

Azolla a Boon for the Growth of Gift Tilapia, *Oreochromis Niloticus* (Linnaeus, 1758)

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Abstract

Appreciative dietary desires and fabrication of fish nourishment is vital to the progress, sustainability of aquaculture and for the advanced feed mill rehearsal. Organizing fish feed includes choosing the exact feed, using an acceptable feeding technique, work out the feed charge and ensuring the cost efficiency of fish farm. The purpose of our present study was to feed the fishes with four different feeds and assessment of growth performance by length weight relationships. The growth analysis was executed by measuring FCR and related indices in gift tilapia *oreochromis niloticus*. Four feed composition was selected without any chemical contamination. In the present study fishes were collected from the golden farm, Neyyattinkara, Thiruvananthapuram district, South India. Fishes were introduced into four different tanks of well oxygenated good quality water. In each experimental tank, 20 fishes were introduced. For each experimental container a specific feed was fixed from 4 different diets. Every day feed was given to the fishes. They were fed two times for the period of 3 months. They were maintained to assess their growth performance. Four types of feeds used for the present study were control diet, diet 1, diet 2 and diet 3. Length and weight were measured on every 15 days interval for growth estimation. Based on the length-weight data, growth analysis was carried out by calculating relative growth (RG), relative growth rate (RGR), specific growth rate (SGR), feed conversion ratio (FCR) and the Fulton's condition factor. The results of mean length in diet3 proved the highest length of 6.455 ± 0.46 cm and diet one contain lowest length of 5.03 ± 0.68 cm. Highest weight of 96.8 ± 0.37 g was recorded in diet3 and lowest weight obtained for the control diet (3.645 ± 0.306 g). In growth analysis the relative growth of fish was estimated in diet 3 having high relative growth (11.91). Relative growth rate was elevated in diet 3 (1.5597). The upper limit of specific growth rate was 1.9146% noticed in diet 3. The feed conversion ratio was maximum in diet 3 (58.06) and minimum in control diet (36). The highest k value in Fulton's condition factor was noticed in diet 3 (88.32). All experimental results proved that live Azolla [D3] was a superior feed for the present trials.

Introduction

The raise of human inhabitants has led to the scarcity of animal protein sources all over the globe. It has directed the awareness of fish as the fast and strong compensatory source of high quality animal protein. Fishes are quite diverse from the other animal food sources because they provide calories with high class proteins which hold all essential amino acids in simply digestible form. So they are the valuable nutrition source. Plentiful studies have investigated the probability of optional protein source (Gatlin *et al.* 2007).

Aquaculture contributed healthiness characteristics of fish in the human diet by way of Omega 3 fatty acids and other vital ingredients. Fish meal is a derisory and high-priced protein source for trade oriented fish feeds. This makes understandable about the substitution of fish proteins by other resources. The majority of explorations described the biased substitution of fish meal can be successfully gifted to dietary and health aspects.

Supplemental feeding is necessary for the enhancement of fishery to attain greatest production from capital of fresh water fish farming. Replacement of improved nutrients can instigate fish growth

rapidly and they accomplish maximum weight in shortest possible time. The dietary substance of the feed decides the type of fish being cultured and which size is cultured. In recent years Fish nourishment has advanced with the growth of latest, unbiased, profitable diets that encourage most favourable fish augmentation and healthiness. When fishes are raised in high mass in indoor practices or restricted cages, they cannot freely search on ordinary food.

,Abwao *et al.* (2017) reported the effect of alternative hydrolyzed feather meal for fresh water shrimp meal on development, clear digestibility and body composition in tilapia, *Oreochromis mossambicus*. The results recommended its 10% substitution. Jim *et al.* (2017) studied the relative analysis of dietary standards of *O. niloticus*. The results suggested the effluent from sewage and fertilizer industries caused contamination and explosion of water hyacinth added the chemical composition pervasion of fish. Velasquez *et al.* (2015) conducted a trial to assess the effects of Spirulina (*Arthrospira platensis*) insertion in investigational diets of juvenile Nile Tilapia (*Oreochromis niloticus*). The results indicated that the most favorable level of nutritional substitution for amplified growth performance enhanced feed consumption effectiveness and improved health status of juveniles taken as a whole. Mustafa *et al.* (2016) reported the consequence of nutritional supplementation with Azomite, a natural mineral of volcanic ash on growth performance, its innate immune response and infectious fight in *O. mossambicus* against *Aeromonas hydrophila*. Azomite projected the capability to support all functions. Onder *et al.* (2014) conducted a study to resolve the effects of diets replacement in fish meal (FM) with Peanut meal (PNM) on feed consumption, growth performance and body composition of Mozambique tilapia (*O. mossambicus*). Their results indicated the replacement of 20% dietary FM with PNM had no unfavorable effects on the development, body composition parameters and common health of Mozambique tilapia fries. Oliver *et al.* (2008) conducted a study to concentrate the use of micro alga *Spirulina maxima* in diets for tilapia, *O. mossambicus* fry as a protein source. it was scrutinized that in tilapia diets, Spirulina can substituted up to 40% of the fish meal protein.

