1.0 Introduction

Nepal, naturalist's paradise, attracts and lures world's vision, with her immeasurable natural beauties and diverse cultural and social aspects. The country is rich in water resources. Agricultural, subsistence small land holdings form the basis of livelihood and backbone of the economy of the country. Proper management and scientific utilization of these water resources create opportunities for employment and beneficial in improving the socioeconomic status of poor people. In this context, fish farming is established as promising industry in Nepal. Fish farming utilizes water resources like rivers, ponds, lakes, marshes, canals etc unsuitable for other types of food production. Fish farming can also be combined with agriculture or livestock in order to obtain higher farm income. This kind of typical farming system (integrated fish farming) is characterized by waste recycling, energy saving, resource utilization and integration of ecological niches.

Strengthening the self-help capacity of farmers towards more sustainable land use and improved livelihood by decreasing economic and environmental vulnerabilities can enhance the strategic integration of the management of farming systems and watershed ecosystems to assure the improved livelihood and sustainable development.

1.1 Status of fisheries in Nepal

Fisheries and aquaculture is a small sub-sector of agriculture sector having high growth potential but with low organizational stature in Nepal. The modern aquaculture along with fisheries practices contributes nearly 2%of Gross Domestic Production (GDP). The primary objective of the national fisheries and aquaculture policy is to contribute in economic growth and reduce poverty through inclusive, equity based and ecosystem approach based Aquaculture (EAA) development. The estimated families were 73,000 in 1996/97 engaged in aquaculture, fisheries and related activities with about 264,000 people actively involved in this profession. About 366,000-439,000 people or around 2% of the total population are benefited directly from aquaculture and fisheries (Thapa and Pradhan 1999). Fish farm production, especially the carp production has been practiced widely with substantial increment in production in the terai regions of the country. So far, culture of fish is

focused on those species capable of efficiently converting low quality and inexpensive feeds into higher quality proteinous food to enhance productivity. Low cost but more efficient supplementary feed (artificial feeds) is being used for farming purpose. The basic principle of Nepalese small and large scale aquaculture is ecological approach based aquaculture activities within the wider ecosystem in compliance with all applicable international, national and local laws/regulations prioritizing equity, inclusion and resilience to interlinked social ecological system for nutrition, poverty alleviation and income.

However, commercial farming of coldwater fishes is comparatively less developed but has gained more attention in recent days. Improving the supply of major production inputs particularly seed and feed, strengthening technical services to the farmers and improvement of production and marketing related infrastructure are recommended as the most needed supports for coldwater aquaculture.

1.2 Importance of fish culture in Nepal

Fish farming not only utilizes the available water resources but also acts as simple and practical solution to the hunger and malnutrition problem of the low income people. Due to climatic diversity of Nepal, there is wide possibility for rearing variety of species of the fishes. Importance of fish culture can be summarized as follows:

1.2.1 Nutrition

Fish flesh provides an excellent source of essential proteins along with fat, essential amino acids and vitamins A and D. In addition to this, a large amount of phosphorus and other vital elements are also present in it like K, Cl, P, Mg, Fe etc. Fish proteins comprise all the ten essential amino acids in desirable amount for human consumption – lysine, arginine, histidine, leucine, isoleucine, valine, thronine, methionine, phenylaline and tryptophan. Fish flesh, therefore, becomes a valuable supplement to human diet for people who are habitually taking cereals, starch, roots and sugar as their principal diet. Fish flesh is relished by all for it has good taste and is easily digestible as compared to the digestibility of beef and poultry. So, fish farming not only provide alternative

means of income to the people but also play an important role in maintaining good health.

1.2.2 Diversity of climate

The climate of Nepal ranges from subtropical monsoon conditions in the terai region to the alpine conditions in the great Himalayas, facilitating different flora and fauna. A large number of fishes are found in Nepal and offer an opportunity for development of inland fisheries in the country. About 234 different fish species have been reported in Nepal till date (Shrestha, 2008). The list also included several exotic fish species of commercial value introduced in Nepal. Exotic fishes include Tilapia (*Oreochromis mossambica*), Common carp (*Cyprinus carpio*), Grass carp (*Ctenopharyngodon idella*), Silver carp (*Hypopthalmicthys molitrix*), Bighead carp (*Aristicthys nobilis*), Rainbow trout (*Oncorhynchus mykiss*) to name a few.

Fish fauna in Nepal consists mainly of catfishes, sheat fishes, featherbacks, eels, hill stream fishes like *Glyptothorax, Pseudoecheneis* etc. The indigenous fish fauna show great diversity in structure and behavior due to the torrents and currents of water and zoogeographic regions. In fact, freshwater fishes are more complex and diverse as compared with estuarine and marine fishes. Hill stream fishes like *Schizotharax plagiostomus, Schizothorax rarensis, Tor putitora, Garra* species etc survive in very low temperature of mountainous rivers. On the other hand, species like *Clarias batrachus, Labeo rohita, Heteropneustus fossilis, Wallago attu* etc survive in warm and calm rivers and ponds in the terai regions. The suitable climate and coldwater supply has attracted the concept of culture of exotic fish like trout in the country.

1.2.3 Cultural aspect

Nepal is famous for its cultural heritages flourished with its many ethnic groups, religions, and cultures showing special and valuable features. Prohibition of certain meat such as pork, buff, chicken etc is present in certain caste, religion and ethnic groups due to tradition or health reasons but there is no any such case found for fish consumption. Fishes are considered to be sacred food by vegetarians too. Fish is

considered as an object of the good luck in Nepalese culture in most cases. It is served on special occasions of religious events as a food gift (sagun).

1.2.4 Employment

Nepal is an agricultural country; agriculture alone accounts for about one half of the Gross National Production (GNP). Fish culture plays an important role to raise the economic standard of the people of the country. Through advanced integrated agriculture system, the socio- economic status of the people can be improved. Aquaculture provides employment opportunity through fish production, marketing activities and contributes to generate additional income for the rural masses.

1.2.5 Ecological advantage

Most of the land of our country remains untouched from the point of view of production. The marginal lands can be used for aquaculture to utilize unused inorganic and organic materials as nutrients for the production of proteinous flesh. When fish farming is integrated with livestock and cash crops, it establishes a recycling system for different organic effluents, thereby maintains a balanced ecological norms within the broader context of ecosystem and also improves the existing habitat of the ecology of the area concerned.

1.3 Rainbow trout (Oncorhynchus mykiss)

Oncorhynchus mykiss is a game fish belonging to the family Salmonidae that noted for its spectacular leaps and hard fighting. This fish is rated as one of the top five sport fish in North America and used as angling fish. It has been introduced from western North America to many other countries. Trout is covered with small black spots and reddish band on either side of body extending from gill to the tail.

The natural habitat of this fish extends from Alaska of Atlantic seacoast area of North America to rivers and lakes of Baza, California. Rainbow trout grows faster than other trout species of salmon family. Rainbow trout is also called as *Salmo*

irideus (*Salmo gairdneri*) in North America and is a hybrid of *Salmo shasta*. Although this fish is long, it is shorter and broader as compared to other trout species of salmon family. It can be easily distinguished from other trouts in not having hyoid teeth. The backbone consists of 60 to 66 vertebrae and consists of an adipose fin apart from a dorsal fin. Dorsal fin consists of 3-4 dorsal spines and 8-12 dorsal soft rays and 3-4 anal spines and 10-12 anal soft rays in the anal fin. Caudal fin consists of 19 caudal rays. Average life span of this fish is 4-6 years. 70% -80% of the total body portion of this fish is edible and the bones of this fish being small and soft are equally liked by children and aged people. Its flesh possesses altogether 18 different types of amino acids including 10 essential ones. The fish contains Licospentoic acid that helps in reducing the cholesterol level in the blood. Moreover, its consumption helps in making one’s skin shine brighter.

