# FEEDING STRATEGIES FOR ROHU, LABEO ROHITA (HAM.) FINGERLINGS IN RELATION TO NUTRITIONAL ASPECTS

BY

*Jayanta Kumar Samal*

A THESIS SUBMITTED TO
THE ORISSA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY, BHUBANESWAR
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

**MASTER OF FISHERY SCIENCE**

IN

**AQUACULTURE**

**POST GRADUATE DEPARTMENT OF AQUACULTURE**

**COLLEGE OF FISHERIES**

Orissa University of Agriculture and Technology

**BHUBANESWAR**

1991

DEDICATED TO

MY BELOVED PARENTS

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BHUBANESWAR

(1991)

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ICAR AUG. 1989 JULY 1990

No.

Date

## CERTIFICATE

This is to certify that the thesis entitled **"Feeding Strategies for rohu Labeo rohita (Ham.) fingerlings in relation to Nutritional Aspects"** submitted for the degree of **Master of Fishery Science** in the subject of **Aquaculture** of the Orissa University of Agriculture and Technology, Bhubaneswar is a faithful record of bona fide and original research work carried out by Jayanta Kumar Samal under my guidance and supervision and that no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of investigation have been fully acknowledged.

1/10/91

(Dr. Satyendranath Mohanty)
Senior Scientist,
Nutrition Division,
CIFA (ICAR),
Bhubaneswar.

**CERTIFICATE**

This is to certify that the thesis entitled **"Feeding Strategies for rohu *Labeo rohita* (Ham.) fingerlings in relation to Nutritional Aspects"** by Jayanta Kumar Samal submitted to the Orissa University of Agriculture and Technology, Bhubaneswar in partial fulfilment of the requirements for the degree of **Master of Fishery Science** in the subject of **Aquaculture** has been approved by the student's Advisory Committee after an oral examination on the same in collaboration with an External Examiner.

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Advisory Committee Members:

1. Dr. S.N. Mohanty, Senior Scientist, Fish Nutrition Division, **CIFA**, Kausalyaganga. (S.N. Mohanty) Head of Deptt.

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J. K. Samal.

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# CHAPTER I

# INTRODUCTION

# INTRODUCTION

*Catla catla* (Ham.), *Labeo rohita* (Ham.) and *Cirrhinus mrigala* (Ham.) commonly known as catla, rohu and mrigal respectively are widely cultured in Indian subcontinent at semi-intensive and intensive levels and supplementary feeding is essential for promoting their growth and hence production. When fish are stocked at higher and higher densities the natural food which provides about 50% protein in pond ecosystem becomes limiting and protein is used for maintenance energy instead of growth since energy is not available in sufficient quantity to meet their requirements.

The knowledge of nutritional requirements of different cultivable species is most necessary to formulate nutritionally balanced diets for them. Taking the difference in nutritional requirement for different fish species and stages i.e. spawn, fry, fingerling, growers and brood fish into consideration, suitable feeds are developed. The estimation of an optimum ration level of a farmed fish depends on the information of its feed requirements. Type of feed, feeding strategies, rearing systems, water quality, ambient oxygen and genetic material always determine the optimum ration level of a fish (Storebakken and Austreng, 1987). Artificial feed is used to bridge up the gap between the quantum of energy available and the amount of energy which spares protein for growth. Quality and quantity of protein can not reflect protein synthesis unless diet is properly balanced. Excess protein becomes wastage and causes metabolic stress to the fish and high energy diets lead to fat accumulation.

Among the nutrients protein is the major dietary component which influences growth of fish. Requirements of protein for fish are about 2-3 times higher than that of mammals (Cowey, 1975; Pandian, 1987) ranging in between 35 and 55% or an equivalent of 45-75% of the gross energy content of the diet (Tacon and Cowey, 1985). Inadequate protein in diet reduces growth rate. When the rate of protein ingestion exceeds the utilisation, the excess is deaminated and therefore when the dietary protein exceeds optimum requirement the dietary efficiency is adversely affected (Cowey and Sergent, 1972; Jauncey, 1982).

The dietary protein contributes to over 60% of the diet cost. The supplementary feed alone costs about 50% of the total expenditure in fish culture operations. Hence the choice of expensive dietary protein is dependant on economic decision which is determined by the cost of protein source as well as on the expected returns from fish growth and its value. Protein quality and quantity which influence growth need to be properly assessed and judiciously used. The most economic source of protein is from natural foodstuffs of both plant and animal origins, particularly animal wastes and non-conventional feed sources. Animal proteins in general are superior over the plant proteins because these are rich in all essential amino acids and are more digestible. Addition of animal protein improves the nutritional status and biological values of formulated diets. For economical and practical reasons these diets must be prepared from locally available protein sources, preferably those unsuitable for human consumption.A problem which is being faced by fish culturists is non availability of economical sources of fish feed ingredients, the cost of which escalates from time to time. The problem frequently is more serious in developing countries where the traditional market value of fish and fish products is low, thus limiting the use of relatively expensive feed materials in the production of fish feed. Few of these countries can afford the luxury of using animal proteins in feeds and in some countries the cost of cereal grains and legumes is prohibitive. Hence, for better return care must be taken to minimise protein which is the major cost contributing factor.

Most experimental works carried out in this direction revolved around substitution of expensive animal proteins by the inexpensive protein of plant origin (Cruz and Laudencia, 1977; Jackson et al., 1982; Mohanty and Swamy, 1986). In a recent approach rhythmicity in feeding and in digestibility in certain fishes have been utilised for achieving best results on growth and to develop appropriate feeding strategies at low cost (De Silva and Perera, 1983; 1984; Nandeesha et al., 1989; Das, 1981).

Feeding at 2-6% of body weight has been reported optimum for carps. Excess food supply leads to fouling and wastage.Though it is not always possible to completely avoid fouling yet feeding to satiation at a particular frequency can minimise the wastages and the cost (Jobling, 1983 b). Growth and feeding frequency are positively related. Fish at higher feeding regimes grow faster. However, there is a maximum limit to feeding beyond which the increase in body biomass is not in commensurate with the amount of feed given. The feeding frequency therefore, is one of the important considerations as its irregularities can affect water quality, growth and feed utilisation particularly for young and growing fishes stocked at higher densities.

Management of protein feeding and adjustment of feeding to satiation are the important considerations to evolve an efficient mechanism and strategy for the fish and hence two laboratory experiments were conducted which have been described in this thesis.

Among the Indian major carps the fish, rohu, is well known for its delecacy and occupies an important position in culture practices. It inhabits midzone of pond ecosystem and is herbivore which also responds well to supplementary feeding like other carps and hence the fish was selected for the experiments.

# CHAPTER II

# REVIEW OF LITERATURE

# LITERATURE REVIEW

The judicious expenditure of proteins for its gainful use, selection of quality ingredient, appropriate feeding schedules are some of the important considerations for economising the feed cost.

Unlike in mammals, protein acts both as a structural component and also as an energy source in fish (Brett and Groves, 1979). Hence their dietary protein requirements are higher. The requirements of protein both at macro and micro levels have been studied in many fishes. De Long et al. (1958) first studied the protein requirement of chinook salmon Oncorhynchus tshawytscha for their optimal weight gain. Jauncey and Ross (1982) summarized the requirements of dietary protein of tilapias which ranged from 29 to 59% depending on protein source, body size and species. Jauncey (1982) reported protein requirement of Sarotherodon mossambicus which is 40% of the diet. Protein requirement is also influnced by the quality and quantity of dietary protein which has been observed to be 36% for Tilapia aurea when fish meal and soybean meal were used as protein sources (Davis and Stickney, 1978). Winfree and Stickney (1981) obtained maximum growth of T. aurea when the fish was fed with casein based diet containing 56% protein. De Silva and

Perera (1985) studied the protein requirement of Tilapia nilotica reared at different salinities and observed that young fish require 28-30% protein in the diet at 10-15 ppt salinity. Further, De Silva (1989) evaluated the protein requirement of young Oreochromis mossambicus, O nilotica O. aurea and Tilapia zillii and reported that 28% protein is optimum for them. Austreng (1977 and 1978) reported 40-50% dietary protein to be optimum for salmon and trout. Satia (1974), Zeitoun et al. (1976), Tiews et al. (1976) observed 40-46% protein requirement in rainbow trout. Zeitoun et al. (1973 and 1974) did not find any difference in the protein requirements of euryhaline fish (rainbow trout, coho salmon) when they are cultured in either fresh water or in saline (20 ppt) water. Shell and Nail (1962) observed that the protein requjirement of channl catfish was 25% when casein was the protein source. For channel catfish Ictalurus punctatus cultured in Kansas (Mississipe delta), protein supplement have been recommended at 28%, (Hastings and Dupree, 1969); 30% (Hastings and Dupree, 1969) depending on the availability of natural food. Lovell (1972), Garling and Wilson (1976) reported that channel catfish cultured intensively in an optimum ratio of dietary protein and energy attain maximum growth (in terms of weight gain) when 35% and 36% protein level in the diet was provided using fish meal and hexane extracted whole egg powder respectively as the protein source. Kaushik et al. (1981) and Kaushik and Luquet (1983) reported that the maintenance needs of rainbow trout Salmo gairdneri would amount to 1.8g. protein/kg body weight per day for fish weighing between 40 and 200 g. Lovell (1977) observed that 32% protein in fishmeal (5-8% inclusion level) based diet yielded best growth in channel catfish.

Protein requirements of cultivable warm water carps have been studied by many workers (Ogino and Saito, 1970; Sin, 1973; Dabrowski, 1977; Sen et al, 1978; Renukaradhya and Verghese, 1986; Singh and Bhanot, 1988; Swamy et al., 1988; Mohanty et. al., 1980). Sen et al. 1978 reported that protein requirements of carps, Labeo rohita and Cyprinus carpio are 45% when casein was used as the source of protein. From a study on Cirrhinus mrigala (Ham.), Singh et al., (1987) reported 45% is the optimum protein requirement at about 29$^{o}$C temperature. Swamy et al. (1988) and Mohanty et al. (1990) observed that 40% protein is optimum for rohu, Labeo rohita and mrigal, Cirrhinus mrigala when fish meal-cakes based practical diets were fed while it is more for Catla.

Singh and Bhanot (1988) reported 47% protein in the fish meal and hexane extracted whole egg powder respectively as the protein source. Kaushik et al. (1981) and Kaushik and Luquet (1983) reported that the maintenance needs of rainbow trout Salmo gairdneri would amount to 1.8g. protein/kg body weight per day for fish weighing between 40 and 200 g. Lovell (1977) observed that 32% protein in fishmeal (5-8% inclusion level) based diet yielded best growth in channel catfish.

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Singh and Bhanot (1988) reported 47% protein in the diet to be optimum for catla, Catla catla using casein as protein source at water temperature between 25 and 27°C. Common carp, Cyprinus carpio requires 31-38% protein for its optimal growth, (Ogino and Saito, 1970; Takeuchi et al., 1979). Dabrowski (1977) observed that 41-43% protein is required for grass carp Ctenopharynogodon idella (Val.) when casein was used as protein source. With the use of leaf protein concentrate, its requirement decreased to 36% as reported by Das and Tripathi (1979). Using casein as the main source, Renukaradhya and Vergheese (1986) studied the protein requirement of catla and rohu and observed 30% and 40% dietary proteins respectively optimum for them. Singh 1990 reported that protein requirement of young silver carp, Hypophthalmichthys molitrix (Val.) is about 37-42% at 23-28.7°C. Pandian (1987) reported that protein requirement of tilapia and carps is in the range of 25 to 30%. De Silva and Gunasekera (1991) evaluated the dietary requirements of Indian and Chineese carps for protein and observed that 45% and 31% protein levels in the diets respectively are optimum for them. In a study to determine the protein requirement of different size groups of catla, Khan and Jafri (1991) stated that requirement for small size groups (0.134 g.) was higher than the larger groups (5.12 g.) for whom 40% and 37% protein levels respectively have been reported optimum. Protein requirement of herbivorous and omnivorous fishes decreases in manured ponds, which ranges from 25 to 30% as against 30 to 40% protein required by the carnivorous fishes like salmon and trout (Pandian, 1987).

