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Evaluation of specific growth rate (Sgr) in the rainbow Trout

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Key words: Diet, Feed ingredients, Feed conversion ratio (FCR), Specific growth rate (SGR), Rainbow trout

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Abstract

An experiment was conducted in "Trout Culture Training Centre" (TCTC) in Madyan district Swat to study the growth performance of Rainbow trout *(O. mykiss)* during 2014-15. The aim of this study was to evaluate the physical changes (weight and length), Feed Conversion Ratio (FCR) and Specific Growth Rate (SGR) on the basis of providing two different artificial feeding formulation Type-1 and Type-2. After six months of feeding procedure the body weight of the fingerlings was recorded and the length was measured. Body length and weight increased in Group-1 as compared to Group-2. In group-2 the FCR was significantly higher than in Group-1 ($p=0.026$). Similarly the specific growth rate was found lower in Group-2 than Group-1 ($p=0.061$). Whereas Type-1 artificial feeding formulation showed better growth rate in Rainbow trout fingerlings as compared to Type -2 artificial feeding formulations. It was observed that feed with higher protein level was better for the fish growth and the growth of fish was different significantly among the treatment. Thus animal protein containing artificial feed, on the basis of growth performance can be induced in the feed formulation of fry of Rainbow trout *(O. mykiss)*.

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Introduction

Rainbow trout (*O. mykiss*) belong to family salmonidae. It is a fresh water fish. Its biological characteristic contain 3-4 dorsal spines, 60-66 vertebrae and 10-12 dorsal soft rays along with minute black spots on the head, fins and back but its colors are due to its size, habitats and sexual condition (Cowx, 2005). It is the local fresh water fish of all the rivers, lakes of Pacific coast, Asia and North America. It distributed to 82 countries because it has best ability to adapt to tolerate environmental factors and the production capacity of rainbow trout is more as compare to other trout species (Woynarovich *et al*., 2011).The taxonomy of rainbow trout (Starnes, 2003). Nutrition is essential activity of feeding for enough growth to maintain weight, health and development of fish body (Anderson and Silva, 2003). Balance diet formulation and proper feeding are the main necessary factors of aquaculture, without these fish could not be healthy and productive (Watanabe, 1988). It has been reported that biological evaluation, quality control are essential to prepare diets correctly (Watanabe, 1988).

Fish feeds are divided into dry, wet and moist according to consisting of moisture (Goddard, 1996; Jobling, 1994; Hardy, 1989). The moisture content of moist and wet feed has 50-70% and bearing other fish waste and ground fish. Dry feed contain fish meal, minerals, premixes, cooked starch, vitamins and alginate binder (Jobling *et al*., 2001b). During spawning season between autumn and spring rainbow trout spawn per kilogram body weight, mature female lays 2000 eggs (Purser and Forteath, 2003). Male and female mature at different rate simultaneously in 2 years and 3 years as well and after hatching optimum temperature 12°C-18°C is essential for their growth (Purser and Forteath, 2003).

For the past several years, one of the main directions in improving fish feeds has been the search for protein source alternatives to fish meal and determining their nutritional suitability in diets (Watanabe, 2002). This trend is, firstly, a response to growing demands for formulated diets, and secondly, a response to limited resources of fish meal that will soon hit the upper threshold of exploitation. Additionally, according to Hardy R.W. 2008 (Hardy, 2008) one of methods to develop less expensive and effective formulations is lowering fish meal levels in diets. The total replacement of fish meal with soybean protein was successful only in a few cases (Kaushik *et al.,* 2004 and Adelizi *et al.,* 1998). Fish meal has been an important source of protein in fish diets because of its high protein quality and palatability. However, fish meal is very expensive and can substantially increase feed costs. Since fish meal is used as the main protein source in aqua-feeds, recent researches have been concentrated on the partial or total replacement of fish meal with less expensive and locally available protein sources for tilapia (Shiau, 2002). Total or partial replacement of fish meal with less expensive animal protein, such as poultry by-product meal (PBM) may help to reduce feed costs, although these sources may be lower in digestibility, palatability and essential amino acids (Hertrampf and Piedad, 2000; Emre *et al.,* 2003 and Hu *et al.,* 2008).

The choice of Rainbow trout is necessary in this study because of its remarkable fast growth rate. It has very high commercial value in our markets due to its ability to adapt readily to poor conditions, fast growth rate, acceptability and high conversion of artificial feeds, tolerance to crowded conditions and high quality of its flesh (Jain, 2002). Having considered the above facts, this study was carried out therefore, to assess the effect of different feed ingredients with two type of supplemented fish meal.

