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ASSESSMENT OF GROWTH AND NUTRITION OF BROWN TROUT *(SALMO TRUTTA)* IN SHERINGAL, DIR UPPER, KHYBER PAKHTUNKHWA, PAKISTAN

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Abstract

The current study was carried out to assess the growth and nutrition of brown trout in pond at the trout fish facility, Shaheed Benazir Bhutto University (SBBU), Sheringal, district Dir Upper from January to August, 2021. A total of 40 seedlings were taken from Madyan trout hatchery Swat and transferred to SBBU, Sheringal hatchery for research purpose. The various physio-chemical parameters of the hatchery were assessed on weekly basis. The average temperature ranged from 8.0 to 30.3°C, conductivity ranged from 0.04 to 0.06 S/m, dissolved oxygen ranged from1.24 to 3.2 mg/L and the pH ranged from 7.8 to 7.9. At the beginning of the research the average size of the Juvenile was 2.5 to 3.0 inch. In January food was provided in powder form. In the remaining time the food was provided in pellets form and the size of the pellets were increased with increase in growth. At the end of each month the length-weight were measured. The fish were not grown uniformly and slope of "B" value was 1.19 which is below 3.0 which indicates the negative allometric growth. Similarly, the length-weight frequencies were determined on monthly basis which showed that the length and weight frequencies continuously changed from one month to next month.

Keywords
Brown Trout, Nutrition, Length, Weight, Frequency and Growth

1.Introduction

Fish are the most diverse vertebrate group occupied almost every hydrosphere location. Fish are the earliest and most numerous vertebrates on the planet. Out of a total of 40,000 species 21,723 species belong to the superclass Pisces which includes vertebrates (Jayaram, 1999). According to their habitat, fish have a wide range of shapes, sizes, and colors (Yuan *et al*, 2003). Fish are cold-blooded aquatic animals that have a backbone, gills for breathing, and fins for swimming. They rely on water for respiration, food, shelter, and reproduction (Goldman *et al*, 1997). With approximately 22,000 species, fish have the highest biodiversity among vertebrates (animals with backbones), about 58 percent of them are marine species, 41% are freshwater species, and 1% are saltwater/freshwater hybrids. Saltwater covers 70% of the earth's surface while marine fishes are naturally the most varied. Freshwater covers less than 1% of the planet's surface, approximately 8,000 freshwater fish species may be found in a short region (Helfrich *et al*, 2009). There are 66,000 vertebrate species on the earth, 33,400 of which are live fish species, 14,953 of which are freshwater fish and 18,447 of which are marine. A total of about 86 fish species are estimated to be economically important in various regions in Pakistan's (Tedesco et al, 2017). Various climatic conditions are inhibited by fish during his life time depending on the availability of their nutrition and suitable environmental conditions. Fish surpass other vertebrates in numbers, making up around 50 percent, due to their ability to adapt to diverse environments (IUCN, 2014). Fisheries have a significant part in the global economy, fisheries generate an annual income of $80 billion dollars throughout the world. People who work in the fisheries sector earn a total of US$235 billion from the industry each year (Tedesco et al, 2017). Fisheries supply 15% of the total protein consumed by the world's three billion inhabitants. Approximately 520 million people are directly or indirectly dependent on fisheries. New ships, boats, and other watercraft are built with the incomes from the fishery industries which then are used for transportation (Sumaila *et al*, 2011). Fish is a great red meat alternative as well as a good source of protein. All necessary amino acids and minerals, such as iodine, phosphorus, potassium, iron, copper, and vitamin A and D are present in sufficient amounts in fish meat (Muhammad *et al*. 2014). Because of its low carbohydrate and unsaturated fat content, it is an important part of a balanced diet. Doctors normally recommend it to heart patients since it is high in Omega 3 polyunsaturated fatty acids. Therefore, fish in our diet can be a beneficial addition to any diet that mostly consists of grains, starchy roots, and sugar for good growth (Sumaila *et al*, 2011). Cold-water fishes found in regions with a high concentration of oxygen, the respiratory system of these fishes undergoes structural changes as a result of the high oxygen concentration and gills opening become narrow due to reduced usage. In water with a lower oxygen content, these fish have a hard time for adapting to these conditions. The Himalayan area is home to 19 major rivers, the biggest of which are the Ganga, Indus, and Brahmaputra (Mohan & Basade, 2008). Pakistan is recognized for its abundance of aquatic environments, with a diverse fish species found across the country. From various areas of the country, 198 freshwater species and 28 Coldwater

