Use of Herb, Gokhru (*Pedalium murex* Linn.) as Growth Promoter in the Supplementary Feed of an Indian Major Carp, *Labeo rohita* (Ham.)

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Dated : / /2004

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1. INTRODUCTION

Fisheries sector plays an important role in the socio-economic development of the country. It helps in augmenting food supply, generating employment, raising nutritional level and earning foreign exchanges. It is not only an important source of direct employment but generates employment in downstream industries. It is estimated that about six million people are employed in fisheries sector (Economic Survey 2001-02)

Indian fisheries is an important component of the global fisheries, with India being the third largest producer of fish in the world and second in inland fish production (FAO, 1998). India's share in the world production of fish is 4.5 per cent of present, with total fish production in 2001-02 being 6.13 million tonnes (2.83 MT from marine and 3.3 MT from inland fishery) (Fishing Chimes Vol. 24, No.1). The fisheries sector has been one of the major contributor of foreign exchange earnings through export, with an export of 5.08 lakh tonnes valued of Rs.6,368.37 crores in 2000-01. Further, the contribution of fisheries to GDP of the country is about 1.4 per cent (2001), (The Hindu Survey of Indian Agriculture, 2002).

Fish is one of the most important group of vertebrates, influencing life of man in various ways. The importance of fish culture in the rural economy is being increasingly realized at every level, which is evident from the fact that about 2.6 million hectares of water is under fish farming. Apart from the food importance, there is one more important consideration of the fishery industry as it plays an important role in the rural economy. The immense job-potential it can provide can go a long way to ease the pressure of unemployment. Currently there is great scope of self-employment in fish culture industry especially in rural areas.

The world per capita fish consumption is about 15 kg per year. It is 8 kg for developing countries and 25 kg for developed countries. The per capita fish consumption for India and Bangladesh is lower and is less than 11 kg per year. Moreover, India is also listed among the low income food deficit countries (LIFDCs) of the world.

Inspite of using the latest improved technologies in land based agriculture, the agriculture productivity is still lagging behind in fulfilling the per head consumption of foodgrains due to the population explosion. Thus, the problem of protein gap in developing countries like India is notably high. Another aspect of fishery industry lies in the alleviation of suffering of the people due to malnutrition. It is a paradox that malnutrition of people persists in the world even where fish resources are in plenty or are simply wasted. Fish is a rich source of protein as it contains 10 essential amino-acids viz; Lysine (high concentration), Arginine, Histidine, Leucine, Isoleucine, Valine, Threonine, Methionine, Phenylalamine and Tryptophan. The digestibility of fish flesh is 96% and also serve as a good source of minerals.

In order to achieve the desired increase in the fish production either expand the area under fish production which is not possible due to the limited freshwater resources and the other way out is to enhance its production under captive conditions by the use of improved supplementary feed. By going for the use of herb we can, not only safeguard the fish consumers from the ill-effects of the artificial chemical substances but also maintain and improve the quality of fish flesh.

The mountain ranges of India are gifted with a vast biodiversity, with different plants and herbs being used to cure human beings from the time immemorial according to the Ayurvedic doctrine. Looking to this concept the use of herb in the supplementary feed is being done to get maximum growth of fish, while going hand in hand with nature without disturbing the ecological balance that is the step towards the use of organic food.

Among the Indian Major carps, rohu is the most palatable and widely consumed fish. As it is also an early maturing breed so it is most popular among the fish producers. For the above said reasons the present research programme has been designed aiming at stimulating the basal metabolism of fish with the use of herb, Gokhru (*Pedalium murex* Linn.), the herb is a well known growth promoter and thus frequently prescribed for human beings. The present investigation is conducted to work out effects of the herb using Indian Major Carp, *Labeo rohita* (Ham.) as a test fish with following objectives:

1. To investigate impact of selected herbal feed formulation on the growth of freshwater fish, *Labeo rohita* (Ham.).
2. To work out appropriate dose by enriching supplementary diet with herb.
3. To screen fish fed with herb supplemented diet for proximate compositon.

2. REVIEW OF LITERATURE

In present day scenario the need is to search cheap and nutritive feed to minimize input with maximum economic return. Efforts to improve the efficiency of food conversion for better fish yields in an ongoing research activity. The drugs used in animal husbandry for promoting anabolic activities to enhance growth rate and realize substantial savings in production costs prompted the use of various minerals, vitamins, carbohydrate, hormones and their synthetic analogues in fish also.

(i) For enhancing anabolic activities and growth and for improving the quality of flesh, researches in the field of nutrition vary widely.

Sehgal and Thomas (1985) experimented with rice bran (50%), kitchen garbage (25%), mushroom, wheat straw (5%), poultry droppings (5%), fish meal (2.5%) and cheese whevy (12.5%) and reported high survival with low food conversion ratio and maximum yield of carp *Cyprinus carpio communis* (L).

Mukhopadyay and Hajra (1986) studied the intestinal protease activity and liver protein synthesis in magur, *Clarias batrachus*, when fed isonitrogenous diets of different energy levels.

Renukardhya and Varghese (1986) reported that isocaloric pelletized feeds gave fastest growth rates when catla and rohu were fed at different levels of casein content and also observed adverse effects on growth at higher protein content than the optimum level.

Mohanty and Swamy (1986) compared growth rates of rohu fry when fed with two different diets. One diet contained blood meal, rice bran and groundnut oil cake whereas, other diet was of groundnut oil cake, salvinia powder and sugar waste. The diet with blood meal imparted significantly improved growth rate to the fish.

Takaii *et al*. (1986) studied the use of trypsine on *Anguilla japonica* and amylase activities in the gastro-intestinal tissue and found that the diet containing alanine, glycine, proline, histidine and uridine-5-monophosphate showed remarkably high growth, feed efficiency and energy retention as compared to control.

Ufodike and Madu (1986) found that the diet treated with 17-∝ methyl testosterone showed better growth, feed conversion ratio, protein efficiency ratio and mean growth rate as compared with alcohol and untreated diet when fed to different groups of *Sarotherodon niloticus* fry.

Degani and Levenon (1987) examined the influence of different levels of carbohydrate in diet at temperature range of 25ºC – 27ºC and was shown that elevers of Anguilla fed with high percentage of carbohydrate and maintained at 27ºC temperature had high percentage of lipid in body weight but there was no significant difference in protein content of fish.

Hidalgo *et al*. (1987) obtained better growth in sea bass when fed with diets containing methionine and cystine in 20 : 80 ratio. However, no significant effect on body composition of juvenile sea bass was reported.

Paul Raj and Thirunavakkarash (1987) observed that diet containing 6 per cent lipid level induces the food intake, maximum growth and best utilization of food and protein. Gatlin *et al*. (1989) studied the effect of various levels of dietary copper and zinc on channel catfish.

Ayyappan *et al*. (1990) used different levels of crude protein in various feeds *viz*., bacteria (*Bacillus subtillis*), fungus (*Aspergillus flavus*), plankton, wheat bran-groundnut oil cake mixture, fermented rice bran cake and processed water hyacinth. The specific growth rates of carp fry fed on the above feed mixture ranged between 0.02 and 3.4 gm per day.

Alexis (1990) reported that when fingerlings of rainbow trout fed with carol seed germ meal (CSGM) and soybean meal (SBM), growth rate declined. A lower fish growth with diet containing CSGM as compared to SBM diets was also recorded. Further, increased level of CSGM in diet decreased body protein and increased liver protein.

Dioundick *et al*. (1990) worked on five artificial diets with dietary alpha-cellulose levels of 0, 2.5, 5, 7.5 and 10 per cent and their effects on growth, survival, food conversion ratio (FCR), protein efficiency ratio (PER), body condition factor and hepato somatic index were evaluated for juvenile tilapia. The best growth, survival, FCR and PER were obtained with 2.5-5 per cent supplemental fiber. Tilapia fed with 10 per cent cellulose supplemented diet demonstrated depressed growth just as did fish fed with cellulose free diet.

Gogoi and Keshavanath (1990) reported that diet containing 17-alpha-methyl testosterone in lower doses (2.5 and 5 ppm) resulted in higher growth, increased body protein and fat but reduced moisture, ash and nitrogen free extract in *Tor khudree*.

Phadate and Sarkar (1990) reported that protein rich diets have better growth in *Cyprinus carpio, Catla catla* and *Hypophthalmicthys molitrix*. Better growth, food utilization and food conversion were observed when diets containing human chorionic gonadotrophin (HCG) and diethylistibestol (DES) and admixture of HCG and DES, in *H. molitrix* and *Catla catla* and *Cyprinus carpio* @ 5 per cent body weight.

Shyma and Keshavanath (1990) observed that diets containing human chorionic gonadotrophin (HCG), diethylistibestol (DES) and admixture of HCG and DES fed to silver carp (*Hypophthalmicthys molitrix* and mahseer (*Tor khudree*) at 5 per cent body weight resulted in better growth, food utilization and food conversion in both the species than other diets. These hormones did not bring any drastic change in proximate composition of carps.

Azad (1992) used different levels of dietary thyroxine in grass carp (*Ctenopharyngodon idella*) and found better growth in the diets, which contained lower doses of thyroxine.

Manikandaveda *et al*. (1992) used ensilage based diet as growth enhancer for *Cyprinus carpio*. Three isoprotein feeds containing 25 per cent protein namely rice bran, fish meal and fermented fish ensilage were used in feeding experiments. After 45 days of experiment, growth was considerably higher in fishes fed with ensilage based diet than the control diet and fish meal based diet.

Erfanullah and Jafri (1995) reported growth response of fingerlings of Indian major carp *Labeo rohita* to various sources of dietary carbohydrates. Maximum growth and best conversion efficiency and increased nutrient retention occurred in fish fed with sucrose diet.

Abraham and Varghese (1996) found significantly higher growth by using Livol (a herbal product) than control diet and suggested optimum dose of 1 per cent Livol in the diet of common carp, *Cyprinus carpio* (Linn.). Euphrasia and Jayaprakas (1996) studied the potential of herbal growth promoter Livol-IHF 1000 on the growth performance of *Cirrhinus mrigala* and found superior growth over control. They recommended Livol as a safe feed additive for enhancing growth production of Indian major carps. Gireesha *et*

al. (2002) found the impact of dietary Livol on the growth, biochemical composition and gut digestive enzyme activity of Catla [*Catla catla* (Ham.)].

