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Impact of Nile tilapia (*Oreochromis niloticus*) feeding on Selected Water quality Parameters

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Abstract
The study has been carried out to study the impact of Nile tilapia (*Oreochromis niloticus*) feeding on selected water quality parameters. Five experimental diets were prepared to evaluate the effects of different protein levels 26 % (T_1), 28 % (T_2), 30 % (T_3) and 32 % (T_4) of feed protein (Casein) and without casein in control to see impact on of Nile tilapia feeding on selected water quality parameters. The best and safe level of supplementation of protein (Casein) in the feed of Nile tilapia fry in the present study was found to be at 32% protein level. This experiment was conducted in rectangular plastic tanks with 225 liters containing bore-well water. During the study period water quality parameters such as water temperature, pH, dissolved oxygen, Alkalinity, Total hardness and Electrical conductivity were recorded.
The experimental water has shown a congenial water quality with average values of temperature 17.70°C to 27.70°C, pH 8.03 to 8.50, dissolved oxygen 5.33 mg/l to 8.67 mg/l, hardness 488.56 mg/l to 530.22 mg/l, Total alkalinity486.33 mg/l to535.00 mg/l and Electric conductivity 1.80 mS cm^{-1} to 1.83 mS cm^{-1}.

Keywords: Nile tilapia, feeding, water quality, water temperature, pH, dissolved oxygen, Alkalinity, Total hardness, Electrical conductivity

1. Introduction
Tilapia is the second world wide cultured species after carps. They are also known as “Aquatic chicken” as they are present in all continents except Antarctic. The species is favoured among aqua culturists due to its ability to tolerate a wide range of environmental conditions, fast growth, successful reproductive strategies, and ability to feed at different trophic levels. The Nile tilapia, *Oreochromis niloticus* is responsible for reducing local biodiversity, through competition with other aquatic species for available food resources. Lack of predation and adaption to changing environmental conditions increase the impact of Nile tilapia on the ichthyological composition. In some cases, the introductions have been accidental; tilapia fish have managed to escape from fish farms or ornamental fish units. In other cases, the introduction has been deliberate, e.g. to combat mosquitoes or aquatic weeds. Tilapia has also been introduced as food fish to lakes and other bodies of water. Nile Tilapia is native to the Nile River and to Africa in general. Furthermore, the Nile tilapia constitutes a rough species, which occurs in a wide range of environmental variations, tolerating extreme limits of temperature and oxygen, as well as the presence of various pollutants.
According to Jauncey and Ross (1982) [11], fry and fingerlings require a diet high in protein, lipids, vitamins and minerals and lower in carbohydrates. Adult fish need more calories from fat and carbohydrates for basal metabolism and a smaller percentage of protein for growth. In view of this, the present study is proposed to investigate the optimum level of protein in tilapia fry diet.

2. Materials and Methods
2.1 Experimental diet
Nile tilapia feed was formulated using groundnut cake, rice bran and mineral mixture and commercially available casein. The treatment tank considered as a control which was fed without casein, while groups T_1, T_2, T_3 and T_4 contained included casein. The dry ingredients (consisting of groundnut cake, rice bran, and minerals mixture) of the experimental diets were thoroughly mixed and made in a pellet form by addition of boiled water. The paste was then extruded through a commercial pelletizing machine. The resulting Vermicelli like diet was air dried and stored in air tight containers for further use.

2.2 Water quality analysis
Water quality such as water temperature, pH, Dissolved oxygen, Alkalinity, Total hardness and Electrical conductivity were analyzed on initial day and subsequently on 7, 14, 21, 28, 35 and 42nd day of the experimental period following standard methods of APHA (2005) [2].

3. Results and Discussions
The results of this study indicate a better growth rate; specific growth rate, food conversion ratio and gross conversion efficiency in fry fed with different protein levels mixed diet. The fry of Nile tilapia fed on protein (Casein) level 32% in diet have shown the best growth among all the five diets including control. During the experimental period, 100% survival rate of test fishes was observed owing to good water quality maintained in the experimental tanks. The fry of Nile tilapia fed on protein (Casein) level 32% in diet the net weight gain was (1.139 g) and specific growth rate was (0.850%). In this experimental diet 32% protein level the lowest FCR i.e. (4.395) was reported as compared to all other diets (protein levels). The gross conversion efficiency for this diet (32% protein level) was (0.264). In the control diet the overall growth of fish was relatively lower. The statistical analysis of data has further revealed significant variation in the result of weight gain, food conversion ratio and gross conversion efficiency as compared to control diet. (Fig. 1-3)
The experimental results of water quality parameters carried out during the experimental period are presented in (Tables 1 and figures 4to 9). It is apprehended from the results of present study that the differences in water quality parameters were not significant in different treatments.

