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NONI, *MORINDA CITRIFOLIA* LEAF EXTRACT IMPROVES GROWTH PERFORMANCE IN NILE TILAPIA, *OREOCHROMIS NILOTICUS*

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Abstract
Noni, Morinda citrifolia is a tropical shrub known to contain appetite-enhancing and growth-promoting compounds that aid in the growth of organisms. For this reason, this study was carried out to observe the effect of Noni leaf extract (NLE) on the growth parameters such as Weight gain (WG), Feed conversion ratio (FCR), Specific growth rate (SGR), Condition factor (K), Hepatosomatic index (HSI) and Viscero somatic index (VSI) of Tilapia, Oreochromis niloticus. Tilapia fingerlings of about 6 ± 2 g were placed in five concrete ponds assigned and fed with a control diet and NLE at 1%, 2%, 3% and 4% for eight weeks. Upon termination of the feeding trial period, the results indicated that NLE significantly increased the WG, FCR and SGR in fish fed 1% NLE compared to all other tested diets ($p < 0.05$) but showed no effect on K, HSI and VSI among all tested fish ($p > 0.05$). The authors of the present study suggest that the inclusion of 1 % NLE in Tilapia fish diets might improve their growth.

Keywords: Herbs, Growth, Fish Weight, Hepatosomatic

Introduction

Herbal remedies are preferable to stimulate the secretion of bile and interaction of pancreatic enzymes to promote digestion in organisms (Platel et al., 2002). Noni is a plant that is scientifically known as *Morinda citrifolia*. This plant is native to Southeast Asia, Australia and can now be found on the African continent. The Noni plant's parts (i.e. leaves, fruits, roots and branches and stems) have traditional or medicinal uses ranging from the roots to the leaves and flowers (Nelson et al., 2006). Noni leaves and fruit juice have been found to improve weight gain and feed utilization (Sunder et al., 2016) when used as a feed additive in the diets of animals. Noni has been reported to be used as a natural health enhancer as it is known to contain phytochemicals that have antimicrobial properties hence is reported as an immune enhancer/buster (Assi *et al*., 2017). Noni leaf extract (NLE) is a natural substance derived from the tropical plant *Morinda citrifolia* that has various health benefits and potential applications in aquaculture. NLE has immunostimulatory, antioxidant, and anti-inflammatory effects on fish. Nile tilapia (*Oreochromis niloticus*) is widely cultured for food and has high economic value. The growing reputation of cultivated tilapia as an aquaculture fish worldwide has prompted considerable research on improving growth performance in tilapia. The study intended to determine the optimal dosage of NLE on the growth performance and feed utilization of Nile tilapia.

Methods

Experimental Fish and Set-up

The test was conducted at the fish farm of the Department of Aquaculture and Fisheries Sciences, Nyankpala campus. Nile tilapia fingerlings without any physical symptoms of infection with an initial weight of 6 ± 2g were obtained from the Water Research Institute, Tamale of the Council for Scientific and Industrial Research and stocked in concrete tanks with about 20 fingerlings each and allowed to acclimatize within that environment for a duration. During this time, they were fed with a control diet at 5% of body weight. Feeding was done three times a day with equal rations at the times 9:00 am, 12:00 pm and 4:00 pm. Water quality in the tanks was monitored and completely changed biweekly to maintain water quality.

Preparation of Leaf Extract

One hundred and eighty (180) grams of fresh leaves of Noni were obtained from the plant house of the University for Development Studies, Nyankpala Campus washed with distilled water and then blended and the sap strained by filtration using a fine mesh into a bottle for.

Diet Preparation

Noni leaf extract (NLE) was added to a commercial diet at 0%, 1%, 2%, 3% and 4% by spraying and then allowed to dry under room temperature for 48 hours. Diets were kept in plastic containers at room temperature and used throughout the experimental period.

Administration of Treatment

After acclimatization, the weight of the fish was measured using a digital scale and treatments were assigned to the tanks at random. Fish were fed with their respective diets at a 5% body weight. The total ration for each day was divided into three and fed to fish. Feeding rates were adjusted every two weeks after taking bulk weight fingerlings in each group. The total feed consumed was recorded after biweekly feed adjustment and this was summed after a duration of eight weeks of the experiment's duration.