Murthy and Varghese (1996) conducted study to determine the qualitative requirement of the essential amino acids valine for *Labeo rohita* and found it essential for growth of rohu.

Arockiaraj *et al*. (1999) conducted a trial to evaluate the utilization of carbohydrates as a dietary energy source by fingerlings of striped murrel, *Channa striatus*. Seven isonitrogenous diets were formulated from semipurified ingredients with seven different levels of carbohydrates (8%, 12%, 17%, 21% , 25% 30% and 34%) which were fed to replicated groups of fishes at a rate of 3 per cent of their bio-mass daily for 8 weeks in the aquaria of 40 litres capacity. This study indicates that an optimal carbohydrate level (12%) could be effectively utilized by striped murrel fingerlings with no adverse effects.

Kissil *et al*. (2000) used soy and rapeseed protein concentrates (SPC and RPC) as fishmeal substitutes in gilt-head seabeam *Sparus aurata* (L.) diets. The protein concentrates were used to replace 30%, 60% and 100% fish meal and found to effect feed intake, and weight gain determined in a 56 days growth trial. Some groups were then grown beyond 56 days, until reached an average weight of 50 gm. A comparison of body composition showed no significant differences in protein and ash contents among all fish, while lipid and energy contents were different.

Ali *et al*. (2001) determined the effect of feeding different carbohydrate to lipid rations on the growth performance and body composition of Nile tilapia (*Oreochromis niloticus*) fingerlings. Cho *et al*. (2001) investigated the effects of variable feed allowance with constant energy and ratio of energy to protein in a diet for constant protein input on the growth of common carp, (*Cyprinus carpio* L.).

Satpathy *et al*. (2001) observed the effects of dietary inclusion of the beta-adrenergic agonist, salbutamol, on growth performance and whole body composition of rohu, *Labeo rohita* (Ham.) fingerlings fed diets containing two protein levels. Swamy *et al*. (2001) studied the effect of varying levels of solvent extracted soybean meal on nutrient digestion and nutrient accretion by Indian major carp *Catla catla* (Ham.). Ali Qing-hai and Xic Xiao-Jun (2002) investigated the nutrition of *Silurus meridionalis* (cat fish) to assess effect of different levels of dietary soybean protein on growth.

Catacutan and Mae (2002) experimented on the growth and body composition of juvenile mud crab, *Scylla serrata* which was fed different dietary protein and lipid levels and protein. Fontainhas *et al*. (2002) evaluated the effect of supplemental dietary sodium chloride on growth rate of Tilapia (*Oreochromis niloticus*) reared at viable salinities. Francis *et al*. (2002) studied the dietary supplementation with a *Quillaja saponin* mixture, which improved growth performance and metabolic efficiency in common carp (*Cyprinus carpio* L.).

Hanumanthappa *et al*. (2002) reported the effect of a non hormonal feed additive, chalymbi on growth, body composition and digestive enzyme activity of common carp (*Cyprinus carpio* L.). Keshavanath *et al*. (2002) conducted the effect of periphyton and supplemental feeding on the production of the indigenous carps *Tor khudree* and *Labeo fimbriatus*. Sathpathy *et al*. (2003) reported the effect of dietary protein and lipid levels on growth feed conversion and body composition in rohu, *Labeo rohita* (Ham.) fingerlings.

(ii) Some scientists have also used plant based supplementary feed ingredients to investigate their effect on the growth and body composition and have suggested doses suitable for promoting growth in fishes.

Fagbenro *et al*. (1991) tried coffee pulp with partial and complete replacement of yellow maize for cat fish, *Clarias iisheriensis*. It was concluded that coffee pulp was potentially useful as replacement for yellow maize in low cost diet for *C. iisheriensis*.

Johnson *et al*. (1991) determined the effect of leaf nutrient concentration in fish feed of rainbow trout (*O. mykiss*). The fish showed a decreased growth at high percentage of leaf nutrient concentrate incorporated diet than those fed with lower percentage which showed same results as control diet. Further in this study the muscle lipid levels were reduced with increased leaf nutrient concentrate levels of feed. Fagbenro (1992) found that in *Clarias batrachus* fingerlings fed with pelleted diets of small cocoa-pod huskmeal (CPHM), one single feeding equivalent to 3 per cent body weight per day showed a decline in growth rate with increased CPHM feed.

Mathew and Gopakumar (1992) used red colour extracted from sandal wood (*Pterocarpus santatinus*) in fish feed which was found to increase the acceptability of feed in tilapia (*Tilapia mossambica*). It imparted a pink colour to the whole fish as well as to fish flesh. The fish fed with coloured feed showed increased feed intake and

growth. Shah *et al*. (1994) evaluated the effect of napier grass and found better growth rate and increase in body weight of the fingerlings fed with crushed giant napier leaves.

Yousif *et al*. (1994) used alfalfa (*Medicago sativa*) and salt bush leaves (*Atriplex*) in diets of male tilapia. The potential of dehydrated alfalfa and salt bush in formulated diets for male tilapia was evaluated. All fish diets supplemented with various levels of the two plant leaves shown reduced growth and feed utilization.

Nandeesha *et al*. (1995) conducted a mixed feeding schedules in fish culture, performance of common carp, *Cyprinus carpio* L., on plant and animal protein based diets. A 90 days growth trial was conducted with common carp to test mixed feeding with a plant-based low-protein diet (16% CP), and 2 diets based on fish meal, containing 26% and 31% CP. Specific growth rate (%) and feed conversion efficiency and protein retention were good for all mixed feeding schedules. It was concluded in this study that carp can be fed alternately on animal and plant-protein based diets of varied protein levels.

Hanifa *et al*. (1996) conducted a feeding trial to determine the efficacy of plant protein ingredients such as native beans (*Dolichos lablab*) (DLL), groundnut leaf (*Arachis hypogea*) (GNL), banana flower (*Musa paradisiacal*) (BF), lencanea leaf (LL) and cotton seed (CS) incorporated as substitutes for fishmeal in the diet and found best growth in the order of DLL, GNL followed by LL, BF, CS, respectively.

Kavitha (1996) used a herb Chandrashoor (*Lepidium sativum*) in *Labeo rohita* as a growth promoter in the supplemented diet of poultry feed layer and found significantly higher growth rate with the diet containing 0.2 gm Chandrashoor per kg body weight per day. Kavitha (1996) also used another herb Satavari (*Asparagus racemous*) to assess its impact on the growth of *Labeo rohita* and found higher growth as compared to control.

Mandal and Ray (1996) studied the effect of leaf meal of *Acasia auriculiformis* as a protein source at different levels on *Labeo rohita* fingerlings and indicated that raw Acasia leaf meal is not suitable as dietary protein source in the carp diet.

Singh A.K. and Bose S.K. (1997) conducted a trial on growth of grass carp, (*Ctenopharyngodon idella* val.) fed on cauliflower leaves. The leaves of cauliflower (*Brassica oleracea*) were fed to grass carp in a polyculture pond. Feed conversion ratio

of cauliflower leaves was 37.57 kg (wet weight basis) and 4.87 kg (dry weight basis). Feed conversion efficiency was 2.66.

Falaye *et al*. (1999) with the use of cocoa-husk found positive feed consumption, growth and nutrient utilization in *Oreochromis niloticus*. Xie *et al.* (1999) investigated the effects of incorporation of potato protein concentrate (PPC) and supplementation of methionine in the diet for rainbow trout (*Oncorhynchus mykiss*) on feeding rate, digestion, growth, feed utilization and body composition. The results showed that feeding rate decreased with increased levels of PPC. Apparent digestibility of dry matter, crude protein and ash increased with increased proportion of dietary PPC, while there was no significant effect on the apparent digestibility of crude fat. This incorporation of 5.6% PPC decreased growth rate and 8.9% PPC decreased both growth and feed efficiency. However, supplementation of 1.7% methionine decreased both feeding rate and growth.

Sharma and Mehta (1999) worked on *Cirrhinus mrigala* (Ham.) fingerlings using foxtail millet (*Setaria italica* L.) as a feed and concluded that foxtail millet can be used as fish feed without adversely affecting the growth.

Kumar (2000) used the herb Ashwagandha (*Withania somnifera* L. Dunal) as growth promoter in the supplementary diet (Groundnut oil cake and rice bran in 1:1) of *Cirrhinus mrigala* (Ham.) and found that Ashwagandha supplementad diet enhanced the weight gain, specific growth rate and food conversion efficiency of the fish.

Kumar (2000) conducted a trial to determine the efficacy of a medicinal plant safed musli (*Asparagus adscendens* Roxb.)as growth enhancer in the supplementary diet (ground oil cake and rice bran 1:1) of an Indian major carp Cirrhinus mrigala (Ham.) and found significant result.

Kochenborger *et al*. (2000) reported that fish flour can be replaced by soybean meal in the diets of pacu (*Piaractus mesopotanicarp*) without affecting fingerling weight gain, feed gain, specific growth rate and protein efficiency rate of the fingerlings. It was also reported that protein source replacement did not affect the body composition, nitrogen retention efficiency, body nitrogen, body fat and nitrogen of the fingerlings. Hadjinikolova, and Grozev (2000) reported the comparative study on cotton seeds, sunflower meal and starter food aquaweaner-003 in rearing of carp larvae *Cyprinus carpio* L. in aquarium.

Hossain *et al*. (2001) studied the effect of purified alcohol extract from sesbania seeds on the growth and feed utilization in common carp *Cyprinus carpio* (L.).

Nandeesha *et al*. (2001) observed the growth performance of two Indian major carps, *Catla catla* (Ham.) and *Labeo rohita* (Ham.) which were fed diets containing different levels of *Spirulina plantensis* meal. Siddhuraju *et al.* (2001) investigated the preliminary nutritional value of mucuna seed meal (*Mucuna pruriens* var. *utilis*) for common carp (*Cyprinus carpio* L.).

Takeuchi *et al*. (2002) found the effect raw spirulina on the growth and body composition of juvenile tilapia, *Oreochromis niloticus*.