3.1 Physico-Chemical Parameters
The bore well water was used as source water during the whole experimental period. Physico-chemical parameters of water such as water temperature (°C), pH, dissolved oxygen (mg/l), total alkalinity (mg/l), Electric conductivity (mS cm^{-1}) and total hardness (mg/l) were recorded and the average value of all these parameters are presented in (Table1).

3.2 Temperature
The water temperature increased progressively. During the experiment, the average water temperature recorded was 24.25°C. Further, the minimum water temperature of 17.70°C was recorded in $T_{2,}$ whereas the maximum 27.70°C was recorded in $T_{1.}$ However, the mean values of water temperature ranged between 23.94°C to 24.38°C (Table 1 and Fig. 4). All the values of the water temperature in different tanks were statistically non-significant to each other at 5% level of significance.
Hickling (1962) [9] reported that fall in temperature slow down the carp feeding activities. The intolerance of tilapia to low temperatures is a serious constraint for commercial culture intemperate regions. Optimal water temperature for tilapia growth is about 85 to 88^0F. Growth atthis optimal temperature is typically three times greater than at 72^0 F. Backiel and Horoszewicz (1970) [3] found that the intensity of carp feeding increases with the rise in temperature from 28.0 °C to 29.0 °C. Jhingran (1983) [12] has suggested the optimum temperature range for major carp culture from 18.3 to 37.8°C. Prinsloo and Schoonbee (1984) [20] observed a marked decline in fish production when mean water temperature of ponds, was below 20 °C. In the present study, the temperature of water varied between 17.7 °C to 27.7 °C, with a mean of 24.07 °C to 24.43 °C in five experimental diets. It was quite favorable for fish growth and was very similar to the optimum temperature range given by Jhingran (1988) [13]. The results of our study are in accordance with the earlier findings of Kumar *et al*. (2007) [16] who in their study found that the temperature range of 19.8-29.0 °C is safe for growth and survival of carp, *Cirrihinus mrigala.*

3.3 pH
During the experimental period, the water of tanks remained alkaline. The values of pH ranged between 8.03 and 8.50.The minimum pH values 8.03 and maximum 8.50 was observed in control and T_4 respectively. Whereas, the mean values of pH were in the range of 8.25 to 8.32 (Table 1 and Fig. 5) in different treatments. All the pH values during the study period were found to be statistically non-significant to each other.
Lagler (1972) [17] considered water having pH range of 7.0 to 8.5 as favorable for fishes. The pH of pond water undergoes wide fluctuations. In open waters the diurnal change in pH being most alkaline in afternoon and most acidic just before the day breaks. Swingle (1957) [23] reported optimum growth of fish at pH ranging between 7.5 and 8.5. In the present experiment, the values of pH ranged from 8.03 to 8.50 in tanks and this could be considered congenial for fish growth. Thus, pH had not been a limiting factor for fish growth. The pH in aquatic system reflects an integration of several environmental conditions. Jhingaran (1991) [14] reported that pH is determined by the relationship between free carbon dioxide and carbonates. The pH can also affect fish health. Optimum pH level for carp culture is 7.5 to 8.5 (ICAR, 2011) [10]. In general, tilapia can survive in pH ranging from 5 to 10 but do best in a pH range of 6 to 9.

3.4 Dissolved oxygen (DO)
During the experimental period narrow fluctuations in the levels of dissolved oxygen were recorded. The values of dissolved oxygen ranged between 5.33 mg/l to 8.67 mg/l. The minimum (5.33 mg/l) and maximum (8.67 mg/l) was observed in T_4 and control respectively. Whereas, the mean values of dissolved oxygen were noticed lowest (6.71mg/l) in T_2 and highest (6.89mg/l) in T_3 respectively (Table 1 and Fig. 6). All the values obtained for dissolved oxygen during the experimental period were found to be statistically non-significant, among different tanks.
Dissolved oxygen concentration in water, plays a vital role during fish culture. Tilapia survives dissolved oxygen (DO) concentrations of less than 0.3 mg/l, considerably below the tolerance limits for most other cultured fish. In research studies by Trewavas (1983) [25] Nile tilapia grew better when aerators were used to prevent morning DO concentrations from falling below 0.7 to 0.8 mg/l compared with unaerated control ponds (Trewavas, 1983) [25]. Growth was not further improved if additional aeration kept DO and other concentrations above 2.0 to 2.5 mg/l. The lowest limit of the dissolved oxygen for good fish production in pond has been suggested to be 5 mg/l (Dandraff and Dean, 1967) [6]. However, Smitherman and Boyd (1974) [22] considered dissolved oxygen level of about 2 mg/l, as favorable for proper health and growth of fish in normal pond condition. Jhingran (1983) [11] opined that the concentration of dissolved oxygen above 7 mg/l is suitable for productive pond water. Further, the high concentration of dissolved oxygen affects metabolic rate and consequently, the feeding of fish (Lovell, 1976) [18]. The dissolved oxygen content of the experimental