Gangadhar *et al.* (2015) studied the consequences of azolla integrated diets on the survival and growth of *Labio fimbriatus* all through fry and fingerling rearing. The study designated the option of azolla incorporated in diets of *L. fimbriatus* up to 40% resulting in savings of feed cost. The aquatic fern Azolla can store more nitrogenous nutrients due to the presence of the N₂ fixing ability of symbiotic Anabaena in it. Djissou *et al.* (2017) studied the result of whole substitution of fishmeal by *Azolla filiculoides* meals and earthworms in the diets of Nile tilapia, *Oreochromis niloticus* which were nurtured in concrete tanks. In their experiments the mean weight was lesser than the control and best development concert and feed consumption were obtained in fishes fed with test diets.

Felicitta *et al.* (2013) studied the influence of *Allium sativum* (Garlic) and *Allium cepa* (onion) on development, endurance and hematological parameters of *Oreochromis mossambicus*. The results suggested that in fish diet 3% garlic improved development and prevention of infection in *O. mossambicus*. Jisr *et al.* (2018) reported the length weight relationship and relative condition factor of fish dwelling in the marine area of the Eastern Mediterranean city, Lebanon. The results pointed out that almost all the captured species demonstrated a thinner growth and unconstructive allometry. Leonard *et*

al. (2012) studied the length weight relations for 36 freshwater fish species from two tropical reservoirs. The results signified the family cichlidae with the uppermost figure of eight species. Amonodin *et al.* (2018) reviewed the length and weight connection of freshwater fishes in Malaysia. Their results influenced the environmental changes related to fish ecological health.

Typically in the formulation of feed, selected parameters were greatly predisposed by the raw material choice by the alternative nutrition sources introduction. Dietary changes using alternative sources can be utilized in the culture system. Moreover 40 - 60 % of the total feed manufacture cost, any unconstructive effects on feed effectiveness should be avoids. Finally the quality of the product including its highly beneficial properties for human health should not be compromised.

Due to the demand of fish meat, to overcome the nutrition deficit and to get a good quality fish meat without any chemical contamination; it is necessary to substitute a superior feeding exploration. In the present study, assessment of growth was substantiated by measuring length-weight relationships and by applying statistical factors due to the interpretation of relative growth, relative growth rate, specific growth rate, feed conversion ratio and Fulton's condition factor. Gift tilapia, *Oreochromis niloticus* fishes were fed by mentioned diets. The present study was framed to weigh up the growth of fishes in three selected feeds with control and comparing them by utilising natural feed ingredients.

Materials And Methods

COLLECTION OF SAMPLE

For the present study purpose gift tilapia, *Oreochromis niloticus* was collected from the Golden farm, Neyyatinkara, Thiruvananthapuram district of Kerala. The collected fishes were maintained and cultured by using selected feeds.

MAINTENANCE AND CULTURE OF FISHES

In the present study 1cm mean sized fishes were introduced into different cement tanks of well oxygenated good quality water. In each experimental container 20 fishes were introduced. Four different diets were given to the fishes in four different tanks. All the experimental trials were done in triplicates and their average was taken for data analysis. Every day, they were fed two times. For the period of three months they were maintained to analyse different assessments of their growth performance.

FEED INGREDIENTS

Control Diet	Rice, ground nut oil cake, turmeric, corn, Green gram.
Diet 1	Rice, dry shelled fish, wheat, fenugreek and corn.
Diet 2	Growfin (readymade feed obtained from farm)
Diet 3	Azolla

FEED FORMULATION

Different ingredients selected to formulate the feed were separately sun dried and crushed well using a mixer grinder to small particle size. A sieve was used to remove large particles or foreign materials which can damage the machinery. The ingredients were weighed and appropriate quantities were taken for feed preparation.