Initially, this fish was considered only for sports fishing and for recreation rather than for consumption. Dem Juliana has described this fish as the best sports fish in ‘Tritize on fishing with an angel,' in 1486. It is only in the year 1741 that Stefan Ludwig Jacov of Germany established trout Hatchery. The main objective was to support the insufficient natural stock density of trout for sports fishery. Trout thrives in cold water and must have a constant supply of sufficient oxygen. The economic significance of the trout and salmon both as sporting fishes and as commercial products needs no exaggeration.

Taxonomic status

Classification**5.2.3 Length weight relationship** after Rupert Watson (1993)

Class- Teleostomi
Order- Salmoniformes
Family- Salmonidae
Sub family- Salmonini
Genus- Salmo (*Oncorhynchus*)
Species- *mykiss*
(Old: *Salmo gairdneri*)

1.4 Introduction of Trout in Nepal

Rainbow trout (*Oncorhynchus mykiss*) was introduced in Nepal from United Kingdom and India in the late 1960s and early 1970s and reintroduced from Japan in 1988. In the earlier years the culture and production of Rainbow trout was confined to two Fisheries Research centers, Trishuli and Godawari. Trout was successfully introduced in Nepal to meet substitution of import, economic benefit, promotion of tourism in hill streams etc Gurung and Basnet 2003).

Although the indigenous fishes like Asala and Katla are much in demand for their taste. Commercial culture of these indigenous fishes is not profitable as growth is much slower and technology is not established for their culture. There is a need for fast growing fish species that can be cultured for the establishment of coldwater fishery in the country. Rainbow trout may set up as a very promising fish for this purpose. Realizing the feasibility of trout in cold waters of Nepal, the technology for the breeding and culture has been developed in the fisheries research centers, Godawari and Trishuli, NARC. Furthermore, trout being suitable for large scale commercial production, the culture of Rainbow trout has been certified as a regional item of Trisuli and Nuwakot under the program “One village one product” or OVOP.

Artificial breeding is the usual process of breeding for trout in intensive culture. The fertilized eggs are incubated in atkins with the flow of water 3-5 l/sec with DO above 7mg/l. The egg hatches within 27-30 days at 9-13°C (FRD.1996). In Fisheries Research Division, trout were fed with 35% protein pellet at the rate of 3% of their body weight in water having 8.5-13° C. Feed efficiency ranged from …… depending on the size of the fish. The study indicated that the application of prevailing technology could produce 100-150 mt/ha. Till date several farmers in Rasuwa, Nuwakot, Sindhupalchowk, Dolkha, Dhading, Makawanpur, Kathmandu, Patan etc. are involved in trout farming business. On the basis of the data collected from these farmers, the yearly production of Rainbow trout is approximately…….metric ton (FRD, Godawari, 2008/2009).

1.5 Feeding habits of trout

Trouts are predatory and carnivorous fish feeding mainly on aquatic insects, crustaceans and small fishes. In many

countries, rearing is done in concrete tanks, which are easy to keep clean and permit disinfectant application. It has been reported that their digestive system is designed to handle animal protein and they can only digest and make use of strictly limited variety of vegetable products. Inspite of these conditions, trout can also be cultured using artificial feed at all stages from fry to adult. The growth of trout basically depends upon diet and water temperature. Thus with good and sufficient supply of food and proper maintenance, trout can reach marketable size (200-300 gm) within 14 months starting from free swimming larva. It breeds once a year from November to January and mature after 2-3 years. The fish spawn 2000-3000 mature eggs per kg body weight.

Composite feeds for the rainbow trout should have a high content of protein ranging from 35-40 %.The feed is provided 5-7% of body weight to young fish below 30g size and 1.5-2% of body weight to above 30g size . The low cost protein content feed for trout has not been developed though work is under study and shrimp is used as an alternate to fishmeal. While preparing feed for the trout, shrimp is mixed with local ingredients like soybean, wheat, oilcakes, rice bran, vitamins, minerals and vitamin C. Depending upon the size of the fishes or appropriate to the mouth gape of the fishes, the pellets should be grated into different sizes and this is done through use of dykes of suitable mesh. For free swimming fry, crumble feed is prepared by using sieves of different mesh sizes like 240 micron, 420 micron till the fishes reach 5g sizes. The ingredients of the crumble feed may include boiled egg yolk, yeast etc along with the usual ingredients. However, the free swimming fry is provided boiled egg yolk for a week or two in the beginning.

1.6 Nutritional requirement

Rainbow trout is a typical high protein and high oxygen demanding carnivorous fish. In natural habitats trout depends on aquatic insects, small crustaceans and small larvae. It is true to say that the best Rainbow trout food should contain high amount of animal protein. 40-50% protein containing food is considered as high grade food. Qualitatively, 40 nutrients have been identified as necessary for the normal metabolic function of trout. The growth, health and reproduction of fish and other aquatic animals are primarily dependent upon an adequate supply of nutrient, both in terms of quality and quantity, irrespective of the culture system. Nutritional

elements required by the fishes for the optimum physical development could be categorized into 5 groups – Protein, Carbohydrate, Lipid, Vitamin and Mineral. The minimal amount of nutrients required for feed formulation are as follows :

Table 1. Basic nutrient requirement for trout.

Nutrients	Percentage of diet
1. Protein	28-35
2. Carbohydrate	>9
3. Fats	5-8
4. Minerals (Mg, Ca, Cu, Se, Zn, K and Na)	2 (iodine 0.0006 - 0.011 mg /kg)
5. Vitamins A, D, E, K, Thiamine, Riboflavine, Pyridoxine, Pentathonic acid, Niacin, Folic acid, Vitamin B12,	1

Source: S.D.Sedgewick,1985.

Table 2. Requirement of protein and carbohydrate in trout.

Stage of fish	Protein (%)	Carbohydrates (%)
Small fry (<1gm)	50	15
Bigger fry (>1gm 10gm)	47	20
Table fish (>10gm)	40-45	25

Table 3. Requirement of amino acids for trout.

Amino acids	Diet (%)		
	Small fry	Bigger fry	Table fish
Arginine	2.15	2.02	1.94
Histidine	0.91	0.85	0.82
Isoleucine	1.40	1.32	1.26
Leucine	2.55	2.40	2.30
Lysine	2.96	2.78	2.66
Methionine	0.96	0.90	0.87
Cystine	0.35	0.33	0.31
Phenylalanine	1.45	1.36	1.31
Tyrosine	1.15	1.09	1.04
Threonine	1.61	1.51	1.45
Tryptophan	0.30	0.28	0.27
Valine	1.66	1.56	1.50

Source: First National Workshop on Rain trout farming and scaling up strategies in Nepal.

Fats constitute the other major source of energy in the diet. Fats are the sources of fatty acids which are essential for the absorption of vitamins like A, D, E and K. These are stored in the body as the energy sources. The trout food should contain 12-15 % fatty acids. Vitamins are required for optimum growth and to increase the immunity against diseases. Vitamins A, D, E, K, Thiamine, Riboflavine, Pyridoxine, Pentathonic acid, Niacin, Folic acid, Vitamin B12, Choline, Inositol, Biotin, Ascorbic acids should be present in the diet . Trout food should contain 1% vitamins. Minerals like Mg, Ca, Cu, Se, Zn, K and Na are required for bones development, osmoregulation, water retention, coordination of the endocrine glands, nervous development .Trout food should contain 1% minerals.

Table 4. Ingredients required in preparing feed for free swimming larvae of trout.

Ingredients	**Raw materials (%)**	**Crude protein (%)**	**Mixed protein (%)**
Shrimp	50	43.70	21.85
Soyabean	35	36.12	12.64
Wheat flour	15	12	1.80
Powder milk	25	20.50	5.12
Egg	25	17.40	4.35
Bread yeast	15	17	
Vitamin	2		
Minerals	2		
Vitamin C	0.2		
Sum: 45.76%			

2.0 Objectives

In culturing fish in captivity like Rainbow trout, which requires high animal protein, nothing is more important than well balanced diet and adequate feeding. Malnutrition results in deterioration of health until recognizable diseases ensue. The production of nutritionally balanced diets for fish requires research, quantity control and biological evaluation.