water ranged between 5.33 mg/l to 8.67 mg/l. The aeration of water with the help of aerator (2 hours daily during morning and evening hours) and periodical renewal of water probably helped to maintain higher dissolved oxygen levels throughout the experiment. Movement of fishes in plastic tanks as revealed from the visual observations further affirmed the view that fish enjoyed favorable dissolved oxygen throughout the experiment (Sharma and Jain, 2000; ICAR, 2011) [21, 10]. All the values obtained for dissolved oxygen during the experimental period were found to be statistically non-significant, among different tanks. Dissolved oxygen (DO) is considered as one of the most important aspect of aquaculture. It is a crucial factor in natural waters for the growth and survival of fishes. It is needed by fish to respire and perform metabolic activities. Thus, low levels of dissolved oxygen are often linked to fish kill incidents. On the other hand, optimum levels can result to good growth which in turn results in high production yield. The DO concentration of 5mg/l in pond water is considered optimum for growth and survival of fish (Das, 2000, 2001) [7, 8].

3.5 Hardness

The fluctuations in water hardness have been depicted in Table 1. In general, hardness varied from 401.33 mg/l to 634.00 mg/l with lowest in T_3 and highest in control. The average values of water hardness were noticed (488.56 mg/l) lowest in T_3 and highest (530.22 mg/l) in control (Table1 and Fig. 7). All the values obtained for hardness during the experimental period were found to be statistically non-significant, among different tanks.

Swingle (1967) [24] has suggested a hardness from 150 ppm or above as satisfactory for growth of fish and do not require addition of lime. The levels of hardness in experimental water clearly indicated that the experimental water was hard with an average hardness of 488.56 mg/l to 530.22 mg/l.

3.6 Total alkalinity

The levels of total alkalinity ranged between 409.33 to 620.67 mg/l (Table 1 and Fig. 8).The minimum (409.33 mg/l) and the maximum (620.67 mg/l) were observed in control and T_4 respectively. Whereas, the mean values of total alkalinity were noticed lowest (486.33 mg/l) in T_2 and highest (535.00 mg/l) in T_4 respectively. All the values obtained for Total alkalinity during the experimental period was found to be statistically non-significant, among different tanks.

Banerjee (1967) [5] found water having total alkalinity above 90 mg/l to be productive. Alikunhi (1957) [1] reported that in highly productive water, the alkalinity ought to be over 100 mg/l. Moyle (1946) [19] opined that higher alkalinity has greater complement to most of the ions than water with low alkalinity. In this experiment, total alkalinity average ranged between 486.33 mg/l to 535.00 mg/l. obviously, this range of total alkalinity is good for rearing fish in the tanks.

3.7 Electric conductivity

The values of electrical conductivity ranged between 1.73 to 1.98 mS cm^{-1} (Table 1 and Fig. 9). The minimum (1.73mS cm^{-1}) and the maximum (1.98 mS cm^{-1}) were observed in control and T_4 respectively. Whereas, the mean values of Electric conductivity were noticed lowest (1.80mS cm^{-1}) in T_1 and highest (1.83mS cm^{-1}) in T_4 respectively. All the values obtained for Electric conductivity during the experimental period was found to be statistically non-significant, among different tanks.

The electrical conductance represents total ionic load in water due to dissolved substances and sometimes considered as an index of productivity. High EC value designates pollution status of the lake (Kadam, 1990) [15]. Balai (2007) [4] observed positive significant relationship of electrical conductance with carbonates, bicarbonates, total alkalinity and silicates. In this experiment, Electric conductivity (mS cm^{-1}) average ranged between 1.80 mS cm^{-1} to 1.83 mScm^{1}.

