

Effects of Natural Dietary Supplementation on Growth and Survival rate of Freshwater Ornamental Fish, *Pseudotropheus demasoni* (Konings, 1994)

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Abstract

Ornamental Fishery is one of the fast growing fisheries sector, for its increasing demands in world markets due to their attractive colour. Colouration is one of the essential supremacy qualities of the fish for consumer acceptability. Carotenoids are accountable for colouration of muscle in food fish and skin colour in ornamental fish. The present experiment was carried out to investigate the effect of three different natural feed supplements for the growth and survival rate in Demasoni Cichlids (*Pseudotropheus demasoni*). Totally 100 numbers of Demasoni Cichlids are equally distributed (10 fish in each tank) in ten different aquarium tanks and every 3 groups of cultural tanks were fixed with three different concentration of feed composition with remaining one fish tank as a control group. Four different treatments were selected for this present experiment with naturally obtained feed used as the base additive feed. Three different natural feed sources of raw materials tested were Dragon Fruit (*Hylocereus undatus* (Haw.)), China Rose (*Hibiscus rosasinensis* L.) and Beetroot (*Beta vulgaris* L.), with an incorporation level of 7.5%, 10% and 12.5% respectively, including control feed without any natural feed additives. The total experiment was performed for a period of 60 days and all the fishes of each tank were fed with different feeds thrice a day. The preset study revealed that 12.5% of maximum value of crude protein was found in natural sources of dragon fruit could be incorporated in fish feed and it was expressed highest level of length and weight with 100% survival rates were found in each experimental tanks. The water quality parameters of all the experimental tanks were kept within the optimum range. The present result concluded that supplementation of incorporated Dragon Fruit, Beetroot and China Rose fish feed additives can successfully improve the growth and survival performance.

Introduction

Aquaculture is the scientific management and exploitation of all aquatic organisms including plants and animals for human benefit. Aquaculture is an important sector of food production, providing nutritional security to the human population, contributing to the agricultural exports and providing employment opportunities. The important profitable value of ornamental fishes is resolute by the beauty and potency of pigmentation or colouration patterns (Felix, 2009). The pigments of the ornamental fish is mostly because of diffusion or aggregation of chromatophores consisting of 4 chromatin group viz., carotenoids, melanin, pteridine and purine present in the skin. Among these, carotenoids are the most significant group representing over 600 accepted fat-soluble greatly conjugated polyprenoids pigments. Every natural pigments are originate in a natural sources including animals, plants, and photosynthetic/non-photosynthetic microorganisms like bacteria which act as primary source of yellow, orange and red colouration in fish skin (Paripatananont et al., 1999).

The importance of fish is not only bound to the production of food fish only, the ornamental fish industry also shown an ever-increasing demand throughout the world. Ornamental fishes are also referred as “Living Jewels” as they are beautifully colorful and attractive in nature. Ornamental fish keeping is one of the most demanded hobbies in the world; it also provides employment opportunities to a large number of people. Aquarium keeping is an art of scientific management of ornamental fishes. Jeanne Villepreux

Power, a French Marine Biologist, was the first person to create Aquaria in 1832. The English Biologist Richard Owen referred her as the “Mother of Aquariophily” (Rafferty, 2021). Keeping ornamental fishes in an aquarium has various benefits such as: it helps to keep the mind relax; control the blood pressure, satisfaction etc. Aquariums are broadly classified into two types: Freshwater Aquaria, containing freshwater flora and fauna and Marine Water Aquaria, containing marine flora and fauna, though Brackish water Aquaria are also existing. According to geographical positions, again another two types of Aquariums are present namely, Tropical Aquaria and Coldwater Aquaria, both of which houses freshwater, mixed and Marine water species.

Aquarium Keeping is a global industry worth between 15 and 30 billion U.S. dollars (Hoff, 1996; Wood, 2001; Cato and Brown, 2003; Tlusty et al., 2013). Its include trading of more than 2 billion live ornamental fishes. Over 2500 species are involved in this industry, of which 60% comes from freshwater origin, 30% from marine and 10% from brackish water. The traded fishes are mostly wild caught, where as some are breed in captivity. The international market of Ornamental Fish export and import is mostly occupied by developing countries (60%). In the import point of view, USA holds the first position, followed by U.K, Germany, Japan, Netherlands, Singapore, China, France, Hong Kong and Italy in the top 10. The export share of Indian ornamental fishery was fluctuated and remained less than one percent for most of the years. The export value for the Indian ornamental fish industry in 2016 was 1.06 million US dollar, which contributed about 0.3% of the total export. In other hand the import value of the Indian ornamental fish industry in 2016 was 192,511 US dollar, which contributed to 0.1% of the total imports. In India, Kolkata and its adjoining districts alone contribute about 90% of total export. Some other major hubs of Ornamental Fish Industry in India are Mumbai, Chennai, Kochi, Bangalore etc.

One of the most interesting types of fishes to keep in Aquarium is Cichlids, which is one of the most species rich families of vertebrates. They possess a great diversity in colouration, social behaviours both within and between species. The Demasoni Cichlid, *Pseudotropheus demasoni* (Konings, 1994), belongs to order Cichliformes and family Cichlidae, is relatively a very rare kind of cichlid fish, which originates from a small rocky reef known as Pombo Rocks in the Tanzanian part of Lake Malawi located in Tanzania, Africa (Konings, 1994). This species demasoni is named after Mr. Laif DeMason an importer, exporter, and breeder of cichlids, who has greatly influenced the keeping of cichlids in the USA. The Malawi Demasoni Cichlid can be recognized easily by its distinguishable blue coloration and alternating stripes. The stripes are a crisp and brilliant blue or black and light blue or white. The colour pattern is more prominent on the male, which has typical spots on the anal fin as well. The male fish is considerably larger than the female. These Malawi Demasoni Cichlids are a mouth-brooding species, which produces about 6 to 20 fry after spawning, depending on the size of the female.

Fish need energy and essential nutrients to maintain their physiological state, movement, metabolic functions, growth rate, reproductive ability etc. In case of Ornamental Fishes reared in Aquaria, the main source of the energy and nutrients is the supplementary foods. The major components of any feed are Protein, Carbohydrate, Lipid or Fat, Vitamins and Minerals. Among these the main energy sources in a fish feed are Protein, Carbohydrate and Lipid, which are termed as Macronutrients, whereas the other essential

components Vitamins and Minerals are required in small amount and termed as Micronutrients. Protein is composed of various Amino Acids, there are 10 different types of Essential Amino Acids, which cannot be synthesized in a fish normally at a good rate at which they are needed for the maximum growth of fishes, and these are needed to be supplied via supplementary feeds. In a supplementary feed, Carbohydrates are used as the most inexpensive source of energy; they also worked as a good binding agent.

Lipids also perform as sources of energy, some of the fatty acids are essential in fish body as well. Vitamins are complex organic compounds, which generally needed in a small amount, to maintain normal growth rate, health state, and reproduction etc. of a fish. Minerals play very important roles in maintaining enzymatic activities, metabolic functions etc. of a fish. Commonly used Fish Feed ingredients are Fish Meal, Soybean Meal, Corn Powder, Wheat Powder, Fish Oil etc. In case of Ornamental Fishes, one of the main criteria for a good feed is its colour enhancement factors. And one of the important criteria for success in Ornamental Fish trading is the vibrant colouration of fishes, which must be aesthetically pleasing.

Thus, the present study aimed to the growth and survival performance of fishes by using various natural feed additives such as Dragon Fruit (*Hylocereus undatus* (Haw.) Britton & Rose), China rose (*Hibiscus rosasinensis* L.), and Beetroot (*Beta vulgaris* L.) were investigated. Use of the plant materials as feed additives has double advantage, besides being a rich source of carotenoid pigments; they are a direct source of nutrients like protein, lipids and vitamins. Dragon fruit also known as Pitaya or Pitahaya, is gaining much interest in many countries, including India. It is an exotic fruit considered as a super future fruit, having numerous benefits. It contains various nutrients in small amount, also contains a good amount of Iron, Magnesium and Fibre. The Dragon fruit is consumed by human being but the peels are often considered as waste or by-products. Here we have used the Dragon fruit peel as a source of Carotenoid and Protein Source. China rose flower is well known for its colour enhancing qualities. Here in this study, the China rose petals are used to observe the effect of its dietary implementation as a fish feed. Beet Root is a rich source of Carotenoids, which can be used as a cheap source of additive in fish feed.