At a microlevel, several workers have investigated amino acid requirements for many species in order to develop amino acid balanced diets. (Halver, et al., 1959; Dupree and Halver, 1970; Ogino, 1980; Arai, 1981; Jackson and Caper, 1982; Ketola, 1983; Moon and Getlin, 1991; Kaushik 1988; Santiago and Lovel, 1988. Reports are also available on the amino acid requirements of carps (Nose, et al., 1974; Nose, 1979; Ogino, 1980; Murai et al., 1982 a, b, 1986. However, using the concept of whole body tissue composition, Wilson & Cowey (1985), Wilson and Poe (1985), Gatlin (1987) and Mohanty and Kaushik (1991) determined the amino acid requirements of rainbow trout, atlantic salmon, channel catfish, goldfish, golden shimer, fathead minnows and the three Indian major carps. All the ten essential amino acids are required for fish.

The commonly used supplementary feed for young carp consists of a mixture of rice bran and locally available oilcakes in 1:1 ratio which contains 20-22% protein. Das (1958) using an artificial feed containing hydrolysed protein and carbohydrate (50:30) in manured nurseries obtained a better growth of carp spawns. Mitra and Das (1965) obtained better growth and higher survival of carp spawn by feding them till oilcake, black gram and rice powder. Better growth and higher survival of carp spawn feeding with a mixture of notonectids, prawn and cowpea (5:3:2) has been reported by Lakshman _et al_. (1967). Verghese _et al_. (1976) obtained 50% more production compared to those fed with a mixture (1:1) of rice bran and groundnut cake by using peleted feeds containing fish meal, rice bran, groundnut cake, rice flour and mineral mixture. For rearing of Indian major carps fingerlings Lakshman _et al_. (1968) chalked out a monthwise feeding programme in which he suggested that first month ration should be equivalent to the body weight of fry stocked while, in the second and third month the feeding rate should be twice the initial weight of fry stocked. But Swingle (1958) proposed a sliding scale for channel catfish in which feeding rate decreased as the weight of fish in ponds increases. Experimenting on bighead carp (_Aristichthys nobilis_) fry, Carlos (1988) stated that better growth and higher survival was obtained by feding the fishes at 30% of body weight. Sen _et al_. (1980), Rangacharyulu _et al_. (1990) reported best growth and conversion rates of carp fingerlings when they were fed suplementary diet at 5% body weight. Seenappa and Devaraj

(1991) opined that feeding at 10% body weight would be optimal for catla fry. But ration size should be decided according to the prevalent environmental conditions in addition to fish biomass than on the fishbiomass alone (Sehagal and Toor, 1991).

Considering the nutritive value and high palatability, incorporation of fishmeal in fish feed have been advocated by several authors (Lovell et al., 1974; Dabrowski and Kozak, 1978; Seneriches and Chiu, 1988, Swamy et al. 1988). As protein is the major cost contributing dietary component, its economic utilization have been studied particularly for replacement of fish meal and other animal protein sources (Cruz and Laudencia, 1977; Devaraj and Keshavapa, 1980; Anil, 1981; Devaraj et al., 1981; Bhat, 1986; Mohanty and Swamy, 1986; Nandeesha et al., 1986, 1989).

The high cost, short supply, uncertain quality and multiple use of fish meal has made it necessary to substitute this with low cost protein ingredients of plant origin such as soybean meal, peanut meal, cotton seed meal, sunflower seed meal, leucaena leaf meal etc. and also with animal wastes like slaughter house waste, marine products wastes, wastes of sericulture industries, poultry wastes etc. substitution of fish meal with by-products of animal processing industries like meat & bone meals (Tacon et al., 1984; Coehl, 1984) blood meal (Asgard and Austreg, 1986; Mohanty and Swamy, 1986) with feather meal and poultry by-products meals (Tiews et al., 1979) have been studied to work on aspects of dietary cost. These are grouped as secondary grade and usually incorporated in between 5 and 20 percent. Collectively they may contribute upto half the available protein in fish diet, the remeinder consists of high grade fish meal (Tacon and Jackson, 1985). Koops et al. (1982) prepared a diet for rainbow trout using feather meal and poultry by-products as the major protein source. Blood meal has also been shown useful substitute (up to 20%) of the total protein content of salmonid diets (Fowler and Banks, 1976; Asgard and Austerg, 1986). Mohanty and Swamy (1986) found a significant growth in rohu when a diet containing 10% blood meal was fed. Nandeesha et al. (1986) studied the growth response of catla, rohu and common carp fed with three diets based on slaughter house waste, silk worm faecal and fish meal. Venugopal and Kesavanath (1987) reported higher conversion rates in common carp reared with a feed containing silage as a substitute of fishmeal. Better growth of common carp as reported in an experiment where fish meal in diet was completely substituted by worm meal and 5% sardine oil (Nandeesha et al., 1988). Nandeesha et al. (1989) while studying the growth performance of catla, rohu and silver carp fed with a diet prepared from sericulture wastes, found better growth and conversion with the diet containing deoiled silkworm pupae. As compared to conventional feed mixture of bran and the cake (1:1), the diet containing Bran and the vicearas of fish and goat yield better growth result in rohu fingerlings (Jadhav and Rao, 1991).

Use of dried algal meal adophora, Scenedesmus, Chlorella, Oocystis, Euglena) as a partial dietary replacement of fishmeal within practical fish rations for Oreochromis niloticus (Appler and Jauncey, 1983) and for common carp (Hepher et al., 1979; Meske and Pfeffer, 1978) have been reported. Patnaik and Das (1979) reported the usefulness of dried powder of nymphoides and spirodela mixed with rice bran as fish feed. Das and Singh (1989) stated on the use of biogas effluents in the form of daugh or pellet to substitute carp diets. Ayyappan et al. (1991) obtained higher weight increments in case of rohu and mrigal with diets containing 10% spirulina powder.

Reports are also available on the protein sparing action of lipid and carbohydrates which minimises protein expenditure (Thompson and Munro, 1955; Garling and Wilson, 1977; Watanabe, 1977; Watanabe et al., 1979; De Silva et *al.*, 1991). Keshavanath *et al.* (1991) reported protein-sparing effect of virginiamycin, thereby enhancing the growth of carp.

Efficient growth and production of fish depend on feeding the best possible diets at levels not exceeding dietary needs. In fish culture practices studies on the amount and frequency of feeding are aimed at identifying the optimum level of both such that wastage of feed is reduced, hence feeding cost is minimized. To decide the feeding frequency for a species knowledge of return of appetite is important (Brett, 1971). As the voluntary intake by a fish is assumed to be an objective measure of appetite, the time required for return of appetite is assessed by examining the relationship bertween food deprivation time and food intake (Elliot, 1975).

Significant relation betwen the optimum feeding frequency and growth has been reported for several fish (Andrews and Page, 1975; Chua and Teng, 1978; Sampath, 1984; Charles *et al.*, 1984; Kaushik and Gomes, 1988). Andrews and Page (1975) reported two times feeding in channel catfish to satiation level produced optimal growth. With three feedings a day, rock fish (*Sebastes inermis*) and rainbow trout (*Salmo gairdneri*) registered maximum growth while jack mackeral and the gold fish Carassius auratus required 4 and 12 feedings per day respectively for their optimal growth. Better growth of Chana striatus from a feeding once-a-day has been advocated (Sampath, 1984). Chua and Teng (1978) reported two times a day feeding is optimum for Epinephelus tauvina. Charles et al. (1984) advocated feeding 3 times per day for higher food consumption. In juvenile milk fish Chanos chanos (Forsskal) increases in feeding frequency of four to eight times per day significantly increased growth and feed efficiency (Chiu et al., 1987). Sampath and Ravindran (1987) found increase in feeding rate, absorption and conversion with a feeding frequencyof three meals per day. Kaushik and Gomes (1988) reported significant conversion of body protein in rainbow trout by feeding them once in every two days with a ration to cover the maintenance needs. Murai et al.(1983) studied the effects of glucose chain length of various carbohydrates and frequency of feeding on their utilization in common carp.

For consideration of cost benefit ratio in the aquaculture operation, it is necessary to evaluate the cost for rearing the fish with protein level optimum for growth or with a lower level which is desirable. When lower dietary protein gives more or less same growth as that of high protein, the former is economical and desirable. Zeiton et al. (1976), De Silva and Perera (1983 and 1984) observed day to day variation in digestibility of dry matter and protein showing an apparent rhythmicity when two cichilid species were reared on different diets and under different environmental conditions. From these observations a hypothesis that a daily presentation of a high protein diet is wasteful and alternate of feeding of high and low protein diets may be beneficial has been postulated by De Silva (1985). Subsequently, De Silva (1985) and Nandeesha et al. (1989) woprked on this hypothesis for O. niloticus and C. carpio respectively. Khan (1972) (as reported by Das 1981) and Das (1981) studied the intestinal amylase activity in relation to rhythmicity in rohu fry.

It is clear from the review of literature that informations are lacking on the effect of alternate feeding of low and high protein diets together with their costs and on the frequency of feeding for Indian major carps.

# CHAPTER III

# MATERIALS AND METHODS

# MATERIALS AND METHODS

## 3.1 PREPARATION OF DIETS

Proximate composition of ingredients is given in Table 1. Three diets containing 20,35 and 40% proteins were prepared by using varying amounts of fish meal, groundnut oilcake, silkworm pupae and rice bran and were fortified with vitamins and minerals (Table 2). The diets were extruded into 2 mm dia dry pellets by using California Pellet Mill and were broken into small size suitable for feeding the fish.

## 3.2 EXPERIMENTAL PROTOCOL

The experiments were conducted at room temperature under natural photoperiod during June-Aug, 1991. Induced bred fingerlings (3-10g) produced from the brood stock maintained at Central Institute of Freshwater Aquaculture (CIFA) were used for the experiments. In each experiment five acclimated fish were randomly distributed in plastic containers containing 20 litre of stored tube-well water. Each treatment had three replicates. Daily feed consumption was estimated based on feed that remained unconsumed. The

**TABLE - 1**

Proximate composition of ingredients used in experimental diets for rohu fingerlings.

| Ingredient | Moisture* % | Crude Protein % | Crude Lipid % |
|---|---|---|---|
| Fish meal | 6.5 | 65.4 | 16.0 |
| Groundnut Oilcake | 3.2 | 50.9 | 8.0 |
| Rice bran | 4.8 | 13.8 | 7.0 |
| Silkworm pupae | 5.2 | 70.0 | 5.0 |

* Moisture is expressed as percentage of fresh weight, protein and lipid as percentage of dry weight of diet.

left over feed and excreta were collected daily, dried, sieved and stored for future analysis. Before ration was provided each day, the faecal matter was siphoned out and containers were cleaned and filled with fresh stored tube-well water. Feeding adjustments were made following weekly sampling for growth. Aeration to each container was provided by using an air compressor. Complete evacuation of intestinal content were ensured in all fish samples by starving them for 24 hrs before recording initial and final body weights.

### 3.3 ANALYSIS

Proximate composition of ingredients, diets and body biomass were analysed following AOAC (1975). Gross energy values of diets were calculated by using caloric values given by Davidson *et al*. (1979) as reported by Cho *et al*. (1982). The values are: 5.65, 9.38, 4.11 Kcal/g for protein, lipid and carbohydrate respectively.

