure 1) leaves were collected in Okun-Owa, Ogun State, Nigeria. The plants were identified and authenticated by the technical staff of the Department of Botany of the University of Ibadan. The voucher specimen (**UIH - 22521**) was deposited at the herbarium of the University of Ibadan for future use. The plants were thoroughly washed with clean water, followed by sterile water before air-drying at room temperature. The dried leaves were ground into a fine powder and stored in a tightly sealed container until use.

Formulation of the experimental diets

The isocaloric diet was prepared from local market fishmeal, maize, wheat bran, soya bean meal, calcium carbonate, and limestone. The basic diet (36 percent, crude protein) was prepared without herbal plants. Table 1 displays a chemical analysis of the basic diet. The four experimental diets were prepared using 0.0 percent (control), 0.5 percent, 1.0 percent, and 3.0 percent concentrations of *Chromolaena odorata* leaf powder as feed additives (Table 2). Prior to forming (processing), the feed ingredients and experimental feeds were individually ground to a fine powder using a hammer mill machine, then individually weighed and properly mixed with water adequate to ensure smooth pelleting. The preparation was finally sun-dried for 4 days (Abdollah et al., 2013). Throughout the trial, the dry pelleted feed was stored in airtight containers until use (Amisah et al., 2009).

Figure 1: - *Chromolaena odorata* (Siam weed)

Table 1. Nutrient Composition of Basic Diet

Nutrient Composition	Percentage
Dry Matter (DM)	90.40
Crude Protein (CP)	30.65
Ether Extract (EE)	11.73
Ash	2.70
Crude Fiber	10.11
Nitrogen Free Extract (NFE)	44.81
Gross Energy (Kcal/100 g DM) (GE)*	467.77
Protein/Energy (P/E) ratio (mg CP/Kcal GE)*	65.52

* Not in percentage

Table 2. Inclusion Rates of *C. odorata* powder in the Experimental Diets

Diet Variants	Inclusion Rates of *C. odorata* powder
1	Basic Diet (BD) + 0.0 percent (as a control)
2	Basic Diet (BD) + 0.5 percent *C. odorata* powder
3	Basic Diet (BD) + 0.1 percent *C. odorata* powder
4	Basic Diet (BD) + 3.0 percent *C. odorata* powder

Experimental procedure

Twelve rectangular plastic aquaria tanks of 40 cm x 27 cm x 27 cm were used. Water levels of each tank were maintained at 20 liters and aerated using the air compressor during the 10-week trial (70 days). A total of 144 mixed-sex African Catfish fingerlings (*Clarias gariepinus*) with an average body weight of 1.10± 0.01g and an average length of 4.85± 0.04 cm were randomly assigned at a rate of 12 fish per tank into each experimental tank which was arranged into four (4) treatment diets with triplicate. Tanks were covered with a nylon net to avoid fish jumping out from tanks. The fish were acclimatized for 15 days (Okoye & Sule, 2001) and fed the control diet at the rate of 5% of body weight twice daily (8.00-9.00 am and 4.00-5.00 pm). The fish were deprived for 24 hours before the feeding trial in order to empty their stomach and prime their appetite for the new diet (Madu & Akilo, 2001). Fresh borehole water was used to change the water each day. The experimental tanks were examined daily to remove dead fish leftover feed and feces. Body weight standard length and water quality parameters were taken weekly, and the rations were adjusted accordingly. A portable HannaR H198186 meter and Aqua chek® (USA) water quality test stripes were used to detect water temperature (^oC), dissolved oxygen (DO), pH, total dissolved solids (TDS), ammonia (NH_3), and nitrite (NO_2). Weight gain (WG), specific growth rate (SGR), and food conversion ratio (FCR) were obtained using the following formulae:

WG = Final average weight (g) − initial average weight (g);

$$SGR\ (\%\ d^{-1}) = 100 \times (\ln Wt - \ln W0)/t$$

Where Wt and $W0$ represent the final and initial body weights of fish, respectively, and t represents the duration of the feeding trial;

FCR = Dry weight of feed (g) / wet weight gain by fish (g)

$$\text{Condition factor (K)} = W \times 100/L^3$$

Where: W = Weight of fish (g), L = Standard length of fish (cm), Rahman, (2018).