China Rose Petals and Beet Roots are cheap and readily available in market, so in this experiment they are used to study the growth performance, and survivability in Demasoni Cichlids, on the other hand though Dragon Fruits are not cheap, but they have a bright future prospect, due to its numerous health benefits. The peels are not consumable, but it can be used as a good source of Carotenoid as well as a source of Protein in the fish feeds. It is also known for having high amount of nutrition. Protein source is the costliest ingredient for making a fish feed; supplementing them with cheap alternative can eventually help the farmer to earn more profit. Natural feed additives can reduce the cost of the feed; as well can be used as a rich source of numerous amounts of nutrients. Hence, the present experiment is carried out to find out the effectiveness of three natural feed additives (i.e. a Dragon Fruit, China Rose and Beetroot) for the growth and survival rates in Demasoni Cichlids, *Pseudotropheus demasoni* fish.

Materials And Methods

Experimental design

The experiment was carried out for a period of total 65 days with including find out the effectiveness of selected feed ingredients (a Fruit, a Flower, and a Vegetable) in the growth and survival rate of *Pseudotropheus demasoni* (Demasoni Cichlid). 100 number fish were selected in the present study. The experimental ornamental Demasoni Cichlid were used during this experiment and acclimatized under indoor conditions. Totally 100 numbers of *Pseudotropheus demasoni* were selected for this experiment and were stocked after doing proper acclimatization. 10 numbers of Demasoni Cichlids (*Pseudotropheus demasoni*) were transferred per experiment unit with uniformly size and length glass aquarium tanks (76 Length x 45 width x 36 height cm) through persistent oxygen supply working in recirculation system. Demasoni Cichlids of average weight of 10 mg and average length of 2 cm was taken for the experiment, which was bred in the Fish Breeding and Rearing unit of Sasya Shyamala Krishi Vigyan Kendra, Arapanch, Sonarpur, Kolkata under Ramakrishna Mission Vivekananda Educational and Research Institute.

Experimental Feed Additives

To undergo this experiment selected feed additives i.e. Dragon Fruit, China rose and Beetroots were bought from the local vegetable market. Aside these, some other common fish feed ingredients like fish meal, meal worm, soya meal, mustard oil cake, corn powder, wheat powder; vitamin-mineral premix and fish oil were also collected from local markets.

Preparation of Feed Supplement

For preparation of experimental feeds and control feed were consists of the fish meal, meal worm, soya meal, mustard oil cake, corn powder, wheat powder, vitamin-mineral premix, fish oil and feed additives i.e. Dragon Fruit, China rose and Beetroots were collected from local markets and flake food was being prepared. At first the Dragon fruit was peeled off, and the peeled part was cut into small pieces and dried at room temperature. At the same time China rose flowers and Beetroots were separately cut into small pieces and also dried at room temperature. After 48 hours all the dried feed ingredients were measured accordingly and blended to make a fine powder (Table 1). Following the powder formed feed ingredients were transformed into thin plastic sheet and spread into a thin layer and dried in room temperature for 24 hours. After that big chunks of fish feeds were came up from the plastic sheets, which were broken apart into small flakes, and the fish flakes were ready to feed the fishes. Total 10 types of ingredient feeds were prepared for this experiment with including control was prepared without additives feeds which were divided as follows: T1A- Fish Feed having 7.5% of Dragon Fruit Peels; T1B- Fish Feed having 10% of Dragon Fruit Peels; T1C- Fish Feed having 12.5% of Dragon Fruit Peels; T2A- Fish Feed having 7.5% of China Rose Petals; T2B- Fish Feed having 10% of China Rose Petals; T2C- Fish Feed having 12.5% of China Rose Petals; T3A- Fish Feed having 7.5% of Beet Roots; T3B- Fish Feed having 10% of Beet Roots; T3C- Fish Feed having 12.5% of Beet Roots; Control-Fish Feed without any additives (i.e. Dragon Fruits Peels, China Rose Petals, Beet Roots). The feed flake was provided at approximate 2% of their total body weight thrice a day.

Proximate Analysis of experimental feeds

The proximate analysis of experimental feed ingredients was carried out by the various parameters such as Moisture, Protein, Fat, Fiber and Ash Content of the feeds by using the standard methods of Lowry's Method (1951) and AOAC (2000).

Growth Parameters

The growth parameters was determined by utilized control and experimental feeds fish tanks such as length gain, weight gain, and survival rate was estimated for every 5 days interval based on standard formula as follows.

$$\text{Length Gain (cm)} = \text{Mean Final Length} - \text{Mean Initial Length}$$

$$\text{Weight Gain(gm)} = \text{Mean Final Weight} - \text{Mean Initial Weight}$$

$$\text{Survival Rate (\%)} = \frac{\text{Final Number of Fish}}{\text{Initial Number of Fish}} \times 100$$

Routine Maintenance

Aside giving good quality feed, maintenance of proper water quality parameters is essential in fish culture practices. Here, the fishes were kept in ten different glass aquariums with no substrates. 20% of water exchange was done in a gap of every two days to maintain all the optimum water quality parameters in check. Water quality parameters viz., water temperature, salinity, pH, dissolved oxygen, ammonical nitrogen, Dissolved CO₂, total alkalinity, and total hardness were measured at fortnightly intervals by using which are respective instrument and Measuring Kit.

Statistical Analysis

In the present study, all the data collected during the whole experiment were subjected to statistical analysis, which were performed to know the effectiveness of the different feed additives on the growth and survival of Demasoni Cichlid. One-way analysis of variance (ANOVA) was performed among the different treatment systems. The statistical analysis and graphical representations were performed by computer based Data Analysis and Scientific Graphing Software Microsoft Excel and OriginLab.

Results

Comparative Study of Proximate Composition of Fish Feeds

Ten different feeds supplements were prepared by hygienic condition and its where the incorporated with three feed additives were used as Dragon Fruits, China Rose Flowers and Beet Roots. Comparative study of Proximate Composition of Fish Feeds is shown in Table 2.

Water Quality Parameters

The results of the present study revealed that during the experimental period, water quality parameters ((i.e. Temperature, Salinity, pH, Dissolved Oxygen, Dissolved Carbon Dioxide, Alkalinity, Nitrate, Nitrite, Hardness, and Ammonia) (Table 3, Figures 1-7) did not vary significantly among the termination of the treatments.

Influence of Feed Additives in the Growth of Demasoni Cichlids

The effect of various feed additives, in the control diet, the initial average length and weight of the fishes were 1.8 cm and 0.12 ± 0.01 gm respectively and the final average length and weight of the fishes were 4.3 ± 0.03 cm and 1.68 ± 0.01 gm respectively. The growth parameter of Demasoni Cichlids for the Dragon fruit incorporated diet at the inclusion level of different percentages was found and results were shown in Table.4. At the time of stocking the length of the fishes fed with Dragon fruit feed at various inclusion lengths of 7.5, 10 and 12.5 percent were 2, 2 and 2.1 cm respectively. After 60 days of experiment the mean final length of the fishes fed with different feed i.e. T1A, T1B and T1C were found at 5.6 ± 0.09 , 5.3 and 5.8 ± 0.03 cm, respectively. Where the maximum length was observed in fishes fed with T1C, where the fishes were fed with Dragon fruit feed at an inclusion level of 12.5% and minimum length was observed in T1B tank fishes fed supplements, where the fishes was fed with Dragon Fruit Feed at an inclusion level of 10%.

The increase in weight in the fishes of various experimental aquariums for the Dragon fruit included diet at various inclusion levels are shown in Table 5. At the time of stocking the weight of the fishes fed with Dragon fruit feed at various inclusion levels of 7.5, 10 and 12.5 percent with significantly increase the growth values were found 0.16 ± 0.01 , 0.15 and 0.16 ± 0.01 gm respectively. At the end of 60 days of experiment the mean final weight was recorded in different feed i.e. T1A, T1B and T1C with values are 2.22 ± 0.02 , 2.19 ± 0.01 and 2.34 ± 0.02 gm, respectively. The maximum weight was observed in fishes fed with T1C, where the fishes were fed with Dragon fruit feed at an inclusion level of 12.5% and minimum weight was observed in fishes fed with T1B, where the fishes were fed with Dragon Fruit Feed at an inclusion level of 10%.

The effect of China Rose Flower in the growth parameters of Demasoni Cichlids was recorded in the feeds inclusion levels percentage is shown in Table 6. At the time of stocking, the length of the fishes fed with China rose feed ingredients at various inclusion values was recorded in 7.5, 10 and 12.5 percent were 1.9, 1.8 and 1.9 cm respectively. At the end of experimental period of 60 days the fishes fed with China rose feed at various inclusion values of 7.5, 10 and 12.5 percent attained a length of 4.3 ± 0.03 ,

4.5±0.03 and 4.6±0.09 cm respectively. The maximum length was observed in fishes fed with T2C, where the fishes were fed with China rose feed at an inclusion level of 12.5% and minimum length was observed in fishes fed with T2A, where the fishes were fed with China Rose Feed at an inclusion level of 7.5%. The increase in weight in the fishes of various experimental aquariums for the China rose diet at various inclusion levels are shown in Table 7. At the time of stocking the weight of the fishes fed with China rose feed at various inclusion level of 7.5, 10 and 12.5 percent were 0.12±0.01, 0.14±0.02 and 0.12±0.01 gm respectively. At the end of 60 days of experiment the fishes fed with China rose feed T2A, T2B and T2C were 1.57±0.01, 1.77±0.02 and 1.81±0.01 gm respectively. The maximum weight was observed in fishes fed with T2C, where the fishes were fed with China rose feed at an inclusion level of 12.5% and minimum weight was observed in fishes fed with T2A, where the fishes were fed with China rose feed at an inclusion level of 7.5%.