Growth Measurements

The study evaluated the Initial and final weight gain, Specific growth rate, Condition factor and Feed conversion ratio of the fish, these were measured and computed as described by Adewolu, (2008). Other parameters including Hepatosomatic index and Viscero somatic index were evaluated as described in Abarike et al. (2018).

Mean weight gain (MWG) =
Final mean weight (g) −
Initial mean weight (g)
Specific growth rate (SGR) = 100 x (ln final weight-ln initial weight)/days

Feed conversion ratio (FCR) = $\frac{\text{Total feed given to fish (g)}}{\text{total weight gained by fish (g) + dead body weight} - \text{initial body weight (g)}}$ x 100

Viscerosomatic index (VSI) =

$$100\ x\ (\frac{Versra\ weight\ (g)}{total\ body\ weight\ (g)})$$

Hepatosomatic index (HSI) =

$$100\ \text{x}\ (\frac{liver\ weight\ (g)}{total\ body\ weight\ (g)})$$

Condition factor (K) = $(\frac{100\ x\ weight(g)}{total\ length\ cube\ (cm)})$

Statistical Analysis

IW, FW, MWG, SGR, FCR, K, HSI and VSI were analyzed using a One-way analysis of variance (ANOVA) at 95% confidence level. Variances in means were further tested using the Tukey test range test (IBM SPSS statistics data editor version 20). Computed growth

parameters were expressed as mean ± standard error.

Results

Growth Performance

Results generated throughout the eight (8) week trial period for IW, FW, MWG, SGR, FCR, K, HSI and VSI indices of *O. niloticus* are presented in Table 1. Values for IW were similar between treatments ($p > 0.05$) while FW, MWG and SGR were significantly higher in fish fed 1% NLE at 21.82 ± 1.26, 13.41 ± 0.47 and 1.79 ± 0.19 respectively.

It was noticed that increasing dose of NLE corresponded to increasing FCR in the respective treatments. The FCR of test fish ranged 1.57 ± 0.65 to 3.43 ± 2.90. The treatment revealed the lowest FCR was 1%NLE with a value of 1.57 ± 0.65 and the highest was recorded in the control with an FCR of 3.43 ± 2.90.

The K, VSI and HSI of test fish were unaffected by treatments as no momentous differences ($p < 0.05$) were noticed in treatment means calculated.

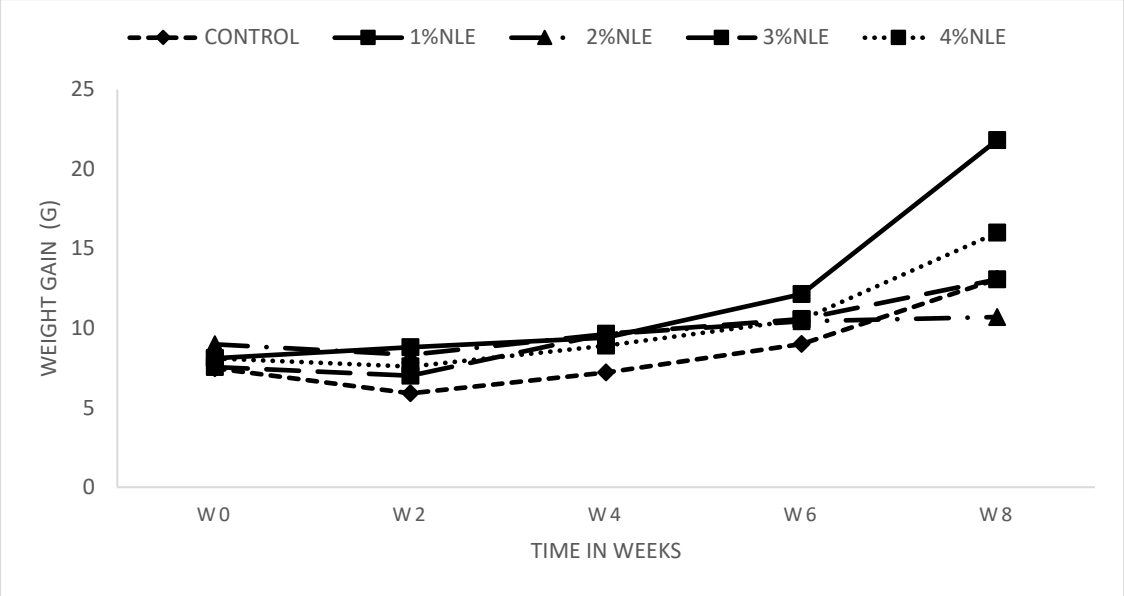
Biweekly measurements of the effect of NLE growth pattern of test fish is shown in Figure 1 over the course of eight weeks. It was found that biweekly mean weight measurements were similar in the first four weeks of the experiment. Changes in them began to show after six weeks and were very prominent at the eight weeks when the experiment was terminated particularly in fish fed 1%NLE recording the highest.