The dietary performances were evaluated by using the following nutritional indices:-

Food conversion ratio (FCR) =

$$\frac{\text{Total food intake (dry weight)}}{\text{Total live weight gain}}$$

Specific growth rate (SGR) =

$$\frac{\text{Log}_e \text{ final body weight} - \text{Log}_e \text{ initial body weight}}{\text{Number of days}} \times 100$$

Protein efficiency ratio (PER) =

$$\frac{\text{Total live weight gain}}{\text{Total protein intake}}$$

Protein retention efficiency (PRE) =

$$\frac{(\text{Total final body weight} \times \text{final carcass protein}) - (\text{Total initial body weight} \times \text{initial carcass protein}}{\text{Total protein intake}} \times 100$$

Energy retention efficiency (ERE) =

$$\frac{(\text{Total final body weight} \times \text{final carcass energy}) - (\text{Total initial body weight} \times \text{initial carcass energy}}{\text{Total energy intake}} \times 100$$

The caloric values of protein and lipid only as stated above were used for the estimation of ERE.

Trophic coefficient =

$$\frac{\text{Consumption of food (dry weight)}}{\text{growth (dry weight)}}$$

Analysis of Variance and Duncan's Multiple Range Test (Duncan, 1955), correlation coefficient and regression analysis were employed for statistical significance.

## 3.4 EXPERIMENT NO. 1 : PROTEIN FEEDING MANAGEMENT

Rohu fingerlings weighing 3.13-4.09 g. were used for this experiment and reared for six weeks. The protein feeding management was resorted to mixed feeding schedules of low and high protein diets. Seven feeding schedules followed in this experiment were diets A and B (control), 1A-2B, 1A-3B, 2A-2B, 2A-3B and 2A-4B, where the numerical value refers to the number of days that a particular diet was offered continuously . Considering large scale use of conventional feed mixture of bran and cake which contains 20-22% protein for feeding the fish in pond and the requirement of fish for 40-45% for dietary proteins, two control diets at 20 and 40% were formulated and termed as low and high protein diets respectively. The ration was offered once a day in the morning. The water temperature and oxygen level varied from 26 .3 to 33.5$^{o}$C and 5.5 to 8 ppm respectively.

## 3.5 EXPERIMENT NO.2 : FEEDING REQUENCY:

Rohu fingerlings weighing 8.17-10.48 g were used in this experiment and were reared for five weeks. A diet containing 35% protein (Table 2) was formulated for feeding

**TABLE - 2**

Formulation and proximate composition of diets for rohu fingerlings.

| Ingredients | Dietary protein level (%) 20 (A)* | 35** | 40 (B)* |
|---|---|---|---|
| Rice bran | 85.16 | 54.21 | 43.76 |
| Fish meal | 4.28 | 14.53 | 18.08 |
| Groundnut Oilcake | 3.00 | 11.26 | 16.16 |
| Silkworm pupae | 5.56 | 18.00 | 20.00 |
| Dicalcium phosphate | 1.50 | 1.50 | 1.50 |
| Vitamin mixture[1] | 0.10 | 0.10 | 0.10 |
| Mineral Mixture[2] | 0.10 | 0.10 | 0.10 |
| Sodium Chloride | 0.30 | 0.30 | 0.30 |
| | Composition moisture free basis | | |
| Moisture (%) | 6.23 | 2.81 | 3.45 |
| Crude protein (%) | 18.38 | 32.04 | 38.90 |
| Crude lipid (%) | 7.60 | 9.38 | 10.56 |
| Crude fibre (%) | 20.66 | 16.54 | 16.87 |
| Ash (%) | 13.00 | 19.25 | 21.43 |
| NFE (%) | 40.36 | 22.79 | 12.24 |
| Gross energy(Kcal/g) | 3.40 | 3.61 | 3.67 |

* A and B refer to low and high protein diets used in experiment No.1.

** Used in experiment No.2.

1. Consists of vitamin A 5000 IU, vitamin D 600 IU, Thiamine 10mg, Riboflavin 20 mg, Pantothenic acid 50mg and Ascrobic acid 200mg.

2. Consists of $CuSo_4$ $5H_2O$, $FeSo_4$ $7H_2O$, $MnSO_4$ $H_2O$, ZnO, $CoCl_2$ $6H_2O$, KI and $CaHPo_4$ (Filler) to provide (ppm total

the fish. The feed was offered once a day (1-D), twice a day (2-D) and thrice a day (3-D) at 5% body weight of fish. The feeding schedules as followed were 1-D at 12 hrs, 2-D at 09 and 16 hrs, 3-D at 7, 13 and 19 hrs. The water temperature and oxygen levels were 25.8 to 32.4$^{o}$C and 6.3 to 8.7 ppm respectively.

# CHAPTER IV

# RESULT

# RESULTS

## EXPERIMENT NO.1 : PROTEIN FEEDING MANAGEMENT.

Table 2 indicates diet formulations and their proximate composition. The diets A and B were almost iso-caloric (3.4 - 3.67 Kcal/g). Diet A had 18.38% protein, 7.6% lipid, 20.66% fibre, 13% ash and 40.37% NFE while diet B had 38.90% protein, 10.56% lipid, 6.87% fibre, 21.43% ash and 12.24% NFE (Table 2).

Table 3 and Figures 1 - 5 show growth performances and nutrient utilization in fish. No mortality was observed in any of the experimental containers. Though best growth was obtained in fish reared with diet B, the SGR value (0.81) was not statistically significant from the corresponding value 0.78 of the group maintained on 2A-3B feeding schedule. However, the growth performance of fish reared on 1A-3B, SGR (0.71) is comparable to those maintained on 2A-3B feeding schedule. Best FCR (3.16), PER (0.86), PRE (19.94) and ERE (16.01) were obtained in the fish maintained on 2A-3B feeding schedule (Table 3, Figures 1-5).

TABLE - 3

Growth and nutrient utilization in rohu fingerlings in relation to various protein feeding schedules.

| Feeding Schedule | Weight ± S.D(g) Initial | Weight ± S.D(g) Final | SGR | FCR | PER | PRE | ERE |
|---|---|---|---|---|---|---|---|
| 1A-2B | 15.88 ± 0.77 | 19.89 ± 0.63 | $0.54^{ac}$ | $4.64^{a}$ | $0.68^{ace}$ | $13.3^{a}$ | $11.04^{a}$ |
| 1A-3B | 16.54 ± 0.089 | 22.26 ± 0.33 | $0.71^{d}$ | $3.52^{bc}$ | $0.84^{bf}$ | $16.54^{b}$ | $14.24^{b}$ |
| 2A-2B | 16.33 ± 0.27 | 20.46 ± 0.57 | $0.54^{ac}$ | $4.76^{a}$ | $0.73^{ce}$ | $14.70^{c}$ | $11.04^{a}$ |
| 2A-3B | 16.33 ± 0.44 | 22.37 ± 0.24 | $0.78^{ed}$ | $3.16^{c}$ | $0.86^{bf}$ | $19.94^{d}$ | $16.01^{c}$ |
| 2A-4B | 19.52 ± 1.33 | 24.74 ± 1.96 | $0.62^{ab}$ | $4.01^{d}$ | $0.77^{be}$ | $16.26^{b}$ | $13.59^{d}$ |
| A | 18.38 ± 0.45 | 22.20 ± 0.56 | $0.45^{c}$ | $5.99^{e}$ | $0.91^{f}$ | $8.95^{e}$ | $2.64^{e}$ |
| B | 20.79 ± 1.99 | 29.2 ± 2.59 | $0.81^{e}$ | $3.97^{bd}$ | $0.65^{ac}$ | $14.95^{c}$ | $14.58^{b}$ |

Figures having same letter are not statistically significant ($P > 0.05$)

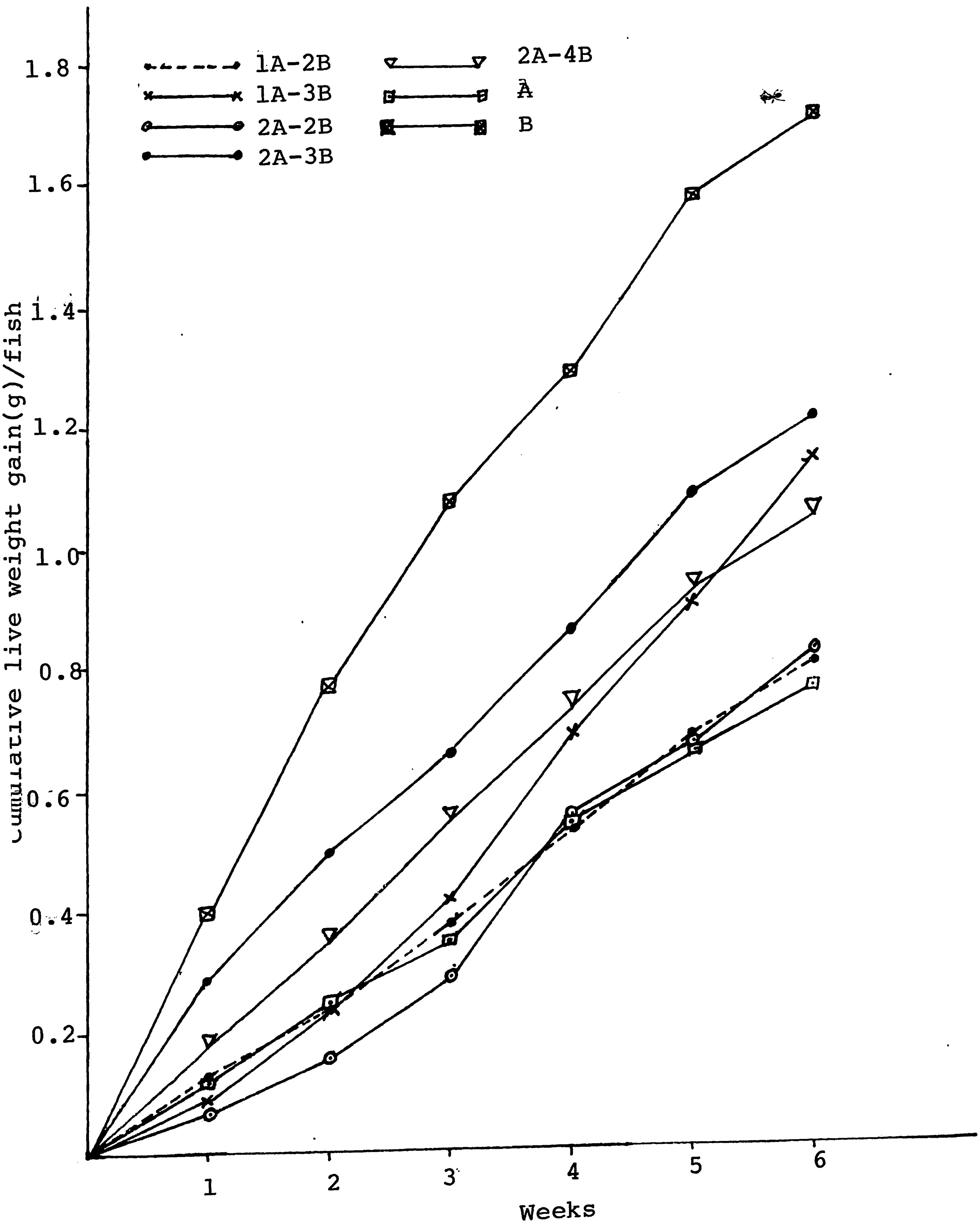


Fig. 1 Growth of rohu fingerlings in relation to various protein feeding schedules