The nutrient requirements of fish should be considered at all stages of development including larval, fry, grower and brood stock stage. But the rearing of fry requires both proper management and precise feed formulations. For exotic Rainbow trout fish larva, formulated feed is too expensive. It is very essential to develop feed containing locally available feed ingredients for trout larvae under local management.

The study purpose is aimed to include buff liver as starter feed along with conventional feed already proposed. The main objective of present study was-

1. To formulate artificial diets containing different local ingredients.

2. To evaluate growth and mortality of free swimming trout larvae at different formulated test diets.

Photo 1. Rainbow trout (Adult)

3.0 Literature Review

Trout is a typical high protein (40-50%) and high oxygen demanding carnivorous fish. Rainbow trout was bred for the first time in 1990, culture experiments were initiated in 1993, and production of rainbow trout was started from 1995 and 1998 by government and private farms respectively in Nepal (Aryal et. al., 2007 and Rai et. al. 2007). Hence trout farming in Nepal has a fairly short history. The research works carried out by NARC during past 10 years have demonstrated appreciable achievements in trout farming practices by developing suitable trout farming system in the country. Rainbow trout (*Oncorhynchus mykiss*) is a suitable fish for intensive aquaculture, sport fishery (Rai, 2007) and possess high economic prospect providing ample of opportunities for commercial production in mid and high hill area (Singh, 2007). Comparative study on Rainbow trout *Oncorhynchus mykiss* breeding and table fish production management (Govt.& Private farm) and various aspects of rainbow trout farming in Nepal was done by Basnet et al. (2007). Basnet et al. (2008) had carried scaling up of Rainbow Trout Farming in farmer field. Basnet et al. (2008) had described that supplement feed took about 70 percent weightage of cost for trout fish farming.

Trout including catfishes required a non- specific nitrogen source and indispensable amino acids (Robinson and Li, 1996). Despite of low protein content, moist or dry buff liver has proved to be a good source of digestible protein for early stage of trout grows out (Pradhan, 1999). Blood meal, prepared by heating and grinding of clotted animal blood (buffalo, or goat) contains 80 to 86 % crude protein and is an excellent source of lysine (Robinson and Li 1996).

Trout larvae, fed upon fresh buff liver and egg custard, grow steadily at specific growth rate SGR of 4.2% with survivability over 99 % (FRD, Pradhan, 1999). Poultry by products meal containing ground, clean parts of the carcass (hands, feet, underdeveloped eggs and visceral organs) of slaughtered poultry, could be a major source of protein in trout feed in future. Study on the response of trout towards mutton and chicken liver is reported very limited. However, introduction of both of these in the starter feed may be appropriate and meet the nutritional requirement of young trout.

Water quality

Water quality refers the extent to which water is biologically, chemically and physically suitable to specific purpose; such as fishery, aquaculture, irrigation, water recreation and water sports (Boyd 1979). To great extent water quality determines the success or failure of an aquaculture operation. Rainbow trout culture depends upon a year round supply of water with a temperature ranging from 10º to 18ºC (Yamajaki 1991). Water temperature should never exceed more than 23°C for rainbow trout culture. Trout should not be kept for longer period in water temperature above 21°C as it stops feeding. It also stops feeding at temperatures less than 10°C but 18°C is regarded as the optimum for metabolism in rainbow trout (Sedgwick,1985). Higher temperature would assist higher level of metabolism and growth as well. The pH value of 6.5 to 8.5 and DO above 8 mg/L are considered suitable for trout culture (Huet 1975).

Growth

Rainbow trout grow rapidly in comparison to other cold water indigenous fish species. This fish grow up to the commercial size 200 to 300gm) during the second year (FRD1992/93).
The two types of diets - one crumble feed from Trishuli farm (CP 32.59%, CF 6.38%, ash 15.23% and moisture 6.48%) and bo.iled egg yolk (CP 12% and CF 12 %) showed no significant difference in growth rate and survivability (Gurung and Tamang 1992/93). But, encouraging results obtained on survivability (>70%) and SGR(< 3%) of trout larvae fed upon fish meal and milk powder based formulated feed (FRD, 2000).

Refinement of buff liver into microencapsulated feed and nutrient supplemented egg custard improved the feed quality; but feeding raw buff liver increased water turbidity (Pradhan 1999) and similar result reported on bent caudal fin of trout (Igarashi and Roy 1999).

All fish, including trout, required protein, vitamins, minerals, lipids and energy for the normal growth and physiological functions. Because the nutrient contribution from natural food organisms is minimal in trout farming, as nutrient and energy are provided primarily by prepared feeds. The amount of vitamin and minerals play an important role in terms of weight gain, survival rate, feed efficiency and specific growth rate. Gurung and Basnet

(2003) reported fin rot disease in adult trout associated with vitamin deficiency and Hepatoma disease due to development of aflatoxins in poorly processed and stored feeds in trout farms of Nepal. Appropriate precautions during feed formulations and processing can minimize these risks (Devresse et. Al.1997).

Yamada et. Al. (1997) had emphasized the need for the study of protein sparing effect in order to decrease feed cost and increase feed quality for trout larvae. Generally, lipid considered as source of energy for carnivorous fish like Rainbow trout and lipid functioned as protein sparing effect (Ogino et.al.,1976).

In the study conducted at FRC, Trishuli, 2002 with different feeds with different levels of crude protein(CP), survivability ranged from 36% to 79%.

4.0 Materials and methods

4.1 Study period

The field study was carried out from 28th December 2008 to 24th February 2009. The investigation was performed daily at the study site from 9 a.m. till 5 p.m.

4.2 Project location

The present work was done in Fisheries Research Division (FRD), Godawari located about 12 km southeast of Lagankhel at Bisankhu Narayan V.D.C. ward no. 9, Kathmandu valley. It is situated at 27°35' latitude, 85°40' E longitude and is about 5100 ft.above the sea level.

FRD was established in 1961 A.D. as Fisheries Development Center and later recognized as Fisheries Research Division in 1993 A.D. From then on, it has been playing important role in providing technical support and improved fish seed to farmers for aquaculture activities as well as to establish a national network of modern aquaculture activities throughout the country for extension, development and research. Scaling up of carp aquaculture technology, development of technology on trout breeding, culture and multiple use of common carp brood, feed formulation of carp and trout are summarized as important achievements of FRD till date.

4.3 Experimental fish

For the study, alevins produced in Godawari, FRD was used for experimental purpose. The average initial weight and the size of the fishes varied from 0.08274gm to 0.08706 gm and 1.58cm to 2.13 cm.

Photo 2. Experimental fish (Alevin)

4.4 Experimental Diet

Trout alevins were fed with 4 types of feeds. The artificial diets used were as follows:

1. Diet-1. Normal feed given in Godawari fish farm was used as control diet .
2. Diet-2. Normal feed plus buff liver cakes.
3. Diet 3. Normal feed plus chicken liver cakes.
4. Diet 4. Normal feed plus mutton liver cakes.

Photo 3. Preparation of crumble feed for trout larvae

Photo 4. Control feed without liver.

Photo 5. Preparation of liver cakes.

4.5 Culture unit

The experiment was conducted on twelve floating net cages. Each cage of size 34x34x36 cm^3 was set in a circular tank at completely randomized design (CRD). The experiment was conducted with three replications for each feed. The numbered chits were pulled for the randomization. The flow of clean and fresh water was maintained in the circular tank. The cages were cleaned everyday by manually and dead larvae were counted and

removed by siphoning daily. The whole circular tank was cleaned once a week by siphoning.

Photo 6. Arrangement of the cages

Arrangement of cages with respect to allocated feed:

Cage No.	**Feed supplied**
Cage No.1	Control trout feed with mutton liver
Cage No.2	Control trout feed with mutton liver
Cage No.3	Control trout feed
Cage No.4	Control trout feed
Cage No.5	Control trout feed with buff liver
Cage No.6	Control trout feed with buff liver
Cage No.7	Control trout feed with chicken liver
Cage No.8	Control trout feed
Cage No.9	Control trout feed with buff liver
Cage No.10	Control trout feed with chicken liver
Cage No.11	Control trout feed with chicken liver
Cage No.12	Control trout feed with mutton liver

4.6 Stocking density

Hundred and fifty alevins were stocked in each experimental cage.