The results revealed that the Growth parameters of Demasoni Cichlids for the inclusion of Beetroots in their diet at inclusion levels of different percentages are shown in Table 8. Fish length was increase by the various experimental aquariums for the inclusion of Beetroots at various levels in their diet represented in Table 8. At the time of stocking, the length of the fishes fed with Beetroot meal at various inclusion level of 7.5, 10 and 12.5 percent were 2, 1.9 and 1.9 cm, respectively. At the end of 60 days experiment, the fishes fed with Beetroot feed at inclusion levels of 7.5, 10 and 12.5 percent attained 5.1±0.01, 5.2±0.04 and 5.3±0.01 cm length respectively. The maximum length was observed in fishes fed with T3C, where the fishes fed with Beetroot feed at an inclusion level of 12.5% and minimum length was observed in fishes fed with T3A, where the fishes were fed with Beetroot feed at an inclusion level of 7.5%.

The results of the present experiments revealed that the weight of the fishes for the Beetroot feed at various inclusion levels are shown in Table 9. The weight of the fishes fed with Beetroot feed at various inclusion level of 7.5, 10 and 12.5 percent was observed at the time of stocking were 0.15±0.01, 0.14±0.01 and 0.15±0.01 gm respectively. At the end of experimental period of 60 days the fishes fed with Beetroot feed T3A, T3B and T3C gain a weight of fish was found 2.16±0.01, 2.19±0.02 and 2.24±0.02 gm respectively. Where the maximum weight was observed in fishes fed with T3C, where the fishes were fed with Beetroot feed at an inclusion level of 12.5% and minimum weight was observed in fishes fed with T3A, where the fishes were fed with Beetroot feed at an inclusion level of 7.5%.

Survival rate, Length and Weight Gain

The results of the Length and Weight Gain growth and percentage of survival Rate of experimental details was given in Tables 10, 11 and 12. The Length and weight gain of Demasoni Cichlids was significantly improved with the use of natural feed supplementation sources Dragon fruit, China rose and beetroot and overall results were represented the following descending order.

T1C → T1A → T3C → T1B = T3B → T3A → T2C = T2B → CONTROL → T2A

At the end of 60 days experiment, the survival rate was found 100% in all treated supplemented feed and control tanks, no mortality was occurred among the fishes shown in Figure 8.

Discussion

The present study confirmed the effectiveness of Dragon Fruit, China Rose and Beetroot based feed in the survival and growth performance of *Pseudotropheus demasoni* (Demasoni Cichlid). The present experiment was undertaken in Sasya Shyamala Krishi Vigyan Kendra, Arapanch, Sonarpur. Totally 100 number of fishes having almost the same length of 1.8 to 2.1 cm and weight of 0.12 to 0.16 gm were taken, divided and stocked into 10 different aquariums of same size and length. The experiment was carried out for total 60 days. During the experimental period, the growth and survival rate of fishes was monitored in every 5th day and also 20% of water exchange was done in an interval of every 2 days.

In the present study, water quality parameters of all the ten different treated aquarium tanks were recorded every 5 days gap during the experimental period. The water temperature recorded in all the experimental tanks during the experimental period ranged from 22.7° to 27.2°C. These results are similar to those observed by Aminul (1996) who discussed that 25 to 35°C is the optimum range of water temperature for fish culture, which is a little bit area specific as well as specific to weather conditions. The salinity of the experimental tanks was maintained in the range of 2 to 3 ppt and the pH value was found in between 7.2 to 8.05 in all the experimental tanks. According to DoF (1996) reported that the suitable pH range for fish production was maintained at 6.5 to 8.5. In addition, dissolved oxygen was maintained in the range of 6.2 to 6.81 mg/L in all the experimental tanks during the experimental period. Banerjee (1967) stated that ranging between 5.0 to 7.0 ppm of dissolved oxygen content of water is fair or good in respect of productivity and water having dissolved oxygen below 5mg/L to is not good and unproductive. The dissolved CO₂ of the experimental tanks water was maintained under the range of 2 to 4 mg/L. Crosby et al. (2005) observed that fishes perform well where dissolved CO₂ was kept under 5 ppm range. The alkalinity level of this study experimental tanks water was found between the ranges of 170 to 260 mg/L during the experimental period. The results of improved good growth level in culture tanks during the culture periods were accordance with the study of Crosby et al. (2005) proving in fish culture, when fish was maintenance of the alkalinity is kept below 250 mg/L. The total hardness of the experimental water was found in the range of 390 to 460 mg/L being culture period. According to Wurts et al. (1992) confirmed that water with at least 20 ppm hardness is for good productivity. From all the above statements it can be said that, the water quality parameters maintained in the fish tanks were good and might be helpful to improve the good health, survivability of fishes and optimum for fish growth performance.

The mean length gains of the fishes fed with Dragon fruit feed with inclusion level of 12.5% showed the highest value of 3.7 cm and the lowest value was observed in fishes fed with Control feed followed by fishes fed with China rose feed with an inclusion level of 7.5%, having a value of 2.4 cm. Whereas, the mean weight gains of the fishes fed with Dragon fruit feed with inclusion level of 12.5% also showed the highest value of 2.18 gm and the lowest value was observed in fishes fed with Control feed followed by

fishes fed with China rose feed with an inclusion level of 7.5%, having a value of 1.45 gm. The survival rate of the fishes was showed 100% in all the experimental tanks, which means '0' mortality occurs in during the study period.

The analyzed moisture value (%) in ten different feeds T1A, T1B, T1C, T2A, T2B, T2C, T3A, T3B, T3C and control was 15.87 ± 0.08 , 15.78 ± 0.02 , 15.29 ± 0.04 , 14.17 ± 0.06 , 14.89 ± 0.03 , 14.11 ± 0.03 , 12.30 ± 0.04 , 12.18 ± 0.04 , 11.51 ± 0.05 , and 12.19 ± 0.05 respectively. The present study shows that crude protein value (%) of ten different feeds T1A, T1B, T1C, T2A, T2B, T2C, T3A, T3B, T3C and control was 34.02 ± 0.04 , 34.04 ± 0.05 , 34.33 ± 0.02 , 30.05 ± 0.04 , 30.11 ± 0.02 , 30.64 ± 0.04 , 32.05 ± 0.06 , 31.89 ± 0.06 , 31.09 ± 0.05 , and 30.01 ± 0.05 respectively. Similarly, Craig et al. (2002) explained that the levels of protein in aquaculture feeds generally average 30 to 35 percent for Shrimp, 28 to 32 percent for Catfish, 35 to 40 percent for Tilapia, 38 to 42 percent for hybrid Striped Bass, and 40 to 45 percent for Trout and other marine finfish. In general, protein requirements are typically lower for herbivorous fish and omnivorous fish than they are for carnivorous fish. Protein requirements are higher for fish reared in high-density systems (e.g. RAS) compared to low-density culture (e.g. ponds).

The Ash Content (%) of ten different feed was found at 12.59 ± 0.04 (T1A), 12.64 ± 0.04 (T1B), 12.92 ± 0.05 (T1C), 11.89 ± 0.03 (T2A), 11.54 ± 0.04 (T2B), 11.21 ± 0.03 (T2C), 11.32 ± 0.06 (T3A), 11.86 ± 0.05 (T3B), 11.18 ± 0.01 (T3C), and 11.12 ± 0.02 (Control), respectively. These results were in agreement with the study of Miles et al. (2012). The normal ash content of fish feeds ranges from 7–12%. The Crude Fat (%) of ten different feed was observed at 6.91 ± 0.03 (T1A), 6.90 ± 0.04 (T1B), 6.92 ± 0.02 (T1C), 6.87 ± 0.03 (T2A), 6.52 ± 0.03 (T2B), 6.28 ± 0.04 (T2C), 7.04 ± 0.02 (T3A), 7.02 ± 0.02 (T3B), 7.01 ± 0.03 (T3C), and 6.89 ± 0.02 (Control), respectively, which is little bit lower than the value Cowey and Sargent (1979), who state that in general 10–20% of fat content in most fresh water fish diets gives optimal growth rates.