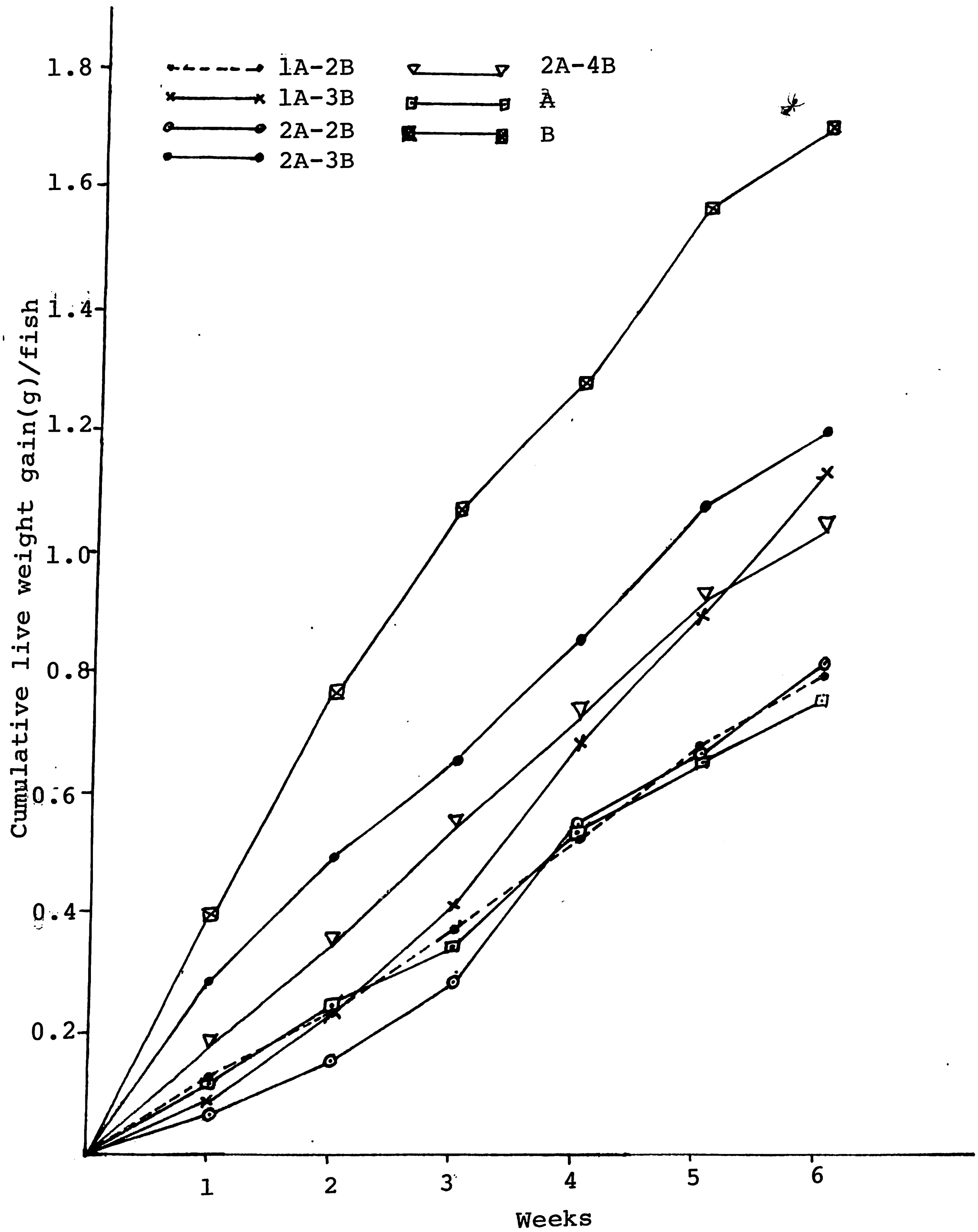


Fig. 1 Growth of rohu fingerlings in relation to various protein feeding schedules

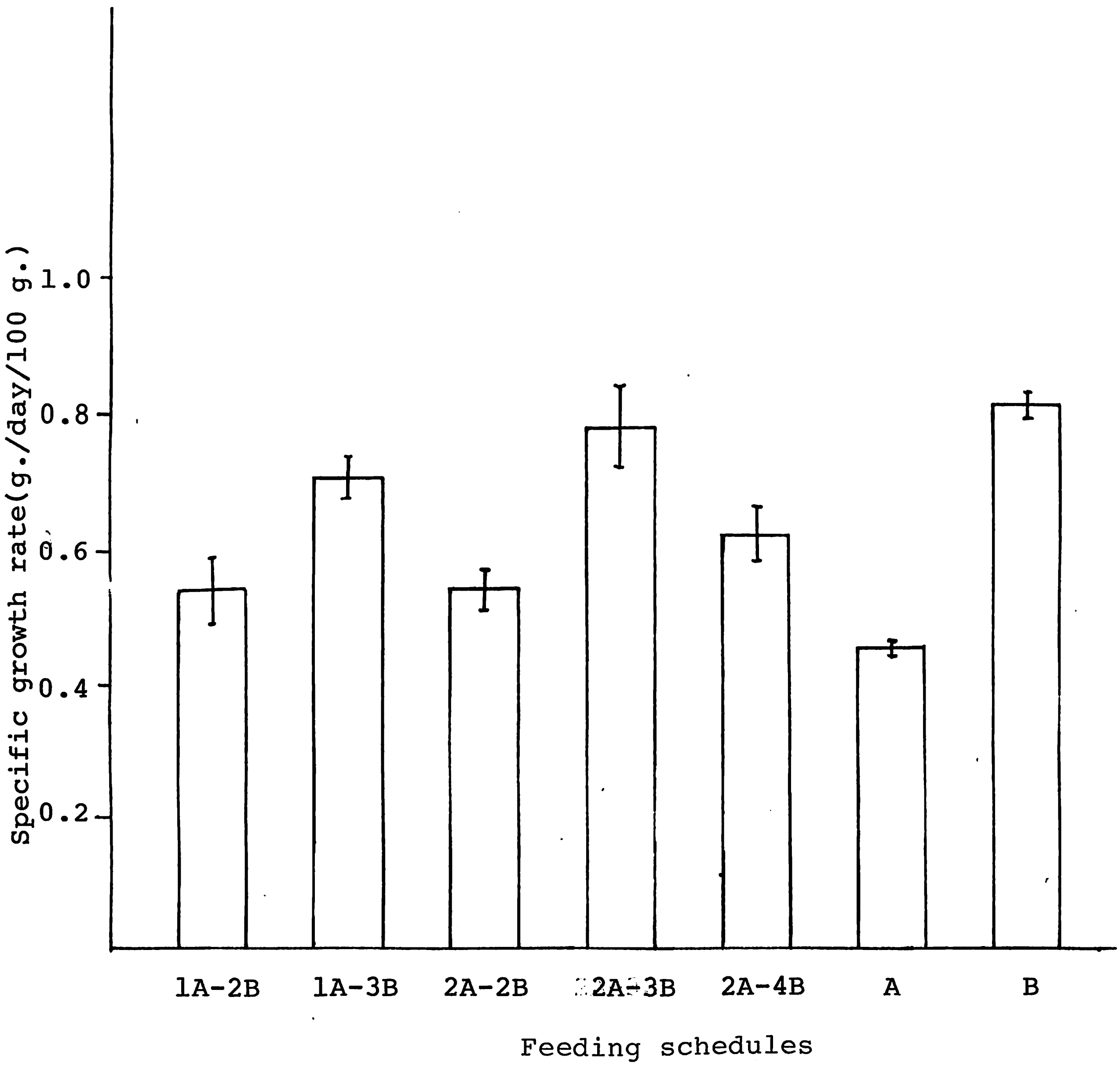


Fig. 2 Variations in specific growth rate (SGR) of rohu fingerlings in relation to various protein feeding schedule

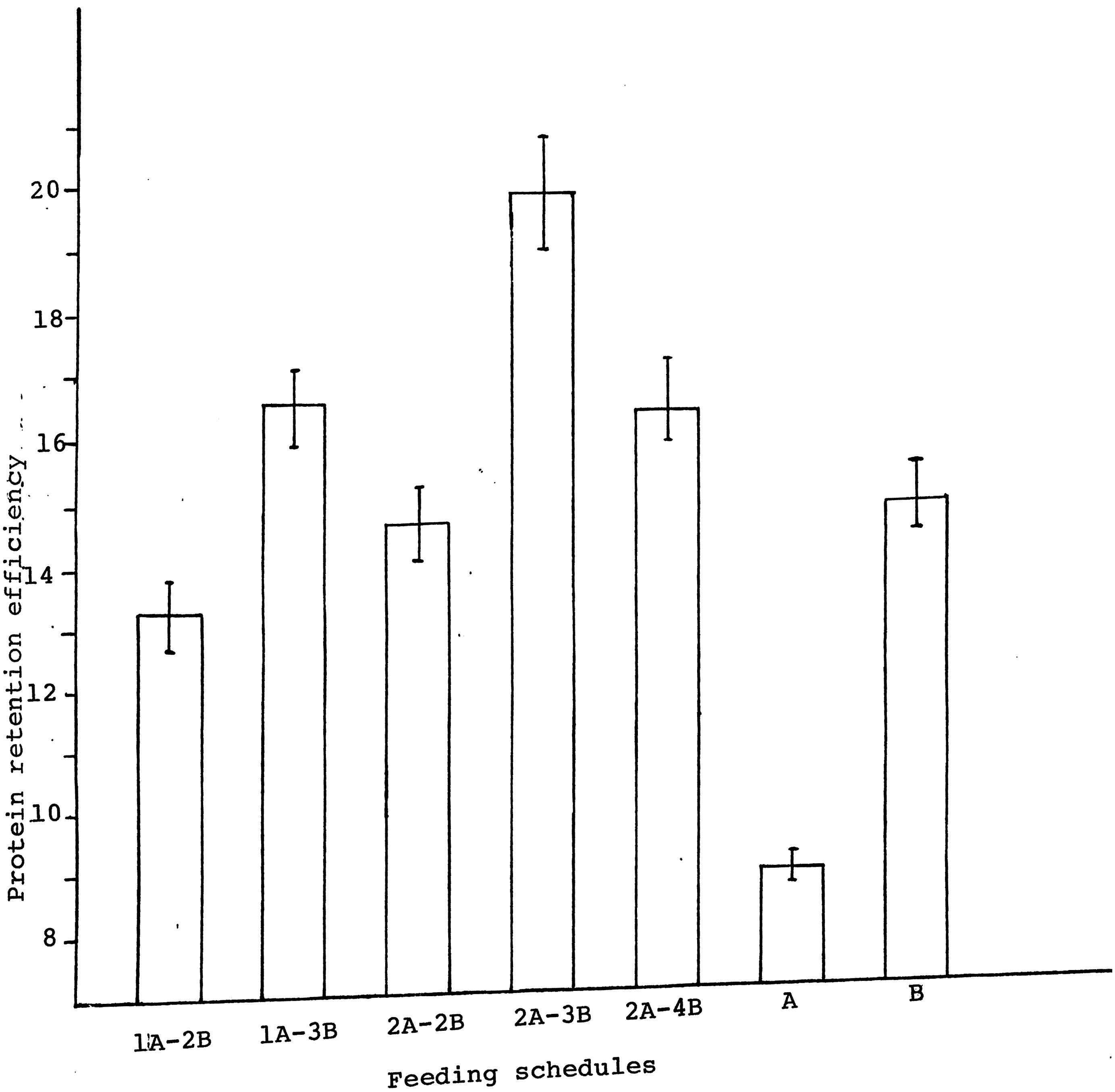


Fig. 3 Variotions in protein retention efficiency(PRE) of rohu fingerlings in relation to various protein feeding schedules