Gangadhara *et al*. (2002) evaluated rapeseed meal as a feed ingredient in catla (*Catla catla*) diets. Rapeseed meal is reported to have amino acid composition similar to that of soyabean meal. With a view to utilize this important non-conventional source of protein, five isonitrogenous and nearly isocaloric diets, containing 0, 6, 12, 18 or 24% rapeseed meals were prepared by replacing groundnut oilcake at 0, 25, 50, 75 and 100%, respectively, in a fish-meal-based pelleted diet. These diets were tested for their growth inducing potential and the associated biochemical changes in an Indian major carp catla (*Catla catla*). Test diets had no significant effect on flesh quality. The results indicated that rapeseed meal could be safely included in the formulated diet for catla, at least upto 24% level.

Nandeesha *et al.* (2002) studied on the use of mixed feeding schedules with plant and animal based diets for common carp, *Cyprinus carpio* (Linn.). The diet tested were a fish meal based diet (30.9% protein) and three *Colocasia esculenta*- based diets (16.7%, 19.7% and 25.8% protein) separately and in three mixed feeding combinations of diet. An increase in dietary protein led to decreased protein and increased fat deposition in the carcass. An increasing trend in the protease and amylase activities was recorded with increased dietary protein level. The study highlights the efficient utilization of plant proteins by common carp under mixed feeding schedules.

Garg *et al*. (2002) reported the evaluation of raw and hydrothermically processed leguminous seed as supplementary feed for the growth of two Indian major carps *Cirrhinus mrigala* (Ham.) and *Labeo rohita* (Ham.). Rajkumar (2002) reported the effect of two herbs, Mulethi *(Glycyrrhiza glabra* Linn.) and Kali musli *(Circligo orchiaides* Gaertn.) as growth promoter in the supplementary feed of an Indian major carp *Cirrhinus mrigala* (Ham.).

Kashmir Singh *et al*. (2003) studied oilcakes as protein source in supplementary diets for the growth of *Cirrhinus mrigala* (Ham.) fingerlings; under laboratory and field studies. Kour Dalveer (2003) experimented use of herb 'Bala' (*Sida cordifolia*) and found increased growth in Indian major carp *Cirrhinus mrigala* (Ham.). Similarly Udai Singh (2003) showed that growth of Indian major carp, *Cirrhinus mrigala* was enhanced by the application of berb, Makhana (*Eurgale ferox* salisb).

(i) Many scientists have used different supplementary feeds and ingredients to investigate their effect on the growth and body composition of Indian major carp *Labeo rohita* and they have suggested doses suitable for promoting growth in this fish.

Singh *et al*. (1986) conducted experiments on rohu and mrigala fry and fingerlings for testing fortified conventional feeds (rice / wheat bran and groundnut oil cake) with multivitamins, minerals, trace elements, yeast powder etc. and found increase in growth efficiency by more than 100 per cent.

Erfanullah and Jafri (1998) studied the effects of the dietary carbohydrates to lipid (CHO : 1) ratio on the growth rate, conversion efficiencies and body composition of Indian major carp fry, *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala*. They found that the Indian major carp fry efficiently utilize carbohydrate for energy and excess lipid diet resulted in increased accumulation in the body.

Ray and Das (1994) experimented on apparent digestibility of some aquatic macrophytes in rohu, *Labeo rohita* (Ham.), fingerlings and showed that *Nymphoides cristatum* was the most digestible species for *L. rohita* fingerlings in term of protein, lipid, carbohydrate and energy digestibility.

Ray and Das (1995) also experimented on dried aquatic weed, *Pistia stratiotes*, meal as a feedstuff in pelleted feed for rohu, *Labeo rohita* fingerlings, and found that weed meal was effective in promoting fish growth, feed conversion, protein efficiency ratio. In the same year Mohanty and Dash studied *Azolla caroliniana* for inclusion in carp rohu, *Labeo rohita*, diet. Best growth and diet utilization were obtained in fish reared with a diet containing 60% *Azolla* at 22.5 – 26.5ºC.

Jayaprakas and Euphrasia (1997) experimented on growth performance of *Labeo rohita* (Ham.) to Livol (JHF-1000), a herbal product. The highest growth rate was achieved with 2% Livol. In the same year Usmani *et al*. studied the effect of feeding

glanded cotton seed meal on the growth, conversion efficiency and carcass composition of *Labeo rohita* (Ham.) fry. Again in 1997, Mukhopadhyay and Ray experimented on the apparent total and nutrient digestibility of sal seed (*Shorea robusta*) meal in rohu, *Labeo rohita* (Ham.) fingerlings.

Chamundeswari and Shanta (1999) studied on effect of soybean meal (Glycine max) feeding on the biochemical composition of *Labeo rohita* (Ham.) fingerlings, and showed better feed conversion ratio and protein efficiency ratio, higher protein and low lipid levels in the carcass and muscle were observed in soybean meal based ratios.

Nandeesha *et al*. (2001) experimented on growth performance of two Indian major carps, catla (*Catla catla*) and rohu (*Labeo rohita*) fed diets containing different levels of *Spirulina platensis*. The study demonstrated the usefulness of spirulina for partial or complete replacement of fish meal in the diets of catla and rohu.

Patra *et al.* (2002) studied *Nymphoides cristatum* (Roxb.) O. kuntze as feed for an Indian major carp, *Labeo rohita* (Ham.). The study showed the aquatic weeds *N. cristatum* in the diet of *L. rohita* substituting conventional feed ingredients. Jayaram and Aruna (2002) experimented on nutritional performance of *Labeo rohita* fingerlings fed on dairy sludge based feed and conventional standard feed. Bairagi *et al.* (2002) studied on duckweed (*Lemna polyrhiza*) leaf meal as a source of feedstuff in formulated diets for rohu (*Labeo rohita* Ham.) fingerlings after fermentation with a fish intestinal bacterium. The highest carcass protein and lipid deposition was recorded in fish fed with the diet containing 30% fermented leaf meal.

Virk and Saxena (2003) experimented on potential of Amaranthus seeds in supplementary feed and its impact on growth in some carps, and it was shown that the Amaranthus seeds at different levels showed better growth than the control, because of the availability of good quality protein in Amaranthus seeds.

Considering encouraging results with certain herbs by earlier workers, a new herb has been tried for the first time on an Indian Major carp *Labeo rohita* in the present study.

3. MATERIALS AND METHODS

In this experiment performance of medicinal plant "Gokhru" as a diet ingredient has been screened using Indian Major Carp, *Labeo rohita* (Ham.) as experimental fish. The experiment was conducted in glass aquaria of 54 litres capacity. In each glass aquarium, 36 litres of water was maintained throughout the experimental period (plate-1). The tests were conducted in five sets for each of the supplementary diet. Four diets contained different doses of "Gokhru" (*Pedalium murex* Linn.) and one was kept as control. The duration of experiment was for a period of 60 days.

EXPERIMENTAL DESIGN

In this experiment "Gokhru" herb was used as an additive in the supplementary diet of conventional feed comprising of groundnut oil cake and rice bran using the fingerlings of *Labeo rohita* (Ham.). The fishes for the experimental purposes were collected from the nursery ponds of the Rajasthan Tribal Area Development Co-operatives Federation (RTADCF), Jaisamand, Udaipur. Prior to the experiment, glass aquaria were scrubbed thoroughly, washed and dried.

The aquaria were then filled with 36 litres well water and analysed for selected water quality parameters (Table-1). All the glass aquaria were kept in control conditions in shade to protect these from direct sunlight so as to prevent algal growth. After 5 days of filling water, the fingerlings were introduced in each glass aquaria @ 5 fingerlings of *Labeo rohita* (Ham.). Prior to this, these fingerlings were acclimatized for a period of five days in the glass aquaria. During this period, they were fed basal conventional diet (groundnut oil cake + rice bran in 1:1) @ 2 per cent body weight/day. These diets were offered for experimental period of 60 days (excluding initial conditioning of 5 days).

At the time of introduction into glass aquaria, the initial weight of fishes was measured by water displacement method (Sharma *et al*., 1998). Subsequently, the weight of these fingerlings was measured after seven days for monitoring the growth. At the end of the experiment, the final weight of fishes was measured and statistical analysis was made for the gain in body weight and other related growth parameters.

EXPERIMENTAL FEED

1. Preparation of feed:

For this trial, the conventional feed was procured from the local market of Udaipur. The groundnut oil cake and rice bran were powdered (Plate-C) with the help of an electric grinder and then sieved through a fine meshed sieve. For formulating conventional feed rice bran and groundnut oil cake were taken in a ratio of 1:1. The powdered rice bran and groundnut oil cake were mixed well with little amount of water and a binding agent (gwargum for binding all these things for reducing the loss of feed due to rapid dissolution in water) to prepare paste. Noodles were made from this paste using a hand machine. These noodles were subsequently dried in shade and stored in airtight bottles for further use. The groundnut oil cake generally contains about 31.82 per cent crude protein whereas, rice bran has about 13.24 per cent.

Mineral composition of groundnut oil cake and rice bran was as under:

S.No.	Mineral	Percentage (%)	Parts per million (ppm)
A.	**Groundnut oil cake**		
1.	Ash	5.6-12.3	
2.	Calcium (Ca)	0.12-0.51	
3.	Phosphorus (P)	0.48-0.82	
4.	Magnesium (Mg)	0.33	
5.	Sodium (Na)	0.24	
6.	Potassium (K)	1.99	
7.	Copper (Cu)		16.6-50.5
8.	Cobalt (Co)		0.33-0.56
9.	Manganese (Mn)		26.9
10.	Iron (Fe)		1072.0
B.	**Rice bran**		
1.	Ash	15.9-30.6	
2.	Calcium (Ca)	0.13-0.23	
3.	Phosphorus (P)	1.57-1.83	
4.	Magnesium (Mg)	0.28	
5.	Sodium (Na)	1.58	

Source : Chemical composition and nutritive value of Indian feeds and feeding of farm animals by S.K.Ranjan, 1991.

2. Description of the herb:

Gokhru (*Pedalium murex* Linn.)

Family	-	Pedaliaceae
Botanical name	-	*Pedalium murex* Linn.