Fish stocking plan

Treatment	Replicates	Average weight of 150 fish (g)
Control feed	Cage No. 3	12.903
	Cage No. 4	13.3605
	Cage No. 8	10.968
Control diet plus buff liver cakes	Cage No. 5	13.1865
	Cage No. 6	11.5575
	Cage No. 9	12.5865
Control diet plus chicken liver cakes	Cage No. 7	12.849
	Cage No. 10	13.098
	Cage No. 11	12.8535
Control diet plus mutton liver cakes	Cage No. 1	13.1295
	Cage No. 2	12.9045
	Cage No. 12	13.143

Photo 7. Stocking of free swimming larvae of trout in the cage

4.7 Water quality analysis

Physicochemical parameters were recorded twice at 9:00 a.m. and 4:00 p.m. every day.

4.7.1 Temperature

The temperature was recorded with the help of simple Celsius thermometer ranging from 5 to50 ° C. The temperature was recorded by dipping the thermometer bulb into the water body.

4.7.2. PH (Hydrogen ion concentration)

The PH of water was measured by pH meter.

4.7.3 Dissolved Oxygen (DO)

DO was recorded by DO Meter. It was also determined by titration following Winkler's iodometric method. For which, water sample was collected in 250 ml BOD bottles avoiding bubbling. 2ml of each manganous sulphate and alkaline iodide azide solutions were poured one after other, right at the bottom of the bottle with separate pipettes .Then the bottle was shaken upside down at least for six times and the brown precipitation was allowed to settle down. Then the precipitation was dissolved by adding conc. H_2SO4 and shaking the stoppered bottle. The oxygen was fixed in the 250 ml glass bottle. 50 ml of the fixed sample was titrated against 0.025 N sodium thiosulphate ($Na_2S_2O_3$) till the colour changed to pale straw. Again two drops of starch solution was added and titrated further till the blue colour disappeared. The total amount of titrant used in the process was noted and the following formula was used to make the final calculations.

$$\textbf{DO mg/l} = \frac{\text{used vol. of titrant (ml) x 8 x (0.025) x1 000}}{\text{Vol. of the sample}}$$

Where, 8=½ molecular weight of oxygen and 0.025 N is the normality of $Na_2S_2O_3$

4.8 Growth Measurement

4.8.1 Measurement of the length and weight

To study the growth rate, 10 alevins were taken out from each cage with the help of a simple scoop net and weight and length measured. The average initial weight of experimental fish was 0.0774 g and the initial length 1.9 cm. The weight of the fish was recorded using a digital balance and length was measured by using a vernier's calipers. To monitor the growth rate, growth check up was performed regularly every fortnightly.

4.8.2 Length weight relationship

1.0 The growth of fishes was calculated by using the Fulton's formula of condition factor. Length is not the component of fish size as increase in length is invariable accompanied with weight. The approximate weight can be calculated by a simple formula.

$$K = \frac{\text{Wt. (g) x 100}}{(\text{length in cm})^3}$$

If the resulting value is greater than 1; it indicates the fish has shown satisfactory growth, value less than 1 indicates poor growth.

2.0 Relation between weight and length of trout was calculated by using coefficient of correlation following Karl Pearson (Gupta, 1988).

Photo 8. Alevins devouring liver meal

4.8.3 Feed conversion Ratio (FCR)

The growth can be calculated by analyzing food conversion ratio.

$$FCR = \frac{\text{Total dry weight of food}}{\text{Increased weight}}$$

4.8.4 Feed Efficiency (F. E.)

This is the ratio of net increased weight to the total feed can be calculated by Feed Efficiency.

$$F.E. = \frac{\text{Increased weight x 100}}{\text{Given feed}}$$

4.8.5 Specific Growth Rate % (SGR) and Percentage Weight Gain (PWG)

The relation between total weight gain to specific time can be calculated by the following formula.

$$SGR = \frac{\text{Length (Harvest weight)–Length(initial weight)x 100}}{\text{Raising days}}$$

$$PWG = \frac{\text{Harvest weight – Initial weight x1 00}}{\text{Initial weight}}$$

4.9 Survival rate

This is the ratio of number of fish harvested to number of fish stocked. It is calculated as follow:

$$\text{Survival rate} = \frac{\text{No. of larvae harvested x 100}}{\text{No. of larvae initially stocked}}$$

Photo 9.Growth check up.

5.0 Results

5.1 Water quality

The productivity of fish is directly or indirectly affected by physicochemical parameters.

Table 5. Physicochemical parameters.

Parameters	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week	9th week
Temperature	10.71	10.07	9.78	10.82	11.96	11.75	12.14	12.46	12.5
pH	8.5	7.96	7.4	7.15	7.17	7.17	7.83	7.56	7.0
DO	8.27	8.80	9.0	8.54	8.5	7.5	6.5	8.0	8.0

5.1.1 Temperature

During the study period, the lowest temperature recorded was 9.78° C on third week and the highest was 12.5° C on last week.

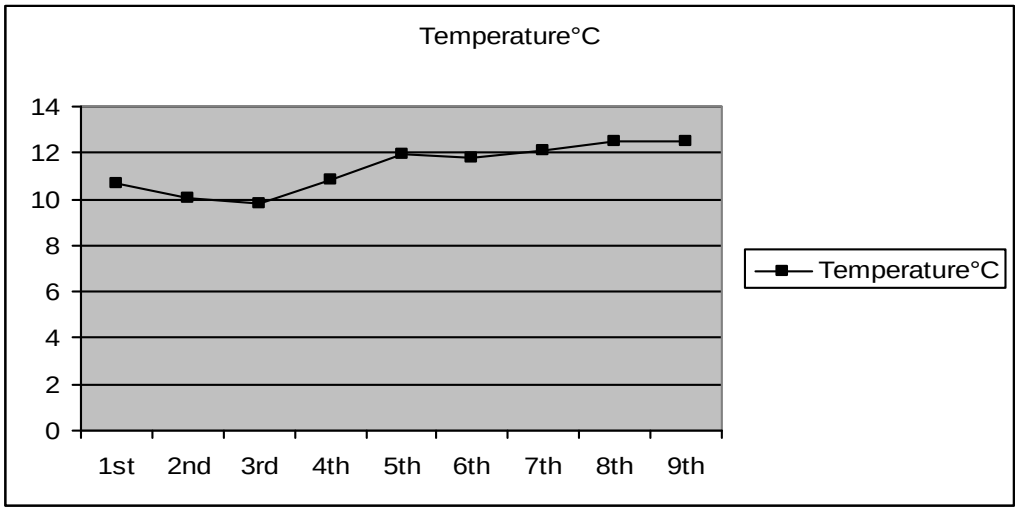

Fig. 1. Variation of Temperature

5.1.2 pH

pH is defined as the logarithm of the reciprocal of the H-ion concentration. During the study period pH of the water ranged from 7 to 8.5. Weekly mean readings of the pH are tabulated in the figure below.

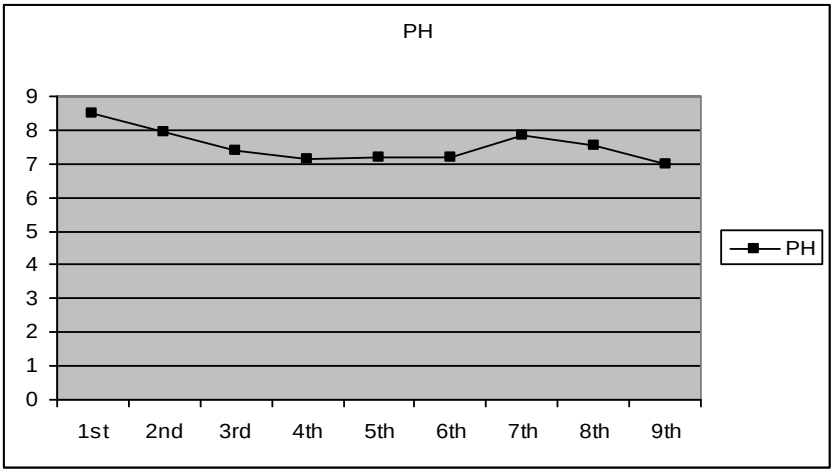

Fig 2. Variation of pH

5.1.3 Dissolved oxygen (DO)

During the study period, the DO ranged from 6.5 to 9 mg/l.