Materials and methods

Fish and Fish Raceways

The fingerlings of rainbow trout were the production of Government Hatchery and the research work was conducted in "Trout Culture Training Centre" (TCTC) Madyan swat Pakistan. One hundred and eighty fingerlings of rainbow trout were selected from 1000 on the basis of length and weight. These fingerlings were divided into two groups as Group-1 and Group-2 on the basis of feeds. Each group contained 90 numbers of fingerlings. During the process of grading the initial size of the selected fingerlings in each group was 5g by weight and 3 inches by length.

These fingerlings were finally placed in six separate raceways each contained only 30 number of fingerlings.

The raceways were rectangular in shape about 4.0 feet high from the earth. The length, width and depth of the raceways were 50x5x4 feet respectively. The walls of the raceways were finely plastered both externally and internally so that the fish may easily swim in fast flowing water. The proximal ends of the raceways born the inlet measured 4 inch while the distal end showed the outlet 6 inch in diameter. The distal end of the raceways reserved a pipe of 6 inches diameter for increasing or decreasing of water at the time of grading, capturing, or shifting of fish. Water flowing capacity in and out of the raceways was 80-85 gallons recorded during the experimental work.

Feed Ingredients and Feeding Formulation

The feed was in the form of pellets having 2mm in size, produced by the company of Lahore Pakistan. During the experimental work two different artificial feeding formulations were used as Type-1 and Type-2. Both the artificial formulation had 14 ingredients as fish meal, wheat flour, soya bean meal, meat meal, rice polish, dry milk, soya bean oil, colin chloride, brewer yeast, bone meal, butyl hydroxyl toluene,(BHT), vitamin premixes, vitamin minerals, vitamin c, but with different percentage.

The feeding time was set as morning, noon, and evening which was started from 6:00 am to 6:00 pm and the gap was recorded between these time was 6 hours. Hand methods were used for the distribution of feeds to both the groups (Table 1).

Table 1. Showing Type-1 and Type-2 Artificial Feeding Formulation.

First type artificial feeding formulation (Type-1)		Second type artificial feeding formulation (Type-2)	
Ingredients	percentage	Ingredients	Percentage
Fish meal	35%	Fish meal	25%
Wheat flour	20%	Wheat flour	20%
Meat meal	12%	Meat meal	18%
Soya bean meal	12%	Soya bean meal	13%
Rice polish	8%	Rice polish	8%
Dry milk	5%	Dry milk	5%
Soya bean oil	4%	Soya bean oil	3%
Colin chloride	0.200%	Colin chloride	2%
Brewer yeast	2%	Brewer yeast	2%
Bone meal	1%	Bone meal	1%
BHT	0.100%	BHT	1%
Vitamin minerals	0.075%	Vitamin minerals	0.75%
Vitamin “C”	0.075%	Vitamin “C”	0.75%
Vitamin premixes	0.550%	Vitamin premixes	0.50%

Feeding groups and its procedure

The feeding experiment was conducted from September, 2014 to February, 2015. Group-1 was fed by Type-1 artificial feeding formulation, while Group-2 was fed by Type-2 artificial feeding formulation.. During the trials 50 grams of feed was given to each raceway in a three split doses i.e. 16.67 grams in the morning, the same quantity in the afternoon as well as in the evening. In this way both the groups were fed 150 grams of feeds per day.

Maintenance of Water Temperature

The water supply to Government trout hatchery” Trout Culture Training Centre” (TCTC) was from Chail-Beshigram stream of swat.

The distal end of the water channel was joined with large size of saltine tank. The saltine tank was rectangular in shapes with average length was 37 feet, while depth and width were 2 and 7 feet respectively.

The saltine tank makes the water clear and safe from the plants and animals’ debris, wood, carcasses, and other sand particles.

The temperature of the water was decreased gradually from 13°C to 3°C from September to February for both the groups so the average temperature was 6 to 9°C and the flow of water to each raceways recorded 80 to 85 gallons during the experimental work.

Anaesthetization, Equipment and measurement the biomass of fish

The fingerlings of rainbow trout were measured and anaesthetized using graders, buckets, nets, scales, and anaesthetization solution. The anaesthetization solution was prepared by adding MS-222 (100mg/liter) and $NaHCO_3$ (100mg/liter). The solution was poured into bucket. Nets were used to capture fingerlings from raceways and kept it into the bucket to anaesthetize the fish for measuring the total length and weight. The fish were slightly numb in the solution and finally the total maximum length was measured.