Indian names:

Hindi	-	Baragokhru, Faridbuti, Kadvagokhru
Bengali	-	Baragokhru
Goa	-	Karonta
Gujarati	-	Kadvagokhru, Mothaghokru, Mothangokhru, Mottoghokru, Ubbaghokhru
Malayalam	-	Ananerinnil, Kakkamullu, Kathenerinmil, Katunerinjal
Marathi	-	Gokhura, Hatticharatte, Karonathia, Mothegokharu
Oriya	-	Gokshura
Punjabi	-	Gokrukalan
Sanskrit	-	Gokshuru, Tittagokshura
Tamil	-	Anainerunji, Ananeringie, Perunerunji
Telugu	-	Fnugallerumullu, Peddapaleru, Yenugapalleru

Gokhru herb is a much-branched herb 15-38 cm high; stems and branches are slightly rough with scaly glands. Leaves opposite, pale glaucous-green, somewhat fleshy, 2.5-5 by 2-3.8 cm. broadly ovale, oblong, truncate or obtuse, coarslely crenate-serrate or sublabate, glabrous above, the lower side usually covered with minute scales, base acute; petioles long. Flower axillary, solitary; pedicles long, calyx small, scarcely long, minutely scaly outside, divided rather more than half way down, lobes 5, linear-triangular, acute. Corolla long, across at the mouth, bright yellow; tube long, slender; lobes broad, rounded. Filaments glandular-hairy at the base. Fruit 1.3-2 cm long narrowed at the base, pyramidal-ovoid above the spines, bluntly 4-angled with stout sharp conical horizontal spines from the angle (Indian medicinal plants vol. III).

Distribution:

The gokhru is a succulent herb, common in the sea-coasts of southern India (Kathiawar, Gujarat, Konkan) Deccan peninsula and Ceylon-Tropical Africa (The Indian materia medica Vol. I and Indian medicinal plants Vol.III).

Medicinal value:

Gokhru is sweet, tasty and have cooling effect. The green seeds in younger or immature stage are giving aroma and bitter in taste. Action and uses for alterative, diuretic, demulent and aphordisiac. An infusion is used to relieve painful micturition to increase the flow of urine and as a vehical for diuretic medicines in Dysuria, Gonorrhoea, Urinary disorders, and for the relief of nocturanl emission, incontinence of irine and importance : its action closely resembles that of buchu and uva uris. It is given with the hyoscyamus and opium. (Materia medica of India, Part-II).

Chemical composition:

The four-angled spiny fruit contains a mucilaginous alkaloid, fat, resin, gum and ash 5 p.c. The extract of the powdered fruits contains a resin, an alkaloid, probably the source of the aroma, fat and mineral matter 14 p.c. (Materia medica of India, Part-II).

Dose:

For human beings the recommended dose range from 5-6 gm/50 kg body weight.

The seeds of Gokhru (Plate-B) were ground to powder with the help of an electric grinder. This powdered herb was mixed with the powder of groundnut oil cake and rice bran at four different levels. For this purpose the material was then kneaded well with some amount of guargum and water to form paste for preparing noodles (Plate-B). While preparing the feed, care was taken for obtaining homogenous materials of even particle size so that proper utilization of feed could be ensured. These noodles were then dried and stored in airtight glass stoppered bottles.

The experimental diets were prepared by mixing Gokhru with the basal diet at following four levels.

Dose Code	Composition of feed
T_1	Rice bran + groundnut oil cake (1:1) + Gokhru @ 0.04 gm/ kg body wt./day.
T_2	Rice bran + groundnut oil cake (1:1) + Gokhru @ 0.08 gm/kg body wt./day
T_3	Rice bran + groundnut oil cake (1:1) + Gokhru @ 0.12 gm/kg body wt./day
T_4	Rice bran + groundnut oil cake (1:1) + Gokhru @ 0.16 gm/kg body wt./day
C	Rice bran + groundnut oil cake (1:1) (control)

These feed formulations were used to feed the fish daily @ 2 per cent body weight per day. The diets were offered to fish in glass petri dishes placed at the bottom of aquaria.

Growth parameters:

1. Weight gain: The weight of *Labeo rohita* (Ham.) fingerlings was obtained at fifteen days interval. The weight gain (gm) was calculated as given below:

$$\text{Weight gain} = \text{Final weight} - \text{Initial weight}$$

$$\text{Weight gain in per cent} = \frac{\text{Final weight} - \text{Initial weight}}{\text{Initial weight}} \times 100$$

2. Growth per day in per cent body weight:

$$= \frac{W_2 - W_1}{W_1 \times D} \times 100$$

Where,

W_1 = Initial weight of fingerlings in gm

W_2 = Final weight of fingerlings in gm

D = Duration of study (days)

3. Specific Growth Rate (SGR):

$$= \frac{\log W_2 - \log W_1}{D} \times 100$$

Where,

W_1 = Initial weight of fingerlings in gm

W_2 = Final weight of fingerlings in gm

D = Duration of study (days)

4. Food Conversion Ratio (FCR):

$$= \frac{\text{Food given (gm)}}{\text{Weight gained (gm)}}$$

5. Gross Conversion Efficiency (GCE):

$$= \frac{\text{Weight gained (gm)}}{\text{Food given (gm)}}$$

Analytical Methodology:

Water of the experimental units was partially replaced every alternate day using well water to maintain congenial environment for fish. Water quality parameters viz., temperature of air and water, pH, dissolved oxygen were investigated on alternate day. On the other hand free carbondioxide, alkalinity, hardness, nitrate, orthophosphate and electrical conductivity (EC) were investigated on every seventh day.

For investigating water quality parameters stated above, methods of APHA (1989) and Trivedi and Goel, (1986) were followed.

Air temperature:

Air temperature near the experimental aquaria was measured using centigrade thermometer having minimum graduation of 0.1ºC.

Water temperature:

The temperature of water was observed directly by immersing the thermometer into the water of experimental aquaria.

pH:

The hydrogen ion concentration was determined in the aquaria with the help of a prestandarised pen type digital pH meter.

Electrical conductivity:

Electrical conductivity of the experimental water was determined with the help of a digital Systronics direct reading conductivity meter. The result obtained were expressed as electrical conductivity in dS/cm.

Free carbondioxide:

Free carbondioxide was estimated by titrating the sample with standard alkali titrant to pH 8.3 as per the method below:

(ii) 50 ml of water sample was taken in a flask and 2 drops of phenolphthalein indicator were added.

(iii) If the solution remained colourless, it was then titrated with standard sodium hydroxide (0.022 N) to slight pink end point.

(iv) The reading was noted and free CO_2 was calculated by the following formula:

$$\text{Free } CO_2 \text{ (ppm)} = \frac{\text{ml of titrant used}}{\text{ml of sample}} \times 100$$

Dissolved oxygen:

The dissolved oxygen of water was estimated by modified Winkler's method.

Following steps were adopted for oxygen estimation:

(i) Water sample was collected in 250 ml glass stoppered bottles without bubbling.

(ii) 1 ml of each Mangnous sulphate (Winkler A) and alkaline-iodide solution (Winkler B) were dispensed, one after other, right at bottom of the bottle using separate pipettes. Then stopper was replaced.

(iii) The bottle was shaken upside down at least 6 times and allowed the brown precipitate to settle down.

(iv) The precipitate was dissolved by adding 2 ml of concentrated sulphuric acid and the stoppered bottle was again shaken.

(v) 50 ml of aliquot was taken in a conical flask and then titrated with sodium thiosulphate (0.025 N) till the colour changed to pale straw.

(vi) After that 2 drops of starch indicator were added and titrated further till the blue colour disappeared for the first time to a colourless end point.

(vii) The total amount of titrant used was noted and the dissolved oxygen content was calculated as

$$\text{Dissolved oxygen (ppm)} = \left[\frac{8 \times 1000 \times N}{V_1}\right] \times V_2$$

Where,

N = Normality of the titrant (0.025 N)

V_1 = Volume of sample (ml)

V_2 = Volume of titrant used (ml)

(1 ml of sodium thiosulphate is equivalent to 0.2 mg oxygen)

Alkalinity:

Alkalinity of the water used in the experiment was measured by titrating 50 ml of sample with standard solution of hydrochloric acid (0.02N). Carbonate alkalinity was determined to the first end point (pH 8.3) using phenolphthalein indicator and bicarbonate alkalinity was determined to the second end point (pH 4.5) using methyl orange indicator.

Total alkalinity was calculated using following formula:

$$\text{Total alkalinity (ppm)} = \frac{\text{ml of titrant 't'}}{\text{ml of sample}} \times 1000$$

Where,

't' = Total volume of titrant used for both the titrations

Nitrate:

The reaction between nitrate and 1, 2, 4-phenoldisulphonic acid produces 6-nitro-1, 2, 4-phenoldisulphonic acid which on conversion to the alkaline salt produces yellow colour. It is employed for the colorimetric determination at a wavelength of 410 nm.

Following steps were followed:

(i) 25 ml of water sample was taken in a china clay dish and evaporated to dryness on a hot water bath.

(ii) The residue was then rubbed thoroughly with 0.5 ml phenoldisulphonic acid reagent to dissolve all the solids.

(iii) 5 ml distilled water was then added and 1.5 ml of concentrated NH_4OH were added one after the other. This mixture was then stirred.

(iv) A yellow colour may develop depending on concentration of nitrate in water.

(v) The supernatant was taken for reading in spectrophotometer at 410 nm against a distilled water blank.

(vi) The value of nitrate was calculated with the help of a standard curve and expressed as NO_3-N in ppm.

Orthophosphate:

Orthophosphate (PO_4-P) in an acidified ammonium molybdate solution produces blue colour when stannous chloride is added. This colour can be measured by spectrophotometer at 690 nm. The estimation was made using following procedure.

(i) 25 ml of water sample was taken in an Erlenmeyer flask. Distilled water blank was also prepared simultaneously.

(ii) 1 ml of ammonium molybdate solution and 0.12 ml (3 drops) of stannous chloride solution were added to this.

(iii) Blue colour appears gradually.

(iv) After 10 minutes, reading on spectrophotometer was taken at 690 nm against a blank.

(v) The value was found with the help of a calibration curve and orthophosphate was expressed as PO_4-P in ppm.

Hardness:

Hardness of experimental water was measured in the following way:

(i) 50 ml of water sample was taken in a conical flask.

(ii) If sample has higher calcium, then a small volume of sample may be taken and diluted to 50 ml volume.

(iii) Then 1 ml of buffer solution is added.

(iv) If higher amounts of heavy metals are present in the sample, 1 ml of Na_2S solution may be added in that sample.

(v) A pinchful of Eriochrome Black T indicator is added which turns the solution red.