Control Diet [CD]

The control diet was prepared by adding different amount of ingredients such as 25gm rice flour, 25gm ground nut oil cake; 5gm turmeric powder, 20gm corn flour and 25gm green gram were taken. The modified method of Gull *et al.* (2005) was adapted. With the help of warm water the dry ingredients were mixed slowly. Good mixing can improve palatability. Water was added and mixed well to form a squash with a cake like evenness. As a general rule, the total wetness of the squash should be in the range of 45 to 55% to make good pellets. Pass the feed squash combination all the way through a pellet machine (mincer) with 1mm diameter. The mash was then steamed in a food steamer for about 10 to 15 minutes. Later it is cooled and kept in the refrigerator for 48 hours. This mash was then dried in the room temperature and slices the extrusion (which looks like noodles) into related length to the pellet diameter. The wet pellets were then dried to 10% or simply by spreading the pellets under the sun rays.

Diet 1[D1]

This diet was prepared by taking 25gm rice flour, 25gm powdered shelled fish, 25gm wheat flour, 10gm fenugreek and 15gm corn flour and mixed thoroughly to formulate an suspension with the help of lukewarm water. Blend with dry constituents gradually. To improve palatability the contents were mixed well. By the addition of needed water the mash with a cake like consistency was formed. The whole wetness of the squash should be reserved in the range of 45 to 55% to fabricate good pellets. feed mash mixture was passed through a pellet machine (mincer) having 1mm diameter. The mash is then steamed in a food steamer for about 10 to 15 minutes. Later it is cooled and kept in the refrigerator for 48 hours. This mash is then dried at the room temperature and slices the extrusion (which looks like noodles) into similar length to the nearby pellet diameter. The moist pellets were then dried to reduce the moisture content of 10% or less simply by spreading the pellets under the sun rays.

Diet 2[D2]

Grow out (commercial) feed was bought as a readymade feed from the aquarium to fed the fishes in the third tank.

Diet 3[D3]

Azolla (natural feed) were given to the fishes in the fourth tank directly without any modification of the feed.

FEEDING THE EXPERIMENTAL FISHES

To reduce feed waste, right delivery of food is important. Undernourishment can cause loss of weight, while feeding more than limit affected feed wastage and can lead to decline in water quality. More deterioration in water quality may led to loss of reserve and the need for remedial process. The fishes were fed twice a day preferably after sunrise (7 to 9 am) and before sunset (4 to 6 pm). 2gm of feed was provided to fishes in each container every time.

ESTIMATION OF LENGTH - WEIGHT RELATIONSHIP

The length and weight of each fishes (Jisr *et al.* 2018) from each container were measured at every 15 days to estimate the length – weight relationship. Fish was measured in terms of weight gain and increase in length. Total length (TL) was measured to the nearest 0.1mm using 30cm ruler as the distance from the tip of the anterior most part of the body to the caudal fin. Measurements of weight were taken in gm using 0.01g sensitive weighing balance at an interval of 15days.all the trials were done in triplicates and their mean values were calculated.

GROWTH ANALYSIS

Relative growth (RG)

It is used for the comparison of the size of similar organisms. RG is calculated with the formula quoted here.

$$RG = \frac{W_2 - W_1}{W_1}$$

$$W_1$$

Relative growth rate (RGR)

RGR is the growth rate relative to the size of the population. It is calculated by the following formula.

$$RGR = \frac{W_2 - W_1}{W_1 (t_2 - t_1)}$$

$$W_1 (t_2 - t_1)$$

Specific growth rate (SGR)

The rate of increase of biomass of a cell population per unit of biomass concentration was defined as the specific growth rate. Weight was recorded in grams. It is calculated by using the following formula (Steel *et al.* 1997).

$$SGR = \frac{\text{Log}[\text{Final weight}] - \text{Log}[\text{Initial weight}]}{\text{Culture days}} \times 100$$

$$\text{Culture days}$$

4. Feed conversion ratio (FCR)

The success of an aquaculture practice is dependent upon many factors describing to the field of biology, engineering and economics. The feed conversion ratio is a remarkable tool for understanding the acceptability of given feed (Inayat and Salim, 2005). FCR is calculated using the following equation.

$$\text{FCR} = \frac{F}{W_f - W_0}$$

Where F is the weight of food supplied to fish during the study period; W_f is the live weight of the fish at the end of the study period; W_0 is the live weight of the fish at the beginning of the study period

Length- weight relationship

The Length - weight (log transformed) relationships of the experimental fishes were worked out as per cube law given by Le Cren (1951).

$$W = aL^b$$

Where, W= Weight of fish (g), L is observed total length (cm), 'a' is the regression intercept and 'b' is the regression slope.