For the weighing of the fish, Bin bang balance and wet paper towel were used. The wet paper towel were placed over Bin bang balance and fish paced in it to avoid the fish from the attacking of bacteria and other fungal diseases. All the fingerlings were measured correctly and recorded. During the whole experiment the length and weight of fingerlings were measured two times of each month. The measurement of the fingerlings was taken at the time of beginning of the experiment and then after each month lastly up to the end of the experiment. After the length and weight of the total numbers of fingerlings ware taken, nets, carrier bags, and other buckets were used to convey the fish into their original raceways.

To check the effects of artificial feeding formulation on fingerlings, five (5) fingerlings were randomly selected from each raceway and data was recorded on their weight and length on first and last day of the month for both the groups.

Feed conversion ratio (FCR)

FCR was estimated by the given formula

$$\text{FCR} = \frac{\text{MASS OF FOOD CONSUMED (DRY)}}{\text{INCREASE IN MASS OF ANIMAL PRODUCED(WET)}}$$

FCR used to verify or show that how efficiently the feed is used. It is essential for the nutritionist to estimate how a large amount of feed is necessary for the growing cycle (Anderson and Silva, 2003).

Specific growth rate (SGR)

SGR is the fish body weight that grows in daily percentage.

Specific growth rate (SGR) calculated as

$$\text{SGR} = \frac{\text{FINAL WEIGHT (g)} - \text{INITIAL WEIGHT (g)}}{\text{TIME BETWEEN WEIGHT (DAYS)}} \text{ X } 100$$

Statistical analysis

The average weights of rainbow trout fingerlings were analyzed to compare difference between (Group-1) and (Group-2) as well as also compare Type-1 and Type-2 artificial feeding formulation using Two-sample t-test. The average lengths of rainbow trout fingerlings were analyzed to compare difference between (Group-1) and (Group-2) as well as also compare Type-1 and Type-2 artificial feeding formulation using Two-sample T-Test. Difference in FCR and SGR between (Group-1) and (Group-2) which were fed by (Type-1) and (Type-2) artificial feeding formulation were analyzed with Mann Whitney U-test. The entire statistical tests were executed at 95% confidence level with IBM SPSS 21.0 version.

Results

We defined four different variables for group-1 and group-2 as initial weight and final weight similarly initial length and final length. We estimated the difference of variables of group-1 and group-2, to observe the increase or decrease in weight and length of their fingerlings. The initial mean weight and length of both the groups used were not significantly different for each respective group. No mortality nor external clinical symptoms occurred in any treatment in this study. Mean weights gain of the fingerlings in groups 1 and 2 were observed 1.50 to 3.70g (Table 2) and 1.50 to 2.0g (Table 3) respectively during the study period. For estimation of weights both the groups were equal to test the hypothesis of equal variances we applied Leven's test as Alpha= 0.05, P= 0.449 and P > 0.05. It means that the variances of both the groups are equal so the t-test of equal variances is applicable. Now in t-test variables were recorded as Alpha = 0.05and P = 0.026 P < 0.05, It means that the population means for weights of both the groups were significantly different. Lastly after six months feeding experiment the average weight of fingerlings increased in both the groups but average weight of group-1 increased more than that of group-2 so there were significant differences of weights between the two groups (P= 0.026, t-test).

Table 2. Variation in growth and food of fingerling of Rainbow trout during September 2014 to February 2015 for group 1.

Parameters	September	October	November	December	January	February
Mean initial weight (g)	5.0	7.50	10.20	12.80	14.80	16.30
Mean final weight (g)	7.50	10.20	12.80	14.80	16.30	20.00
Mean weight (g/fish)	2.50	2.70	2.60	2.00	1.50	3.70
Specific growth rate (% fish)	8.33	9.01	9.00	6.67	5.00	12.33
Feed conversion ratio (FCR)	1.8	1.7	1.7	2.3	3.1	1.1

Table 3. Variation in growth and food of fingerling of Rainbow trout during September 2014 to February 2015 for group 2.