Table 1: Weekly water quality parameters (minimum-maximum) values during the experimental period in different treatments (values in parentheses are mean value with SEm±)

Parameters	Control	T_1	T_2	T_3	T_4
Temperature (°C)	18.00-27.20 (24.43±3.26)	18.20-27.70 (24.38±3.29)	17.70-27.10 (24.20±3.29)	18.00-27.60 (24.20±3.17)	18.20-27.10 (24.07±3.03)
pH	8.03-8.40 (8.29±0.13)	8.14-8.44 (8.31±0.14)	8.12-8.41 (8.25±0.13)	8.12-8.42 (8.28±0.12)	8.16-8.50 (8.32±0.14)
Dissolved oxygen (mg/l)	5.73-8.67 (6.82±0.96)	5.87-8.00 (6.77±0.65)	5.47-8.53 (6.71±0.99)	5.73-8.40 (6.89±0.79)	5.33-8.27 (6.78±0.89)
Total Hardness (mg/l)	448.67-634.00 (530.22±63.96)	455.33-616.67 (504.56±59.64)	436.00-614.00 (514.33±61.84)	401.33-626.00 (488.56±70.90)	404.67-632.00 (498.22±74.75)
Total Alkalinity (mg/l)	409.33-577.33 (502.44±74.76)	412.00-596.67 (499.56±73.81)	413.33-572.00 (486.33±65.90)	425.33-604.67 (525.67±66.57)	448.00-620.67 (535.00±67.15)
Electric conductivity (mS cm^{-1})	1.73-1.98 (1.80±0.09)	1.74-1.94 (1.80±0.07)	1.75-1.96 (1.82±0.07)	1.76-1.94 (1.82±0.06)	1.76-1.98 (1.83±0.07)

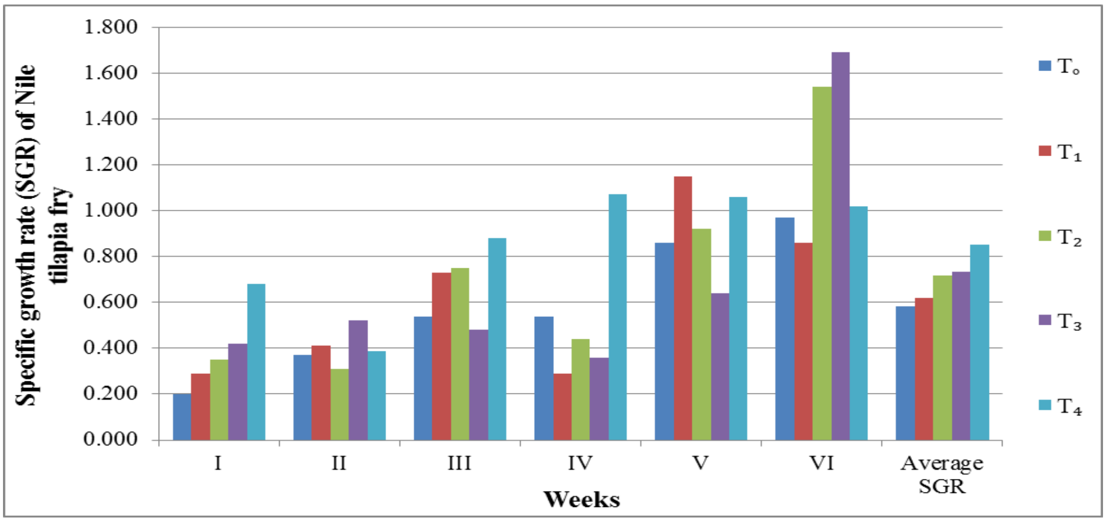

Fig 1: Weekly specific growth rate (SGR) of Nile tilapia fry fed with different levels of Protein (Casein) mixed diet