Hardness was calculated using following formula:

$$\text{Total Hardness mg}^{-1} \text{ as } CaCo_3 = \frac{\text{ml of titrant used}}{\text{ml of sample}} \times 1000$$

PROXIMATE COMPOSITION OF FISH CARCASS

The fish carcass was analyzed for the proximate composition viz. moisture, crude fat, crude protein, ash and carbohydrate contents as per the standard methods of AOAC (1984).

The details of methods followed for the purpose are stated below:

Estimation of moisture:

The fresh sample was placed in a petri dish and dried in an oven at 60ºC overnight and cooled in a dissicator.

The moisture in sample was calculated as follows:

$$\text{Moisture (\%)} = \frac{\text{Initial weight – final weight}}{\text{Initial weight}} \times 100$$

Estimation of crude fat:

This was measured using soxhlet extraction assembly. Two grams of dried and powdered sample was taken in pouch of whatman No.40 filter paper. The sample was then extracted with petroleum ether at 60-80ºC in soxhlet apparatus. The extraction was continued for 14 hours at a condensation rate of 2-3 drop per minute. After extraction, sample was dried in an oven at 60ºC, cooled and final weight was recorded. The difference in initial and final weights of sample indicates the crude fat. The fat content of the sample was expressed as;

$$\text{Crude fat (\%)} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100$$

Estimation of crude protein:

Crude protein was determined following microkjedahl method. One hundred milligram of dried powdered sample was transferred to 30 ml microkjedahl digestion

flask followed by 500 mg-catalyst mixture and 2 ml concentrated H_2SO_4. The mixture was digested till the content become colourless. Sample was cooled and volume made to 10 ml by adding double distilled water.

The content was then transferred to the steam distillation unit, followed by adding 10 ml 40% NaOH to make the contents thoroughly alkaline. In 100 ml conical flask, 5 ml of 4% boric acid solution and 4 drops of indicator (methyl red 0.2% and methyl blue 0.2% in 2:1 ratio) were added. The flask was kept beneath the condenser with the tip of delivery tube immersed in the solution. Steam was then passed through the alkaline digestion. When the volume of collected distillated reaches up to 25 ml, the flask was removed after rinsing the tip of condenser tube in the flask.

The content of the flask was then titrated against standard HCL (0.02 N) till the pinkish violet colour appeared. A blank was also run simultaneously. The total nitrogen was calculated by the following formula;

$$\% \text{ Nitrogen} = \frac{(S-B) \times \text{Normality of HCL} \times \text{Equivalent weight of N}}{\text{Weight of sample used (mg)}} \times 100$$

Where,

S = ml of HCL required for sample

B = ml of HCL required for blank

Equivalent weight of nitrogen = 14.007

The per cent crude protein in sample was calculated by multiplying the total nitrogen value with 6.25.

Estimation of ash:

Two grams of dried and powdered sample was weighed in a previously heated and cooled silica crucible and incinerated in muffle furnace pre-heated to 555ºC for 4-5 hours. The crucible containing fully burnt material was transferred to dessicator, cooled and weighed. The difference between initial and final weights was noted. The ash was reported in percentage as follows:

$$\text{Ash (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

Estimation of carbohydrate:

The amount of carbohydrate in the sample was calculated by difference method. The sum of crude protein, crude fat, ash and moisture was subtracted from 100.

Carbohydrate (%) = 100 – (Crude protein + Crude fat + ash + moisture

Statistical analysis:

For checking the significance level of treatments with respect to measured weight of fish statistical analysis were made using ANOVA table:

Source of variation	d.f.	Sum of squares	Mean sum of squares	f_{cal}	f_{tab}
Between treatment	(t-1)	S.S.T	$\frac{S.S.T}{d.f.}$ = T.M.S.	$\frac{T.M.S}{E.M.S}$	
Within treatment	t(n-1)	E.S.S.	$\frac{E.S.S}{d.f.}$ = E.M.S		
Total	tn-1				

Where,

t = No. of treatments

n = No. of replications

If $f_{cal} > f_{tab}$ at 0.05 level of significance, the result of experiments are considered to be significant.

4. RESULTS

Results on water quality and growth parameters with the use of Gokhru mixed diets are presented in the Table 2-7 and Fig. 1 (a-h).

1. GOKHRU MIXED DIET

WATER QUALITY:

In general, water temperature remained congenial throughout the experimental period. Notable fluctuations in air and water temperatures were observed throughout the experimentation. The minimum water temperature of 27.0 was recorded in T_1 and maximum of 30.5 was in T_3 and C (Control). The lowest mean temperature was in T_1 whereas, T_4 had the highest mean temperature (Table-2).

The pH of the experimental water was in the range of 7.9-8.9 and thus remained alkaline throughout the experiment. The electrical conductivity ranged between 2.14-3.30 dS/cm in different aquaria. In T_1, minimum electrical conductivity was 2.14 dS/cm and maximum was 3.30 dS/cm in T_4. The lowest mean value of electrical conductivity was in T_1 and the highest was observed in T_4.

The dissolved oxygen in experimental aquaria fluctuated between 6.4-8.8. Minimum dissolved oxygen was in T_2, T_4 and C (control) i.e. 6.4 ppm whereas maximum was observed in T_3 and C (control) i.e. 8.8 ppm.

The dissolved carbondioxide of the water in the treatments ranged from 0 to 8 ppm. Minimum dissolved carbondioxide was 0 (zero) that means absent in all treatments but maximum was in T_4 i.e. 8 ppm. The total alkalinity fluctuated between 420 to 680 ppm. The minimum total alkalinity was in T_1 i.e. 420 ppm and maximum was observed in T_2 i.e. 680 ppm. The lowest mean total alkalinity was in T_1 (539.56 ppm) and highest (569.04 ppm) was in C (control).

The values of hardness in the water of different aquaria ranged between 528 to 768 ppm. The lowest mean value of hardness was in C (control) and the highest was observed in T_4.

The orthophosphate of the experimental water was in the range of 0.060 to 0.400 ppm. The lowest mean value of orthophosphate was in T_2, T_3 and C (Control) i.e. 0.216 ppm and the highest was found in T_1 and T_4 i.e. 0.225 ppm.

The nitrate fluctuated between 0.26 to 1.38 ppm. The lowest mean nitrate was observed in T_1, T_2 and T_3 i.e. 0.698 ppm and the highest was observed in T_4 and C (Control) i.e. 0.699 ppm. All the above stated water quality parameters are presented in Table-2 and Fig. 1 (a-h). It would be evident that these water quality parameters remained congenial for fish throughout the experimental period.

FISH GROWTH

Weight gain in fish was observed in all the treatments containing the herb-Gokhru in the diet performed better as compared to control (plate-D). The total food offered was 2 per cent of total body weight of fish in each aquaria. Survival of the fish was 100 per cent in all the treatments including the control.

WEIGHT GAIN:

The diet T_3 (containing Gokhru @ 0.12 gm per kg body weight per day) gave the highest weight gain of 7.832 gm whereas, the lowest weight gain (4.00 gm) was observed in control (diet devoid of Gokhru). The weight gain in T_1 (Gokhru @ 0.04 gm per kg body weight per day), T_2 (Gokhru @ 0.08 gm per kg body weight per day) and T_4 (Gokhru @ 0.16 gm per kg body weight per day) were 6.199 gm, 6.498 gm and 5.665 gm, respectively (Table-3).

Total weight gain in per cent was 44.75 in T_3 and 22.22 in C (Control) whereas in per cent for T_1, T_2 and T_4 were 35.42, 38.21 and 33.01, respectively.

Statistical analysis of variance indicated that weightgain was significantly higher in all treatments as compared to control ($P<0.05$). Moreover, CD test indicated significant difference between all the treatments. CD test further indicated that diets T3 and T2 were not significantly different at 5 per cent level of significance during 31-45th day and 46-60th day (Appendix-1).

Growth per day in per cent body weight of fingerlings:

The growth per day in per cent body weight was highest (0.746) in treatment T_3 and lowest in C (0.370). The growth per day in per cent body weight was 0.590 in T_1, 0.637 in T_2 and 0.550 in T_4 (Table-4). Further, the highest growth per day in per cent was observed during 0-15th days in all the treatments containing Gokhru at different doses as well as control i.e., 0.533, 0.601, 0.711, 0.518, 0.333 in T_1, T_2, T_3, T_4 and C (Control), respectively.

Statistical analysis of variance indicated that growth per day in per cent body weight was significantly higher in all the treatments as compared to control (Appendix-II).

Specific Growth Rate (SGR):

Specific growth rate was highest in T_3. In T_3, it was 0.268 per cent whereas it was 0.219, 0.234, 0.206 and 0.145 per cent in T_1, T_2, T_4 and C (Control), respectively during sixty days (Table-5). Further, SGR were 0.223, 0.250, 0.293, 0.217 and 0.141 in T_1, T_2, T_3, T_4 and C (Control), respectively during 0-15th day. It was observed 0.226, 0.235, 0.275. 0.206 and 0.149 in T_1, T_2, T_3, T_4 and C (Control), respectively during 16-30th day. During 31-45th day, SGR was found 0.218, 0.231, 0.260, 0.202 and 0.142 in T_1, T_2, T_3, T_4 and C, respectively. SGR have been computed 0.211, 0.222, 0.242, 0.201 and 0.149 in T_1, T_2, T_3, T_4 and control, respectively. The SGR was highest during 0-15th day in T_2, T_3 and T_4, whereas in T_1 and C it was highest in 16-30th day.

Statistical analysis of variance indicated that SGR was significantly higher in all the treatments as compared to control (Appendix-III).

Food Conversion Ratio (FCR):

Food conversion ratio in the experimental fish was the lower in the treatment T_3 which has also shown the highest growth rate. T_3 has shown a FCR of 3.120 whereas it was highest in control i.e. 5.828 (Table-6) exhibiting the lowest growth. In T_3, FCR was 2.813, 3.006, 3.196 and 3.438 during rearing period of 0-15th, 16-30th, 31-45th and 46-60th days, respectively. In T_3, FCR was the highest during 46-60th day and the lowest during 0-15th day. FCR in T_1 was 3.750, 3.699, 3.831 and 3.970 during 0-15th, 16-30th, 31-45th and 46-60th days, respectively. The highest FCR in T_1 was observed during 46-60th day and lowest during 31-45th day. In T2, FCR was 3.328, 3.564, 3.625 and 3.778 during 0-15th, 16-30th, 31-45th and 46-60th day, respectively. In T_2, FCR was the highest in 46-60th day and lowest during 0-15th day, respectively. In T_4, FCR was 3.878, 4.063, 4.172 and 4.172 during 0-15th, 16-30th, 31-45th and 46-60th days respectively. In T_4, FCR was highest in 31-45th, 46-60th days and lowest during 0-15th day. On the other hand, the control has shown FCR of 6.010, 5.670, 5.996 and 5.736 during 0-15th, 16-30th, 31-45th and 46-60th days respectively. The treatment with lowest FCR shown highest weight gain.