Overall growth performance in terms of length and weight was significantly higher in feeds prepared with Dragon fruit and also significantly well grown in the fishes fed with Beetroot feed. But the fishes fed with China rose feeds was not shown significant growth rate in terms of length and weight. In T3C fed fishes i.e. fishes which were fed with Dragon fruit feed at an incorporation level of 12.5% showed significantly highest growth performance. They attained a length of 5.8 ± 0.03 cm and weight of 2.34 ± 0.02 gm. In case of the fishes fed with control feed without any natural feed additives showed lowest growth performance in terms of length increase. At the end of 60 days of experiment, the highest total length of 4.3 ± 0.03 cm was observed in China rose supplemented feed (T2A) at an incorporation level of 7.5%, followed by other incorporation supplemented fed. The fishes which were fed with T2A feed showed lowest growth performance in terms of weight, they attain a weight of 1.57 ± 0.01 gm followed by 1.68 ± 0.02 gm attained by fishes fed with control feed.

In the present study total length gains by the fishes fed with ten different feeds T1A, T1B, T1C, T2A, T2B, T2C, T3A, T3B, T3C and Control was 3.6, 3.3, 3.7, 2.4, 2.7, 2.7, 3.1, 3.3, 3.4 and 2.5 cm respectively. The highest total length gain was attained by the fishes fed with T1C feed and the lowest value was attained by the fishes fed with T2A feed. Total weight gains by the fishes fed with ten different feeds T1A, T1B,

T1C, T2A, T2B, T2C, T3A, T3B, T3C and Control was 2.06, 2.04, 2.18, 1.45, 1.63, 1.69, 2.01, 2.05, 2.09 and 1.56 gm respectively. The highest total weight gain was attained by the fishes fed with T1C feed and the lowest value was attained by the fishes fed with T2A feed. No mortality was occurred during the experimental period, Survival rate was 100% in all the fish tanks fed with ten different feeds supplement.

Conclusion

The present results suggested the significantly improve the better growth in terms of length and weight, survival rates were observed in three natural fishes additives fed with dragon fruit, beetroot and China rose feeds. It can be concluded that dietary supplementation of Dragon Fruit, Beetroot Feed as well as China rose feed can enhance growth and survival rate of (*Pseudotropheus demasoni*) Demasoni Cichlids in indoor rearing conditions. Therefore, naturally supplementary feed resources are needed for improving the growth and survival responses and might be extremely valuable to the aquaculture industry. Thus, the further studies to improve on the effects of pigmentation, growth, survival rate of fresh and marine water ornamental and food fishes in aquaculture industry.

Declarations

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Conflict of interest statement

The authors declare that there is no conflict of interest.

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Tables

Table 1. Experimental Feed composition (%) ingredients formulation

Sl. No.	Ingredients	Control	Dragon Fruit Feed			China Rose Feed			Beetroot Feed		
			T1A	T1B	T1C	T2A	T2B	T2C	T3A	T3B	T3C
1	Fish Meal	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
2	Worm Meal	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
3	Soya Meal	15	15	15	15	15	15	15	15	15	15
4	Mustard Oil Cake	25	25	25	25	25	25	25	25	25	25
5	Corn Powder	25	25	25	25	25	25	25	25	25	25
6	Wheat Powder	22	14.5	12	9.5	14.5	12	9.5	14.5	12	9.5
7	Binding Agent	5	5	5	5	5	5	5	5	5	5
8	Fish Oil	1	1	1	1	1	1	1	1	1	1
9	Vitamin-Mineral Premix	2	2	2	2	2	2	2	2	2	2
10	Additives	-	7.5	10	12.5	7.5	10	12.5	7.5	10	12.5

Table 2. Proximate Composition (%) of different Fish Feeds ingredients

Fish Feeds	Moisture (%)	Crude Protein(%)	Ash Content (%)	Crude Fat (%)
T1A	15.87±0.08	34.02±0.04	12.59±0.04	6.91±0.03
T1B	15.78±0.02	34.04±0.05	12.64±0.04	6.90±0.04
T1C	15.29±0.04	34.33±0.02	12.92±0.05	6.92±0.02
T2A	14.17±0.06	30.05±0.04	11.89±0.03	6.87±0.03
T2B	14.89±0.03	30.11±0.02	11.54±0.04	6.52±0.03
T2C	14.11±0.03	30.64±0.04	11.21±0.03	6.28±0.04
T3A	12.30±0.04	32.05±0.06	11.32±0.06	7.04±0.02
T3B	12.18±0.04	31.89±0.06	11.86±0.05	7.02±0.02
T3C	11.51±0.05	31.09±0.05	11.18±0.01	7.01±0.03
CONTROL	12.19±0.05	30.01±0.05	11.12±0.02	6.89±0.02

Table 3. Range and Average of water quality parameters in different treatments during the experimental period

Parameters	T1A	T1B	T1C	T2A	T2B	T2C	T3A	T3B	T3C	CONTROL
Temperature (°C)	22.8-27 24.83±0.479	22.7-27.2 24.8±0.505	22.7-27.1 24.77±0.504	23-27 24.9±0.466	23-27 24.85±0.486	22.9-27 24.83±0.48	23-27 24.82±0.481	23-27.1 24.80±0.491	23-27.2 24.86±0.488	22.8-27.1 24.82±0.499
Salinity (ppt)	2-3 2.46±0.143	2-3 2.23±0.121	2-3 2.53±0.143	2-3 2.38±0.14	2-3 2.53±0.143	2-3 2.46±0.143	2-3 2.38±0.14	2-3 2.53±0.143	2-3 2.38±0.14	2-3 2.38±0.14
pH	7.2-7.8 7.6±0.051	7.3-7.9 7.66±0.05	7.28-8.02 7.69±0.064	7.3-8.05 7.7±0.067	7.2-7.72 7.55±0.046	7.38-8 7.72±0.05	7.3-8.05 7.68±0.064	7.2-7.9 7.61±0.069	7.2-7.8 7.57±0.057	7.38-8 7.68±0.06
D.O (mg/ltr)	6.25-6.71 6.51±0.046	6.25-6.74 6.51±0.045	6.25-6.76 6.53±0.049	6.22-6.74 6.52±0.051	6.24-6.78 6.53±0.05	6.24-6.7 6.51±0.044	6.2-6.81 6.53±0.055	6.21-6.65 6.49±0.041	6.22-6.72 6.50±0.047	6.21-6.7 6.48±0.044
D.CO₂ (mg/ltr)	2-4 2.30±0.208	2 2±0.00	2-4 2.15±0.15	2 2±0.00	2-4 2.15±0.15	2 2±0.00	2 2±0.00	2-4 2.15±0.15	2 2±0.00	2-4 2.15±0.15
Alkalinity (mg/ltr)	180-250 217.69±6.11	190-250 218.46±4.64	200-250 225.38±5.01	170-250 206.15±6.84	190-250 214.61±6.75	190-250 224.61±5.95	180-250 206.15±6.25	200-250 226.92±4.44	200-260 229.23±6.14	170-250 216.15±8.04
Hardness (mg/ltr)	420-450 441.53±3.17	430-450 440.76±1.36	430-450 443.84±2.41	410-460 439.23±4.45	420-460 436.92±3.27	430-450 443.84±2.12	410-450 436.92±3.46	430-450 443.84±2.12	400-450 432.3±5.20	390-450 432.3±5.90

Table 4. Increase in Length of Demasoni Cichlid by Feeding with Dragon Fruit Feed at Different Inclusion Level

DOC	T1A (cm)	T1B (cm)	T1C (cm)	CONTROL (cm)
0	2.0±0.00	2.0±0.00	2.1±0.00	1.8±0.00
5	2.4±0.06	2.3±0.03	2.4±0.03	2.0±0.03
10	2.6±0.09	2.5±0.06	2.6±0.03	2.3±0.03
15	2.9±0.03	2.8±0.03	2.9±0.12	2.4±0.07
20	3.1±0.09	3.0±0.07	3.2±0.06	2.6±0.03
25	3.5±0.00	3.4±0.03	3.6±0.00	2.8±0.03
30	3.8±0.03	3.6±0.00	4.0±0.09	3.0±0.03
35	4.1±0.03	4.0±0.03	4.3±0.03	3.2±0.03
40	4.4±0.00	4.3±0.00	4.5±0.03	3.4±0.00
45	4.6±0.10	4.6±0.07	4.8±0.06	3.6±0.03
50	4.8±0.06	4.7±0.00	5.1±0.00	3.9±0.00
55	5.2±0.03	5.1±0.03	5.5±0.03	4.1±0.03
60	5.6±0.09	5.3±0.00	5.8±0.03	4.3±0.03

Table 5. Increase in Weight of Demasoni Cichlid by Feeding with Dragon Fruit Feed at Different Inclusion Level