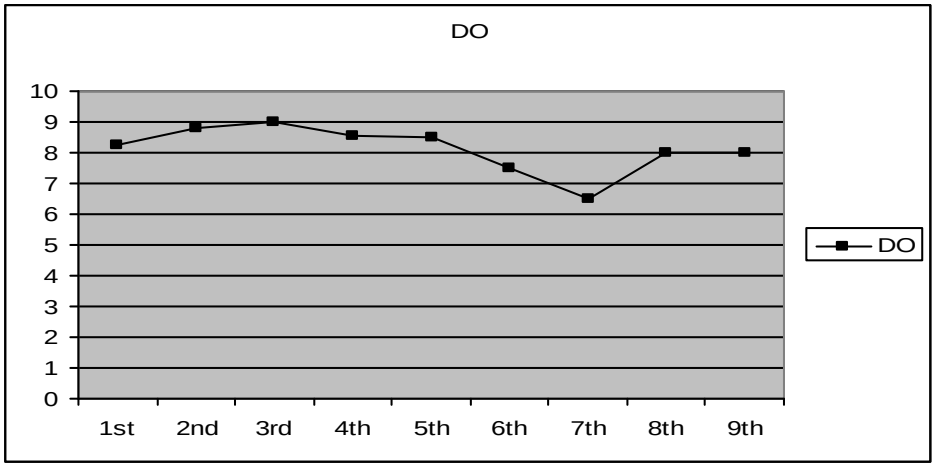

Fig 3.Variation of DO

Photo 10.Titration for estimation of Dissolved oxygen

5.2 Growth

Survival rate was satisfactory throughout the study period except for once or twice when the water became laden with organic matter that in turn caused fouling of the floating net cages. Satisfactory survival of the fishes was mainly accounted to nice handling, failure of any disease outbreak and absence of predators.

5.2.1 Growth in body weight of trout larvae

The larvae of average body weight 0.0827 gm reached up to 0.1492 gm after 60 days under normal diet. The larvae fed with normal diet plus raw buff liver grew up to 0.5078 gm from 0.0829 gm after 60 days. The larvae fed with normal diet plus raw mutton liver grew up to 0.4332 gm from 0.0871 gm. The larvae fed with normal diet plus raw chicken liver grew up to 0.5352gm from 0.0863 gm. The highest growth was observed in larvae fed with normal diet plus chicken liver. While the lowest growth was observed in the larvae fed with normal diet with no liver supplement (Table 6).

Table 6. Comparative growth increase in different diets.

Duration / Diet	Replicate	Initial wt. (gm)	Body wt. after 15days	Body wt. after 30days	Body wt. after 45days	Body wt. after 60days
Diet-1 (normal feed without liver)	R1	0.08602	0.11276	0.12336	0.1549	0.14098
	R2	0.08907	0.13085	0.12105	0.14255	0.17055
	R3	0.07312	0.113	0.11495	0.17097	0.13596
	Mean	0.08274	0.11887	0.11979	0.15614	0.14917
Diet-2 (normal feed plus buff liver)	R1	0.08791	0.14215	0.25192	0.21608	0.49579
	R2	0.07705	0.14544	0.25083	0.23237	0.52476
	R3	0.08391	0.14833	0.2735	0.22475	0.50268
	Mean	0.08296	0.14530	0.25875	0.2244	0.50775
Diet-3 (normal feed plus chicken liver)	R1	0.08566	0.1973	0.27499	0.27385	0.52183
	R2	0.08732	0.20117	0.3089	0.27673	0.55333
	R3	0.08569	0.19559	0.31173	0.27117	0.53024
	Mean	0.08622	0.19802	0.29854	0.27392	0.53514
Diet-4 (normal feed plus mutton liver)	R1	0.08753	0.15878	0.23756	0.24532	0.44001
	R2	0.08603	0.15384	0.2256	0.22989	0.43225
	R3	0.08762	0.15906	0.23453	0.23587	0.42727
	Mean	0.08706	0.15723	0.23257	0.23703	0.43318

The average body growth rate was recorded 0.0075 gm per day in larvae fed with normal diet with raw chicken liver, 0.00708 gm/day in normal diet with buff liver, 0.00576gm/day in normal diet with mutton liver and 0.001108 gm/day in normal diet without liver. The study showed liver constituted the main protein source in crumble feed for free swimming larvae of Rainbow trout. At the same time, the result showed buff liver could be used as a substitute for chicken liver. The study also revealed the slow growth without liver supplement.

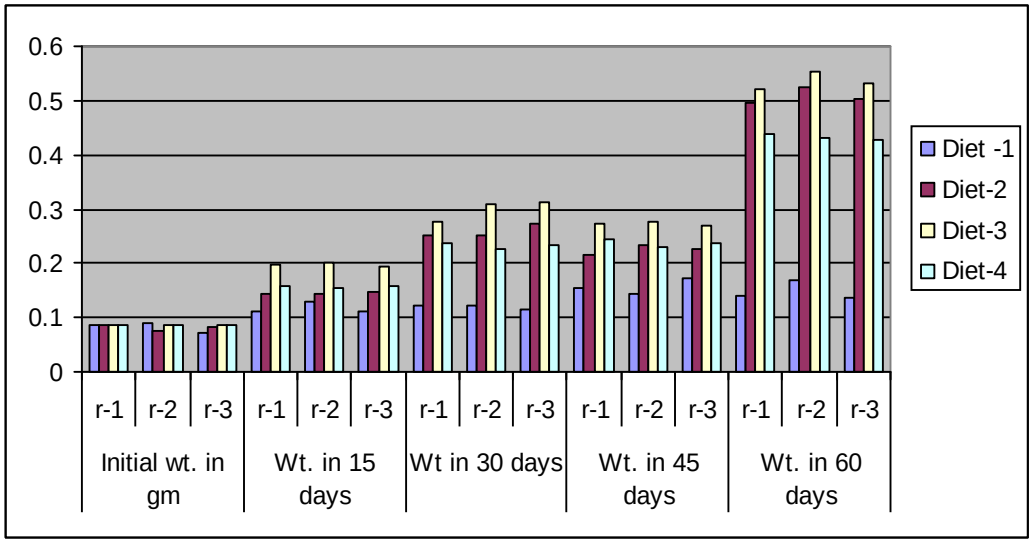

Fig. 4. Comparative body weight increment

5.2.2 Growth in body length of trout larvae

The larvae of average length 1.94 increased up to 2.66 cm when fed with normal diet. The larvae fed with normal diet plus raw buff liver grew up to 3.74 cm from 1.73 cm. Similarly, the larvae fed with normal diet plus raw mutton liver grew up to 3.93 cm from 1.94 cm. On the otherhand, the larvae fed with normal diet plus raw chicken liver grew up to 4.03 cm from 1.88 cm.

Thus the highest growth was observed in larvae when fed with normal diet plus chicken liver. While the lowest growth was observed in the larvae with normal diet without liver supplement (Table 7). This showed that chicken liver as well as mutton liver can be used as a substitute for buff liver.

Table 7. Comparative length increase in different diets.