Statistical analysis of variance test indicated that FCR was significantly higher at 5 per cent level of significance ($P<0.05$) (Appendix-IV).

Gross Conversion Efficiency (GCE):

Gross conversion efficiency was recorded highest (0.320) in T_3 and it was 0.262, 0.280, 0.246 and 0.172 in T_1, T_2, T_4 and C (Control), respectively. The lowest (0.172) GCE was observed in control (Table-7). The highest GCE was observed during 0-15th day in T_2, T_3 and T_4 whereas, 16-30th day in T_1 and C (Control).

Statistical analysis of variance indicated significantly higher GCE in all treatments as compared to control. (Appendix-IV).

Proximate Composition of fish carcass:

The proximate composition of fish carcass has been assessed after the completion of experimental period, which has been shown in Table-8. The results have shown significant changes in the proximate composition of fingerlings fed with herb supplemented diets when compared with that of the control. The protein, fat, carbohydrate and ash contents increased significantly in T_1, T_2, T_3 and T_4 as compared to control. The protein content was highest in T_3.

Protein values of T_1, T_2, T_3, T_4 and control fish were 14.60%, 15.15%, 15.17%, 14.75% and 13.27%, respectively. It is noteworthy that the protein value of fingerlings fed with the basal diet was the lowest as compared to that of fingerlings fed with herbal diets. The fat content was also found higher in the fingerlings fed with herbal diets as compared to that of control diet. However, fat content of T_3 was higher (5.30) than T_2, i.e. 5.05. Fat values of T_1, T_2, T_3, T_4 and control were 4.35%, 5.05%, 5.30%, 4.20% and 2.80% respectively. The carbohydrate contents of fish fed with T_1, T_2, T_3 and T_4 diets were also in increasing order when compared with the control. Thus, carbohydrate values of C, T_4, T_1, T_2 and T_3 fish were 2.94%, 3.37%, 3.62%, 3.97% and 4.08%, respectively. The moisture contents of all the diets were found in the order of $T_3<T_2<T_1<T_4<C$ where the moisture values of 73.00%, 73.48%, 75.33%, 75.48%, and 78.94%, respectively observed. Ash contents of T_1, T_2, T_3, T_4 and control were 2.10%, 2.35%, 2.45%, 2.20% and 2.10%, respectively wherein control fish showed the lowest ash content.

5. DISCUSSION

In the present study use of herb supplemented diet revealed better performance in terms of weight gain and other parameters such as growth per day in per cent body weight, specific growth rate as well as food conversion ratio and gross conversion efficiency. The supplementary diet containing @ 0.12 gm. Gokhru per day kg body weight per day showed the highest growth and gross conversion efficiency. Weight gain in T_3 (diet containing Gokhru 0.12 gm per kg body weight per day) was 7.832 gm whereas, the control diet exhibited weight gain 4.000 gm during 60 days experimental period. Weight gained at different intervals in different treatments are shown in Table-3. During the experimental period, the water quality parameters remained favourable for fishes as evident from their 100% survival.

Temperature determines the rate of chemical transformations (Jhingran, 1983), rate of digestion and frequency of food exchange in the digestive tract (Janeck, 1976). Backiel and Horoszewicz (1970) found that the intensity of carp feeding increased with the rise in temperature from 28ºC to 29ºC. Hickling (1962) reported that fall in temperature slow down the carp feeding activities. Jhingran (1983) has suggested the optimum temperature range for major carps culture from 18.3-37.8ºC. Prinsloo and Schoonbee (1984) observed a marked decline in fish production when mean water temperature of ponds, was below 20ºC. In the present study, the temperature of water varied between 27ºC to 30.5ºC in the experimental aquaria. Further, in present experiment the mean water temperature was between 28.57ºC and 28.78ºC. Thus, the water temperature was similar to the range prescribed by Jhingran (1983).

Lagler (1972) considered water having pH range of 7.0 to 8.5 as favourable for fishes. Swingle (1957) reported the optimum growth of fish at pH ranging between 7.5 and 8.5. In the present experiment, the pH of water ranged between 7.8 and 8.9 in experimental aquaria with Gokhru supplemented diets and this could be considered congenial for good fish growth. Thus, pH had not been a limiting factor for fish growth.

In the present experiment, electrical conductivity of the water also remained suitable in all the aquaria throughout the experiment with Gokhru supplemented diet and observed EC (2.14-3.30 dS/cm) clearly depicts the favourable ionic load of the experimental water (Table-2).

Dandraff and Dean (1967) suggested the lowest lionit of dissolved oxygen (5 mg/lit) for good fish production in pond. However, Smitherman and Boyd (1974) considered dissolved oxygen level of about 2 mg/lit. as favourable for proper health and growth of fish in normal pond conditions. Jhingran (1983) opined that the concentration of dissolved oxygen above 7 mg/lit. is suitable for a productive pond water. Further, the high concentration of dissolved oxygen affect metabolic rate and consequently the feeding of fish (Lovell, 1976). The dissolved oxygen content of the experimental water ranged between 6.4 ppm to 8.8 ppm in the experiment performed with Gokhru supplemented diet. The aeration of water with the help of aerator and periodical renewal of water probably helped to maintain higher dissolved oxygen levels throughout the experiment. Fairly good growth of fish especially with Gokhru @ 0.12 gm/kg body weight/day indicates that the recorded range of dissolved oxygen appears to be suitable for the fingerlings of *Labeo rohita* (Ham.). Movement of fishes in the aquaria as revealed from the visual observations further affirmed the view that fish enjoyed favourable dissolved oxygen throughout the experiment.

According to Swingle (1967), free CO_2 at a concentration of 15 mg/lit. is detrimental for fish growth. From this point of view the free CO_2 content was 0 to 8 ppm in the experimental aquaria. The prevailing environmental conditions of low CO_2 thus clearly justified good sanitary conditions of the experimental waters.

Banerjee (1967) found water having total alkalinity above 90 mg/lit to be productive. Alikunhi (1957) reported that in highly productive water, the alkalinity ought to be over 100 mg/lit. Higher alkalinity has a greater complement to most of the ions than water with low alkalinity (Moyle, 1946). In this experiment, the total alkalinity ranged between 420 to 680 ppm in experimental aquaria with Gokhru supplemented diets. Obviously this range of total alkalinity is good for rearing fish in the aquaria.

In the present study, hardness, orthophosphate and nitrate of the water in the experimental aquaria ranged between 528 to 768, 0.060 to 0.400 ppm and 0.26 to 1.38 ppm, respectively. These values are suitable for fish growth in the experimental aquaria. The performance of Gokhru enriched diets is well reflected in various growth parameters. Therefore, the average weight gain, per day weight gain, specific growth rate and gross conversion efficiency were high with Gokhru @ 0.12 gm/kg body weight/day. Thus, the fingerlings of *Labeo rohita* (Ham.) fed with Gokhru performed much better than the fingerlings fed with conventional control diet (Table-3 to 7).

Ojha (1990) studied the dietary requirement of magnesium and magnesium/calcium of an Indian major carp and during this investigation, he found that proximate composition of carcass showed variation with different levels of magnesium and magnesium/calcium in the supplementary feed. Such variations in proximate composition were also evident in the present study.

Kalla (1995) used sorghum and soybean meals as supplementary feed for *Cirrhinus mrigala* (Ham.) and found significant changes in the proximate composition of fish carcass as compared to control. Nandeesha *et al*. (2000) reported that net protein retention, protein digestibility, carcass protein content in *Cyprinus carpio* (Linn.) and *Cirrhinus mrigala* (Ham.) increased with sodium chloride supplementation in the supplementary feed.

From the proximate composition of the experimental fingerlings fed with Gokhru supplemented diets (Table-8). Increase in the protein content was observed in thefish receiving herb supplemented diets as compared to those receiving only rice bran and groundnut oil cake. Fat content of experimental fishes was found in the order $T_3 > T_2 > T_1 > T_4 >$ C i.e. 5.30% > 5.05% > 4.35% > 4.20 > 2.80%, respectively.

Carbohydrate contents were also higher in the fishes receiving herb supplemented diets as compared to those receiving control diet. However, carbohydrate content of fishes of T_3 was higher as compared to fishes of T_1, T_2 and T_4. This increase in carbohydrate contents in fishes of herb supplemented diet could be due to presence of rich carbohydrate in the herb Gokhru.

Ash contents of experimental fishes of T_1, T_2, T_3, T_4 and control were 2.10%, 2.35%, 2.45%, 2.20% and 2.05%, respectively (Table-8). This increase of ash content in the fishes fed with Gokhru enriched diet compared to fishes of control could be due to lower moisture content in the fishes of T_1, T_2, T_3 and T_4 than those of control. Further, moisture content was higher in fishes fed with control diet as compared to fishes fed with various herb supplemented diets (Table-8).

Growth promoters have been tried successfully by many scientists. Santiago (1991) determined the effect of a commercial growth promoter Bayo-n-Ox in Nile tilapia fingerlings. After six weeks, weight gain of fish fed with 25 mg Bayo-n-Ox body weight was some what higher than that of the control.