species have been identified (Rafique *et al*, 2017). Only two of the 28 species of cold-water fish are alive. Snow trout are found in Trans-Himalayan areas where river water temperatures are often below 20 °C (Yaqoob, 2002). The Indus River originates in Tibet and flows through India before merging with the Zaskar River in Ladakh before entering Pakistan. Brown trout restrict just 350 kilometers of the 2100 kilometers of streams and rivers, trout raising is fairly prevalent in the northern parts. There are 45 lakes in the northern regions, out of which 12 are home to trout. Brown trout and rainbow trout, two exotic species, have acclimated to the region (Yaqoob, 2002). Brown trout are not recommended for commercial raising due to their slower development rate than rainbow trout. Millions of people are employed in the fishing industry all around the world (Nagabhushan and Hosetti, 2010). Fisheries play a significant role in Pakistan's economy, and the people who live there benefit much from it through commercial raising. Fisheries provide a significant contribution to Pakistan's economy, people from poor families depend mostly on fisheries to meet their daily protein requirements (Rafique *et al*, 2017). Pakistan's fishery goods are also sold to other nations. According to a 2004 study, the export of fishery products brought in Rs 7.6 billion in revenue (Hassan *et al,* 2007). It is a beneficial industry that contributes to the economicgrowth of many countries because of its nutritional and medicinal properties (Muhammad *et al.* 2014).

2. Material and Methods

2. 1 Study Site

Dir upper is a district of KPK, located in the Hindukush range of Pakistan, near the province northern border. Dir and Wari are the divisions that make up the district. District Dir upper is situated at 35 06 51 N and 72 01 59 E latitude and longitude. Upper Dir is bordered on all four sides by distinct locations, including district Chitral on the north, district Swat on the east, Lower Dir on the south, and Bajaur Agency and Afghanistan on the west. District Dir Upper has 3,699 square kilometers in total. Sheringal valley is located in district Dir Upper's northwestern corner, around 36 kilometers from the Dir-Chitral major G.T highway. Sheringal Valley covers around 870 square kilometers. The temperature is between 0.7 and 32 degrees Celsius. Rainfall ranged from 700 mm to 1300 mm on a yearly basis (Khan *et al,* 2015).

2.2 Climate of Study Area

Snow is most likely to fall in the months of December, January, and February. During the winter, snow blankets the majority of the mountains. In the winter, temperatures can drop below freezing, while in the summer, temperatures can reach dangerously high levels (Khan *et al*. 2015). Humidity levels in the air can range from 30% to 70%. The Hindu Kush Mountains give rise to the river Panjkora, which flows to the south. At Sharbatayi near Chakdara, the River Panjkora and the River Swat mix (khan & Hasan, 2011). The Sheringal valley is found in Khyber Pakhtunkhwa's The Sheringal valley is found in Khyber Pakhtunkhwa's district Dir (upper). Sheringal is located between 35- and 28-degrees North latitude and 72- and 20-degrees East.

