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Research Article

Growth perfomance of *Tilapia sparmanni* fed on formulated chicken feeds

Abstract

Growth performance of 120 fish fingerlings of *Tilapia sparmanni* stocked in three rectangular tanks was evaluated after feeding on three different formulated chicken feeds for eight weeks. Fish wet weights and lengths were measured after every two weeks, they indicated considerable increase. Positive correlation between mean wet weight increase and percentage increase in lipid and carbohydrate contents (r=0.9861; d.f=1; 0.1 < P < 0.2 and r=0.3312; d.f=1; P > 0.5) was noted respectively. A strong positive correlation r=0.9997; d.f=1; 0.002 < P < 0.05 with increase in mean wet weight was also observed for fish fed diet with relatively the highest % protein contents. Each diet type recorded different food conversion ratio, where F < 9.1339; d. f=6; 0.01 < P < 0.025. Therefore, diet type one was recommended because growth performance of *T. sparmanni* was the highest when compared to performance of the other two feeds.

Introduction

Over half a billion people (workers and dependents) are wholly or partly supported by fisheries, aquaculture and related industries [1]. Of which 95% are in developing countries where aquaculture is on the rise [2]. Demand for fish for food and recreation in these countries have also increased tremendously in the last few decades. Resulting into attempts to improve yield of useful aquatic organism through input of labour and energy Reay, 1979. Improved yield in aquaculture will be however, achieved by deliberate manipulation of fish growth rate, reduction of fish mortality and increased reproduction of fish. For example, in 1990, aquaculture contributed more than 10% of the world fishery production [3]. Beside this direct contribution to dietary intake, fish contributed to household food security indirectly through increasing household income, which can be utilized to purchase other food commodities including lower cost staple foods [4-6]. Like any other form of animal production, yield of fish per unit area depends largely on the quality and quantity of food available to the animal. In this case, additional of external food source is regarded as direct and efficient way of increasing food availability.

Most popular farmed species in Tanzania are Tilapiines and African catfish [7]. Tilapia especially *T. sparmanni* are well distributed in the southern and central regions of the country. Majority fish farmers use fertilizers from animal manure. The manures in use are; cow dung, sheep, poultry and rabbit manure, which increase the risk of introduction of pathogens into the system [8,9]. There is however, many chicken feed factories, which produce feeds that can as well can be used to feed fish in aquaculture sector.

For stance the rapid rise and growth of aquaculture in the major producing countries has been, in part, due to the availability of on-farm provision of feed inputs [10]. These feeds are prepared in both dry and non-dry forms. Dry fish feeds are normally made from dry ingredients, but they are not completely free from moisture. They just reach an equilibrium moisture contents (usually about 7.13%) depending on environment [11]. Dry diets are more suited for use with automatic feeders and generally more suitable in water causing less pollution. A further benefit is that, processing techniques used in the manufacture of dry diets reduces the chance of transmitting diseases through contaminated feeds [12]. These observations explain why dry feeds are widely used for the cultivation of tilapia and other fresh water fishes. It should be noted that the advantages of a dry food would be lost if there was a serious reduction in growth or food conversion efficiency.

Fish feeds may be supplied as "supplementary" or complete'. Supplementary feeds are the additional feeds to the natural food available in the aquatic system. It is an important feed in tilapia culture for improving production. Most supplementary feeds are successful in large-scale culture of tilapia, but few are carried out in a systematic manner. Complete feeds are necessary in intensive systems of aquaculture where natural food is either absent or the proportion of natural food availability is small in relation to the total food requirements. Fertilization is another means of increasing food quantity to aquaculture system. They are applied in form of organic fertilizers (usually manufactured from factories) and inorganic fertilizers, the most suitable in terms of nutritional efficiently. The main purpose of these fertilizers is to provide fish with

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primary source of food. Fish growth is often determined by nutritional, and environmental factors. This paper examines the suitability of three different types of formulated chicken feeds were examined in terms of promoting growth of farm reared *Tilapia sparmanni*. It is well known in Tanzania that chicken feeds are readily available when compared to imported fish feeds. These chicken feeds are analysed relative to their contribution percentage of carbohydrates, proteins and lipids of the diet for promoting fish growth; best with low food conversion efficiency; and finally, a suitable diet for farmed *T. sparmanni* will be suggest.