STATISTICAL ANALYSES

Analysis of variance (ANOVA, one way) was employed to analyze all data with Graph Pad Prism Software Version 5.1. The Mean of the water quality parameters and growth parameters were measured. The outcomes were presented as mean ± SEM (standard error). The means were ranked by the Tukey test. All differences were regarded as significant at α value of 0.05 among treatment groups.

RESULTS AND DISCUSSION

Mean water quality parameters during the experiment (dissolved oxygen 6.52 ± 0.03 mg l^{-1}, pH 7.10 ± 0.0, and temperature 28.07 ± 0.37 °C) were within recommended values for culturing of *C. gariepinus* (Jamabo et al., 2015). The initial body weight of *C. gariepinus* was similar across the treatment groups. Among the growth parameters tested, the average weight gain (AWG), Feed Conversion Ratio (FCR), Specific Growth Rate (SGR), Survival Rate (SR), and Condition Factor (K) were not significantly different (P>0.05) at the end of the experiment. Owing to the natural growth the mean final body weight (MFBW) was significantly (P<0.05) higher than the initial fish weight in all diet treatment groups. Though not significantly different, there were improvements in the growth responses of fish fed with feed additives. The best growth responses were obtained in the fish fed with the diet containing 10g/kg *Chromolaena odorata* (2.39 ± 0.041g) while the slowest growth was obtained in the fish fed with the control diet (1.91±0.127g) (Table 3).

The optimum feed conversion ratio (FCR) (Figure 2), specific growth rate (SGR) (Figure 3), and condition factor (K) (Figure 4) were observed in fish fed with a diet containing 1.0% *Chromolaena odorata* compared with the control. However, the best survival rate was observed in fish with a diet containing 0.5% *Chromolaena odorata* (Table 3). Increases in total length were observed in fish fed with *Chromolaena odorata* compared with the control diet. Fish fed different concentrations of *Chromolaena odorata* in their diet showed slight differences in total length but did not significantly (P>0.05) differ from each other (Figure 5). The significance of fish feed intake as a factor in fish performance has been heavily highlighted (Adewolu & Adoti, 2010). Traditional antibiotic and hormone use for growth promotion, illness prevention and control have been questioned owing to the possible development of antibiotic resistance bacteria, environmental contamination, and residue build-up in fish (Ringo et al., 2010). Phytochemicals have been shown to stimulate a variety of actions in fish culture, including anti-stress, growth promotion, hunger stimulation, immunostimulation, and antibacterial effects (Citarasu, 2010). The *Clarias gariepinus* fingerlings responded positively to all the experimental diets indicating the possibility of using it for promoting growth even though there was no significant difference (P > 0.05) in any of the growth indices assessed across the experimental diets. The findings proved that the use of *Chromolaena odorata* as a feed additive did not affect the palatability of the feed. Weekly increment in fish total length was observed in treatments and control fish. In Overall, fish in the treatment groups grew fairly longer than those in the control groups. Higher growth performance has been recorded for fish-fed with garlic-supplemented diets by Dias, (2002) and Metwally, (2009). In both treatments and control fish, there was a weekly increase in overall length owing to natural growth. However, the overall length of the fish in the treatment groups was higher than that in the control group. According to Awad & Awaad (2017) when fish were given medicinal plants such as garlic-enriched diets they performed better in terms of development (The acceptance of the experimental diets revealed that the quantities of *Chromolaena odorata* powder added as feed additives in the diets did not affect their palatability. This observation was consistent with the findings of other researchers (Francis et al., 2001; Siddhuraju & Becker, 2003), who found that reducing anti-nutrients through various processing techniques (e.g., soaking, drying, flaking, fermentation, and so on) resulted in improved palatability and growth in fish.