Some scientists have also used herbal growth promoters in the fish diet. Euphrasia and Jayaprakas (1996) have tried herbal growth promoter Livol-IHF 1000 on

the growth performance of *Cirrhinus mrigala* (Ham.). It was found that Livol incorporated diets @ 2.5% exhibited superior growth. Kavitha (1996) while assessing the impact of two herbs namely Satavari and Chandrashoor as growth promoters in the supplemented diets of an Indian major carp *Labeo rohita* (Ham.) found significant increases in fish growth using these herbs. Satavari was mixed at three different levels in the conventional feed (viz. 0.1, 0.2 and 0.3 gm/kg body wt./day) and feed was fed @ 6 per cent body weight per day to the fry. The fry fed on feed mixed with Satavari @ 0.2 gm/kg body wt./day has shown the highest growth increments. Another herb Chandrashoor was also mixed at three different levels (viz., 0.1, 0.2 and 0.3 gm/kg body wt./day) in the conventional feed. The feed was fed @ 1.5 per cent body wt./day. The fingerlings fed with feed mixed with Chandrashoor @ 0.2 gm/kg body wt./day has shown higher growth increments than other diets. Kumar (2000) reported that use of herb Ashwagandha as growth promoter in the supplementary feed on Indian major carp *Cirrhinus mrigala* (Ham.). In this study, Ashwagandha was used @ 0.02, 0.04 and 0.08 gm/kg fish body wt./day in the basic diet. The rate of feeding was 3% of body wt./day. The fingerlings fed with diet containing Ashwagandha @ 0.08 gm/kg showed higher weight gain (45.14%) as compared to the control (19.86). Food conversion ratio and gross conversion efficiency were also better with Ashwagandha. Similarly, Kumar (2000) studied the effect of herb used Safed musli as growth promoter in the supplementary diet of an Indian major carp *Cirrhinnus mrigala* (Ham.) for a period of 60 days. In this study Safed musli in the supplementary feed of fish used at three different doses ranging from 0.02 to 0.08 gm/kg body wt./day. The diet given at 3% body weight with Safed musli @ 0.02 gm/kg body wt./day gave better growth in terms of weight gain of 2.9675 gm whereas control exhibited weight gain of 1.925 gm only. The growth per day in per cent body weight, FCR, GCE and SGR were also better with diet S_1 as compared to other diets. Rajkumar (2002) reported two herbs, Mulethi (*Glycyrrhiza glabra* Linn.) and Kali musli (*Circuligo archioides* Gaertn.) as growth promoter in the supplementary feed of an Indian major carp *Cirrhinus mrigala* (Ham.) and found significant results. Under this study Mulethi was mixed in the supplementary feed @ 0.02, 0.04 and 0.06 gm/kg body wt./day namely T_1, T_2 and T_3, respectively. The food offered was 2 per cent of body weight of fish per day in each aquaria. The diet T_3 @ 0.06 gm/kg body wt./day performed better growth of 24% whereas control exhibited weight gain of 12.77%. Another herb Kali musli was mixed in the supplementary feed @ 0.02, 0.04 and 0.06 gm/kg body wt./day namely R_1, R_2 and R_3, respectively. The food offered was 2 per cent of body weight of fish per day in each aquaria. The fingerlings fed with

diet R_3 containing Kali musli @ 0.06 gm/kg body wt./day showed better growth of 28% whereas control exhibited weight gain of 12.77% only. The growth per day in per cent body weight, FCR, GCE and SGR were also better with diet T_3 and R_3 as compared to other diets. Fingerlings fed with T_3 and R_3 diets also showed significant alterations in the proximate composition as compared to the control. Kour Dalveer (2003) reported that use of herb Bala as growth promoter in the supplementary feed of an Indian major carp *Cirrhinus mrigala* (Ham.). In this study, Bala was used @ 0.06, 0.10, 0.14 and 0.18 gm/kg body wt./day in the basic diet. The rate of feeding was 2% of body wt./day. The fingerlings fed with diet containing Bala @ 0.14 gm/kg fish body wt./day showed higher weight gain (26.50%) as compared to the control (12.22%). The growth per day in per cent body weight, FCR, GCE and SGR were also better with diet B_3 as compared to other diets. Similarly, Singh (2003) studied the effect of herb Makhana as a growth promoter in the supplementary feed of an Indian major carp *Cirrhinus mrigala* (Ham.). In this study, Makhana was used @ 0.16, 0.20, 0.24, 0.28 and 0.32 gm/kg body wt./day in the basic diet. The rate of feeding was 2% of body wt./day. The fingerlings fed with diet containing Makhana @ 0.32 gm/kg body wt./day showed higher weight gain (24.23%) as compared to the control (5.26%). The growth per day in per cent body weight, FCR, GCE and SGR were also better with diet T_5 as compared to other diets.

Thus, in view of the promising results of the present research, the Gokhru herb has a great potential in aquaculture as growth promoter. Being an ingredient of herbal origin, bioaccumulation and probably no adverse effects on the consumers health. Moreover, this herb is conveniently available at rather cheaper cost and are more effective than many other commercial growth promoters and thus needs to be tried in commercial aquaculture practices for different fish species.

In view of the preliminary screening experiment it is proved that the herb Gokhru (*Pedalium murex* Linn.) could be used as good growth enhancer for carps. This herb is used in fish for the first time as growth enhancer and thus opens new avenues for further research and experimentation with other fish species taking other water quality, fish biological and biochemical parameters into consideration.

6. SUMMARY

Our country has vast Inland aquatic resources in the form of small, medium and large size reservoirs and lakes. Besides these, thousands of seasonal water bodies and lotic water resources are readily available for carp culture. In view of fact that fish harvesting from sea has already reached to optimum level, there is increasing need harness the aquatic productivity by way of fish farming. This is also essential to cope with increasing human population and demand for the food.

For several reasons freshwater aquaculture industry in India is still under the process of development and standardization with respect to the species selection, their ratio, stocking rate, pond management quality of fish feed, etc.

In aquaculture feed accounts for bulk of the total cost and therefore holds key of success of fish farming. From this point of view fish nutrition has great relevance to fish farming of intensive and semi intensive types. For achieving good growth in fish the feed must be nutritiously balanced with moderate amounts of protein, carbohydrate and minerals as deficiency for these ingredients in the supplementary diets may result ailment in the body of fish for growth. Considering this, such for ideal fish feed is an growing process wherein several attempts have been made so far upgrading the quality of supplementary fish diet for culturable fish.

For pursuing such type of research the herb Gokhru (*Pedalium murex* Linn.) has been employed for the first time as ingredient to supplementary diet of Indian major carp *Labeo rohita* (Ham.). In this investigation, conducted for the duration of 60 days taking rohu fingerlings as the experimental fish, for different doses @ 0.04, 0.08, 0.12 and 0.16 gm/kg fish body wt./day. The basal conventional diets was groundnut oil cake and rice bran in ratio of 1:1. The experiment was conducted in glass aquaria of 54 litres capacity, which were filled with 36 litres of well water. These aquaria were covered with mosquito netting to avoid escape of fish.

In each aquaria five fingerlings were introduced. The fishes were acclimatized for five days before starting the feeding trial. During this period they were fed with basal diet of groundnut oil cake and rice bran. During 5 days acclimatization and subsequently for experimental rearing period of 60 days. Fingerlings were fed at the rate of 2% of their

body weight. The quantity of food required by experimental fingerlings was corrected at 15 days interval after taking their weight.

This thesis comprises of six chapters. Chapter-1 embodies the introduction about the subject matter and importance of the proposed work. Chapter-2 deals with the literature consulted for this research. Chapter-3 contains various materials and methods followed in the present research work for the analysis of water quality, growth of fish and other related parameters. Statistical procedures applied in this investigation have also been stated in this chapter. In Chapter-4 results of this research have been presented. Chapter-5 comprises of all the observations made during this research in the light of observation made by earlier workers in the term of comprehensive discussion.

This study attempts to justify that fingerlings fed with Gokhru have shown better growth, specific growth rate, low food conversion ratio and high gross conversion efficiency than the control diet, which was devoid of Gokhru. The fingerlings of *Labeo rohita* (Ham.) fed on feed mixed with Gokhru @ 0.12 gm/kg body wt./day have shown the highest growth and survival amongst all the five diets (including control) tried.

During the total experimental rearing of 60 days per cent weight gain 44.75 per cent and specific growth rate was 0.268 in the diet mixed with Gokhru @ 0.12 gm/kg body wt./day. In this experimental diet FCR of 3.120 was found, which is the lowest as compared to all other diets. The gross conversion efficiency for this diet was 0.320 for 60 days. By analysis of variance (ANOVA) the fish fed with a diet mixed with Gokhru @ 0.12 gm/kg body wt./day showed significantly higher growth as compared to other diets. In the control, the growth was least as compared to other treatments.

Proximate composition of fish fed with Gokhru mixed diet further confirmed that its biochemical configuration was fairly satisfactory.

Therefore, in the present investigation, it has been clearly proved that for promoting growth in Indian major carp *Labeo rohita* (Ham.), the diet mixed with Gokhru should invariably be offered in the daily rations of this major carp. Moreover, in view of the encouraging results obtaining for Rohu, there is much scope for further research in this direction using this herbal feed formulations and other fish species under varied environmental conditions.

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ABSTRACT

Use of Herb, Gokhru (*Pedalium murex* Linn.) as Growth Promoter in the Supplementary Feed of an Indian Major Carp, *Labeo rohita* (Ham.)

Preeti Naiyr* (Research Scholar)

Dr.B.K.Sharma** **(**Major Advisor)

In the present investigation, herb, Gokhru was used as growth promoter with the supplementary feed of an Indian major carp, *Labeo rohita* (Ham.). Basal diet of fish comprised of groundnut oil cake and rice bran in 1:1 ratio. The fingerlings of *Labeo rohita* (Ham.) were reared for 60 days (excluding initial 5 days of acclimatization period) in the glass aquaria having 54 litres of water. During this experiment, the fingerlings of rohu were fed with four experimental diets. Growth parameters such as weight gain, FCR, GCE, SGR etc. were also monitored to assess the use of this herb as growth promoter. After 60 days of experimental period, proximate composition of fingerlings reared in these aquaria was also determined for observing the effect of herb on the biochemical profile of experimental fish.

Gokhru was mixed with the supplementary diet of fish at four different levels viz., 0.04, 0.08, 0.12 and 0.16 gm/kg body wt./day. The fingerlings fed with diet T_3 containing Gokhru @ 0.12 gm/kg body wt./day performed better growth in terms of weight gain to the extent of 44.75%, whereas, fish reared on control diet exhibited weight gain of 22.22% only. The growth per day in per cent body weight, FCR, GCE and SGR were also superior with T_3 diet. Further, fingerlings fed with this diet showed significant change in the proximate composition compared to the control. Based on this experiment following ranking can be made for relative performance of various doses tried.