Materials and Methods

Study area

The study on tilapia feeds was conducted at science laboratories of the University of Dar es salaam. Tilapia was chosen because is among the most popular farmed species in Tanzania followed by African catfish [7]. Tilapia sparmanni was chosen among the tilapiines due to its widely distribution in the southern and central regions of the country. A total of 120 fish fingerlings of *T. sparmani* were obtained from nursery ponds at Shirika la Uchumi na Kilimo Tanzania (SUKITA) fish farm in Dar es salaam and stocked in three PVC rectangular tanks of 1.22m lengths by 1.22m widths and 0.6m deep. *Tilapia sparmanni* are native fish species in the southward's basin of Lake Nyasa and mainly grow in shallow swampy lakes and river margins. The stocked tanks were filled with tap water to a depth of 0.33m, yielding a volume of approximately 0.49m^3 each while leaving unfilled volume at the surface to prevent fish escape from the tanks. The filled water tanks were left for five days to allow escape of carbonates dissolved in tap water before they were stocked with *Tilapia sparmanni*.

Fish fingerlings were acclimatized for two days in rearing tank before feeding them with the three types of chicken formulated feeds presented in table 1.

Stocking density was 7 fish/m^2 and were fed 10% of their total body weights. This feeding ratio was adopted from Mohammed, et al., [13], as indicated in table 2. In addition, basic guideline of feeding tilapia where a mature fish consumes 1% of their body weight a day, while fingerlings consuming as much as 7% was applied.

The stocked fish initial mean weights were 6.3±2.3 g for the 1st tank, 6.0±3.1 g for 2nd tank, and 6.4±1.2 g for the 3rd tank. Initial fish weights and lengths were measured using an electronic weighing balance (Oertling, OB152), and a ruler respectively. Fish were scooped and measured consistently every two weeks throughout the study. Water was virtually static and levels were constantly maintained in the tanks by replacing water loss through sampling and evaporation with equal volume of the un-carbonated tap water. Tanks were cleaned once per week to reduce contamination which might cause infections from food remains and oxygen depletion leading to possible disease outbreak. Temperature and pH were recorded using thermometer and a Digital min- pH-METER- respectively.

Table 1: Ingredients in food of the diet types 1, 2, 1 and 3.

Diet type	Ingredients in the diet
1.	Maize bran, cotton seed cake, dagaa, Premix and *Leucaena* leaves
2	Maize, bran, cotton seed cake, Dagaa Limestone, Premix, salt and Bon meal.
3	Maize, maize bran, cotton Dagaa, Limestone, Premix, Salt and Methionine

Table 2: Feeding rates of *Tilapia spp.*

Weight of fish (g)	%Biomass per day
<10	9-7
10-40	8-6
40-100	6-5
>100	5-3

Note: This feeding rate was adopted from [13].

Data analysis

Data was analysed in stages. Food analysis was conducted to determine the % of carbohydrates, lipids, and proteins in the three formulated chicken feeds. Then randomised block ANOVA was used to test the effect of diet types on growth of fish. While regression analysis was done to test the increase in weight over weeks for each diet separately and also testing if their slopes were significantly different from zero. Further analysis was done to test for difference between slopes of the three lines (2 at a time). Randomized block ANOVA was again performed to test the effect of diet types on the food conversion ratio (FRC) for *T. sparmanni*. Correlation analysis was done to test if there was any correlation between the percentage lipid, carbohydrate or protein contents in the diet and the mean increase in wet weight of *T. sparmanni.* Carbohydrate contents was analyzed by following Dubois method (The Phenol-Sulphuric method). Lipid was determined following SOXHLET procedure whereas proteins contents in food were analyzed by MICRO-KJELDAHL method.

Results

It was observed that diets have positive effects on growth of reared fish ($F=53.5068$; $d.f=6$; $p< 0.005$). It was further revealed that the first slope $\hat{y}=2.6996+2.2201x$ representing the first diet type treatment shown a significant different from the second and the third slope which are defined by $\hat{y}=1.9543+1.1741\,x$ and $\hat{y}=0.9314+0.9047x$ respectively (Figure 1).

The regression coefficient (slope) for the three equations were significantly different from zero ($t=2.287$; $d.f=12$; $0.02 < p < 0.05$; $t=3.301$; $d.f=12$; $0.005 < p$ and $t=0.914$; $d.f=12$; $0.05 < p < 0.50$ for the first, second and the third slopes respectively. However, the slopes of the second diet type and that of the third diet type treatment are not significantly different.

The ingredients of each diet type and percentage of crude lipid, carbohydrate and crude protein used in this experiment indicate that diet type 3 had the highest composition of carbohydrates compared to diet type 1 and 2 that had high composition of crude protein (18.6% and 14.2%) respectively. Whereas diet type 3 had high composition of crude lipids (2%) as shown in Figure 2.