Chromolaena odorata has 18.86 percent crude protein (Tiamiyu et al., 2019), which is greater than the protein content of maize (10.0 percent) (Oni et al., 2020), and the Tigernut (7.0 - 9.7 percent) (Oladele & Aina, 2007). According to Igboh et al., (2009), *C. odorata* is high in good-quality protein. The implication of this in nutritional protein supplementation cannot be over-emphasized. According to some researchers (Mensah et al., 2008; Aro et al., 2009), *C odorata* is a good source of protein, minerals, protein, flavor, dietary fiber, and energy, which contributes to the palatability and supplementation of feed in animal nutrition. This could be attributed to the increased fecal volume and speedy intestinal transit, both of which have prebiotic properties (Igboh et al., 2009). *C. odorata* moderately (P > 0.05) improved growth of experimental fish at inclusion rates of 0.5 percent, 1.0 percent, and 3.0 percent when compared to a control diet. This finding is comparable to that of Sotolu, (2010) for *Clarias gariepinus* fed diets supplemented with fish oil, sesame seed oil, groundnut oil, soybean oil, and palm oil, where all diets were well received by fish and showed only slightly different SGR across treatments. In the present experiment, the feed conversion ratio (FCR) of the fish fed with 1.0 percent *C. odorata* was the best compared to the control and other treatment groups. This observation of high wet body mass acquired is an indication that less dietary protein has been spent for maintenance energy (Tiamiyu, 2019). The condition factor, which is defined as an indication of fatness, gross nutritional status, and reserve nutrient level (Swanepoel & Goosen, 2018), improved in the treated fish compared to the control, with the best condition factor observed in the group fed with 1.0 percent *C. odorata.* Thus, the optimal inclusion level was attained at a 1.0 percent inclusion rate possibly indicating that the dietary protein level at that rate of inclusion increases the nutrient content in the fish body (Ali et al., 2005).

Table 3: Growth Performance of African Catfish fingerlings fed diets containing different levels of *Chromolaena odorata* Powder as feed additives

	Experiment Diets			
Parameters	**0.0%**	**0.5%**	**1.0%**	**3.0%**
Mean Initial body weight (g)	1.07 ± 0.240^a	1.09 ± 0.007^a	1.13 ± 0.041^a	1.13 ± 0.022^a
Mean Final Body weight (g)	1.91 ± 0.127^b	2.25 ± 0.213^b	2.39 ± 0.041^b	2.05 ± 0.147^b
Average Weight Gain (g)	0.84 ± 0.107^a	1.16 ± 0.212^a	1.26 ± 0.022^a	0.91 ± 0.128^a
Relative Weight Gain (%)	78.9 ± 8.87^a	106.7 ± 19.48^a	111.2 ± 9.18^a	80.3 ± 10.11^a
Survival Rate (%)	75.00 ± 4.81^a	86.11 ± 10.01^a	80.55 ± 2.78^a	80.56 ± 7.35^a

Data represented as the mean of three samples replicates ± standard error of the mean
Mean values with the same superscript in the same row are not significantly different

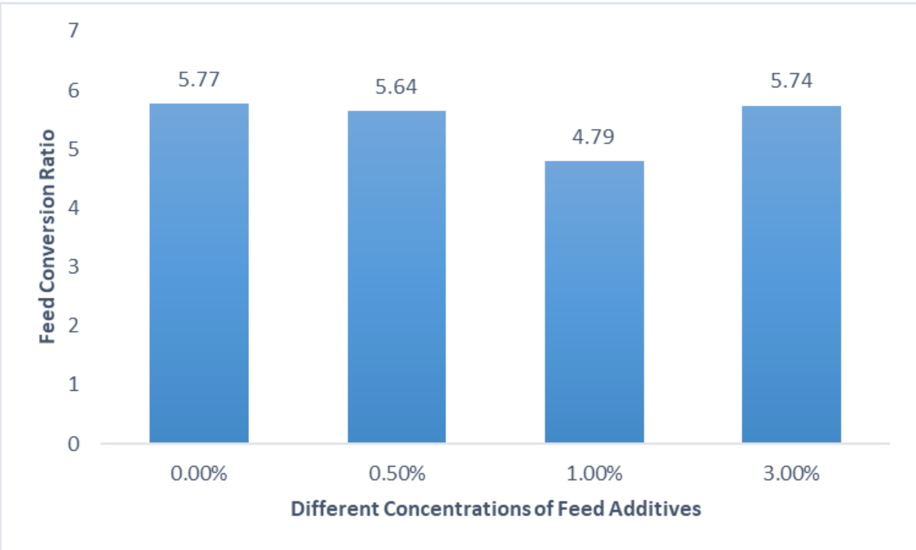

Figure 2: Effect of *Chromolaena odorata* fed as feed additives on FCR in *Clarias gariepinus*