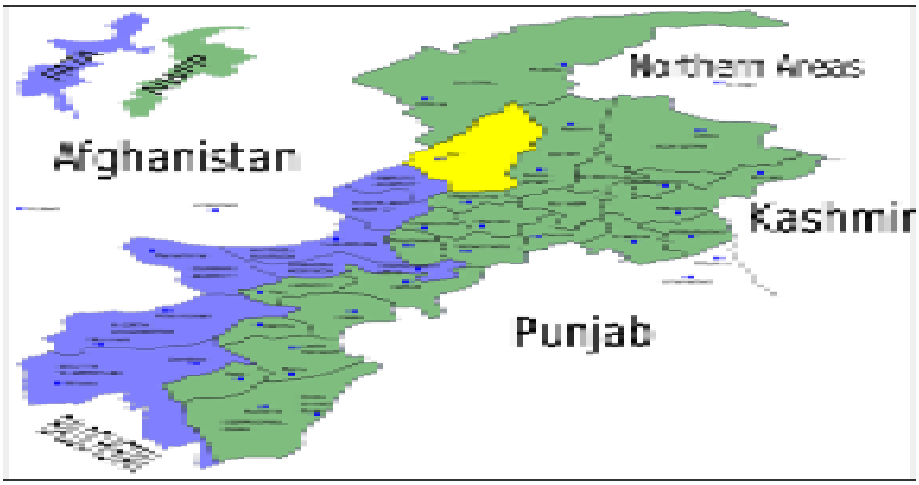

Figure 2.1 as of Pakistan.

Figure 2.2 Geographic map of KPK in (Yellow region presenting the study area of District Dir Upper).

Figure 2.3 Geographic map of the study area from Kumrat to Chukyatan.

Longitude in Dir. It spans 7992.67 hectares and is at a height of 2000 meters above sea level. Summer (April to August) and winter (November to March) are Sheringal's two primary seasons (September to March), Summer is a beautiful time of year with plenty of rain. Winter is really cold, and there is a lot of snow. During the winter season, the temperature ranges from 11.22 to -2.39°C. The Panjkora River runs from the Hindukush Mountains in the north to the Hindukush Mountains in the south. Different tributaries occur on both sides of the bank across the area (Khan *et al.* 2015).

2. 3 Collection of Fish

The experiment was performed at the main hatchery of SBBU Sheringal Dir upper from January 2021 to august 2021. The fish were collected by scoop net. For research work we purchased 40 juveniles of brown trout, the length of these juveniles were 2.5 to 3 inches, from Madyan trout hatchery swat. These seed were transferred to the study area in plastic bags fill with water having temperature of 7-10 °C, oxygen was added to this water and then these seed were shifted from Swat to Sheringal. To keep these juveniles, live different strategies were used, first fish was put in plastic bags filled with water and oxygen externally was added. Time to time the water was changed because these fish cannot live in warm and low oxygenated water. On the way 4 to-6-time oxygen was provided and water was added at different places. At hatchery the seedlings were kept in circular tank, for one month and food was provided in powder form. After month the fishes were transferred to clean cement tanks, the depth of the water in cement tank was kept 20 inches.

Figure 2.4 Collection of fish

2.4 Feeding Protocol

Commercial floating feed was provided 2 times per day (Eight-hour interval) according to their need and naturel food is available in the form of algae. Algae is a good food for juvenile (small fishes).

Figure 2.5: Food pellet

2.5 Food and Nutrition

The Prepared food was composed of the undermentioned ingredients in various percentage accordingly.

Table 2.1: Food composition for Brown trout

S. No	Ingredients	Percentage	
01	Fish meal	32 %	
02	Meat meal	12 %	
03	Soybean meal	12 %	
04	Flour	20 %	
05	Rice polish	08 %	
06	Dry milk	05 %	
07	Yeast	02 %	
08	Bone meal	01 %	
09	Soybean oil	04 %	
10	Vitamin-premix	0.55 %	
11	Vitamin- C	0.075 %	
12	Vitamin-minerals	0.075 %	
13	Colane-chloride	0.2 %	
14	BHT	0.1 %	0.2

2.6 Physiochemical Parameter of Water

To assess the physiochemical parameter of water conductivity a pH meter and water proof Do/O2/temp were used to check the pH, oxygen and temperature of water.

Figure 2.6: Water quality parameter

2.7 Measurement of Growth

After 30 days of interval, all juveniles were collected from each tank by the help of scoop net and total length was measured in inches and body weight in grams by the help of digital scale and then instantly released. The length was measured through a measuring tape.

2.8 Statistical Analysis

ANOVA was use to find linear regression, length frequency, weight frequency. SPSS and Microsoft excel were also used.