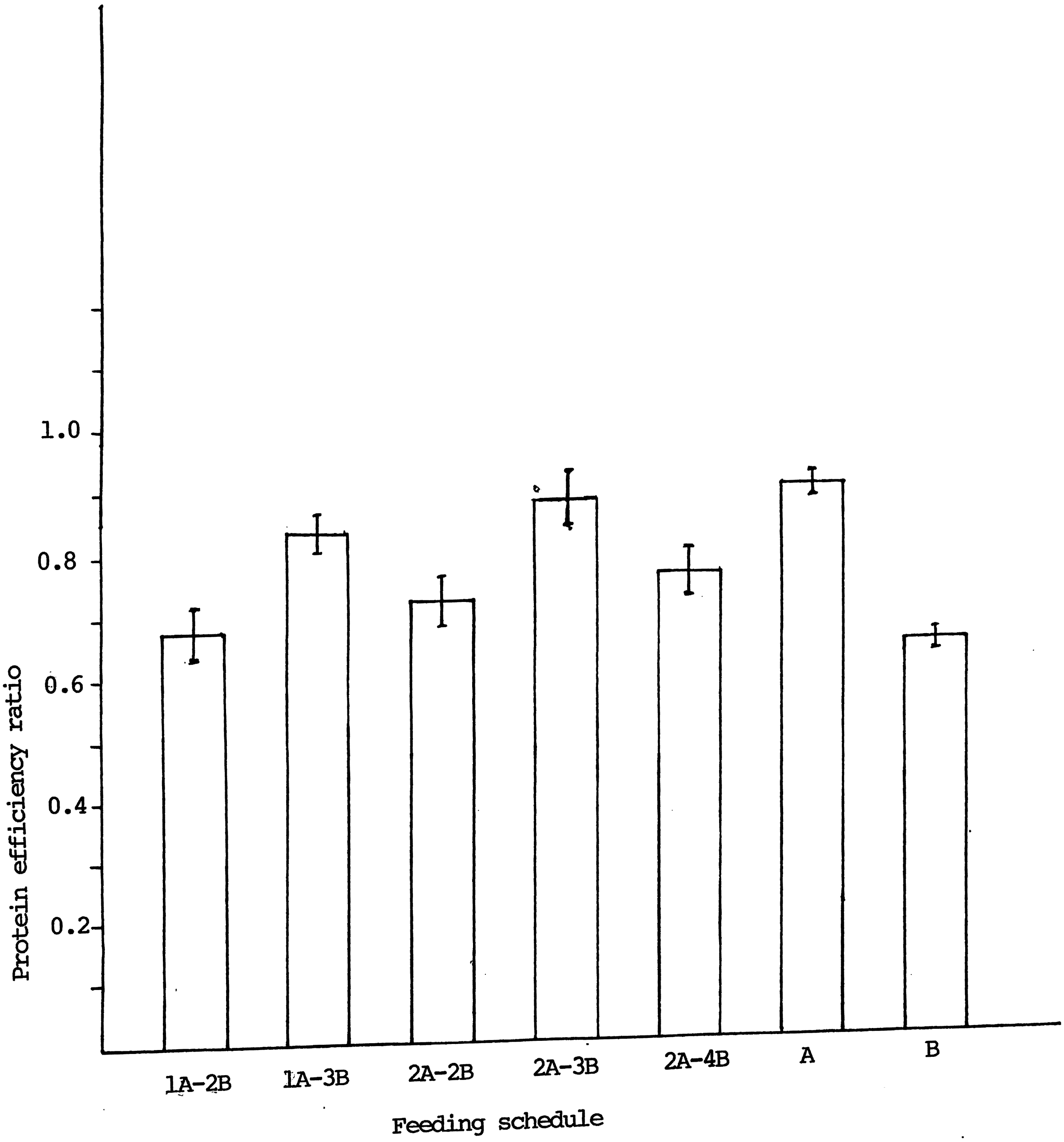


Fig. 4 Variations in protein efficiency ratio in relation to various protein feeding schedule

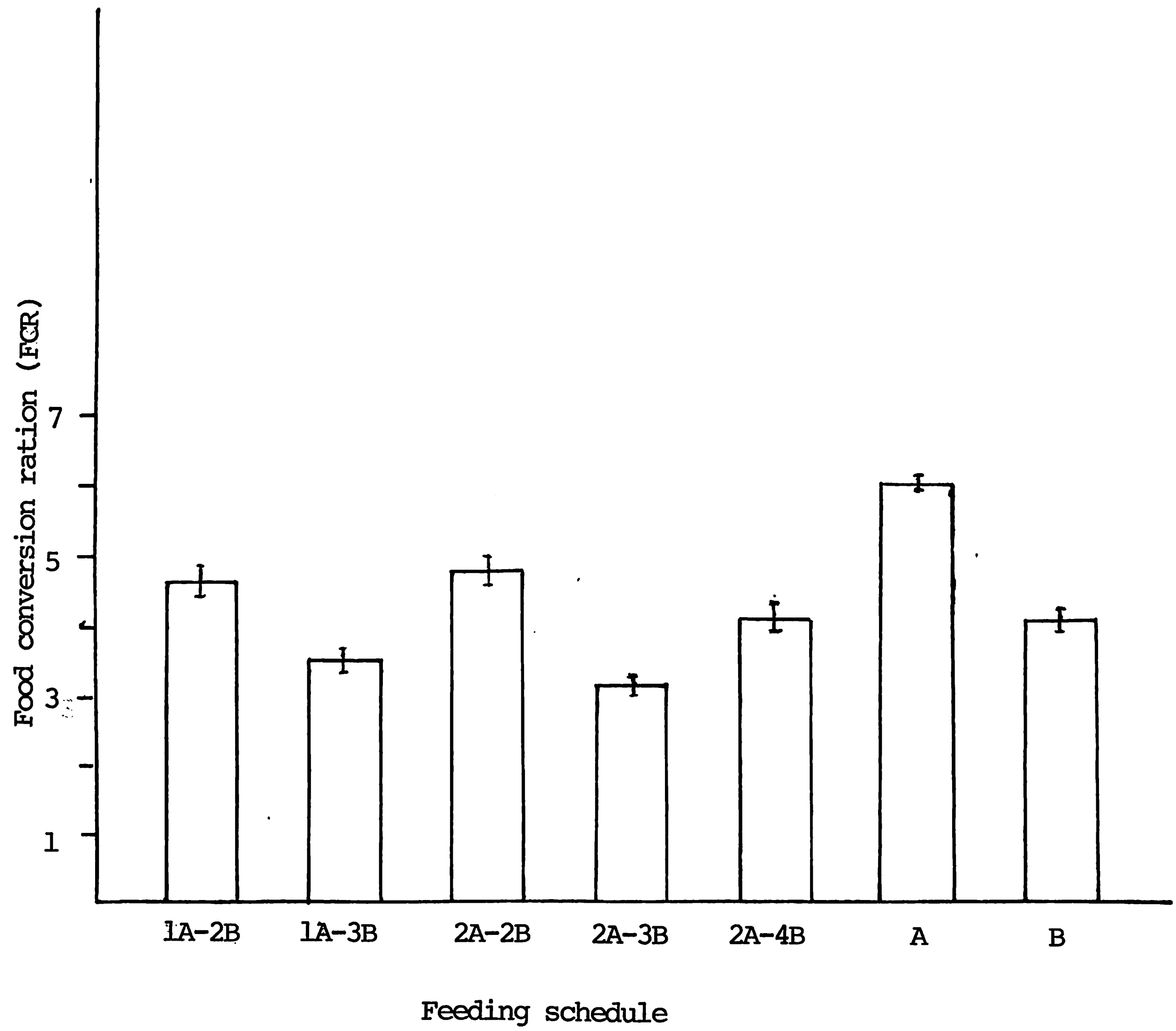


Fig.5 Food conversion ratio (FCR) of rohu fingerlings in relation to various protein feeding schedule

Fish fed diet-A showed poor growth and nutrient retention efficiencies (Table 3). FCR (5.99) was the highest while the SGR (0.45) PRE (8.95), ERE (2.64) were the lowest in the fish fed the diet.

The carcass composition of fish fed various diets has been shown in Table 4. Moisture level in the experimental fish varied from 73.56% to 78.83%. There is a trend in decrease of moisture with increase in bodyweight. Protein level ranged from 61.63 to 63.10% in the fish maintained on various feeding schedules. The protein levels did not vary much in fish body. 20.17 - 23.87% lipid were observed in the fish fed various diets. With rise in body moisture, lipid levels were found decreased. Ash also did not distinctly vary (10.38 - 12.38%).

Table 5 shows two way of analysis of variance for overall growth performance of experimental fish. Though there was no significant difference among the replicates ($P>0.05$), the growth performance among the treatments were highly significant ($P<0.01$).

The economics of feeding has been presented in Table 6. Based on the feed consumption, the cost of production of one

**TABLE - 4**

Carcass composition in rohu fingerlings maintained on various protein feeding schedules.

| | | Fish fed experimental diets. | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial | 1A-2B | 1A-3B | 2A-2B | 2A-3B | 2A-4B | A | B |
| Moisture (%)* | 76.62 | 75.37 | 74.93 | 75.28 | 75.07 | 74.63 | 78.83 | 73.56 |
| Crude Protein(%) | 60.22 | 61.63 | 61.92 | 61.81 | 62.30 | 62.17 | 63.10 | 62.08 |
| Crude Lipid (%) | 22.60 | 23.09 | 22.84 | 23.03 | 23.50 | 23.41 | 20.17 | 23.87 |
| Ash (%) | 12.43 | 11.23 | 11.72 | 11.36 | 10.57 | 11.20 | 12.38 | 10.30 |
| Energy (Kcal/g) | 5.52 | 5.65 | 5.64 | 5.65 | 5.72 | 5.71 | 5.46 | 5.75 |

* Moisture is expressed as percentage of fresh wight ; Protein, Lipid, Fibre and Ash as percentage of dry weight.

**TABLE - 5**

Two-way analysis of variance of average live weight gains of rohu fingerings maintained on various protein feeding schedules.

| Source of variation | Sum of squares | Degree, freedom | Mean sum square | Variance ratio(F) | Probability |
|---|---|---|---|---|---|
| Between treatments | 46.63 | 6 | 7.77 | 194.25 | $P < 0.01$ |
| Between replicates | 0.0322 | 2 | 0.0161 | 0.3985 | $P > 0.05$ |
| Error | 0.4852 | 12 | 0.0404 | | |

TABLE - 6

Feding economics* of rohu fingerlings in relation to various protein feeding schedules.

| Feeding Schedule | Total feed consumed(g) Diet A | Total feed consumed(g) Diet B | Total cost of feed consumed(paise) Diet A | Total cost of feed consumed(paise) Diet B | Total cost of feed consumed(paise) Feeding Schedule | Total live weight gain(g) | Cost/g. body gain (Paise) |
|---|---|---|---|---|---|---|---|
| 1A-2B | 6.19 | 12.38 | 1.455 | 5.262 | 6.717 | 4.01 | 1.675 |
| 1A-3B | 5.02 | 15.07 | 1.180 | 6.405 | 7.585 | 5.72 | 1.326 |
| 2A-2B | 9.81 | 9.81 | 2.305 | 4.170 | 6.475 | 4.13 | 1.568 |
| 2A-3B | 7.644 | 11.466 | 1.796 | 4.873 | 6.669 | 6.05 | 1.02 |
| 2A-4B | 7.32 | 14.65 | 1.720 | 6.226 | 7.946 | 5.45 | 1.458 |
| A | 22.9 | | 5.391 | | 5.391 | 3.82 | 1.419 |
| B | | 33.45 | | 14.216 | 14.216 | 8.4 | 1.69 |

* Approximate costs of 1kg diet A and diet B are : Rs.2.35 and Rs.4.25 respectively as calculated based on the price of ingredients, which were Rs.1, Rs.7, Rs.5, Rs.4.6, Rs.44 and Rs.1 for rice bran, fish meal, silkwork pupae, Groundnut oilcake, vitamin and mineral mixtures and sodium chloride respectively.

gram body weight has been calculated and 2A-3B protein feeding schedule was found comparatively low.