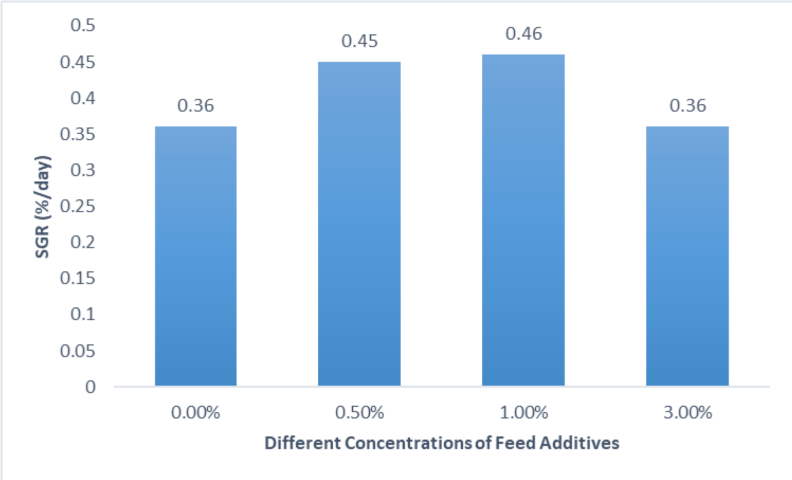

Figure 3: Effect of *Chromolaena odorata* fed as feed additives SGR in *Clarias gariepinus*

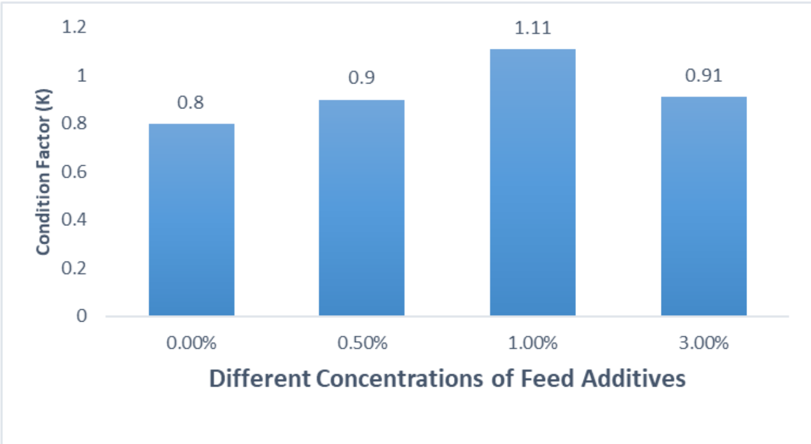

Figure 4: Effect of *Chromolaena odorata* fed as feed additives on condition factor in *Clarias gariepinus*

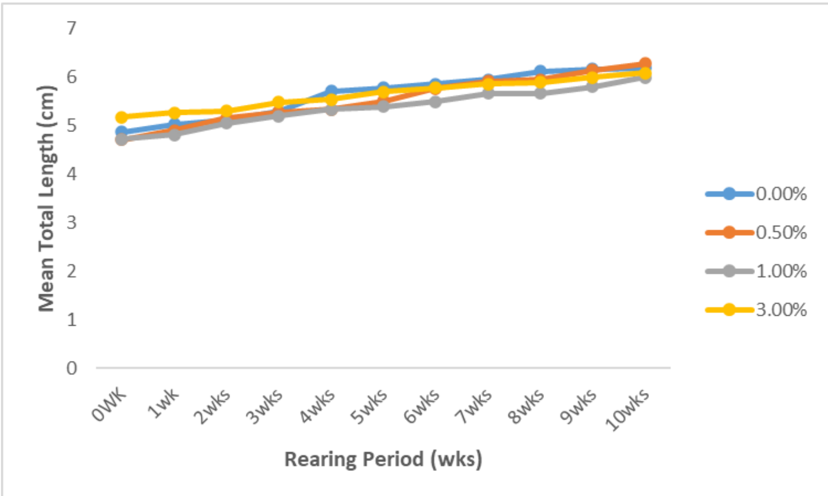

Figure 5: Effect of *Chromolaena odorata* fed as feed additives on length increment in *Clarias gariepinus* during the experimental period

CONCLUSIONS

Chromolaena odorata incorporation in the diet within the range from 0.5 to 3.0 % marginally but not significantly enhanced the weight and length of the treated fish compared to the control group. Therefore, it is advised that further investigations are to be done using various levels of incorporation of this herb. It is also suggested to repeat the experimental diets in other aquaculture systems such as recirculating systems and natural earthen pond settings to investigate the usefulness of this plant as a fish feed in different systems.

Ethical Approval

The ethical approval was obtained from the University of Ibadan Animal Care and Use for Research Ethical Committee. The approval number is UI-ACUREC/App/2015/066**.** The experiment was conducted according to ACUREC-approved protocol.

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