3. Results

In the month of January, the amount of food was 40 g in powder form due to young stage which resulted marked growth then the amount of food was increased on monthly basis in relation to fish growth from the month of January to August as 40 g, 60 g, 140 g, 300 g, 400 g, 600 g, 700 g, 700 g respectively. In the first two months the specimens were fed with small amount of food as compared to the remaining seven months due to the availability of natural food in the raceways.

3. 1 Physio-chemical Parameters of Water

The various physiochemical parameters of the pond were used to observe various parameters in the morning throughout the research work. The average minimum and maximum temperature recorded ranging from 8°C to 30.3°C respectively and similarly the Conductivity ranged from 0.04 to 0.06 S/m while the dissolved oxygen ranged from 1.24 to 3.2 mg/L and the minimum and maximum pH recorded was 7.9 to 7.8 respectively.

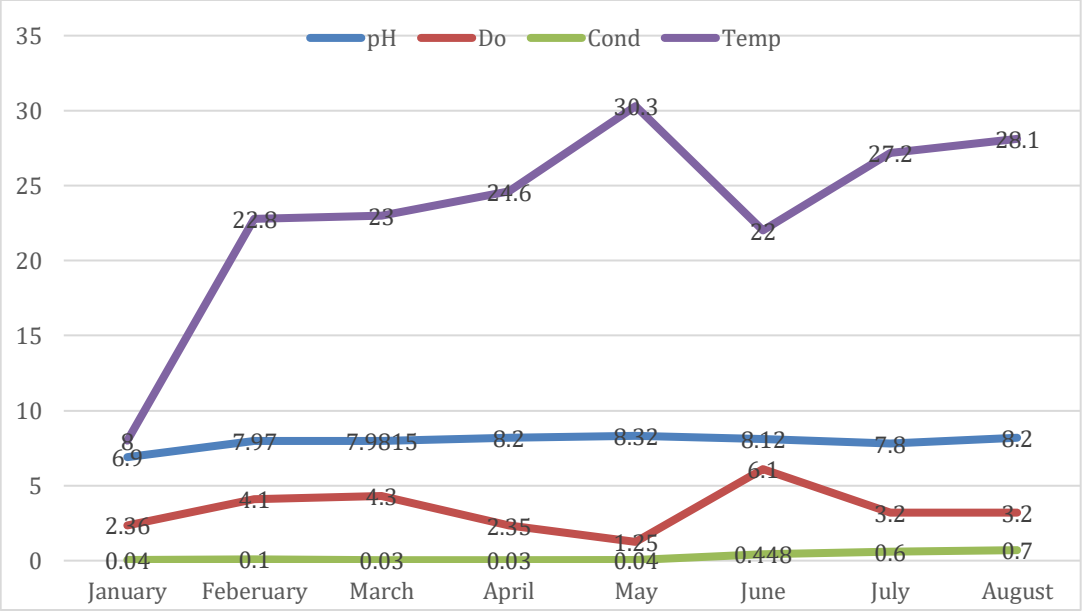

Fig 3.1: Physio chemical parameters of water

3. 2 Length Weight Relationship

In January the smallest and largest size of the specimen was 2.3 and 3.7 inch respectively whereas the lowest and highest weight was 6 g and 19 g respectively. The R^2 value was 0.5553 and B value was 1.8272. The B value is less than 3 which shows that the growth of fishes is negative allometric as shown in fig 3.2A. In the month of February, the smallest and largest size of the specimen was 3.8 inch and 5.8 inch respectively while the lowest and highest weight was 11 g and 31 g respectively. The R^2 value was 0.6784 and B value was 2.3466. The B value is less than 3 which shows that the growth of fishes is negative allometric as shown in fig 3.2B. In March the smallest and largest size of the specimens was 4.9 inch and 6.7inch respectively while the lowest and highest weight was 30 and 48g. The R^2 value was 0.3058 and the B value is 1.0217. The B value is less than 3 its shows that the growth of fishes is negative allometric as shown in fig 3.2C. In April the smallest and largest size of the specimens was 5.8 inch and 8.6 inch respectively while the lowest and highest weight was 60 g and 75 g respectively. The R^2 value was 0.7325 and B = 0.7849. The B value is less than 3 it designates that the growth of fishes is negative allometric as shown in fig 3.2 D. In May the smallest and largest size of the specimens was 7 inch and 8.6 inch respectively while the lowest and highest weight was 60g and75 g respectively. The R^2 value was 0.7325 and B value is 0.7849. The B value is less than 3 so it indicates that the growth of fishes is negative allometric as shown in fig 3.2E. In June the smallest and largest size of the specimens was 7.8 inch and 9.2 inch respectively whereas the lowest and highest weight was 81g and 100g respectively. The R^2 value was 0.4298 and B = 0.726. The B value is less than 3 so it indicates that the growth of fishes is negative allometric as shown in fig 3.2F. In July the smallest and largest size of the specimens was 8 inch and 10.3 inch respectively