Duration / Diet	replicates	Initial Length in cm	Length after 15days	Length after 30days	Length after 45days	Length after 60days
Diet -1 (normal feed without liver)	R1	1.92	2.41	2.16	2.63	2.65
	R2	2.0	2.43	2.18	2.35	2.76
	R3	1.88	2.46	2.38	2.58	2.56
	Mean	1.94	2.44	2.24	2.52	2.66
Diet-2 (normal feed plus buff liver)	R1	1.68	2.49	2.48	2.53	3.69
	R2	1.58	2.53	2.67	2.81	3.72
	R3	1.93	2.48	2.53	2.96	3.85
	Mean	1.73	2.5	2.56	2.77	3.76
Diet-3 (normal feed plus chicken liver)	R1	1.92	2.67	2.76	3.16	3.95
	R2	1.99	2.88	2.74	2.94	4.01
	R3	1.72	2.6	2.8	3.26	4.11
	Mean	1.88	2.72	2.77	3.12	4.02
Diet-4 (normal feed plus mutton liver)	R1	2.13	2.45	2.5	2.81	3.8
	R2	1.98	2.47	2.52	2.53	4.11
	R3	1.7	2.53	2.64	2.75	3.86
	Mean	1.94	2.48	2.55	2.70	3.92

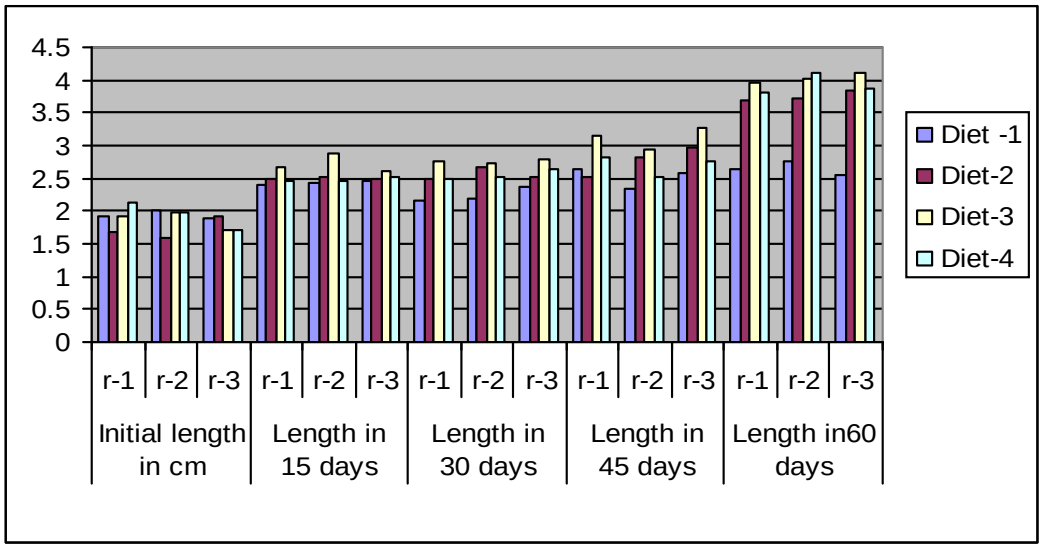

Fig.5. Comparative length increment

Table 8. Comparative rate of weight and length in response to different diets with respect to different replicate cages.

Diet	Replicate	Initial wt/indiv	Final wt/indiv	Indiv. growth/ day	Initial length/ indiv.	Final length/ indiv.	Indiv. increase /day
Diet -1 (normal feed without liver)	R1	0.08602	0.14098	0.000916	1.92	2.65	0.01217
	R2	0.08907	0.17055	0.001358	2.0	2.76	0.01267
	R3	0.07312	0.13596	0.00105	1.88	2.56	0.01133
	Mean	0.08274	0.14917	0.00110	1.94	2.66	0.012
Diet-2 (normal feed plus buff liver)	R1	0.08791	0.49579	0.00679	1.68	3.69	0.0335
	R2	0.07705	0.52476	0.00746	1.58	3.72	0.0357
	R3	0.08391	0.50268	0.00698	1.93	3.85	0.032
	Mean	0.08296	0.50775	0.00708	1.73	3.76	0.0338
Diet-3 (normal feed plus chicken liver)	R1	0.08566	0.52183	0.00727	1.92	3.95	0.0338
	R2	0.08732	0.55333	0.00777	1.99	4.01	0.0337
	R3	0.08569	0.53024	0.00741	1.72	4.11	0.0398
	Mean	0.08622	0.53514	0.00748	1.88	4.02	0.0357
Diet-4 (normal feed plus mutton liver)	R1	0.08753	0.44001	0.00587	2.13	3.8	0.0278
	R2	0.08603	0.43225	0.00577	1.98	4.11	0.0355
	R3	0.08762	0.42727	0.00566	1.7	3.86	0.036
	Mean	0.08706	0.43318	0.00577	1.94	3.92	0.033

5.2.3 Length weight relationship

The fishes stocked were of various sizes ranging from 0.08391gm to 0.08907 gm and harvest size ranged from 0.13596gm to 0.55333gm. Determination of their weight –length relationship was done by using the condition factor formula as explained previously. The fish showed condition as shown by the ratio of condition factor (Table 9).

The correlation coefficient showed the significant relationship with the value of 0.838 for diet-1, similarly positive significant relationship for diet-2, diet-3 and diet-4 with the of value of r=0.9482, r=0.972 and r=0.9509 respectively (Table 10).

Table 9. Condition factor of the fishes.

Diet	Growth check	Average Individual weight (gm)	Average Individual length (cm)	Condition factor $K=\frac{(Wx100)}{l^3}$
Diet –1 (normal feed without liver)	Initial	0.08274	1.94	1.1332
	First (15days)	0.11887	2.44	0.8183
	Second (30days)	0.11979	2.24	1.0658
	Third (45days)	0.15614	2.52	0.9757
	Fourth (60days)	0.14917	2.66	0.7926
Diet-2 (normal feed plus buff liver)	Initial	0.08296	1.73	1.6023
	First (15days)	0.14530	2.5	0.9299
	Second (30days)	0.25875	2.56	1.5423
	Third (45days)	0.2244	2.77	1.0558
	Fourth (60days)	0.50775	3.76	0.9552
Diet-3 (normal feed plus chicken liver)	Initial	0.08622	1.88	1.2976
	First (15days)	0.19802	2.72	0.9840
	Second (30days)	0.29854	2.77	1.4046
	Third (45days)	0.27392	3.12	0.9019
	Fourth(60days)	0.53514	4.02	0.8237
Diet-4 (normal feed plus mutton liver)	Initial	0.08706	1.94	1.1924
	First (15days)	0.15723	2.48	1.0308
	Second (30days)	0.23257	2.55	1.4026
	Third (45days)	0.23703	2.70	1.2042
	Fourth (60days)	0.43318	3.92	0.7191

Table 10. Coefficient of correlation.

Type of feed	Coefficient of correlation(r)	significance
Diet -1 (normal feed without liver)	0.838	significant
Diet-2 (normal feed plus buff liver)	0.9482	Positively significant
Diet-3 (normal feed plus chicken liver)	0.972	Positively significant
Diet-4 (normal feed plus mutton liver)	0.9509	Positively significant

5.2.4 Feed conversion ratio (FCR)

Feed conversion ratio was determined at the end of the research period. Resulted weight gain with feed supply was calculated in total of 150 larvae. By the end of the study, total feed consumed was recorded 14.01 gm for diet-1, 149.36 gm for diet-, 149.36 gm for diet-3 and 149.36 gm for diet-4 respectively. FCR was recorded highest for diet-4, followed by diet-2, diet-3 and diet4 respectively (Table 11).

Table 11. Feed conversion ratio in trout larvae in different diets.