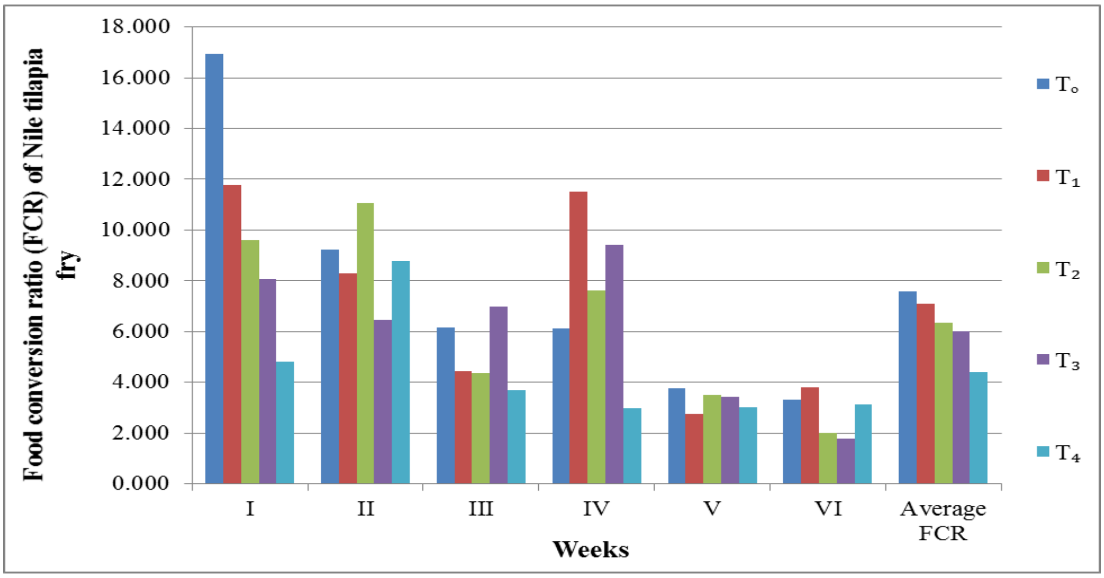

Fig 2: Weekly food conversion ratio (FCR) of Nile tilapia fry fed with different levels of Protein (Casein) mixed diet

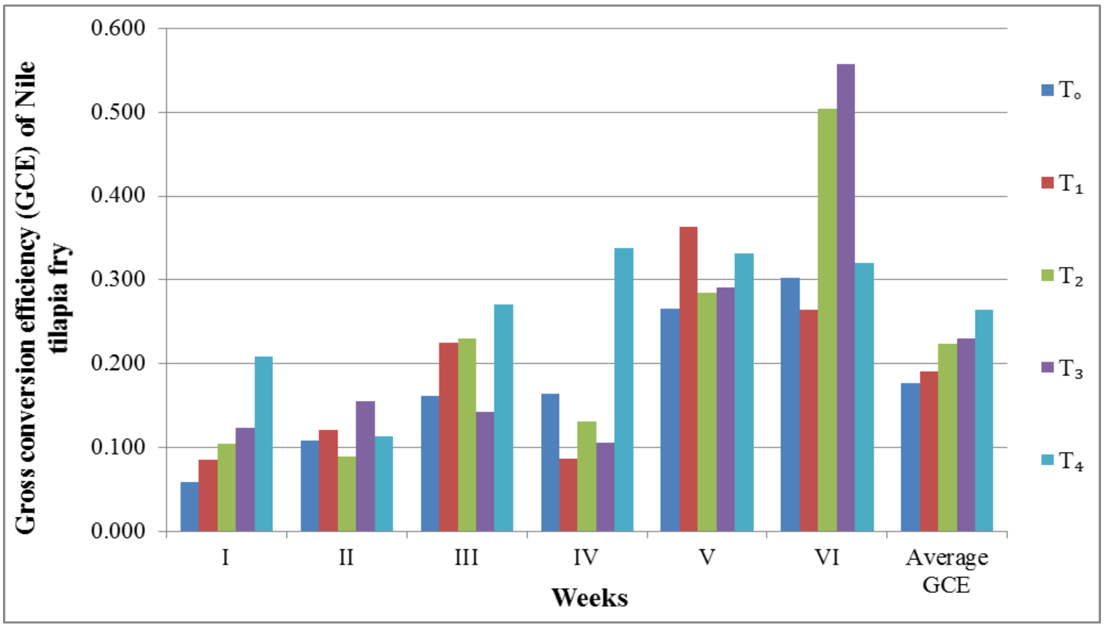

Fig 3: Weekly gross conversion efficiency (GCE) of Nile tilapia fry fed with different levels of Protein (Casein) mixed diet