whereas the lowest and highest weight was 82g and 115 g respectively. The R^2 value was 0.504 and B value is 1.2971. The B value is less than 3 its mean that the growth of fishes is negative allometric as shown in fig 3.2G. In August the smallest and largest size of the specimens was 9.2 inch and 11.4 inch respectively as shown in fig 4.2.8. Whereas the lowest and highest weight was 118g and 145g respectively. The R^2 value was 0.4477 and B is 0.5616. The B value is less than 3 so it indicates that the growth of fishes is negative allometric. In all months the differences among the slope B values may be due to the fluctuation in season, environmental parameters and physical conditions of the fish as shown in fig 3.2H.

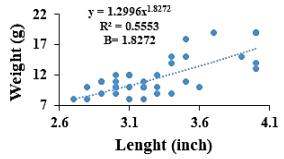

Fig 3.2A LWR of Jan

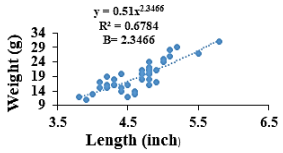

Fig 3.2B LWR of Feb

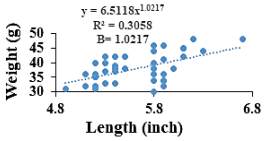

Fig 3.2C LWR of March

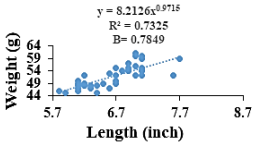

Fig 3.2D LWR of April

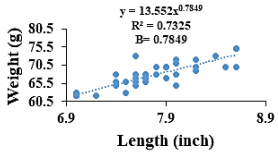

Fig 3.2E LWR of May

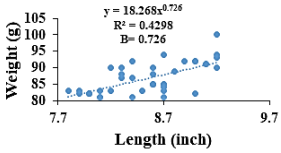

Fig 3.2F LWR of June

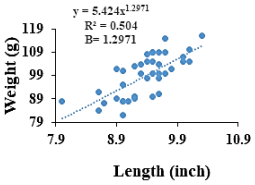

Fig 3.2G LWR of July

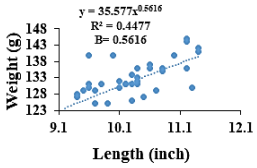

Fig 3.2H LWR of August

Fig 3.2: Length Weight relationship of various Months

3. 3 Length Frequency

The length frequencies were used to measure by tape at the each of each month and noted as under mentioned. At the end of the 1st month of the study the lowest length was recorded is 2.8 inch whereas the highest length was 4 inch while

the lowest length at the end of the last month of research work was 9.3 inch and highest length was 10.5 inch. The length is increased with the passage of time as shown in Fig. 3.3.