Types of feed	Total wt. of feed consumed (gm)	Total wt. gain	FCR
Diet-1	14.01	9.9645	1.4059
Diet-2	149.36	63.7185	2.3441
Diet-3	149.36	67.338	2.2181
Diet-4	149.36	51.918	2.8768

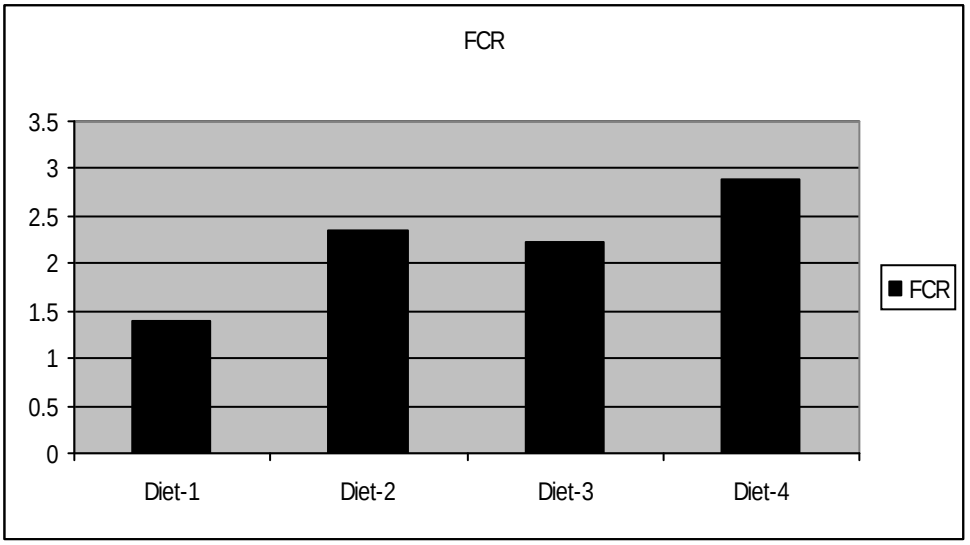

Fig 6. Feed conversion ratio in trout larvae

5.2.5 Feed efficiency (F.E.)

The study indicated the feed efficiency was in reverse order to feed conversion ratio i.e. highest in diet-1 (normal diet without liver supplement), diet-3 (normal diet with chicken liver), diet-2 (normal diet with buff liver) and lowest in diet-4(normal diet with mutton liver) (Table 12).

Table 12. Feed efficiency in trout larvae in different diets.

Types of feed	Total wt. gain(gm)	Total wt. of feed consumed (gm)	Feed efficiency
Diet –1	9.9645	14.01	71.12
Diet-2	63.7185	149.36	42.66
Diet-3	67.338	149.36	45.08
Diet-4	51.918	149.36	34.76

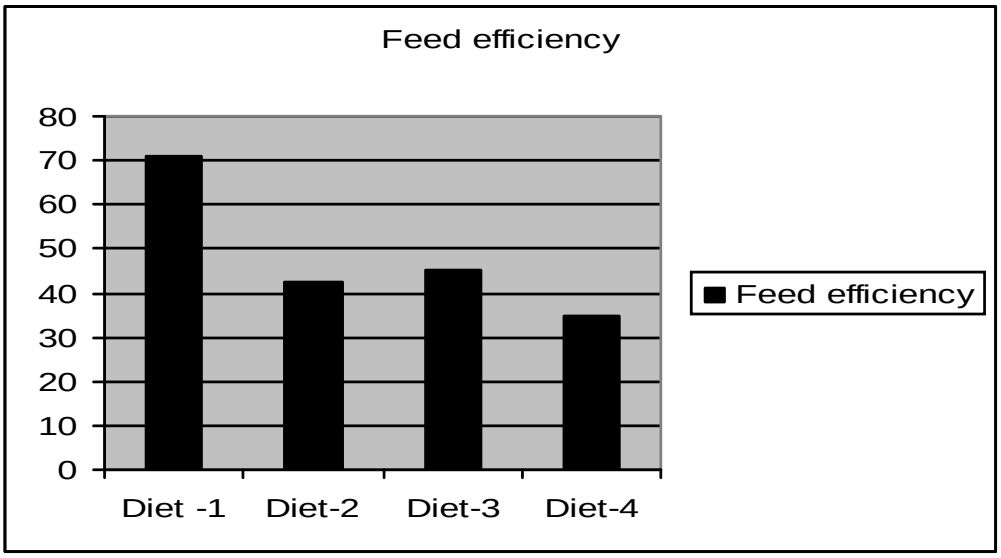

Fig 7. Feed efficiency in trout larvae

5.2.6 Specific growth rate (SGR) and Percentage weight gain (PWG)

Specific Growth Rate (SGR) was found highest in diet-3 (normal diet with chicken liver) i.e. 3.043. The value was found slightly higher than in diet-2(normal diet with buff liver)i.e.3.0175. SGR in diet-4 (normal diet with mutton liver) and in diet-1 (normal diet with out liver supplement) were 2.6745 and 0.9823 respectively. Percentage Weight Gain (PWG) was also found highest in diet 2 and diet-3. The PWG was higher in diet-2 than diet3 but final PWG was recorded higher in diet-3 than diet-2 (Table 13).

Table 13. Specific growth rate (SGR) and Percentage weight gain (PWG).

Diet	Growth check	Initial wt(W_1) gm	Final wt (W_2) gm	SGR	Mean	PWG
Diet -1	1st(15days)	0.08274	0.11887	2.416	0.9823	43.67
	2nd(30days)	0.11887	0.11979	0.051		0.773
	3rd(45days)	0.11979	0.15614	1.767		30.34
	4th(60days)	0.15614	0.14917	-0.305		-4.46
Diet -2	1st(15days)	0.08296	0.14530	3.736	3.0175	75.14
	2nd(30days)	0.14530	0.25875	3.840		78.08
	3rd(45days)	0.25875	0.2244	-0.949		-13.28
	4th(60days)	0.2244	0.50775	5.443		126.27
Diet -3	1st(15days)	0.08622	0.19802	5.543	3.043	129.67
	2nd(30days)	0.19802	0.29854	2.737		50.76
	3rd(45days)	0.29854	0.27392	-0.573		-8.25
	4th(60days)	0.27392	0.53514	4.465		95.36
Diet -4	1st(15days)	0.08706	0.15723	3.942	2.6745	80.59
	2nd(30days)	0.15723	0.23257	2.609		47.92
	3rd(45days)	0.023257	0.23703	0.127		1.92
	4th(60days)	0.23703	0.43318	4.02		82.75

5.3 Survival Rate

Lowest mortality was recorded in diet-3 (normal diet with chicken liver) followed by diet-2 (normal diet with buff liver), diet-4 (normal diet with mutton liver) and highest in diet-1 (normal diet without liver supplement) respectively (Table 14).

Table 14. Survivability rate of the trout larvae.

Diets	Replic-ate	No. of fish stocked	No. of fish harvested	Survival Rate (%)	Mean (Survival)	Mortality rate	Mean (Mortality)
Diet 1	R1	150	90	60	55.11	40	44.89
	R2	150	85	56.67		43.33	
	R3	150	73	48.67		51.33	
Diet 2	R1	150	97	64.67	77.34	35.33	22.66
	R2	150	124	82.67		17.33	
	R3	150	127	84.67		15.33	
Diet 3	R1	150	114	76.0	76.22	24.0	23.78
	R2	150	109	72.67		27.33	
	R3	150	120	80.0		20.0	
Diet 4	R1	150	101	67.33	76	32.67	24
	R2	150	117	78.0		22.0	
	R3	150	124	82.67		17.33	

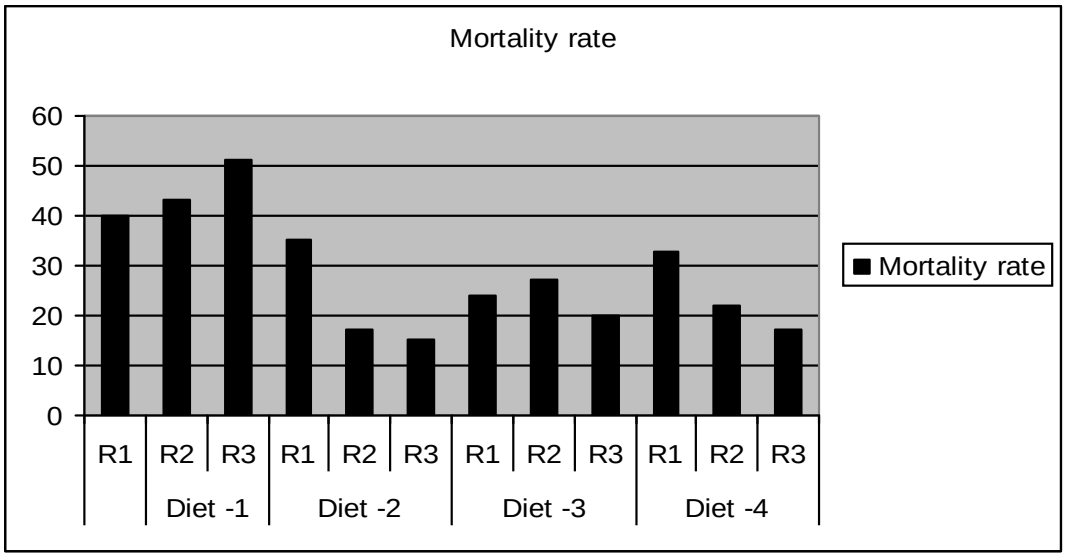

Fig 8. Mortality Rate

5.4 Cost Efficiency

Total feed consumed in the experiment by larvae was converted into monetary tentative cost (Prevailing rate for buff liver/kg was Rs. 100.00, Rs. 150.00/kg for chicken liver, Rs. 200.00/kg for mutton liver and crumble feed were used available at Godawari, FRD). A total of Rs.40.60 was spent in buff liver, (total consumed