Table 1: Growth parameters of experimental fish

Parameters	Control	1%NLE	2%NLE	3%NLE	4%NLE
Initial weight (IW)	6.46 ± 0.45^{a}	8.11 ± 0.79^{a}	8.98 ± 0.83^{a}	7.55 ± 0.62^{a}	8.10 ± 0.60^{a}
Final weight (FW)	13.08 ± 1.33^{b}	21.82 ± 1.26^{a}	10.70 ± 2.35^{b}	13.06 ± 1.61^{b}	15.9 ± 0.65^{b}
Weight gain (WG)	6.62 ± 0.88^{b}	13.44 ± 0.47^{a}	1.72 ± 1.52^{b}	5.51 ± 0.98^{b}	7.90 ± 0.04^{b}
Specific growth rate (SGR)	1.26 ± 0.30^{bc}	1.77 ± 0.19^{a}	0.31 ± 0.25^{c}	0.98 ± 0.15^{b}	1.20 ± 0.09^{bc}
Feed conversion ratio (FCR)	3.43 ± 2.91^{a}	1.57 ± 0.65^{b}	1.79 ± 5.31^{a}	2.48 ± 2.25^{a}	3.03 ± 0.27^{b}
Condition factor (K)	0.01 ± 0.07^{a}	0.012 ± 0.01^{a}	0.01 ± 0.01^{a}	0.01 ± 0.02^{a}	0.01 ± 0.01^{a}
Viscero somatic index (VSI)	9.62 ± 1.67^{a}	12.01 ± 1.35^{a}	10.63 ± 0.58^{a}	13.92 ± 5.13^{a}	13.42 ± 1.54^{a}
Hepatosomatic index (HIS)	1.67 ± 0.74^{a}	2.60 ± 0.70^{a}	2.68 ± 0.70^{a}	2.43 ± 0.88^{a}	2.23 ± 0.73^{a}

NLE = Noni Leaf Extract. Means within the same row with identical superscripts indicate no significant difference ($p > 0.05$)
Source: *field data*

Figure 1: Growth trajectory of Nile tilapia fed Noni Leaf Extract over eight weeks



Discussion

Weight gain is the proportional increase in weight over time due to the synthesis of protein in the fish. The study showed that dietary inclusion of NLE extract in feed fed to tilapia had a positive effect on its MWG particularly with an inclusion of NLE at 1% after 8 weeks of feeding. This study's findings are similar to previously reported studies on the use of herbs to improve fish growth. For instance, studies on the use of herbs such as Red clover (*Trifolium pretense)* (Turan, 2006) and Basil (*Ocimum basilium*) (Ahmad & Abdel-Tawwab, 2011), turmeric powder (Dessouki & Yusuf, 2014), Caraway (*Carum carvi*) (Ahmad et al., 2011), Turmeric (*Curcuma longa*), Rosemary (*Rosmarinus officinalis*) and thyme (*Thymus vulgaris*) (Hassan *et al.*, 2018) have been reported to improve weight gain in fish.