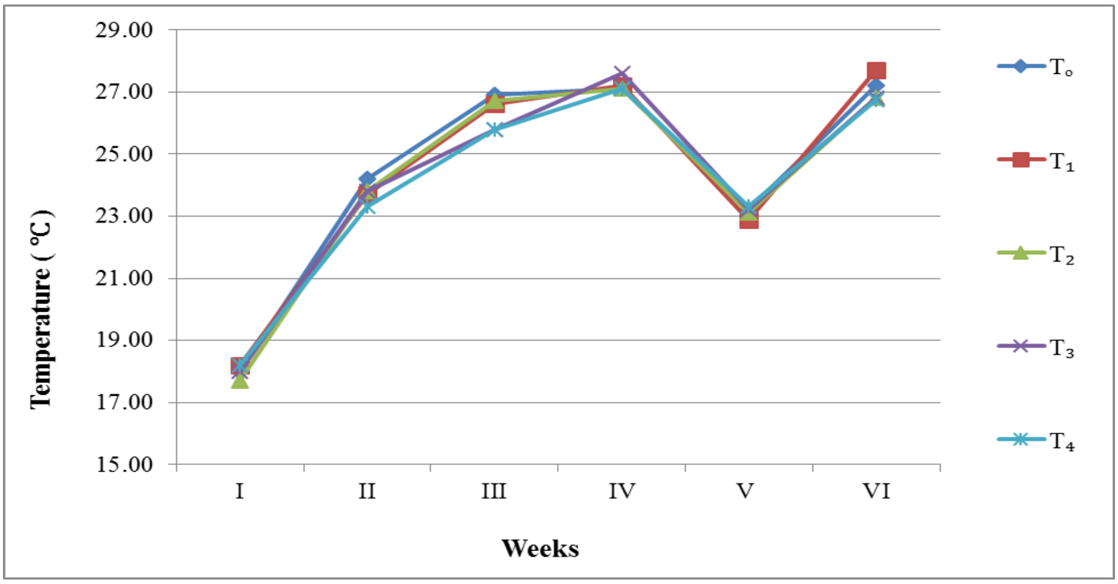

Fig 4: Weekly water temperatures during the experimental period in different treatments