Parameters	September	October	November	December	January	February
Mean initial weight (g)	5.0	7.00	8.50	10.50	11.30	13.00
Mean final weight (g)	7.00	8.50	10.50	11.30	13.00	14.50
Mean weight (g/fish)	2.00	1.50	2.00	0.80	1.70	1.50
Specific growth rate (% fish)	6.6	4.8	6.6	2.5	5.4	5.3
Feed conversion ratio (FCR)	2.2	3.1	2.2	5.8	2.7	2.8

Whereas mean length of both the group i.e. 1 and 2 were recorded as 0.2 to 0.3 and 0.1 to 0.2 inches respectively during study period (Table 4). For measurement of length we applied Leven's test as Alpha= 0.05, P= 0.448 and P > 0.05 so we accepted the hypothesis of equal variances test for length. Now in t-test Alpha = 0.05 and P = 0.022 P < 0.05, It means that the population means for length of both the groups were significantly different. Lastly after six months feeding experiment the average length of fingerlings increased in both the groups but average length of group-1 increased more than that of group-2 so there were significant differences of length between the two groups (P=0.022, t-test). However during the experimental period i.e. September 2014 to February 2015 means weight was found increase (Fig.1) and mean length also observed increasing trend respectively (Fig.2).

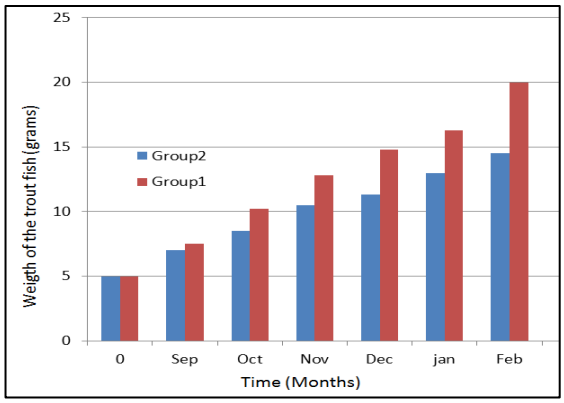

Fig. 1. The average weights of rainbow trout fingerlings *(O.mykiss)* in group-1 and group-2 after six months of feeding.

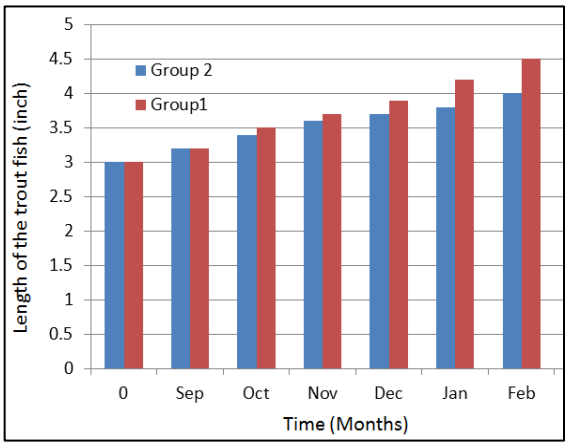

Fig. 2. The average length of rainbow trout fingerlings *(O.mykiss)* in group-1 and group-2, after six months of feeding.

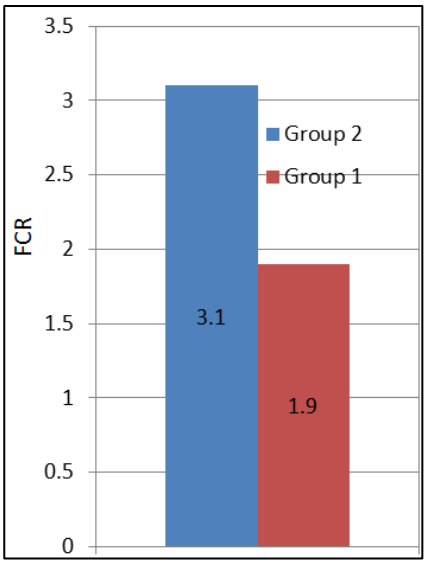

Fig 3. The feed conversion ratio (FCR) of rainbow trout *(O.mykiss)* in group-1 and group-2 after six months of feeding.

Table 4. Length of Fingerlings recorded after six months of feeding with two different groups feeds.

No of Months	Group-1 Initial Length (Inch)	Group-1 Final Length (Inch)	Difference of Length (Inch) Group-1	Group-2 Initial Length (Inch)	Group-2 Final Length (Inch)	Difference of Length (Inch) Group-2
September	3.00	3.20	0.20	3.00	3.20	0.20
October	3.20	3.50	0.30	3.20	3.40	0.20
November	3.50	3.70	0.20	3.40	3.60	0.20
December	3.70	3.90	0.20	3.60	3.70	0.10
January	3.90	4.20	0.30	3.70	3.80	0.10
February	4.20	4.50	0.30	3.80	4.00	0.20