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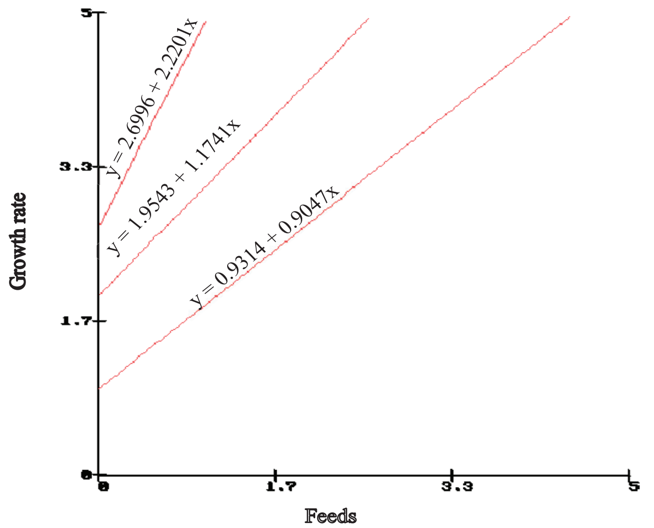

Figure 1: Growth performance of *T. sparmanni* fed on different diet types.

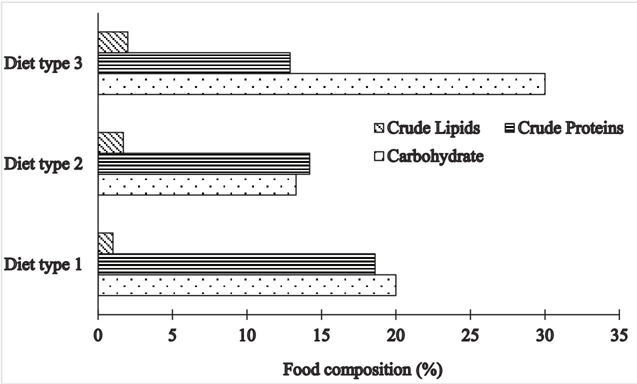

Figure 2: Food composition [(%) carbohydrates, (%) proteins, (%) lipids and its ingredients].

Positive correlation r=0.985; d.f=1; $0.1 < p < 0.2$ was observed between increase in lipid of the diets and the mean final increase in wet weight. Whereas a weak correlation n=0.331; r=0.331; d.f=1; $p > 0.5$ with the final increase in body weight of *T. sparmanni* was noted. Increase in percentage protein content of the diets fed to fish was strongly correlated r=0.999 with increase in body weight. The value of food conversion ratio (FCR) was the lowest for fish fed with diet type one followed by those fed with diet type two, and the highest was to those fed with diet type three (Table 3).

Throughout this experiment, temperature and pH were almost constant at the values of 28±0.51 and 6.55±0.05, respectively. Percentage fish survival was 100% for the fish reared in tank number one, 90.91% (tank two), and 72.78% for the fish in tank number three.

Discussion

In aquaculture, feeds account for 60 per cent of the production costs [14]. The most expensive ingredient in the diet of fish is the animal protein component. But in natural environment fish consumes an array of food, which change seasonally with size or age of fish. This guarantees adequate representation of the complex series of proteins, lipids, vitamins and other nutrients essential for normal growth, as well as relatively standard supply of caloric energy per gram of intake [10,15,16]. Limitations on growth or of increase in population, production in nature seem, to result largely from restrictions in the total food supply [17].

Table 3: Food conversion ratio of *Tilapia sparmanni*.

Weeks	Diet type (1)	Diet type (2)	Diet type (3)
	FCR	FCR	FCR
0.2	4.2	5.9	7.6
2-4	4.5	6.5	6.2
4-6	6.1	6.4	7.9
6-8	5.4	7.7	6.9
Over all FCR	2.1	3.4	3.8

Notes: FRC= Dry weight of food fed (g)/ wet weight gain in (g)

Food supply is probably the most potent factor affecting growth of fish. Proper feeding can make fish attain the maximum growth possible for the existing physico-chemical conditions. The effect of some factors such as temperature affects growth rates by initially effecting feeding and food requirements for fish. The art of preparing good feeds for fish is by formulating it based on the best attempts to duplicate the composition of natural foods. For example, growing of insects, harvesting small fish or other aquatic animals, or by processing culled domestic animals [18-21]. This is done to obtain high quality feed having lipids and other essential ingredients necessary for fish growth.

In fact, the best available food important in life of fish as a whole as observed in this experiment is diet type one. Fish fed on this diet responded much more instantaneous than others fed on other diets. The reasons for the variations as observed in this experiment may be due to differences in feed ingredients (i.e. lipids, carbohydrates, and proteins) and good balance between energy and growth. The good balance between energy and other materials for optimum anabolic activity, which in addition to growth includes tissues repair, reproduction and the formation of essential body products for example haemoglobin hormones and enzymes.