The daily protein consumption and corresponding growth have been shown in Table 7. Protein consumption and growth per day were high in the fish fed diet B. The fish consumed 0.31g protein in a day and showed 0.2g body weight increment. When the fish were fed diet A, protein consumption and body weight increment were 0.1g and 0.09g per day respectively. In rest feeding treatments, per day consumption and body weight increment varied from 0.13 to 0.17g and 0.1 to 0.14g respectively.

**EXPERIMENT NO.2: FEEDING FREQUENCY.**

As shown in Table 2, the diet used in this experiment had 32.04% protein, 9.38% lipid, 16.54% fibre, 19.25% ash, 22.79% NFE, 3.61 Kcal/g energy.

The growth data are presented in Table 8. Survival was cent per cent in each experimental container. When diet was provided 2 and 3 times a day, the fish exhibited best growth and higher nutrient retention efficiencies (Table 8) as compared to one time feeding (1-D). SGR (0.60),

**TABLE - 7**

Rankings of protein intake and corresponding growth in rohu fingerlings maintained on various protein feeding schedules.

| Rank order | Treatment | Protein intake (g/day ) | Growth (g/day) |
|---|---|---|---|
| 1. | Diet-B | 0.31 | 0.2 |
| 2. | 2A-4B | 0.17 | 0.13 |
| 3. | 1A-3B | 0.16 | 0.14 |
| 4. | 1A-2B | 0.14 | 0.1 |
| 5. | 2A-3B | 0.14 | 0.12 |
| 6. | 2A-2B | 0.13 | 0.1 |
| 7. | Diet-A | 0.1 | 0.09 |

TABLE - 8

Growth and nutrient utilization in rohu fingerlings in relation to different feeding frequencies.

| Feeding frequency | Weight ± S.D(g) | | Feed Consumption (% body weight) | SGR | Trophic coefficient | PER | PRE |
|---|---|---|---|---|---|---|---|
| | Initial | Final | | | | | |
| 1-D | 54.52±2.88 | 62.59±2.2 | 3.02 | 0.51 | 22.21 | 0.57 | 15.43 |
| 2-D | 44.42±0.63 | 54.863±0.50 | 3.10 | 0.60 | 18.96 | 0.71 | 18.76 |
| 3-D | 40.87±1.22 | 50.28±1.20 | 3.38 | 0.59 | 19.94 | 0.62 | 18.07 |

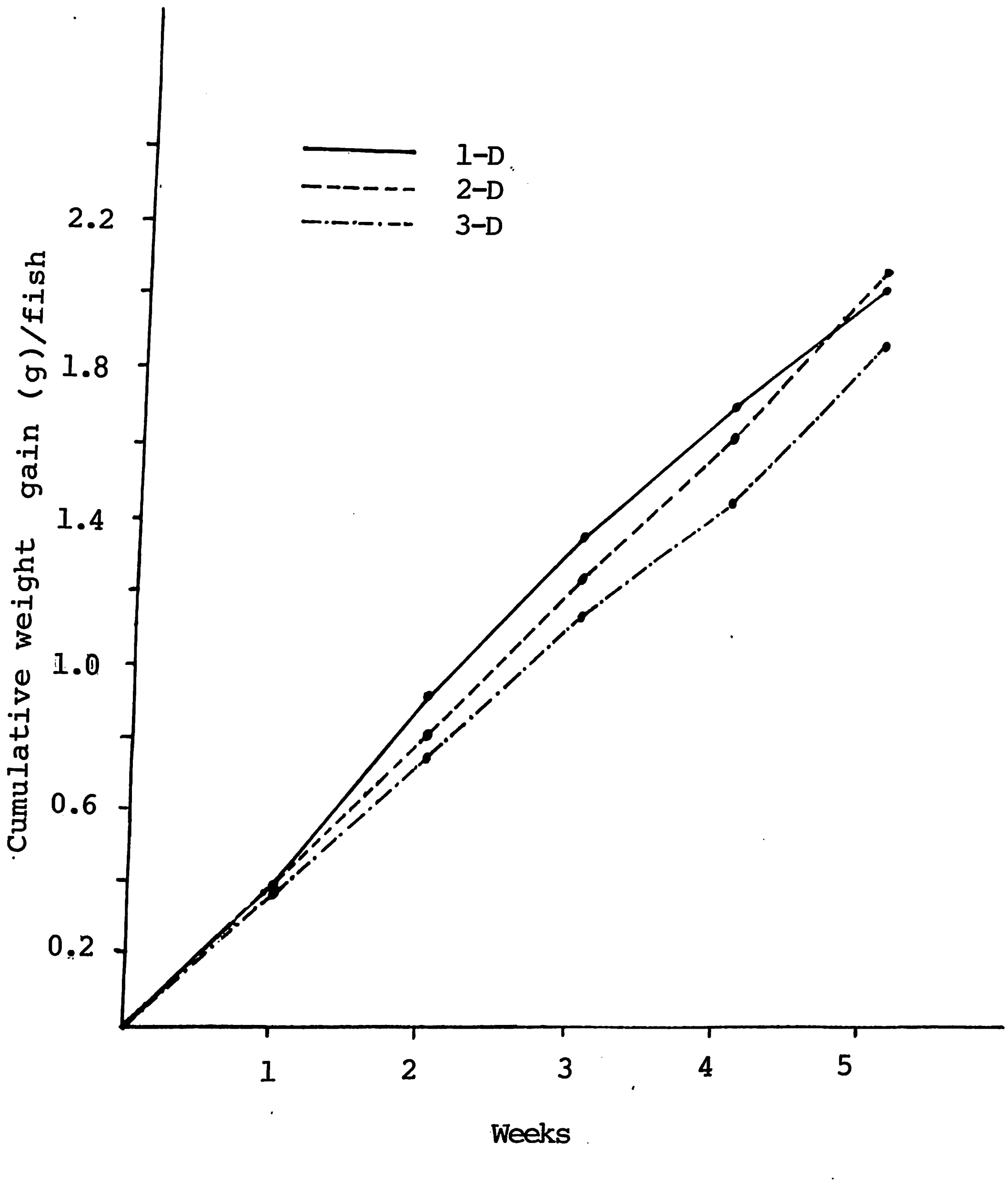


Fig.6 Cumulative live weight gain (g) of rohu fingerlings maintained on various feeding frequencies.

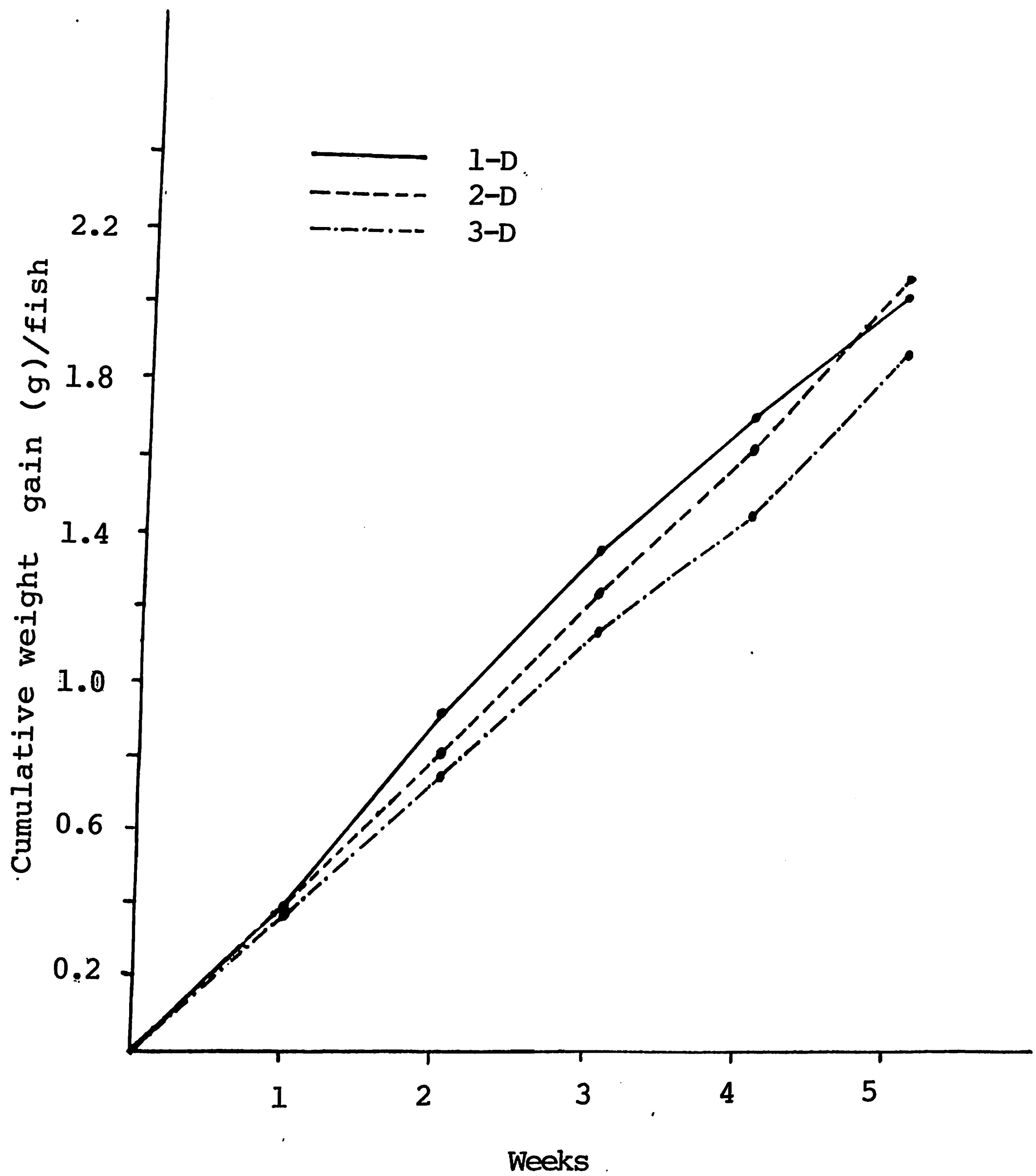


Fig.6 Cumulative live weight gain (g) of rohu fingerlings maintained on various feeding frequencies.