Specific growth rates (SGR%/30days) were recorded ranging from 5.00 to 12.33 for group 1 (Table 2) and 2.5 to 6.6 for group 2 (Table 2) respectively. For measurement of specific growth rate (SGR) two variables from both the groups were used statistically applying the Mann-Whitney U-test the hypothesis about equal distribution and medians were recorded as Alpha= 0.05, P= 0.041, P < 0.05 the mean distribution for SGR of group-1 and group-2 were found significantly different. Similarly the median test for both the group was recorded Alpha = 0.05, P =0.061 so P > 0.05. The median of the both the groups were equal, there was no significant differences for SGR between the median of the two groups. However during six months feeding trials the specific growth rate (SGR) of group-1 was greater than that of the group-2 (P= 0.061 Mann-Whitney U-test). The growth data clearly indicated that the final weight, length and SGR values were found significantly different. The feed conversion ratio (FCR%/30 days) were found ranging from 1.1 to 3.1 for group 1 (Table 2) and 2.2 to 5.8 for group 2 (Table 2) respectively. Variables were estimated appling Mann-Whitney U-test to evaluate the feed conversion ratio (FCR) of both the groups i.e. group 1 and 2 and it were recorded equal distribution and medians of both the groups significantly different, Alpha = 0.05, P= 0.80, P > 0.08. The medians of both the groups were equal so there was no significant difference between the median of the two populations for both the groups. After six months feeding experiment the FCR of the group-2 slightly superior than that of the group-1 and there was significant difference between the two groups (P = 0.026, Mann-Whitney U-test).

Discussion

Studies conducted on other fish species have shown that feed consumption and growth generally increased with feeding frequency up to a given limit (Wang *et al.,* 1998; Baçınar *et al.,* 2007).

This is in agreement with our findings in this study that feeding frequency had a significant effect on feed consumption and growth in the Rainbow trout. Both feed consumption and growth rates appeared to increase. Feed conversion ratio (FCR) and specific growth rate (SGR) were observed best at three times feeding. It shows that this feeding frequency is optimal for the condition of this trial suggesting that both growth and feed utilization are most efficient at this frequency of feeding (Baçınar *et al.,* 2007).

The lack of difference in feed conversion rate (FCR) among the treatments in the fingerlings group was consistent with the argument that the effect of feeding frequency on feed conversion is usually small (Hepher, 1988). The ability of an organism to utilize nutrients especially protein will positively influence its growth rate (Sogbesan and Ugwumba, 2008). This is justified by the highest PER and low FCR in the treatments fed thrice daily. This suggested that fish must have efficiently converted feed consumed to growth.

For fish management, nutrition is essential for the fish farmers to attain better quality and size level, which is needed for the customers as well as for the companies that processing fish. Fish farmers are always struggling to feed the fish properly for which they usually follow the instructions given by feed companies in order to achieve excellent progress and the best quality of fish as well as also activate the fish to increase the optimal body weight and length. Competition occurred for feeds were due to deliver of controlled condition in the term of space and quantity of fish. Inside the tank or ponds the density of fish showed straight reason for fish competition (Kestemont and Baras, 2001). On the other hand in the current study the fish density was very low in raceways so there was not high competition for feeds among the fish between the two groups.

Therefore the fish present in each raceway got enough amounts of feeds for their growth. Different sizes of fish were formed due to cannibalism and aggressiveness. Cannibalism was the main cause of increase the different size of fish at the time of feeding of rainbow trout. To keep away from this difficulty fish should be graded (Woynarovich *et al*., 2011). In our experimental work cannibalism and aggressiveness was not identified among the fingerlings of rainbow trout. According to Suzuki *et al*., (2008) feeding by hand and selffeeding showed great effects on growth, feed conversion ratio (FCR), and fins damage (Dorsal and caudal fins) of rainbow trout along with this, self feeding showed more effects on the growth as compare to hand feeding. In self feeding fish consumed 30% more feed which was significantly higher than that of the hand feedings. In our experimental work both the groups were provided hand feeding although group-1 rainbow trout showed higher growth rate than that of group-2 rainbow trout.

However there was significant difference between FCR and SGR. Rainbow trout is carnivorous fish so it requires great amount of protein level in its diets for normal growth and also for maintaining of variable body functions.

Conclusion

The main objective of this study was to evaluate the effect of different artificial feeding formulation on growth rate, physical changes such as weight, length, feed conversion ratio and specific growth rate in juvenile rainbow trout between the two groups. If the FCR is lower than expected mean then the fish have used the feeds insufficiently and the energy is lost for the growing or surviving of fish. Similarly if the FCR is higher than optimum level then more feed is being wasted.

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