DOC	T1A (gm)	T1B (gm)	T1C (gm)	CONTROL (gm)
0	0.16±0.01	0.15±0.00	0.16±0.01	0.12±0.00
5	0.31±0.02	0.25±0.01	0.32±0.01	0.18±0.04
10	0.49±0.01	0.44±0.02	0.51±0.01	0.23±0.01
15	0.65±0.02	0.59±0.01	0.71±0.02	0.32±0.04
20	0.85±0.02	0.73±0.00	0.99±0.02	0.49±0.03
25	1.08±0.02	0.96±0.01	1.21±0.02	0.58±0.01
30	1.27±0.02	1.10±0.01	1.35±0.02	0.77±0.01
35	1.49±0.01	1.35±0.01	1.51±0.01	0.88±0.01
40	1.65±0.03	1.57±0.02	1.68±0.02	0.96±0.02
45	1.79±0.01	1.76±0.01	1.85±0.02	1.14±0.01
50	1.92±0.02	1.90±0.00	2.01±0.02	1.30±0.01
55	2.07±0.01	2.05±0.01	2.19±0.01	1.49±0.01
60	2.22±0.02	2.19±0.01	2.34±0.02	1.68±0.02

Table 6. Increase in Length of Demasoni Cichlid by Feeding with China Rose Feed at Different Inclusion Level

DOC	T2A (cm)	T2B (cm)	T2C (cm)	CONTROL (cm)
0	1.9±0.00	1.8±0.00	1.9±0.00	1.8±0.00
5	2.0±0.03	2.0±0.03	2.0±0.00	2.0±0.03
10	2.3±0.03	2.3±0.00	2.3±0.00	2.3±0.03
15	2.4±0.00	2.4±0.00	2.5±0.09	2.4±0.07
20	2.5±0.03	2.5±0.03	2.6±0.03	2.6±0.03
25	2.6±0.00	2.7±0.00	2.7±0.06	2.8±0.03
30	2.8±0.03	3.0±0.00	3.1±0.00	3.0±0.03
35	3.0±0.00	3.2±0.03	3.4±0.09	3.2±0.03
40	3.2±0.00	3.3±0.06	3.6±0.03	3.4±0.00
45	3.4±0.00	3.5±0.03	3.9±0.00	3.6±0.03
50	3.6±0.03	3.7±0.03	4.1±0.03	3.9±0.00
55	3.9±0.03	4.2±0.00	4.4±0.06	4.1±0.03
60	4.3±0.03	4.5±0.03	4.6±0.09	4.3±0.03

Table 7: Increase in Weight of Demasoni Cichlid by Feeding with China Rose Feed at Different Inclusion Level

DOC	T2A (gm)	T2B (gm)	T2C (gm)	CONTROL (gm)
0	0.12±0.01	0.14±0.02	0.12±0.01	0.12±0.01
5	0.19±0.01	0.19±0.01	0.20±0.01	0.18±0.01
10	0.24±0.01	0.25±0.01	0.31±0.01	0.23±0.01
15	0.32±0.01	0.34±0.03	0.39±0.02	0.32±0.04
20	0.41±0.01	0.51±0.03	0.55±0.02	0.49±0.03
25	0.48±0.01	0.61±0.02	0.63±0.01	0.58±0.01
30	0.59±0.01	0.78±0.02	0.81±0.02	0.77±0.01
35	0.76±0.01	0.90±0.02	0.95±0.02	0.88±0.01
40	0.88±0.01	1.02±0.01	1.12±0.01	0.96±0.02
45	0.97±0.01	1.19±0.03	1.25±0.01	1.14±0.01
50	1.17±0.02	1.39±0.02	1.47±0.02	1.30±0.01
55	1.38±0.02	1.56±0.01	1.62±0.01	1.49±0.01
60	1.57±0.01	1.77±0.02	1.81±0.01	1.68±0.02

Table 8: Increase in Length of Demasoni Cichlid by Feeding with Beetroot Feed at Different Inclusion Level

DOC	T3A (cm)	T3B (cm)	T3C (cm)	CONTROL (cm)
0	2.0±0.00	1.9±0.00	1.9±0.00	1.8±0.00
5	2.3±0.03	2.3±0.03	2.4±0.03	2.0±0.03
10	2.6±0.03	2.6±0.03	2.7±0.03	2.3±0.03
15	2.8±0.03	2.8±0.06	2.8±0.03	2.4±0.07
20	3.0±0.03	3.0±0.03	3.1±0.03	2.6±0.03
25	3.1±0.03	3.2±0.03	3.2±0.00	2.8±0.03
30	3.3±0.03	3.4±0.09	3.6±0.03	3.0±0.03
35	3.6±0.03	3.7±0.03	3.9±0.03	3.2±0.03
40	4.0±0.03	4.1±0.06	4.3±0.03	3.4±0.00
45	4.3±0.03	4.4±0.03	4.6±0.03	3.6±0.03
50	4.6±0.06	4.7±0.03	4.8±0.03	3.9±0.00
55	4.8±0.03	4.9±0.03	5.1±0.03	4.1±0.03
60	5.1±0.03	5.2±0.03	5.3±0.03	4.3±0.03

Table 9. Increase in Weight of Demasoni Cichlid by Feeding with Beetroot Feed at Different Inclusion Level

DOC	T3A (gm)	T3B (gm)	T3C (gm)	CONTROL (gm)
0	0.15±0.01	0.14±0.01	0.15±0.01	0.12±0.01
5	0.26±0.01	0.26±0.03	0.28±0.01	0.18±0.01
10	0.46±0.00	0.48±0.02	0.51±0.01	0.23±0.01
15	0.63±0.02	0.64±0.01	0.65±0.02	0.32±0.01
20	0.75±0.02	0.76±0.02	0.76±0.02	0.49±0.01
25	0.87±0.01	0.89±0.01	0.92±0.01	0.58±0.00
30	0.99±0.01	1.06±0.01	1.13±0.01	0.77±0.01
35	1.21±0.01	1.32±0.01	1.34±0.02	0.88±0.01
40	1.47±0.01	1.53±0.03	1.54±0.02	0.96±0.02
45	1.62±0.01	1.69±0.01	1.71±0.01	1.14±0.02
50	1.78±0.01	1.81±0.01	1.88±0.02	1.30±0.02
55	1.97±0.01	2.01±0.01	2.04±0.02	1.49±0.01
60	2.16±0.01	2.19±0.02	2.24±0.02	1.68±0.01

Table 10. Survival Rate (%) of Demasoni Cichlids under the Influence of Different Feeds

Different Feeds	No. of Fishes at the time of Stocking	No. of Fishes at the end of Experiment	Survival Rate (%)
T1A	10	10	100
T1B	10	10	100
T1C	10	10	100
T2A	10	10	100
T2B	10	10	100
T2C	10	10	100
T3A	10	10	100
T3B	10	10	100
T3C	10	10	100
CONTROL	10	10	100

Table 11. Length Gain by the Influence of Different Feeds

Different Feeds	Mean Initial Length (cm)	Mean Final Length (cm)	Mean Length Gain (cm)
T1A	2	5.6	3.6
T1B	2	5.3	3.3
T1C	2.1	5.8	3.7
T2A	1.9	4.3	2.4
T2B	1.8	4.5	2.7
T2C	1.9	4.6	2.7
T3A	2	5.1	3.1
T3B	1.9	5.2	3.3
T3C	1.9	5.3	3.4
CONTROL	1.8	4.3	2.5

Table 12. Weight Gain by the Influence of Different Feeds

Different Feeds	Mean Initial Weight (gm)	Mean Final Weight (gm)	Mean Weight Gain (gm)
T1A	0.16	2.22	2.06
T1B	0.15	2.19	2.04
T1C	0.16	2.34	2.18
T2A	0.12	1.57	1.45
T2B	0.14	1.77	1.63
T2C	0.12	1.81	1.69
T3A	0.15	2.16	2.01
T3B	0.14	2.19	2.05
T3C	0.15	2.24	2.09
CONTROL	0.12	1.68	1.56