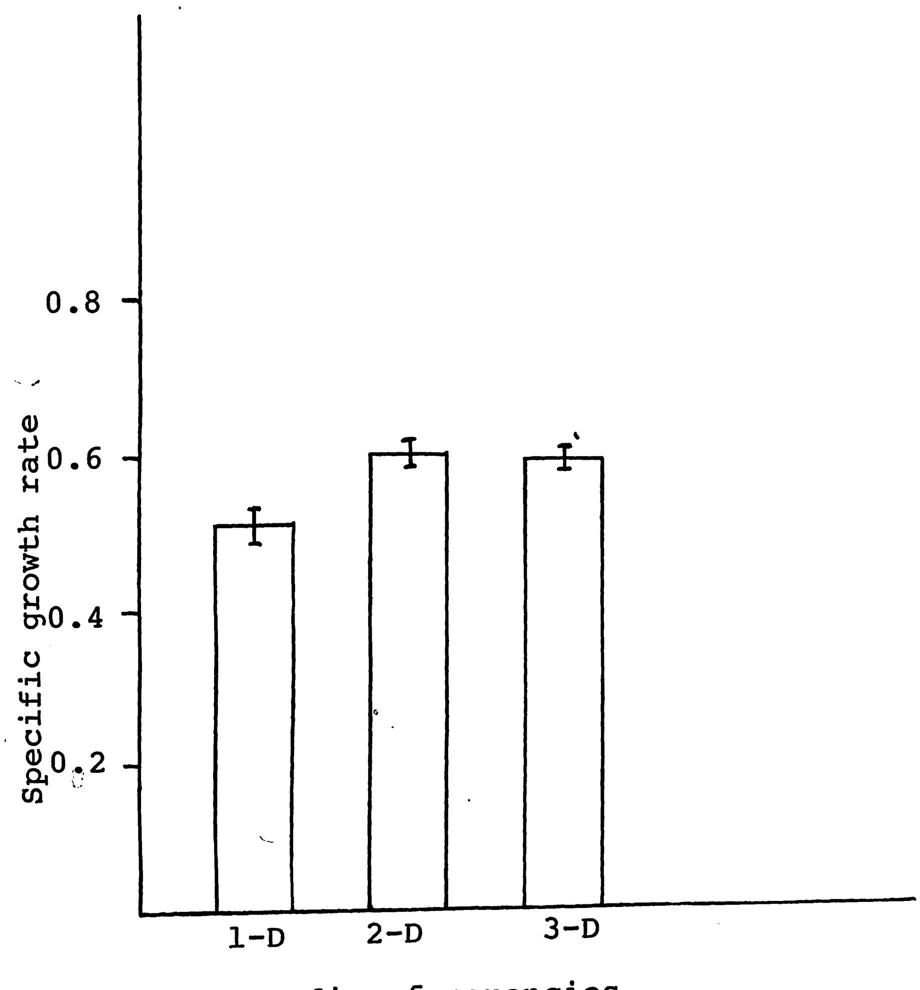


Fig.7 Specific growth rate (SGR) of rohu fingerlings on various feeding frequencies

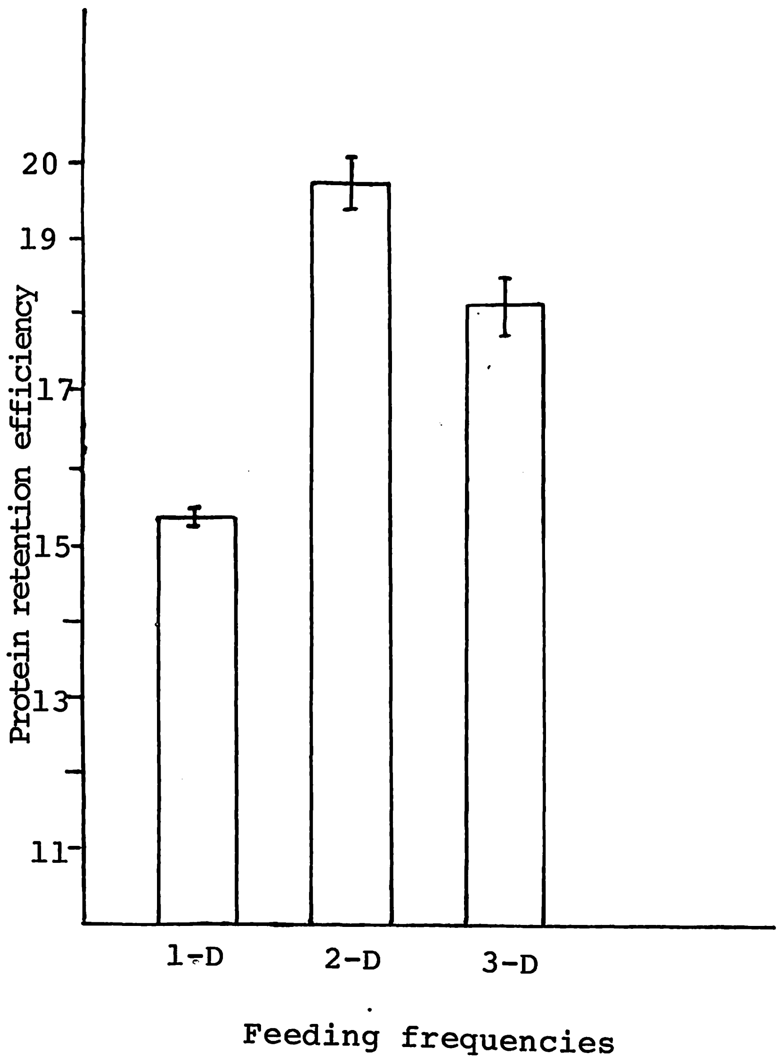


Fig.8 Protein retention efficiency (PRE) of rohu fingerlings on various feeding frequencies.

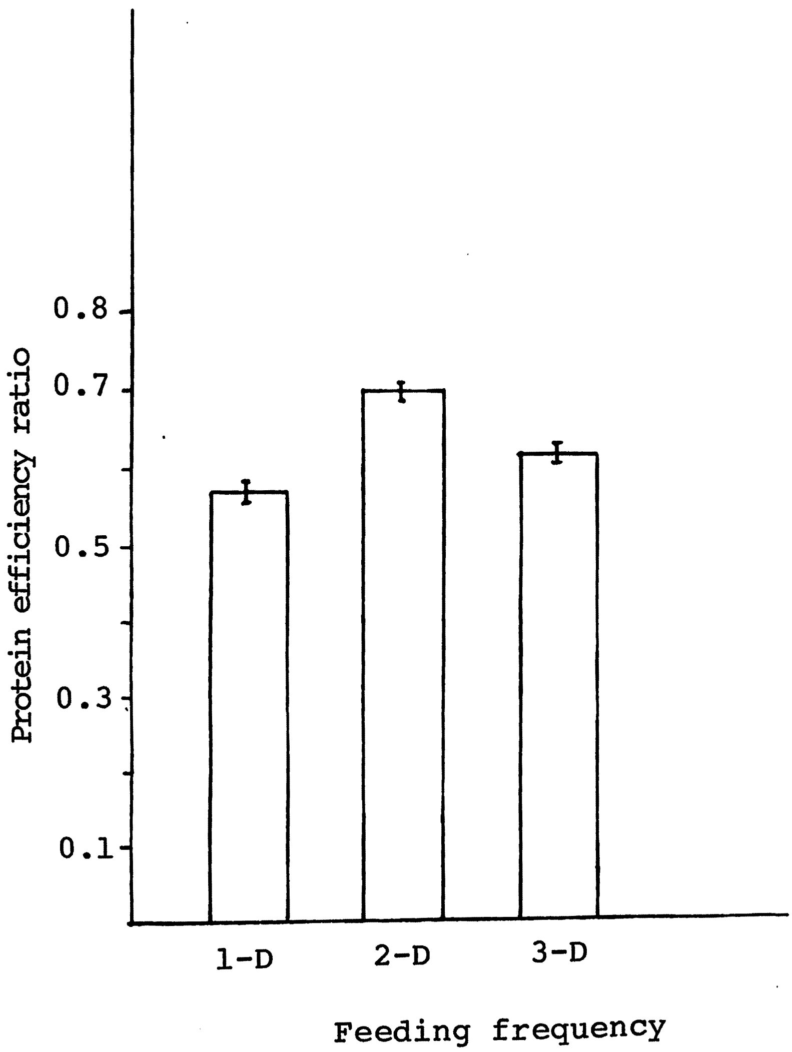


Fig.9 Protein effiency ration (PER) of rohu fingerlings on various feeding frequencies

PRE (18.76) data of the fish which were fed two times a day were comparable with SGR (0.59) and PRE (18.07) values obtained in the fish fed three times a day. The trophic coefficient was lowest and PER was highestin the fish fed two times a day (Table 8).

The analysis of carcass composition has been given in the Table 9. Moisture level in the experimental fish varied from 72.12 to 73.06% which decreased from an initial level of 75.37%. Protein level (64.36-65.61%) did not show any significant variation among the test fishes. Lipid level in the test fish showed an increasing trend from the initial sample and ranged between 22.21-22.46%. Moisture and lipid level in test fishes showed an inverse relationship. Ash content of the test fish showed a decrease trend from the initial fish, but did not vary much among themselves in test animals (10.36-10.38).

Table 10 shows the two way analysis of variance for live weight gain of fishes maintained on various feeding frequencies. Though there was no significant variation among the replicates ($P>0.05$), the growth performance among the treatments varied significantly ($P<0.01$).

**TABLE - 9**

Carcass composition of rohu fingerlings in relation to different feeding frequencies.

| | Initial | Feeding frequencies | | |
|---|---|---|---|---|
| | | 1-D | 2-D | 3-D |
| Moisture (%) | 75.37 | 73.06 | 72.83 | 72.12 |
| Crude protein (%) | 62.76 | 64.36 | 65.61 | 64.72 |
| Crude lipid (%) | 20.46 | 22.21 | 22.43 | 22.46 |
| Ash (%) | 11.75 | 10.38 | 10.41 | 10.36 |

**TABLE - 9**

Carcass composition of rohu fingerlings in relation to different feeding frequencies.

| | | Feeding frequencies | | |
|---|---|---|---|---|
| | Initial | 1-D | 2-D | 3-D |
| Moisture (%) | 75.37 | 73.06 | 72.83 | 72.12 |
| Crude protein (%) | 62.76 | 64.36 | 65.61 | 64.72 |
| Crude lipid (%) | 20.46 | 22.21 | 22.43 | 22.46 |
| Ash (%) | 11.75 | 10.38 | 10.41 | 10.36 |

**TABLE - 10**

Two-way analysis of variance of average live weight gains of rohu fingerlings in relation to various feeding frequency.

| Source of variane | sum of square | Degree of Freedom | Mean sum square | Variance ratio(F) | Proba-bility |
|---|---|---|---|---|---|
| Between the trials | 1.729 | 2 | 0.8645 | 29.91 | $P < 0.01$ |
| Between the replicates | 0.00297 | 2 | 0.00148 | 0.0512 | $P > 0.05$ |
| Error | 0.4628 | 4 | 0.1157 | 0.289 | |

# CHAPTER V

# DISCUSSION

# DISCUSSION

Hypothesis of De-Silva (1985) has been found to hold good in the present experiment. Based on SGR, PER, PRE, ERE and the cost alternate feeding of two times low protein with three times high protein (2A-3B) have been found most beneficial (Table 3,5,7 & Figures 1-5). Low protein level, high carbohydrate and fibre in diet-A (Table-2) explain the reason for its poor dietary performance when continuously fed to fish. As the diet had low protein, the demand was perhaps high for the body protein to meet the requirement for tissue building and repair, metabolism and metabolic faecal nitrogen. The larger proportion of carbohydrate in the diet might have interfered in digestibility (Maynard, 1947) and therfore growth and nutrient deposition efficiencies were very low (Table 3). In the present experiment carbohydrate content of diet-A is more than the level (26-28%) required for carps (Sen et al., 1978; Singh et al., 1987). The results of poor dietary efficiency and retarted growth as observed in diet-A in present experiment are comparable to the observation of Shimeno (1982) Shimeno et al. (1985) Mohanty and Swamy (1986) who have used the diets containing 35-40% carbohydrate for rainbow trout and carps.