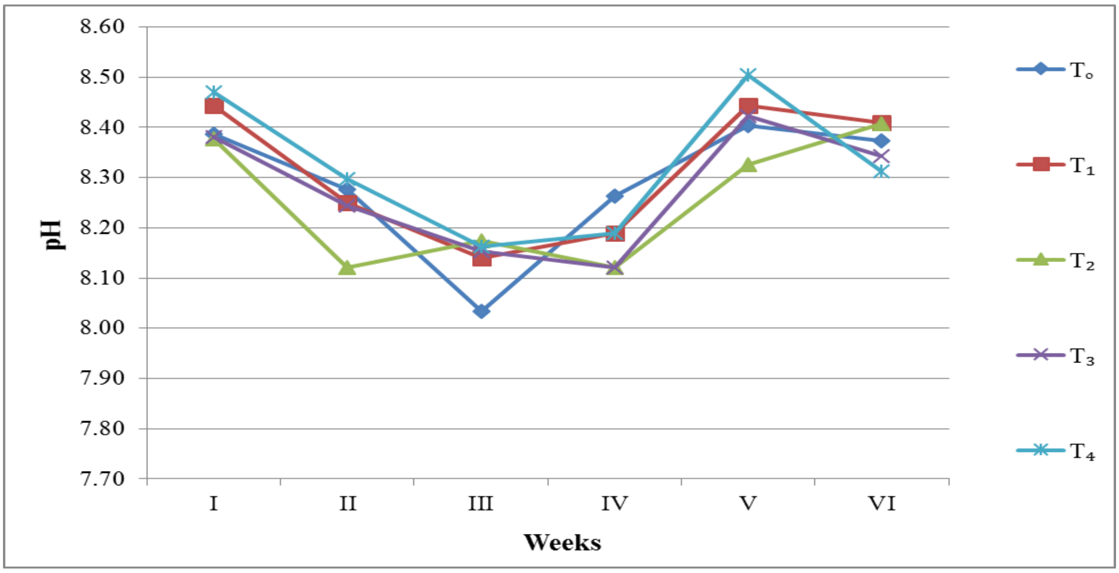

Fig 5: Weekly water pH during the experimental period in different treatments

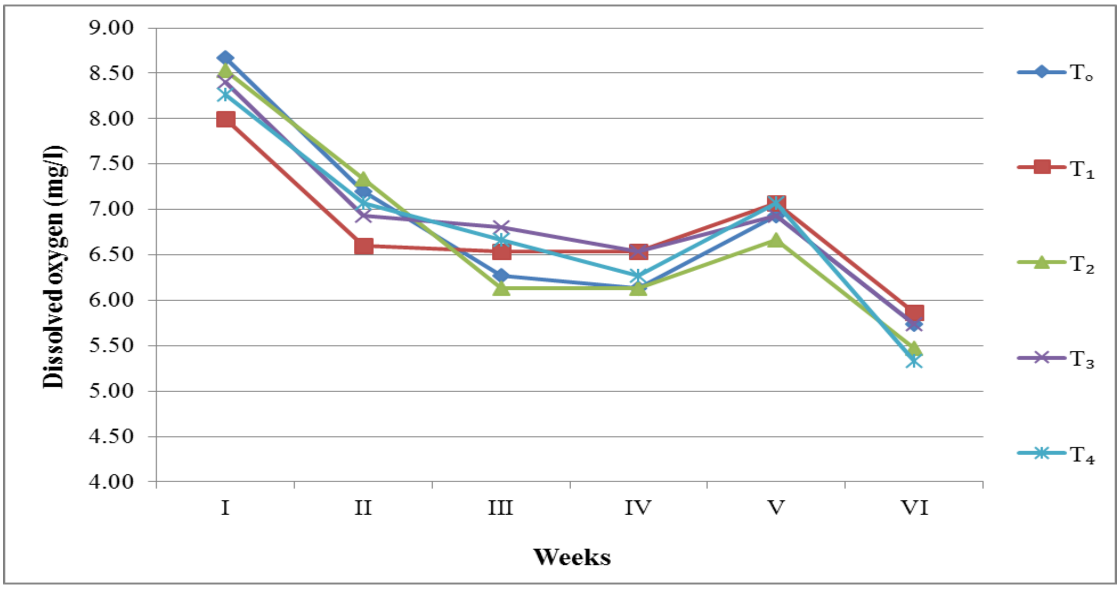

Fig 6: Weekly dissolved oxygen (mg/l) during the experimental period in different treatments

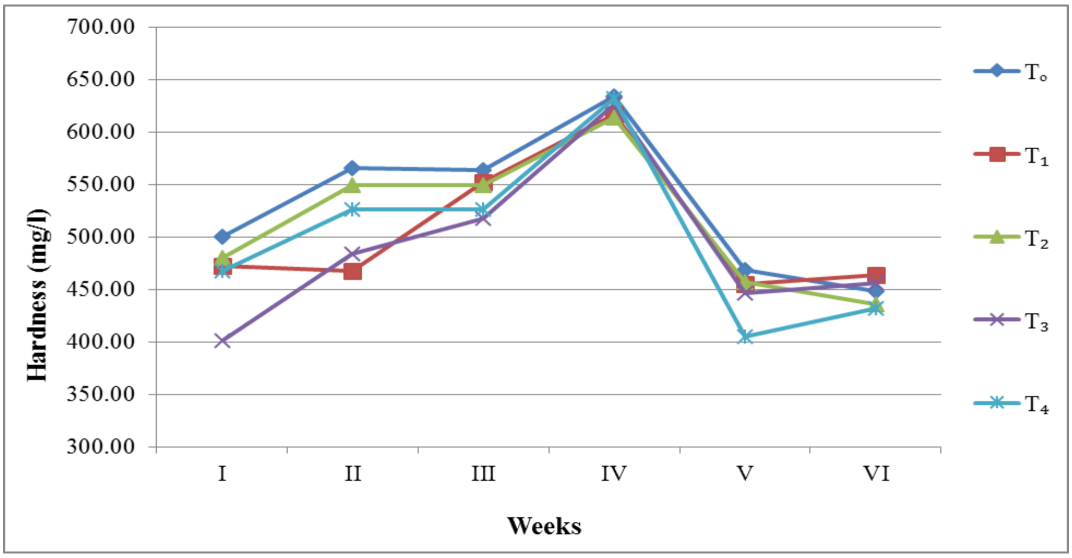

Fig 7: Weekly water hardness (mg/l) during the experimental period in different treatments