The logarithmic transformation of the above formula is

$$\log W = \log a + b \log L$$

Fulton's condition factor (K)

Fulton's condition factor (K) was calculated according to Htun- Han (1978) equation as per formula given below:

$$K = \frac{W}{L^3} \times 100$$

Where W= weight of fish (g), L= length of fish (cm).

Results

ESTIMATION OF LENGTH AND WEIGHT RELATIONSHIP

In the present investigation, an average length and weight of freshwater fish gift tilapia '*Oreochromis niloticus*' was studied for a period of 90 days. The length was measured in centimetres and weight was estimated in grams. The maximum length of *O. niloticus* was 7.1 ± 0.7255 in diet 3. The diet 2 fed fishes showed the moderate length 6.455 ± 0.4647 . The fish fed with control diet and diet 1 showed the minimum length 5.175 ± 0.512 and 5.03 ± 0.6840 . In this study the *O. niloticus* showed the maximum weight of 9.6 ± 0.373 in the D3 feed. Diet 2 showed the moderate weight (5.2 ± 0.324). The fish fed with the control diet and diet 1 were having minimum weight 3.645 ± 0.306 and 3.965 ± 0.171 [Tables 1-2].

Days	CD	D1	D2	D3
0	0.96 ± 0.2121	0.9 ± 0.2578	0.915 ± 0.2636	0.82 ± 0.2760
15	1.48 ± 0.2627	1.34 ± 0.2223	1.79 ± 0.308	1.16 ± 0.1462
30	2.06 ± 0.4722	1.8 ± 0.4006	3.345 ± 0.4455	1.6 ± 0.248
45	2.91 ± 0.5617	2.055 ± 0.3584	2.645 ± 0.2992	2.35 ± 0.2824
60	3.21 ± 0.4370	2.565 ± 0.4706	4.015 ± 0.1597	3.63 ± 0.341
75	3.815 ± 0.2617	3.86 ± 0.5277	5.605 ± 0.4806	5.4 ± 0.418
90	5.175 ± 0.5128	5.03 ± 0.6840	6.455 ± 0.4647	7.1 ± 0.7255

Days	CD	D1	D2	D3
0	0.395 ± 0.102	0.275 ± 0.168	0.515 ± 0.1443	0.8 ± 0.387
15	0.615 ± 0.364	1.155 ± 0.235	0.86 ± 0.162	2.04 ± 0.273
30	0.87 ± 0.52	1.67 ± 0.288	1.43 ± 0.305	2.37 ± 0.515
45	1.11 ± 0.301	2.54 ± 0.376	2.06 ± 0.256	3.32 ± 0.223
60	1.59 ± 0.381	2.895 ± 0.338	2.81 ± 0.3605	5.41 ± 0.428
75	2.61 ± 0.572	3.4 ± 0.316	4.1 ± 0.276	7.34 ± 0.229
90	3.645 ± 0.306	3.965 ± 0.171	5.2 ± 0.324	9.68 ± 0.373

GROWTH ANALYSIS

A wide range of positive or negative impact factors influences enlargement of fishes. Many studies are evidences for the growth of fishes in aquaculture. They mainly proved that increase in size of organisms directly proportional to feed consumption and quality of diets.

Relative growth

In the present study figure 1 showed the relative growth of fishes. The RG of the gift tilapia *O.niloticus* was high in the diet 3 (11.91) and less in the control diet (7.73).

Relative growth rate

The control diet having relative growth rate 0.1031 in CD and the diet1 has the RGR of 0.5385. The relative growth rate of 1.1182 was noticed in diet 2. The maximum RGR was 1.5587 in D3 [figure 2].

Specific growth rate

The specific growth rate of the *O.niloticus* was maximum in the diet 3 (1.9146) and minimum growth rate in control diet (0.8024). Figure 3 showed the results of SGR.