As illustrated in Fig 1, there were no major differences in the MW of treatments at the onset of the experiment. The trend however began to show visible changes after the 6th week, an indication that, the treatment began to take effect afterwards. Possible reasons for the significant increase in MW may be attributed to improved utilization by higher triggers of digestive enzyme secretion and increased fats and protein deposition in carcasses (Priyadarshini et al., 2012). Earlier reports have demonstrated that herbs can induce the release of pancreatic enzymes and critical elements in the absorption and assimilation of nutrients which could result in increased weight gain (Frankic et al., 2009). Although, the above explanations could be of help in understanding the mechanism of action of herbs that could be applied to the mechanism of action of NLE. There is a need for further research into the specific molecular properties of NLE herb that enables them to perform such a function. The SGR period refers to the rate at which the biomass of a cell population increases relative to its biomass concentration. In this experiment, the best SGR rate was recorded in fish feed 1% NLE. This was expected since most of the other growth parameters showed a similar trend. In other experiments, similar reports have been churned out with Garlic (Soltan & El-L, 2008) Turmeric, Rosemary and Thyme (Hassan *et al.*, 2018) on Tilapia and in Catfish in experiments conducted by Gabriel *et al.*, (2015) on *Aloe vera*.. Contrarily (Sahu et al., 2007) reported that, the administration of diet with the inclusion

levels of 0.5% and 1% Garlic powder in Carp fish had no significant difference on SGR of the treatment and control.

Vital parameters used to determine the quality and effectiveness of feed given to fishes in attaining the desired nutritional effects is the measure of the feed conversion ratio (FCR). Generally, FCR ratios above 2 may not be ideal for feed for tilapia. In the present study, fish fed 1% NLE showed a better FCR compared to others and the control. To improve the feed conversion ratio, it is envisaged that NLE might contain saponins, which are bioactive compounds that help catalyze the activities of digestive microbes, increase the penetrability of cell walls in the intestine, and enhance the absorption of food, as explained earlier (Johnson et al., 1986). Although saponins might be the reason for the increased feed conversion ratio, it is greatly tied to the inclusion level (Bhosale et al., 2010).

The K is a parameter used to measure the body condition in fish. When fish grow isometrically, the K component has a value of 3.0. However, if the K value deviates significantly from 3.0, it indicates allometric growth. Fish with a high K are relatively heavy for their length, while those with a low K are light for their length. In the present study, the application of NLE seems not to have any influence on condition factors of test fish as there were no observable differences in fish fed NLE supplemented diets compared to the fish fed the control diets. It could be generally said fish in this experiment showed allometric growth. Although condition factor is an important parameter to monitor the effects of dietary treatments on fish health, not many researchers have paid attention to it. However, for the sake of comparison, (Diab et al., 2008) reported similar results on Nile tilapia, *Oreochromis niloticus* fed with diets supplemented with garlic, black seed and Biogen.

Hepatosomatic index (HSI) is an evaluation of the relative weight of the liver, a major energy store in non-fatty fish. For this reason, in the liver, HSI is usually used as an estimate of energy status of the fish. Food rich in energy have the potential to increase the HSI in fish while food poor in energy shows a reverse effect. In the present study, it came to light that the HSI could increase when fish are fed NLE supplemented diets which could be an added advantage for the use of herbal supplementation in Tilapia diets. Similarly, observations have been reported in Common carps fed *Ferula coskunii* (Yilmaz et al., 2006) and in Gift tilapia fed dietary *Aloe vera (Gabriel et al., 2015).* Viscerosomatic Index (VSI) is a valuable metric in fish biology. It provides insights into the metabolic processes related to digestion, absorption, synthesis, secretion of digestive enzymes, and carbohydrate metabolism. The application of NLE shows a potential to increase VSI in tilapia fish although not significant. In other related experiments, researchers observed significant increases in VSI in fish that were fed a diet supplemented with herbal liver tonic (Patel et al., 2018; Yılmaz et al., 2014) ; Difference in results could be attributed to different experimental conditions and also for the fact that different herbs may have different levels of bioactive compounds.

In this study conducted to investigate the effects of NLE on the growth of *Oreochromis niloticus*, it can be concluded that eight weeks of feeding tilapia with feed supplemented with NLE showed that, an inclusion of 1% of NLE can significantly improve WG, FCR and SGR of tilapia. However, in order to explain further the mechanism of action of NLE in enhancing growth parameters in *Oreochromis niloticus*, molecular such as gene expression would come in handy.

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