Figures

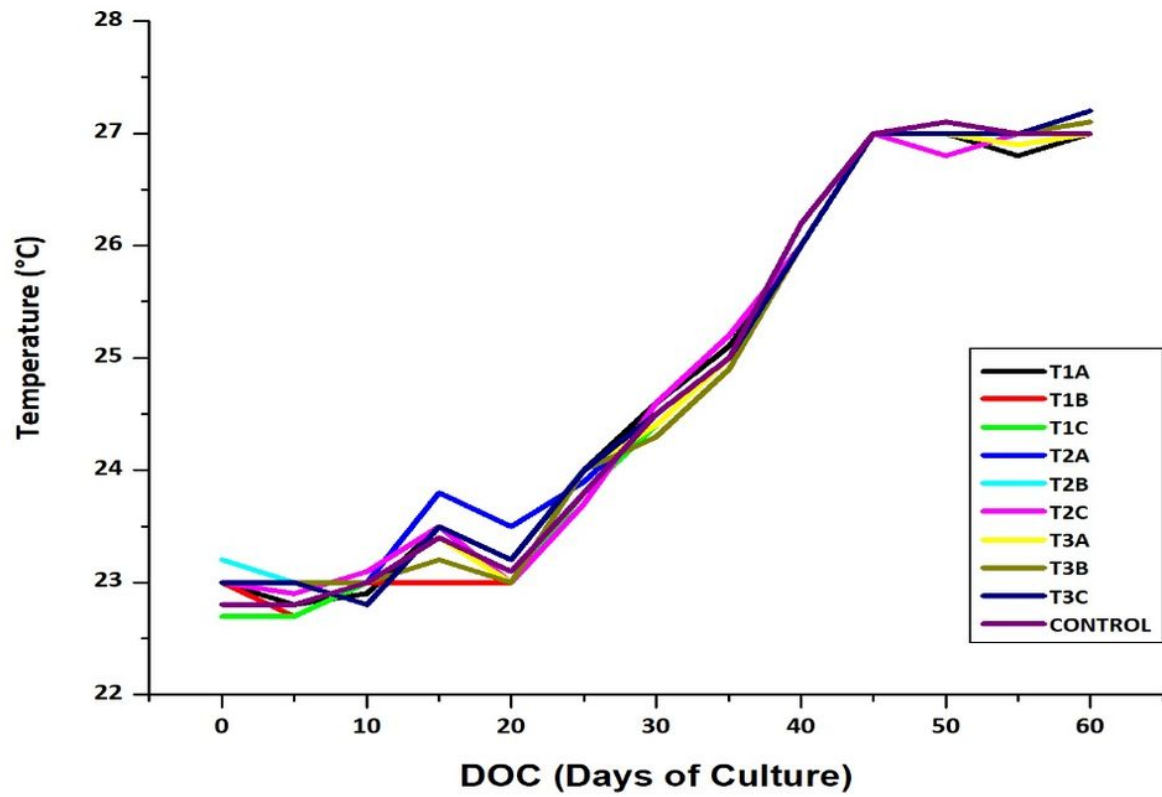


Figure 1

Water temperature parameters of Demasoni Cichlids maintained with different Natural Feed Supplement experimental groups during the experimental period of 60 days

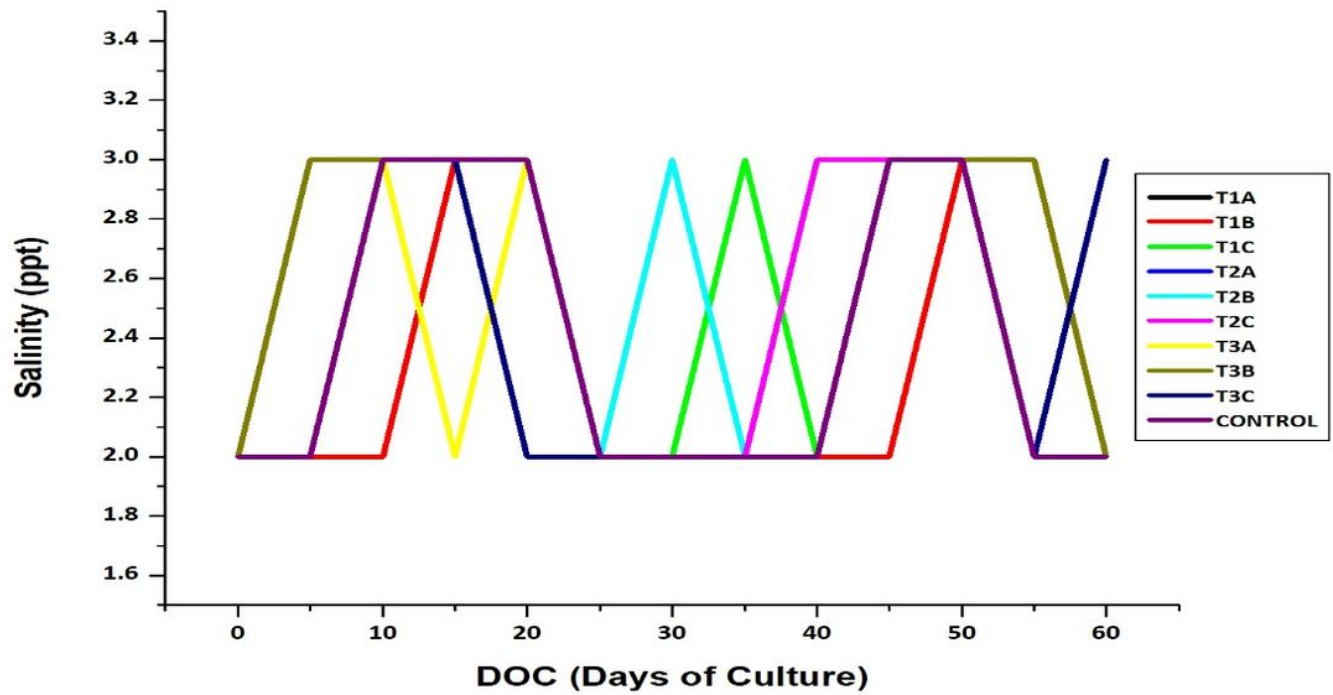


Figure 2

Salinity parameters of Demasoni Cichlids maintained with different Natural Feed Supplement experimental groups during the experimental period of 60 days

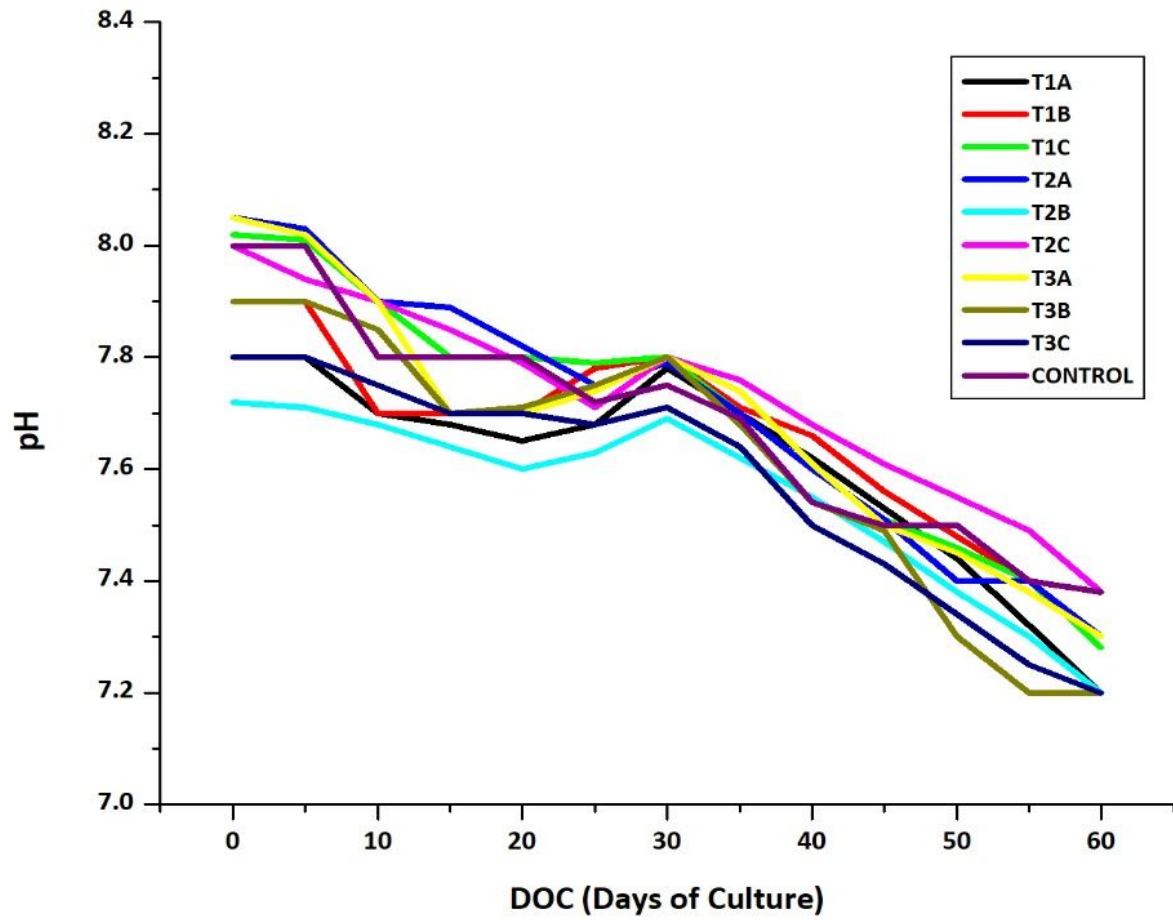


Figure 3

pH parameters of Demasoni Cichlids maintained with different Natural Feed Supplement experimental groups during the experimental period of 60 days