0.406kg), Rs.60.9 for chicken liver (total consumed 0.406 kg and Rs.81.2 was used in mutton liver (total 0.406kg). Diet-1 showed slow growth rate and high mortality. There was no significant difference in the growth rate, survivability in three different diets. The price of buff and chicken liver almost same, one can be used as an alternative for the other.

Photo 11. Taking weight of feed consumed

6.Discussion

Growth, health and reproduction of fish primarily depended upon adequate supply of nutrients, both in terms of quality and quantity irrespective of the culture system. Feed alone comprises 76% of total variable cost and 40% of total production cost of trout farming (Nepal et. Al.2002). Quality feed supply is one of the major constraints after seed supply to expand trout farming in Nepal. Therefore, most of the studies have been focused on finding alternate source of protein supplement in trout feed which are locally available at relatively cheaper cost without affecting the growth, production and quality of trout.

The availability of nutrient diet, palatability or acceptability, processing and storage methods is important aspects of trout culture. Beside it, attention should be in economically sound feed formulation for the success of trout industry.

Buff liver constituted one of the major components in formulated diet for larval rearing of trout. In the context of our country, which is very rich in cultures and religions, there are people who may not consume fishes fed with buff liver as their religion or tradition do not permit buff meat at all. The present investigation was done to develop possible alternatives for the buff liver portion in the starter feed for trout larvae.

Water quality

Water quality refers the extent to which water is biologically, chemically and physically suitable to specific purpose; such as fishery, aquaculture, irrigation, water recreation and water sports (Boyd 1979). To great extent water quality determines the success or failure of an aquaculture operation.

The temperature, DO and pH did not fluctuate beyond the limit during the study period. Temperature ranged from 8ºC to 13ºC during the study period and this range proved to suitable for the growth of larvae as reported by Yamajaki (1991) water temperature in between from 10º to 18ºC suitable for trout suitable farming. DO ranged from 6.5 to 9 mg/l and pH from 7.0 to 8.5 and suitable for the growth of the trout larvae. The pH value of 6.5 to 8.5 and DO above 8 mg/L are reported suitable for trout culture (Huet 1975).

Growth measurement

Fish continue to grow practically throughout life ;however in extreme old age growth is extremely slow. The growth rate is influenced by many physical factors, population density and feed supply throughout the life. In present study, trout larvae showed satisfactory growth with all types of liver supplement. The highest growth rate (0.0075gm/day) was recorded for the larvae fed with diet with chicken liver supplement and was lowest (0.001108 gm/day) in diet without liver. Mean individual body weight at the end of the study period was highest for the fishes fed with chicken liver. However, condition factor value was highest for fishes fed with diet with mutton liver.

Average initial weights of larvae were 0.0827gm, 0.0829gm, 0.0863gm and 0.0871gm in diet-1, diet-2, diet-3 and diet-4 respectively. At the end of the study the larvae grew up to 0.1492gm and 2.66cm in diet-1, 0.5078gm and 3.74cm in diet-2, 0.5352gm and 4.03cm in diet-3 and 0.4332gm and 3.93cm in diet-4. In the similar study, trout larvae fed upon buff liver and egg custard grew steadily at specific growth rate (SGR) of 4.2% (FRD 2000 and Pradhan, 1999). There was no significant difference in growth rate and survivability when fry of 0.92 to 0.11 gm were reared with two types of feeds for 30 days - crumble feed (CP 32.59%, CF 6.38%, ash 15.23% and moisture 6.48%) and boiled egg yolk (CP 12% and CF 12 %) (Gurung and Tamang, 1992/93). Encouraging results have been obtained on survivability (>70%) and SGR(<3%) of trout larvae fed upon fish meal and milk powder based feed formulations (FRD, 2000).

Buff liver has proved to be a good source of digestible protein for the early stage of trout. However, experiment with chicken liver and mutton liver have not yet been conducted in the country although these liver contain less fat and are more digestible. This is not practiced in fish farming in Nepal. The underlying reason may be due to relative high price and limited availability.

Feed conversion ratios were significant in all the types of feed. Most significant was found for diet-1 (1.4059) followed by diet-3 (2.2181), diet-2 (2.344) and diet-4 (2.8768). Feed efficiency (FE) was significantly different in normal diet and highest i.e.71.12. Whereas feed efficiency of other feeds were low i.e.45.08 in normal diet with chicken liver, 42.66 in diet with buff liver and 34.76 in diet with mutton liver. SGR was maximum in diet-3(3.043) followed by diet-2(3.0175), diet-4 (2.6745) and then diet-

1(0.9823). During the study period, SGR was lowest when the growth was slowest. It may be due to less feed and the amount of feed intake was increased after 2nd followed by high SGR.

Survival rate

Survival rate was found to be satisfactory. Diet with buff liver showed least mortality (22.66%), followed by diet with chicken liver (23.78%) and diet with mutton liver (24%); but, and mortality was found highest in diet-1 (44.89%). In the study conducted at FRC, Trishuli (2002) with different types of feed with different levels of crude protein (CP), survivability ranged from 36% to 79%. High survival occurred during study period may be attributed to nice handling, without any disease out break and lack of avian predation.

7.0 Conclusion and recommendations

Rainbow trout (*Oncorhynchus mykiss*) is one of the most popular coldwater fish farming system suitable in the hill and mountain areas in our country. The edible part of trout constitutes 78% to 80% of the fish and its muscle protein contains 18 amino acids, of which 10 are essential for man (Martyshev 1983). It has already been established that trout culture has a promising future in mountainous country like Nepal (83% of its area covered by hill and mountain). By now a complete technological package suitable to Nepalese socio-economic condition is already available. More over the market for trout fish is not a problem as it is consumed within the country and there is increasing demand from overseas country too. Hence, its culture can be a big income source industry not only for the farmers but also for raising the economic status of the country. Therefore, it demands further studies and researches in the field of trout culture. The result of the present study showed that, liver constitutes the major source of animal protein for the trout. It is also seen that chicken liver as well as mutton liver may be successfully used in place of conventionally used buff liver as they make water less turbid. Chicken liver was found to be more palatable than mutton and buff liver.

Recommendations

1. Appropriate filtration facility should be managed before using the water

2. The floating net cages needs improvement with appropriate mesh sizes. As the mesh sizes of the cages used were very small, it fouled water and hindered the flow of the water into the cages. The cages were cleaned everyday which was practically very difficult and tiresome.

3. As the larval stages are very delicate and sensitive there should be stress free environment for study works.

4. The farming of Rainbow trout should be expanded to eastern and western part of the country also instead of confining in and around the Kathmandu valley. For this, technology regarding breeding and feed formulation should be extended to these sites too.

5. Crumble feed preparation for the trout seems to be very important component of culture. Appropriate technology should be improved to manufacture and store feed to save time and money.

6. Experiments should be carried repeatedly to streamline technology.

7. Alevins of similar size of same brood should be used in study.

8. To increase the skill for the culture and researches, training should be provided to the farmers and the students.

Photo 12. Fisheries Research Division, Godawari

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