Dominique [22-24], reported that fats fed to fish at appropriate levels serves as the source of energy while sparing dietary proteins for other protein purposes in the body. This concept relates with the results obtained in this experiment where lipids were positively correlated with the mean final increase in body weight of *T. sparmanni* caused by high intake of fats and ingestion of carbohydrate. In many fish species this would seem likely β-oxidative of fatty acids that constitute a major energy source and essential fatty acids for structure and integrity of the phospholipid membrane [1,25]. However, fats should be supplied with care because the superimposing of supplemental fat in high protein diets results not only in large increase in body fat but, also restrict protein intake and, in some experiments, death of the fish [26]. Jauncey and Ross [27], recommends lipid levels of 10%, 8% and 6% in compounded tilapia diets for feeding 0.5 g, 0.5-3.5 g and above 3.5 g animals, respectively.

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Although carbohydrates are the cheapest source of food energy, they are not all equally well utilized by all animals [28]. In this experiment diet type with increase in carbohydrate percentage did not result in subsequent increase in body weight. It means carbohydrate role was more on energy supply than increasing weight of the fish. The report by Phillips [29], indicated that levels of carbohydrate in diet under his experiment was limited to 12% digestible carbohydrate because any additional amount caused a disposition of excess liver glycogen, caused acute mortality. After his experiment Phillips [29], concluded that like in human being, fish were normally diabetic after feeding a sugar meal the blood glucose increased by 110%. This shows that fish were physiologically unable to utilize high levels of dietary carbohydrates due to its diffuse character of the pancreas in fish and its few insulin producing islets of Langerhans [30]. This finding may explain why significant increase in body weight was not observed in fish fed with high carbohydrate contents in the diet. In this experiment approximately equal to the value of about 25% digestible carbohydrate suggested for tilapia by Jaunecy and Ross [27], was obtained as shown in Table 4.

Protein may serve as a source of energy for fish, but approximately 16% is nitrogen that cannot be used for life cycle [31]. Apparently both plant and animal proteins satisfy, at least in part, the protein requirement of most fish. Similar results were reported by Jauncey and Ross [27], in which they found that 50%, 35% and 30% protein in the compounded diet was necessary for feeding 0.5 g, 0.5-35 g and above 35 g fish respectively. As shown in Table 3 diet type one had more protein content than the others. This result may explain why strong correlation was observed between increase in body weight and an increase in protein content in the diet. Diet type one has the highest performance in body growth rate while diet type three was the least in growth performance.

Table 4: Mean wet weight increase of *Tilapia sparmanni*.

	Diet type treatments		
	Diet type (1)	**Diet type (2)**	**Diet type (3)**
Week	Wt (g)	Wt (g)	Wt (g)
Initial	6.3±2.3	6.0±3.1	6.4±1.2
0.2	10.4±7.5	6.9±1.4	6.8±0.7
2-4	13.0±3.2	7.6±3.8	7.2±4.1
4-6	14.5±4.6	8.7±0.4	7.5±3.7
6-8	16.5±1.5	9.2±1.9	8.3±1.1

In most cases the efficiency of food is normally measured by the amount necessary to produce a unit weight of fish i.e. food conversion ratio/food conversion efficiency. The Feed Conversion Ratio, a major indicator of feed efficiency in fish farming is figured by total weight of food given to fish to the total weight gained by the fish over a given period of time [32,33]. The higher the value of the food conversion ratio the less efficient the feed is and vice versa. The food conversion ratio depends also upon the ability of individual fish to use food given to it. This ability differs according to species of fish, and within a given species the food conversion efficiency will differ from one food item to another.

In this case, the success of experimental diet has frequently been assessed in terms of the food conversion ratio [34-39]. Food conversion ratio (FCR) as shown in Table 3 gives a different picture of food efficiency of the three diets. It is evident that the value of FCR for diet type one was low i.e. 2.1 (Table 3) indicating that the fish converted more food into flesh than could the other two be assimilated. This probably explains why significant increase in body weight was observed in *T. sparmanni* fed with diet type one feed. The opposite was true with diet type three of which FCR value was relatively high (about 3.8) indicating that the fish converted very little food into flesh.

There were no significant variations in temperature and pH throughout the experiment, though the two are among parameters which have a strong influence on growth, but in this experiment, it did not have notable effect to growth of *T. sparmanni*. The highest fish survival was observed in rearing tank no. 1 and the least survival in tank no. 3. The observed mortality in rearing tank number 3 was caused by accident resulting from siphoning of water together with fish at times of cleaning the tanks.

Conclusion

The experiment has shown that type of feed given to a fish has an impact on his growth. Diet type one that had high amount of protein content promoted rapid growth of fish than diet type two that had high lipid and three with relatively high carbohydrate contents. On the other hand, food conversion ratio (FRC), an index that gives an approximate estimation of the best food and a key factor in comparing suitability of different feed types tended to be low in diet type one. These findings show that diet type, one used in this experiment is highly recommended for feeding *T. sparmanni* compared to the other two feed types.

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