Fibre plays an important role in fish ration as a diluent for other nutrients and as an extender in equitable distribution of nutrients (NRC, 1977). Fibre level in the low protein diet in the present work contributes to 20.66% (Table 2) and thus seems to reduce the nutrient intake imbalancing the digestibility. In channel catfish, fibre content over 21% adversely affected the growth (NRC, 1977). Relatively low digestibility in the diet with inadequate protein level caused poor protein utilization (Steffens, 1981).

Though the growth is best (Table 3, Figure 1) in fish fed constant high protein diet (diet B), the growth is not commensurate with the diet and protein consumed (Table 7). Hence, nutrient retention efficiencies such as PRE and ERE are also not in proportion to protein and energy consumptions. The ash (21.43%) in this diet (Table 2) appeared to interfere in the digestibility which had affected FCR and nutrient utilization (Table 3). Cho <u>et</u> <u>al</u>. (1985) reported that dietary ash more than 13% affected growth of salmon. As seen from Table 7 the daily weight increment is significantly correlated with proetin consumption as evident from a regression analysis ($Y=0.0370 + 0.535X$, $r = 0.92$, $df = 6$, $P< 0.01$). With high protein diet (Diet B) there may also be metabolic stress. The rates of metabolism and also the ammonia excretion which is the principal end-product of protein catabolism are directly proportional to the protein intake (Ming, 1985; Mohanty et al., 1990) which might have involved an expenditure of energy affecting nutrient deposition (Table 3 and 7) when the fish were maintained on constant high protein diet (Diet B) in the present study. While comparing with other dietary protein levels, Sen et al (1978) Mohanty et al (1990) observed best growth synchronised with best nutrient retentions with the diet containing 40-45% protein.

In the present study, when feeding schedule was adjusted to alternate high protein diet (Diet B) with low protein diet (Diet-A) a congenial situation with less metabolic stress perhaps was created for fish to grow and for deposition of body nutrients as compared to that of the groups maintained on high protein diet (Diet-B) and also in comparision with low protein diet (diet-A) which showed poor dietary efficiency. The fish reared with high protein diets (diet-B) exhibited more protein consumption rate (0.31g/d) while those reared on low protein diet (diet-A) consumed low protein (0.1g/day) and the daily growth rates as obtained with these two diets were 0.2g and 0.09g respectively (Table 7). This corroborates the observation of Mohanty et al (1990) who observed that consumption was high with high protein diets and low with low lprotein diet. With the mixed feeding of low and high proteins the protein consumption was comparatively low and protein was fruitfully utilized for growth and nutrient retentions. The fish reared with 2A-4B, 1A-3B, 1A-2B, 2A-2B, 2A-3B, had comparatively low protein consumption rate varying from 0.13-0.17g/day and better growth rate which ranged from 0.1 to 0.14 g/day.

The results in the present study indicated that presentation of alternate low and high protein diets may be related to the rhythmicity of certain basic metabolic activity (De Silva, 1985). Further studies in this connection are required. It is evident from the Table 6 that the cost of one gram body weight gain is comparatively low (1.02-1.33 paise), the cheapest trend being with 2A-3B protein feeding schedule in the given feeding situation.

The results are comparable with the findings of De Silva (1985) and Nandeesha et al. (1989) who reported the best performance of tilapia and common carp maintained on 2A-3B and 1A-3B respectively. The diets used by De Silva (1985) had 18% and 30% protein.



In order to improve upon the dietary qualities fishmeal and other animal protein are normally added in carp diets. As the animal protein is a major cost contributing factor, the diets incorporated with animal proteins are expensive. The present experiment have shown the posibility of minimizing the feed cost using the protein feeding schedule as discussed. Gaigher et al. (1984) reported the feeding of duck weed in addition to commercial pellet to the hybrid tilapias in intensive fish culture system. Further investigations can be taken up by taking wider range of feeding schedule and enzyme studies in order to evolve more effective and better feeding schedule.

A positive relationship between the growth and feeding frequency has been established. Higher growth have been reported in fish with higher feeding regime. But this extensive feeding has shown a limitation beyond which the increase in body biomass is negligible in comparision to the amount of feed given (Chua and Teng, 1978) and this is defined as optimal feeding frequency. In the present study such situation has been observed with two times feeding in a day which is optimum. As observed in common carp and murrel (Charles et al., 1983; Sampath, 1983), feeding frequency in the present study influenced growth and protein retention efficiencies in rohu fingerlings (Table 8, Figure 6-9). Food intake is governed by hunger or satiation level which in turn is dependent on the remaining food in the stomach (Brett, 1971; Pandian, 1975). In the present experiment when rohu fingerling was fed after an interval of 7 hrs. of the first feeding, it could consume meal to a tune of 3.10% of body weight which is significantly more than 3.02% at one time feeding. When feeding frequency was increased to three times a day at an interval of 6 hrs feed consumption was still higher. This indicates intermittent feeding habit of the species. Since the fish intestine is longer than a carbivorous fish due to its harbivorous feeding nature, it showed continous feeding trend. But the diet could not be efficiently utilized by the fish. Though high consumption rate was observed when 3 times feeding was resorted the growth rate was comparatively different from that of fish fed twice a day (2D). The feeding at 2-D levels resulted in over all good growth performance (Table 8 & 10, Figure 7 and 8), lowest trophic coefficient highest PER and PRE (Table 8).

The present findings of feeding twice a day (morning and afternoon) agrees with the observations of Khan, 1972 (as reported by Das, 1981) and Das (1981). Khan (1972) observed periodicity of food uptake of rohu where he found two maxima in feeding activity first at 8 hrs. and second at 16 hrs. every day. While studying the pattern of amylase secretion in rohu in relation to natural diet, Das (1981) confirmed the observation of Khan (1972) by showing two peaks of enzyme secretions at the above hours. Though the enzyme study has not been done in the present experiment it is not possible to correlate with enzyme rhythimicity. However, the utilization of diets given in morning and afternoon in the present study appeared to have been body weight which is significantly more than 3.02% at one time feeding. When feeding frequency was increased to three times a day at an interval of 6 hrs feed consumption was still higher. This indicates intermittent feeding habit of the species. Since the fish intestine is longer than a carbivorous fish due to its harbivorous feeding nature, it showed continous feeding trend. But the diet could not be efficiently utilized by the fish. Though high consumption rate was observed when 3 times feeding was resorted the growth rate was comparatively different from that of fish fed twice a day (2D). The feeding at 2-D levels resulted in over all good growth performance (Table 8 & 10, Figure 7 and 8), lowest trophic coefficient highest PER and PRE (Table 8).

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The present study also agrees with the observation of Andrews and Page (1975) and Grayton and Beamish (1977) for channel catfish and rainbow trout respectively which were fed two times a day but differs from the reports of Charles et al. (1984) Chua and Teng, (1978), Marian et al. (1982) for common carp, estuarine grouper and Heteropneustes fossilis fed three times and one time a day, Kono and Nose, 1971 (Murai et al 1983) recommended a feeding frequency upto 12 times a day for maximum feed consumption of fishes without stomach such as carp and gold fish. Murai et al (1983) observed four times feeding of glucose and maltose based diet in a day is optimum for growth and feed efficiency for common carp fingerlings. However the feeding frequency varies from species to species and with environmental condition.

An inverse significant relationship between body moisture and lipid (Table 4 & 9) has been observed in each experiment ($r = -0.93$, df = 6, $P < 0.01$ for experiment-1, $r = -0.89$, df = 2, $p < 0.01$ for experiment-2). This agrees with the observations for other fishes (Garling and wilson, 1976; Huisman et al., 1979; Murai et al., 1985).

# CHAPTER VI

# SUMMARY

**SUMMARY**

Two laboratory experiments on protein feeding management and feeding frequency were conducted for six and five weeks respectively for rohu fingerlings in order to determine the appropriate feeding schedule and to assess the optimum feeding frequency.

In first experiment, two iso-caloric diets were formulated by using fish meal, silkworm pupae, groundnut oilcake and ricebran after fortification with vitamins and minerals. The diets were named as diet A and diet B and were considered as control diets. Diet A and diet B were low and high protein diets respectively. Diet A had 18.38% protein, 7.6% lipid, 20.66% fibre, 13% ash, 40.36% NFE and 3.40 KCal/g energy. Diet B contained 38.90% protein, 10.56% lipid 16.87% fibre, 21.43% ash, 12.24% NFE and 3.67 KCal/g energy.

Seven feeding schedules which were prepared for feeding the fish were diets A and B (control), 1A-2B, 1A-3B, 2A-2B, 2A-3B and 2A-4B where the numerical represents the number of days the particular feed was provided continously in that feeding schedule.

Fish fed high protein diet (diet B) continously showed the highest growth which was not in commensurate with

the diet consumed by the fish. The SGR value (0.81) was not statistically significant from the corresponding value (0.78) obtained in the fish group reared with 2A-3B feeding schedule. FCR (3.16) was the lowest and PER (0.86), PRE (19.94) and ERE (16.01) were highest when fish were continously fed low protein diets for two days and high protein diets for three days (2A-3B). Continuous feeding of low protein diet (diet A) alone resulted in poor growth and nutrient retention efficiencies. FCR (5.99) was highest while PRE (8.95), ERE (2.64) values were lowest with fish fed the diet.

Protein consumption (0.31 g/day) and growth (0.2 g/day) were high when the fish were fed high protein diet (diet B) alone continuously. But, growth was not in proportion to the protein quantity which was consumed by the fish. Fish maintained on 2A-3B showed a consumption rate of 0.14 g protein per day and body weight increment of 0.12 g in a day.

2A-3B protein feeding schedule was economical which costs about 1.02 paisa for raising one gram body weight increment in fish in a day.

Lipid was inversely correlated with moisture in fish ($r = -0.93$, $P < 0.01$).

The results indicated that overall performance of 2A-3B feeding schedule was good for the fish which showed comparatively better SGR, FCR, PRE and ERE as mentioned.

In the second experiment fish were fed a diet containing 32.04% protein, 9.38% lipid, 16.54% fibre, 19.25% ash, 22.79% NFE and 3.61 KCal/g energy which was prepared by fish meal, silkworm pupae, groundnut oilcake, rice bran and fortified with vitamins and minerals. The fish were fed once a day (1 D) at 12 hrs, twice a day (2 D) at 9 and 16 hrs, thrice a day ( 3 D) at 7, 13 and 19 hrs. Fish fed twice a day showed comparatively better results. SGR (0.60) and PRE (18.76) values obtained with two times feeding a day were comparable with those fed three times a day which exhibited 0.50 SGR, 18.76 PRE. However, fish fed two times a day demonstrated a higher PER (0.71) and a lower trophic coefficient (18.96) as compared to those fed three times a day, where PER and trophic coefficient were 0.62 and 19.94 respectively. With only one time feeding the fish growth and nutrient utilisation was poor. The fish showed lowest SGR (0.51), PER (0.57), PRE (15.43) and the highest (22.21) trophic coefficient.

The body moisture was negatively correlated ( $r = -0.89$, $p < 0.01$) with lipid in the fish.

The study indicated that diet is best utilised when fish are fed two times a day, once each in forenoon and afternoon as these periods have been reported corresponding with the time of enzyme secretion.

# CHAPTER VII

# CONCLUSION

## CONCLUSION

Continuous use of high protein diet is wasteful and causes metabolic stress for the fish. Problem is more acute in non drainable ponds where the water exchange is beyond the reach of a farmer and the feed cost is unmanageable for him. In order to provide proper environment for fish to grow with less stress and with low feed cost, it is desirable that the fish may be continuously fed low protein diet for two days alternating with high protein diet for three days during the culture operation.

As growth is positively related to feeding frequency, ration may be provided once each in forenoon (8 - 10 hrs) and in afternoon by 16.00 hrs to fish to take the advantage of timings of enzyme secretion for best utilization of diets.

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