Feed conversion ratio

The feed conversion ratio of the control diet was 36. Diet 3 have the feed conversion ratio of 58.06 and diet1 and diet2 ratio were 42.86 and 47.36[figure 4].

Length weight relationship

The relationship between the length and weight of the control diet was $0.2931 \times L^{1.5235}$, diet1 was $0.002 \times L^{4.483}$. The diet 2 interpreted was $1.9503 \times L^{0.3608}$ and diet 3 showed the length weight relationship of $4.7025 \times L^{0.110}$.

Fulton's condition factor

The Fulton's condition factor for control diet 1 was 64.80 and diet 1 was 66.67. The diet 2 and diet 3 having the Fulton's condition factor of 72.96 and 88.32. This indicated the modification in food reserves[figure 5]

Discussion

Unique set of water chemistry needs is indispensable to a vigorous, reasonable and practical for a good aquaculture scheme (DeLong *et al.* 2009). The escalation of diverse fish species was ideal, which were influenced by diverse choice of water quality features (Nailor *et al.* 2021).

In general organisms augment in size (length, weight) all through development. The amount of food, the number of fish utilizing same food, temperature, oxygen and other water quality factors are key factors that influence the growth of fish. moreover the size, age and sexual maturity of the fish also plays well. The rapport between the applied length and weight gained significance, because every animal gained growth by length and weight in its life.

In the present investigation, an average weight of *O.niloticus* was examined for a period of 90 days. Maximum mean length 7.1 ± 0.725 cm was noticed in diet 3, minimum length found was 0.96 ± 0.212 cm in diet 1 and the moderate length was 5.03 ± 0.684 cm in diet 2. Similar study carried out by Anene (2005) proved that the maximum weight of *Labeo rohito* observed was 1.964 ± 6.212 and minimum of 1.255 ± 3.971 in the carbohydrate diets. However the maximum length of *Labeo rohito* analyzed was 0.293 ± 0.928 and minimum of 0.172 ± 0.544 in the maltose dietary components. The Mean weight of *O.niloticus* showed the maximum of 9.68 ± 0.337 gm in diet 3 and minimum of 3.96 ± 0.168 gm in diet 2 and moderate (5.2 ± 0.324 gm) in diet 3. Compared with these studies, *O.niloticus* had the maximum length and weight in the present study.

Ngugi *et al.* (2007) reason out the discrimination in length and weight gain of fish could be endorsed to perfect circumstances of the fish pond. The feed availability, quality of water in the pond and stocking density may have favoured progress in the pond. In terms of cost efficiency low grade lavers could be a fine resource of feed ingredient for commercially intensive tilapia, *O.niloticus* farming. Little labour value with non profit worth poses serious environmental problems (Ishihara *et al.* 2008). Therefore unexploited D2 and D3 were used as a good fish diet source (Yangthong *et al.* 2014).

Fish Growth depends on a wide range of positive or negative impact factor studies. fish size increase in aquaculture largely depends on feed quality and consumption rate (slawaski *et al.* 2011). The relative growth of the gift tilapia *O.niloticus* was high in the diet 3 (11.91) and less in the control diet (7.73). The relative growth rate was higher in the diet 3 (1.558) and lesser in the control diet (0.1031). The specific growth rate of the *O.niloticus* was high in the diet 3 (1.9146) and minimum in control diet (0.8024). Similar study carried out by Makori *et al.* (2017) proved that the specific growth rate of the *O.niloticus* in earthen ponds were evidenced similar growth rate of 3.7%/day SGR. When compared with these studies, our study reported moderate SGR.

The length weight relationship of fish is significant for evaluation of growth observations. Length and weight relationship of the control diet was $0.2931 \times L^{1.5235}$, the diet 1 having $1.9503 \times L^{4.483}$, the diet 2 having $4.7025 \times L^{0.110}$. Similar study was carried out by shahabuddin *et al.* (2015). They proved relationships of length and weight in the juveniles of Nile tilapia, *oreochromis niloticus* showed the allometric increase of growth. Khallaf (2003) reported variation in length weight relationship of *O.niloticus* in a contaminated canal was weighed against with those of other authors in diverse localities at different times. These divergences were recognized on growth and other biological aspects by the eutrophication and pollution.