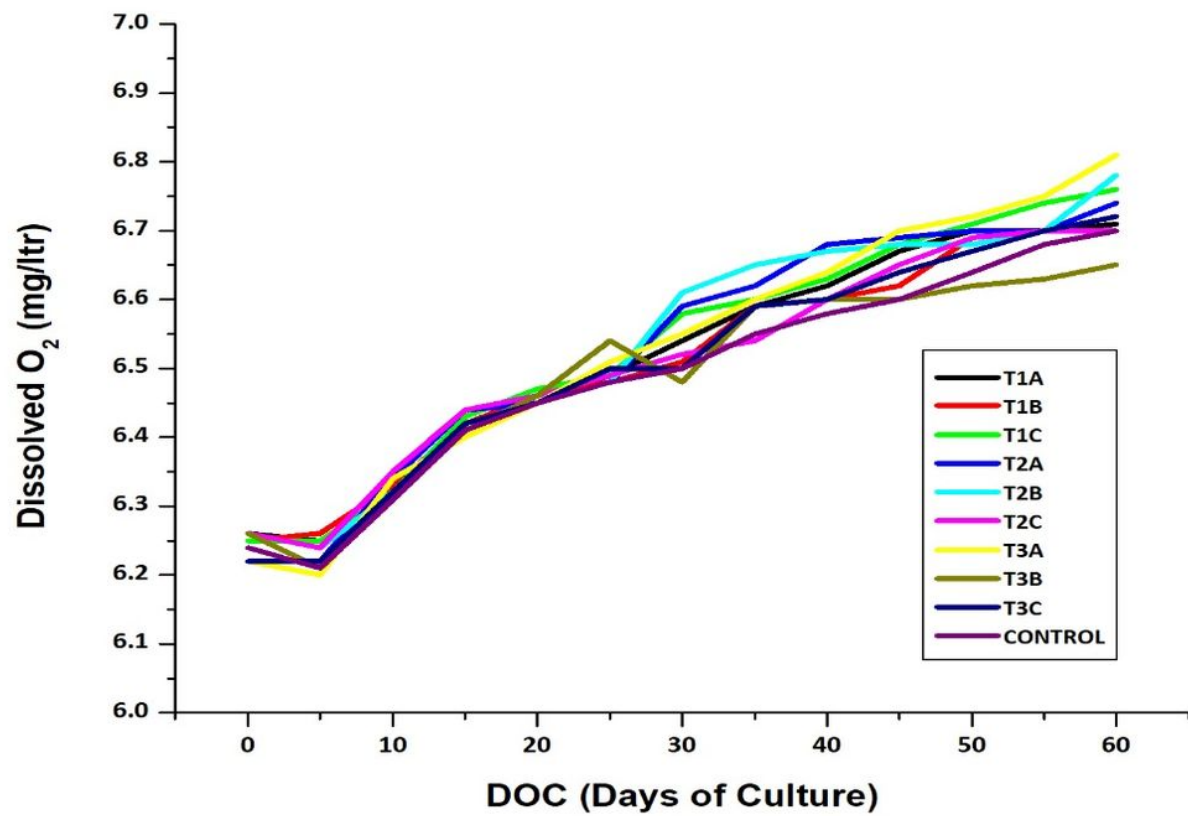


Figure 4

Dissolved Oxygen parameters of Demasoni Cichlids maintained with different Natural Feed Supplement experimental groups during the experimental period of 60 days

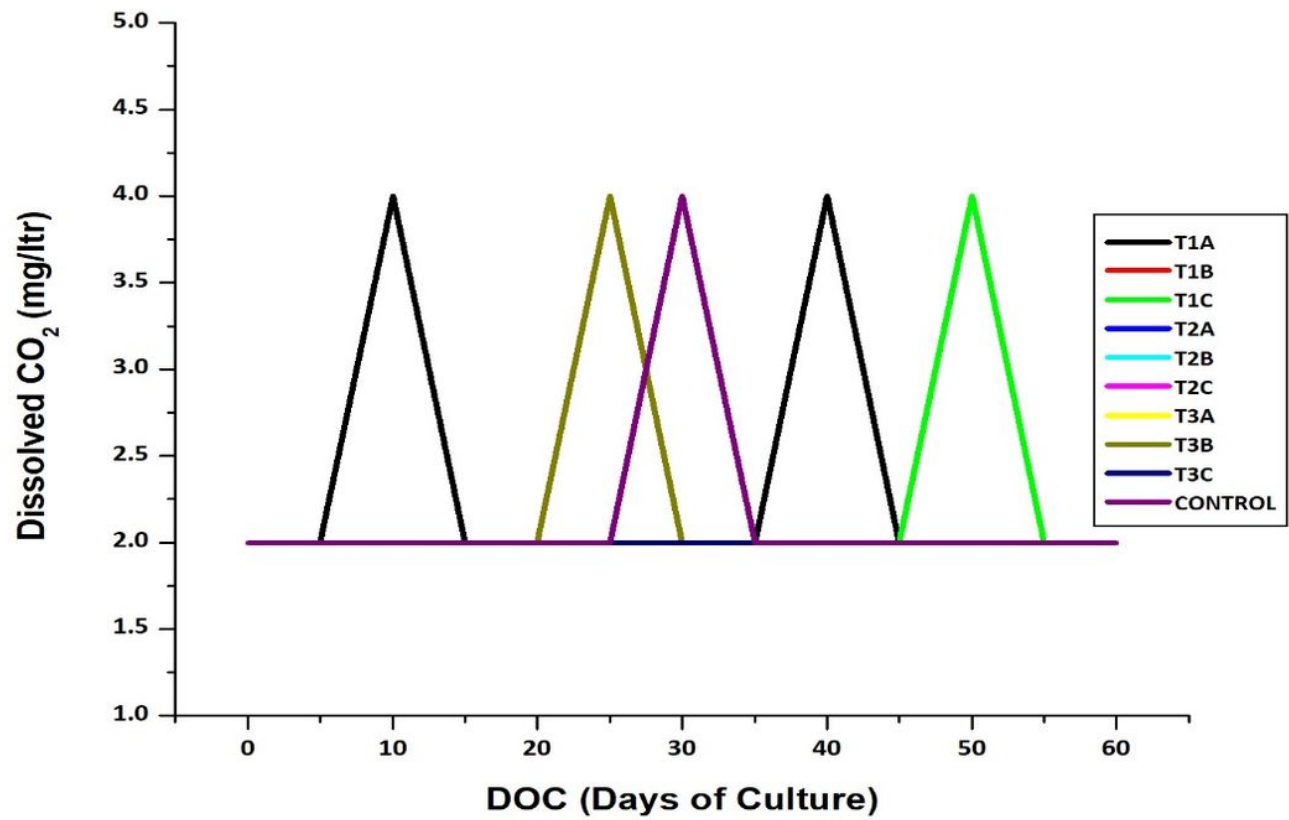


Figure 5

Dissolved CO₂ parameters of Demasoni Cichlids maintained with different Natural Feed Supplement experimental groups during the experimental period of 60 days