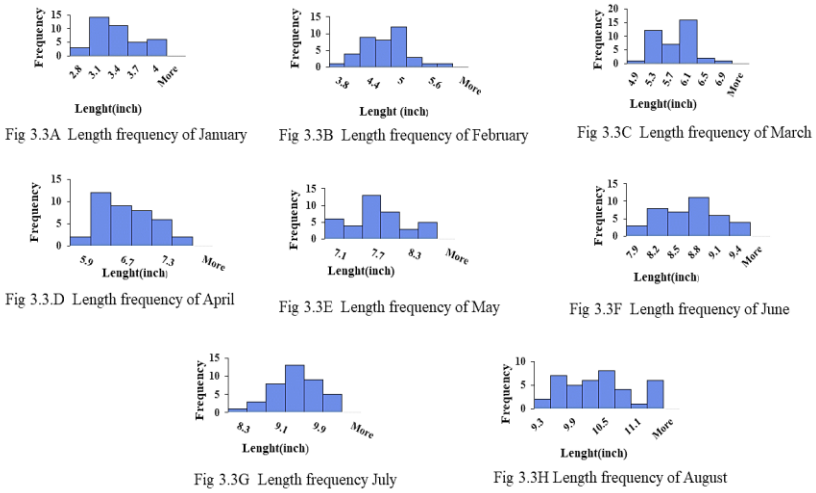

Fig 3.3A Length frequency of January
Fig 3.3B Length frequency of February
Fig 3.3C Length frequency of March
Fig 3.3.D Length frequency of April
Fig 3.3E Length frequency of May
Fig 3.3F Length frequency of June
Fig 3.3G Length frequency July
Fig 3.3H Length frequency of August

Fig 3.3: Length Frequencies of various Months

3. 4 Weight Frequency

The weight frequencies were used to measure by digital scale at the each of each month and noted as under mentioned. At the end of the 1st month of study the smallest weight was recorded is 8g whereas the largest weight was19g.the smallest weight at the end of the last month of the research work was 120g and the highest weight was 145g. The weight is increased with the passage of time and the fish were grown as shown in Fig 3.4.

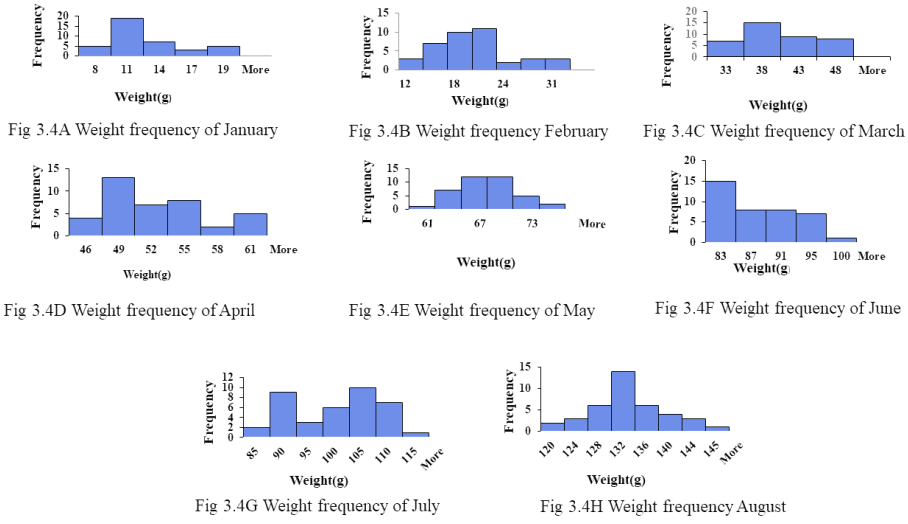

Fig 3.4A Weight frequency of January
Fig 3.4B Weight frequency February
Fig 3.4C Weight frequency of March
Fig 3.4D Weight frequency of April
Fig 3.4E Weight frequency of May
Fig 3.4F Weight frequency of June
Fig 3.4G Weight frequency of July
Fig 3.4H Weight frequency August