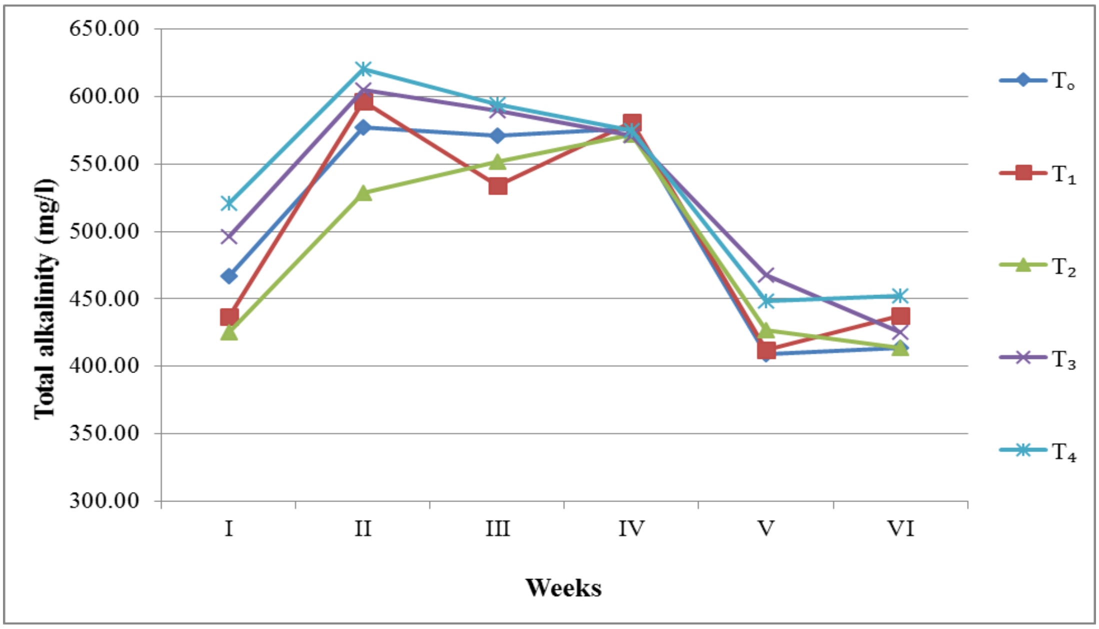

Fig 8: Weekly total alkalinity (mg/l) during the experimental period in different treatments

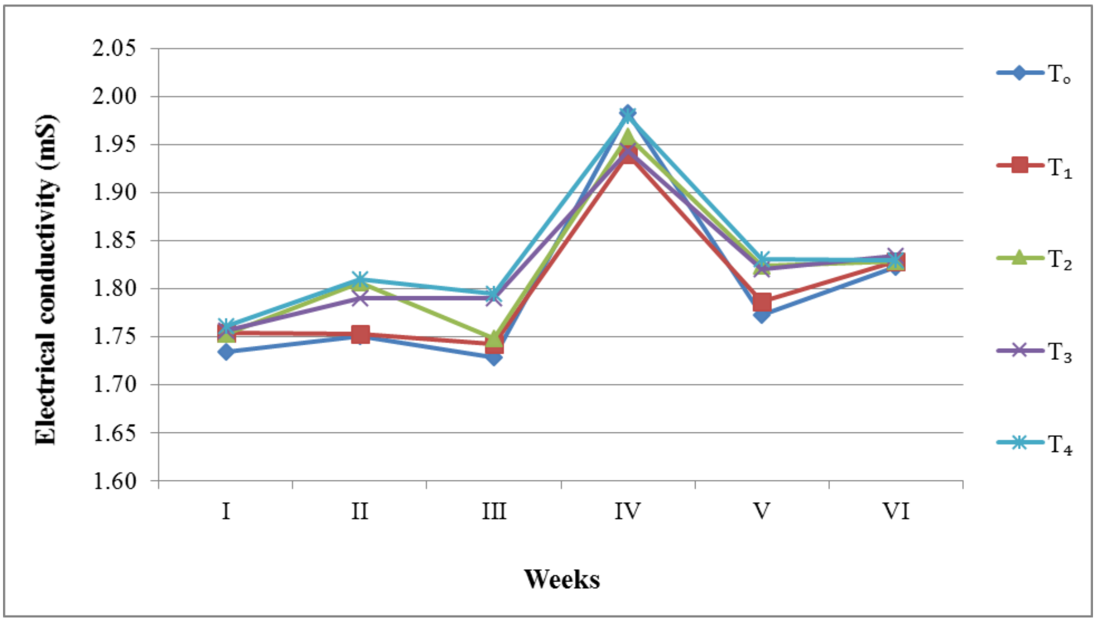

Fig 9: Weekly electrical conductivity (mS cm^{-1}) during the experimental period in different treatments

4. Conclusion

On the basis of the results obtained in the present experiment, it can be concluded that the protein supplement Casein has paramount importance in enhancing the growth performance and survival of Nile tilapia. The incorporation of Casein (protein) in fish diet does not show adverse impact on health of Nile tilapia and it is environment friendly.

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