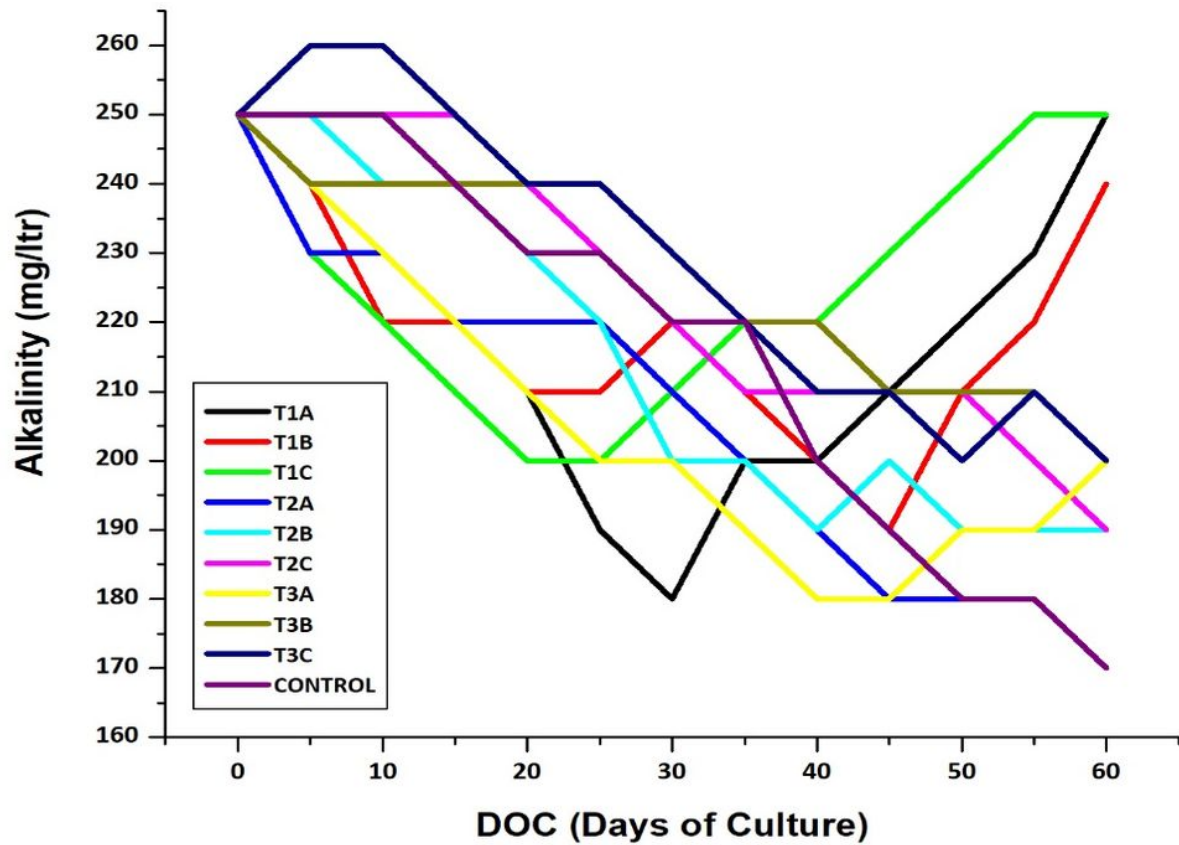


Figure 6

Alkalinity parameters of Demasoni Cichlids maintained with different Natural Feed Supplement experimental groups during the experimental period of 60 days

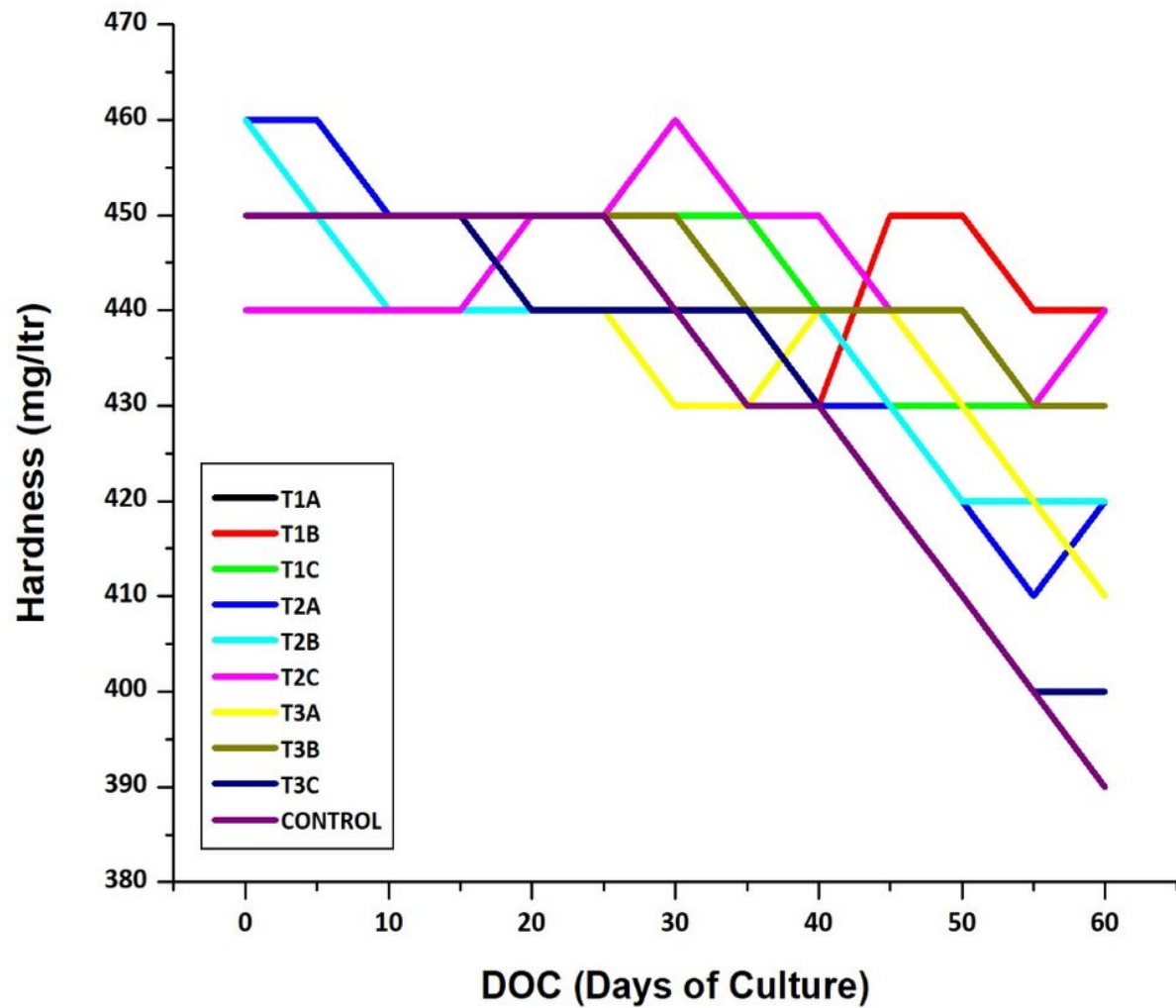


Figure 7

Hardness parameters of Demasoni Cichlids maintained with different Natural Feed Supplement experimental groups during the experimental period of 60 days

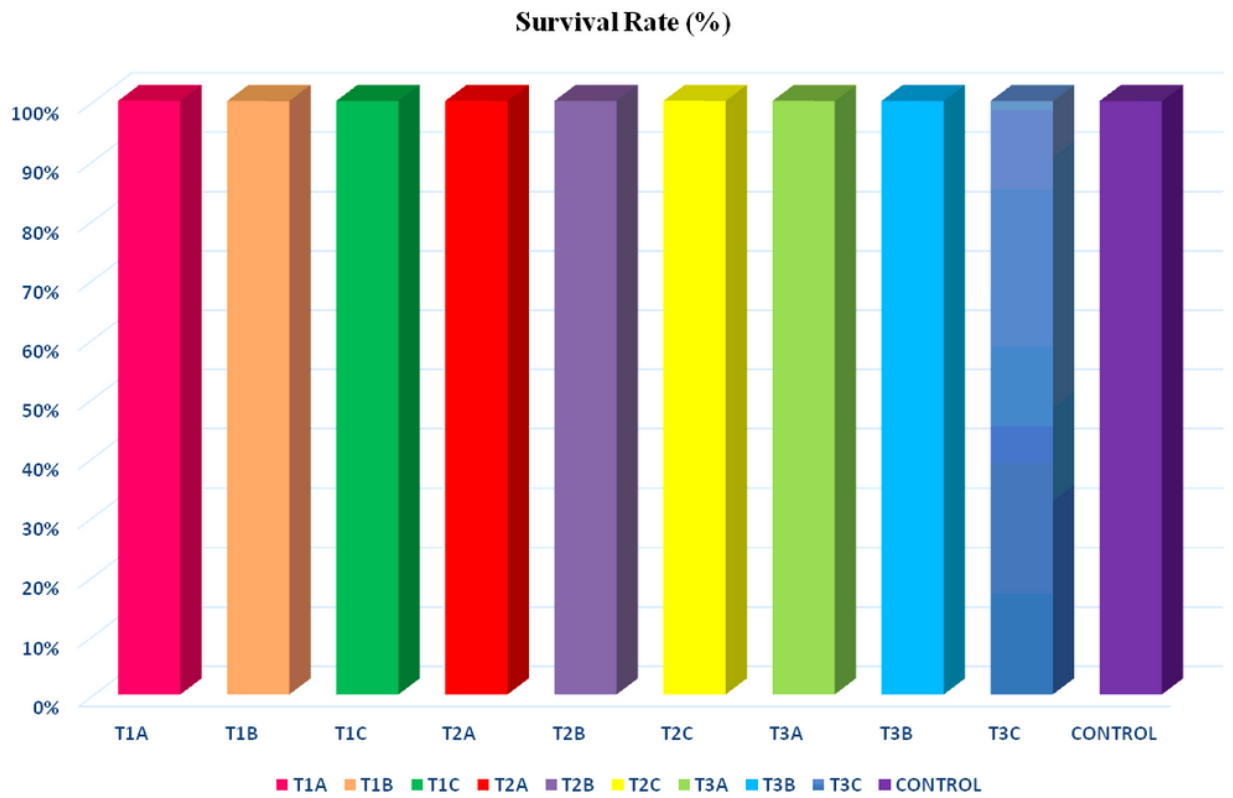


Figure 8

Survival Rate of Demasoni Cichlids maintained with different Natural Feed Supplement experimental groups during the experimental period of 60 days