Fig 3.4: Weight Frequencies of various Months

4. Discussion

Fish is regarded as a significant and primary source of protein. Long chain fatty acids, which may be acquired from the body of a fish, are essential for cardiovascular health, small quantities of polyunsaturated fatty acids, which are needed for human existence, can also be found in freshwater fish (Luczynska *et al*, 2008). In this study the growth assessment of Brown trout and Rainbow trout were compared. The same food was provided in same amount to the fishes in the same environment (Rainbow trout and Brown trout) while the results were different, the growth rate of Brown trout is less than the growth rate of Rainbow trout due to the feeding rates varied by period within the growing process of trout. The average "b" value of brown trout was 1.192 and the "b" value of rainbow trout was 2.07. It can be notice that the brown trout grow less because they ingested less food. The temperature of water is main factor that effect the growth, in these 8 months study the temperature of water was different in each month the minimum and maximum temperature ranged from 08 to 30.3°C. In previous studies different temperature ranges have been used as (McCauley *et al*, 1981) suggested a range between 12 to 15°C for optimal growth, while (Quillet *et al*, 1992) suggested 15 to 17°C. It has been noticed in the current study that the Rainbow trout grow faster than the Brown trout and the same results for rainbow trout were obtained in the past by (Yanik *et al*, 2002; Kurtoglu *et al*, 1998; Shepherd & Bromage, 1988). Brown trout is not a competitive fish to be compared with Rainbow trout because the survival, growth rate and food conservation rate of Brown trout are noticeably lower than Rainbow trout (Serezli *et al*, 2003; Quillet *et al*, 1992). The arrangement of body brown trout is very sensitive to environmental factors, it cannot show any aggressive behavior as shown by rainbow trout and chose to move down in water when it fed, it is important to slow the sinking of food an elicoidol motion is necessary to facilitate visibility for fingerlings (Quillet *et al.*, 1992).The feed consumption rates and appetency are not as much as rainbow trout, feeding frequency has impact on food intake, growth of salmonids seems to have great effect on rearing condition (Jobling, 1985). To find the rate of feeding of fish the most applicable finding is length-weight relationship which is most studied parameter in the science of fishery and stock assessment (Abdurahim *et al*, 2004)In present study the average value of "b" for Brown trout was1.192 (R^2=0.534) from the main hatchery of SBBU Sheringal which showed negative allometric growth same as previously described by (Baset *et al*, 2020) for Indian oil sardine (*Sardinella longiceps*) and Edmond *et al*, 2016; Aggrey *et al*, 2013; Bloch, 1795) for Lesser African Threadfin (*Galeoides decadactylus*). When the value of "b" is less than 03 it shows negative allometric growth, larger than 3 shows positive allometric and equal to 3 it shows isometric growth (King, 1995). This may be due to the same environmental conditions, food compositions as well as same feeding behaviors. In the current study the length weight frequencies were find out on monthly basis. In January 2021 the minimum and maximum length for brown trout was 2.8 and 3.7 inches respectively. Similarly, the minimum and maximum weight was 08 and 19 grams respectively. The same values were found in the last month of the study, the minimum and maximum length was 9.3 and 11.4 inches whereas

the minimum and maximum weight was 120 and 145 grams these values shows that the length and weight have been increased during the eight months of the study then at the same place, same time the effect of food on the growth rate as well as the length weight frequencies of rainbow trout were found which were absolutely different from the frequencies of brown trout. In rainbow trout the minimum and maximum length was 2.4 and 3.5 inches respectively while the minimum and maximum weight was 06 and 15 grams. The same values were determined in last month of the study in which the minimum and maximum was 12 and 14.4 inches while the lowest and highest weight was 400 and 685 grams. The length and weight of the rainbow trout is higher as compared to brown trout due to its aggressive behavior, quick movement, ingestion of more food and movement on the surface of water.

5. Conclusion and Recommendation

The current study was conducted on the assessment of growth and nutrition of brown trout; the brown trout is carnivorous in nature. The present study concludes that artificial food of the same ingredient causes efficient growth in the captivity, in the juvenile stage the food should be provided in powder form while in latter stages the food should be given in pellet form.In the first month growth rate was low due to turbidity of water, the length weight is increasing slowly the length weight was increased by less than one inch in a month. Average increase in length in early stage by 3 to 5 cm while remaining period of study the length was increasing by 0.8 inch similarly the weight was increased in early stage by 7 grams while in remaining period of study the weight was increasing up to 15 grams. The length-weight relationship value is “b” 1.19 which shows that the growth of fish was negative allometric. As a part of recommendation study the behavior of Brown trout. Study the spawning of brown trout in naturel environment and in artificial environment. Study the acclimatization of brown trout. Study the effect of change in temperature on brown trout. Stop over hunting because of declined in status of fish Decreased water turbidity.

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