The Fulton's condition factor for *O.niloticus* was estimated in the range of 64.80, 66.67, 72.68 and 88.32 respectively. Further the highest amount was recorded in diet 3 (82.32) and the lowest amount was noticed in the control diet. The condition factor is an vital factor to establish the relative degree of heftiness and sustenance in fish (Mortuza and Al-Minsed, 2013). This factor influenced the sex, age, maturity and environmental condition (Anyanwu and Okoro, 2007). The condition factor obtained in the present experiment showed fish above average condition which indicated good health condition during

the experiment and indicated an isometric growth, which is the advantageous factor in fish farm. All the results of the present study proved that there was a noteworthy increase in the body size of fishes reared in azolla [D3]. So the present results exposed that *O.niloticus* will grow well in azolla fed tanks.

Declarations

Funding

No funding was received

Conflicts of interest/Competing interests

There are no conflicts of interest to declare.

Ethics approval

The Department of science, Southern Region has approved this research.

Contribution Description

LGB conceived and designed research. MR conducted experiments and generated data. LGB and MR analyzed data. MR wrote the manuscript and LGB corrected and edited the whole contents. All authors read and approved the manuscript.

Data Availability Statement

Data available as supplementary data

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Figures

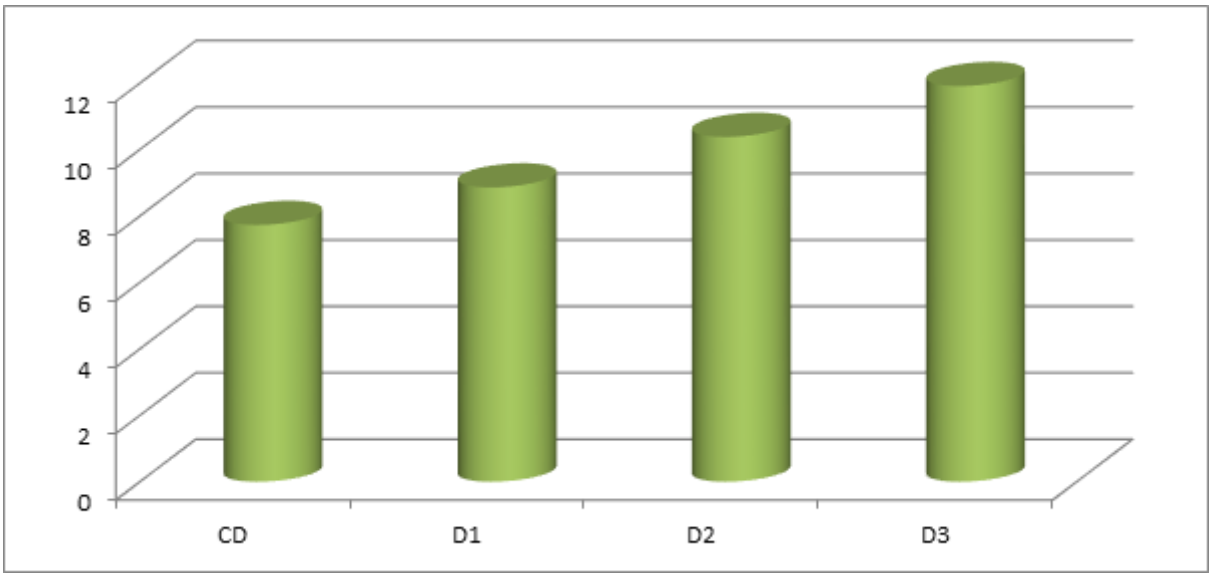


Figure 1

Relative growth in different feeds of *O. niloticus*

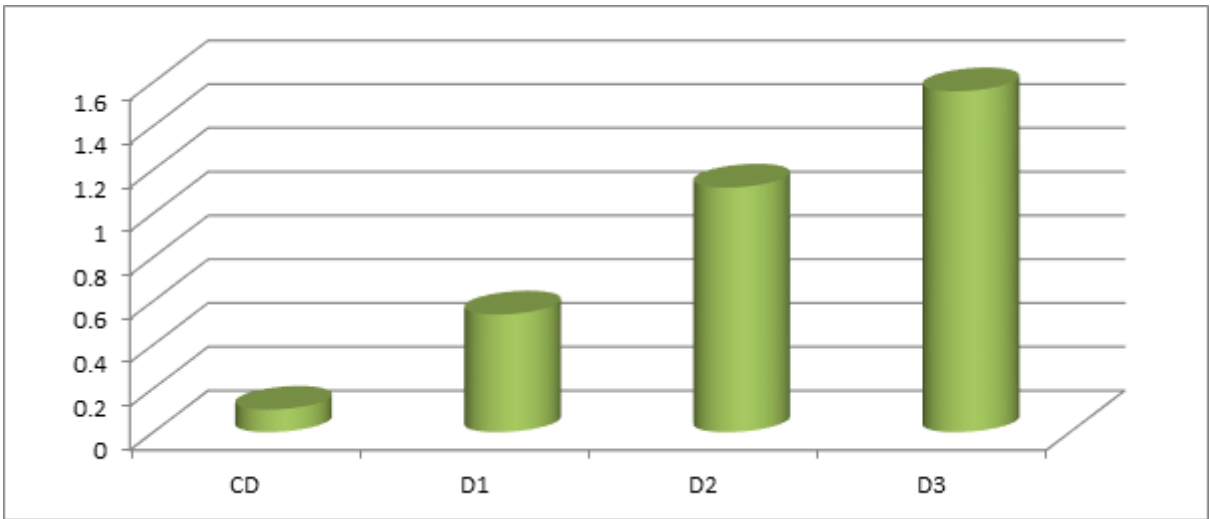


Figure 2

Relative growth rate in different feeds of *O. niloticus*

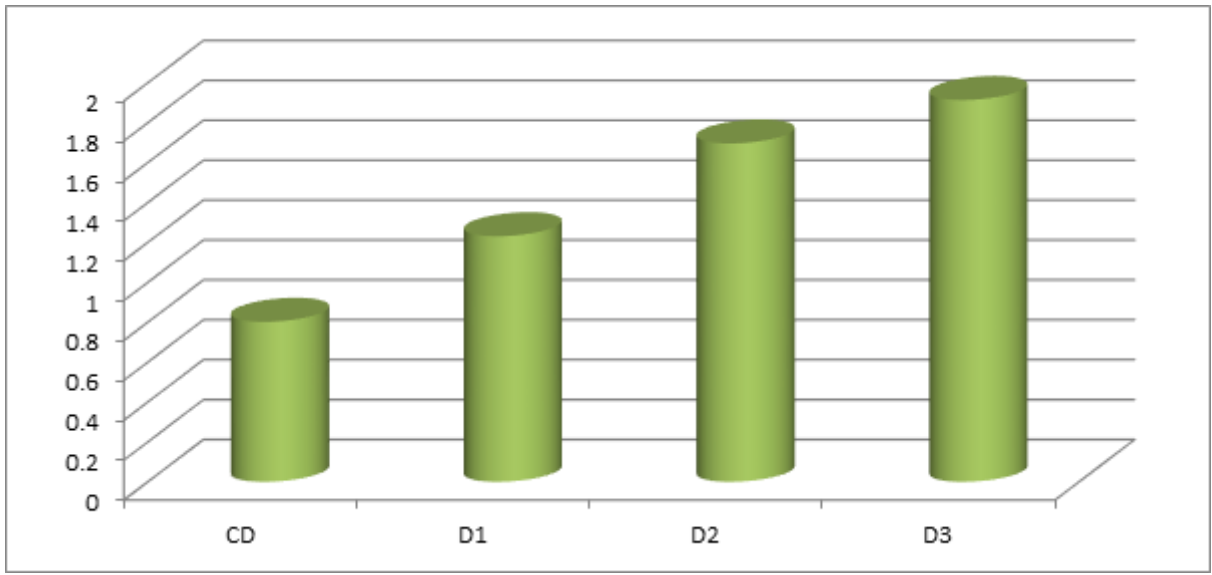


Figure 3

Specific growth rate in different feeds of *O. niloticus*

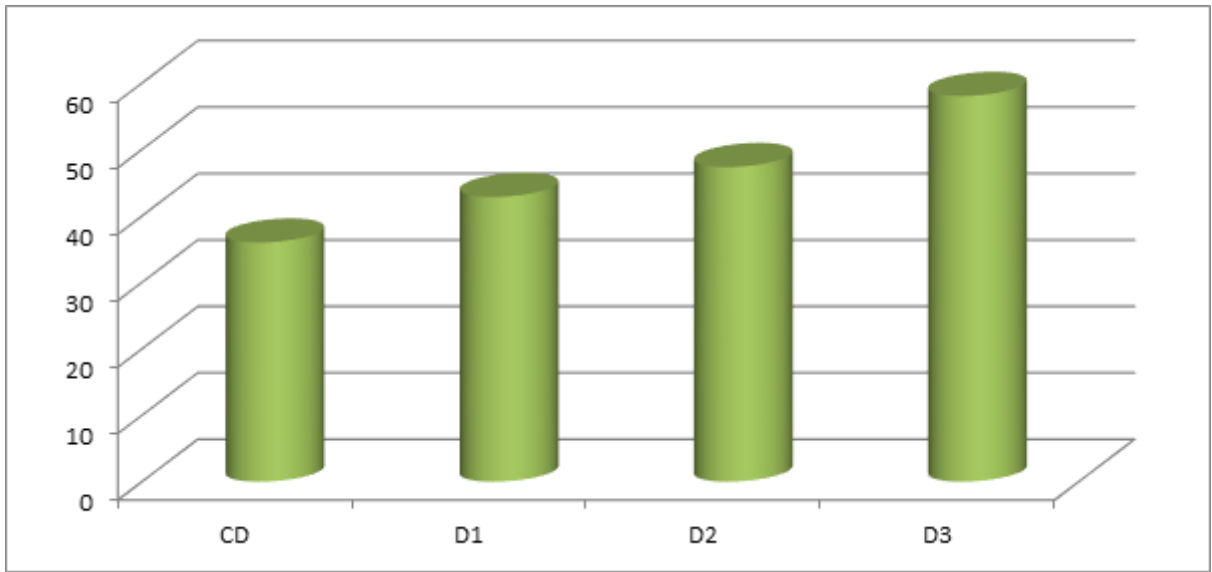


Figure 4

Feed conversion ratio in different feeds of *O. niloticus*

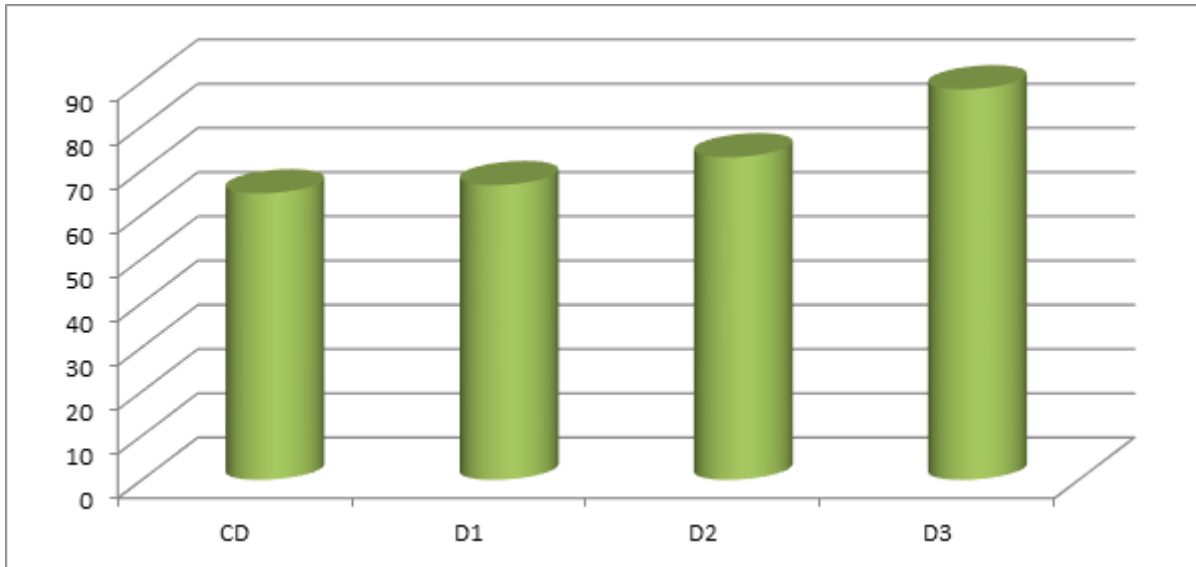


Figure 5

Fulton's condition factor changes in different feeds of *O. niloticus*

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