T_3 > T_2 > T_1 > T_4 > C (control)

(0.12) (0.08) (0.04) (0.16) (No herb)

This preliminary screening of Gokhru herb tried for the first time on rohu suggests for undertaking further trials under field conditions taking different parameters and other fish species for experimentation.

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Place : Udaipur
Date :

Preeti Naiyr

Table 1: Selected water quality parameters of source (well) water used for experimental purpose.

S.No.	Parameters	Range
Physical Parameters		
1.	Temperature (ºC)	26.5-30.0
2.	pH	8.0-8.9
3.	Electrical conductivity (dS/cm)	2.20-3.00
Chemical parameters		
1.	Dissolved oxygen (ppm)	6.4-8.0
2.	Orthophosphate (ppm)	0.060-0.365
3.	Nitrate (ppm)	0.06-1.02
4.	Alkalinity (ppm)	420-640
5.	Hardness (ppm)	530-700
6.	Free carbon dioxide (ppm)	Absent

Table 2: Values of selected water quality parameters in the experimental waters with the use of Gokhru mixed diet

Parameters	Treatment	Minimum	Maximum	Average	SD
Air temperature (ºC)		**29.9**	**34.0**	**31.22**	**±1.363**
Water temperature (ºC)	T_1	27.0	30.0	28.57	±2.758
	T_2	27.2	30.0	28.66	±2.768
	T_3	27.2	30.5	28.71	±2.958
	T_4	27.2	30.0	28.78	±2.895
	C	27.1	30.5	28.74	±1.083
pH	T_1	7.9	8.9	8.51	±0.204
	T_2	7.8	8.7	8.44	±0.185
	T_3	8.0	8.7	8.47	±0.131
	T_4	8.0	8.9	8.45	±0.176
	C	8.0	8.8	8.52	±0.184
Electrical Conductivity EC (dS/cm)	T_1	2.14	2.83	2.59	±0.23
	T_2	2.26	3.25	2.96	±0.32
	T_3	2.20	3.07	2.74	±0.26
	T_4	2.56	3.30	3.00	±0.30
	C	2.40	2.94	2.71	±0.20
Dissolved oxygen (ppm)	T_1	7.2	8.0	8.15	±0.648
	T_2	6.4	8.0	8.17	±0.688
	T_3	7.2	8.8	8.10	±0.446
	T_4	6.4	8.0	8.04	±0.465

	C	6.4	8.8	8.05	±0.662
Total Alkalinity (ppm)	T_1	420	652	539.56	±51.88
	T_2	472	680	565.78	±51.49
	T_3	472	620	550.74	±37.61
	T_4	504	640	569.04	±38.76
	C	504	652	550.22	±46.90
Hardness (ppm)	T_1	532	716	626.07	±62.63
	T_2	528	716	653.11	±66.59
	T_3	528	768	659.56	±61.33
	T_4	532	700	663.56	±68.17
	C	528	700	624.89	±67.90
Orthophosphate (ppm)	T_1	0.062	0.400	0.225	±0.102
	T_2	0.060	0.390	0.216	±0.123
	T_3	0.060	0.390	0.216	±0.135
	T_4	0.062	0.400	0.225	±0.100
	C	0.060	0.390	0.220	±0.113
Nitrate (ppm)	T_1	0.26	1.37	0.698	±0.349
	T_2	0.27	1.38	0.698	±0.349
	T_3	0.26	1.38	0.698	±0.350
	T_4	0.27	1.37	0.699	±0.346
	C	0.27	1.37	0.699	±0.348
Free Carbon dioxide (ppm)	T_1	0	4	0.67	±0.943
	T_2	0	4	0.52	±0.648
	T_3	0	4	0.74	±1.024
	T_4	0	8	1.26	±1.310

	C	0	4	0.67	±1.414

Table 3: Average weight gain of fingerlings of *Labeo rohita* (Ham.) fed with varying levels of Gokhru mixed diet

S.No.	Gokhru (gm/kg body wt./day)	Initial weight (in gm)	Fish weight gain (gm)				Total net weight gain (gm)	% weight gain in 60 days
			15th day	30th day	45th day	60th day		
1.	0.04 (T_1)	17.500	1.400	1.533	1.600	1.666	6.199	35.42
2.	0.08 (T_2)	17.000	1.533	1.566	1.666	1.733	6.498	38.21
3.	0.12 (T_3)	17.500	1.866	1.933	2.000	2.033	7.832	44.75
4.	0.16 (T_4)	17.166	1.333	1.366	1.433	1.533	5.665	33.01
5.	Control (C)	18.000	0.900	1.000	1.000	1.100	4.000	22.22
	CD (P=0.05)		0.069	0.083	0.107	0.111	0.221	

Table 4: Growth per day in per cent body weight of fingerlings of *Labeo rohita* (Ham.) fed with varying levels of Gokhru mixed diet

S.No.	Gokhru (gm/kg body wt./ day)	Growth per day in per cent body wt. of fingerlings (%)				
		0-15th day	**16-30th day**	**31-45th day**	**46-60th day**	**0-60th day**
1.	0.04 (T_1)	0.533	0.541	0.522	0.504	0.590
2.	0.08 (T_2)	0.601	0.563	0.553	0.531	0.637
3.	0.12 (T_3)	0.711	0.665	0.626	0.582	0.746
4.	0.16 (T_4)	0.518	0.492	0.481	0.480	0.550
5.	Control (C)	0.333	0.353	0.335	0.351	0.370
	CD (P=0.05)	0.030	0.027	0.034	0.034	0.021

Table 5: Specific Growth Rate (SGR) of *Labeo rohita* (Ham.) fingerlings fed with varying levels of Gokhru mixed diet

S.No.	Gokhru (gm/kg body wt./ day)	SGR of fingerlings (%)				
		0-15th day	**16-30th day**	**31-45th day**	**46-60th day**	**0-60th day**
1.	0.04 (T_1)	0.223	0.226	0.218	0.211	0.219
2.	0.08 (T_2)	0.250	0.235	0.231	0.222	0.234
3.	0.12 (T_3)	0.293	0.275	0.260	0.242	0.268
4.	0.16 (T_4)	0.217	0.206	0.202	0.201	0.206
5.	Control (C)	0.141	0.149	0.142	0.149	0.145
	CD (P=0.05)	0.012	0.011	0.014	0.014	0.007

Table 6: Food Conversion Ratio (FCR) of *Labeo rohita* (Ham.) fingerlings fed with varying levels of Gokhru mixed diet

S.No.	Gokhru (gm/kg body wt./ day)	FCR of fingerlings				
		0-15th day	**16-30th day**	**31-45th day**	**46-60th day**	**0-60th day**
1.	0.04 (T_1)	3.750	3.699	3.831	3.970	3.817
2.	0.08 (T_2)	3.328	3.564	3.625	3.778	3.577
3.	0.12 (T_3)	2.813	3.006	3.196	3.438	3.120
4.	0.16 (T_4)	3.878	4.063	4.172	4.172	4.071
5.	Control (C)	6.010	5.670	5.996	5.736	5.828
	CD (P=0.05)	0.281	0.177	0.373	0.442	0.122

Table 7: Gross Conversion Efficiency (GCE) of *Labeo rohita* (Ham.) fingerlings fed with varying levels of Gokhru mixed diet

S.No.	Gokhru (gm/kg body wt./ day)	GCE of fingerlings				
		0-15th day	**16-30th day**	**31-45th day**	**46-60th day**	**0-60th day**
1.	0.04 (T_1)	0.267	0.270	0.261	0.252	0.262
2.	0.08 (T_2)	0.301	0.282	0.276	0.265	0.280
3.	0.12 (T_3)	0.355	0.333	0.313	0.291	0.320
4.	0.16 (T_4)	0.259	0.246	0.240	0.240	0.246
5.	Control (C)	0.167	0.176	0.167	0.176	0.172
	CD (P=0.05)	0.015	0.013	0.017	0.017	0.008

Table 8: Proximate Composition of carcass of *Labeo rohita* (Ham.) fingerlings fed with varying levels of Gokhru mixed diet

S.No.	Treatments	Proximate composition of fish (%)				
		Moisture	**Fat**	**Protein**	**Ash**	**Carbohydrate**
1.	Gokhru @ 0.04 gm/kg body wt./day + [oil cake + rice bran (1:1)] T_1	75.33	4.35	14.60	2.10	3.62
2.	Gokhru @ 0.08 gm/kg body wt./day + [oil cake + rice bran (1:1)] T_2	73.48	5.05	15.15	2.35	3.97
3.	Gokhru @ 0.12 gm/kg body wt./day + [oil cake + rice bran (1:1)] T_3	73.00	5.30	15.17	2.45	4.08
4.	Gokhru @ 0.16 gm/kg body wt./day + [oil cake + rice bran (1:1)] T_4	75.48	4.20	14.75	2.20	3.37
5.	Control [oil cake + rice bran (1:1)] C	78.94	2.80	13.27	2.05	2.94

APPENDIX-1

ANOVA for Average weight gain of *Labeo rohita* (Ham.) fingerlings fed with varying levels of Gokhru mixed diet

0-15th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	1.95651	0.48912	233.363*
Within treatments	15	0.03144	0.00209	
Total	19			
S Em± = 0.02289	CD = 0.06900	CV = 3.26		

16-30th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	1.83523	0.45880	152.766*
Within treatments	15	0.04505	0.00300	
Total	19			
S Em± = 0.02740	CD = 0.08259	CV = 3.70		

31-45th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	2.13657	0.53414	106.411*
Within treatments	15	0.07529	0.00501	
Total	19			
S Em± = 0.03542	CD = 0.10678	CV = 4.60		

46-60th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	1.85264	0.46316	84.699*
Within treatments	15	0.08202	0.00546	
Total	19			
S Em± = 0.03697	CD = 0.11145	CV = 4.58		

0-60th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	30.99410	7.74852	360.318*
Within treatments	15	0.32257	0.02150	
Total	19			
S Em± = 0.07332	CD = 0.22101	CV = 2.43		

***** **Significant at 5% level of significance**

APPENDIX-1I

ANOVA for Growth per day in per cent body weight of *Labeo rohita* (Ham.) fingerlings fed with varying levels of Gokhru mixed diet

0-15th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	0.30477	0.07619	187.895*
Within treatments	15	0.00608	0.00040	
Total	19			

S Em± = 0.01006 CD = 0.0303 CV = 3.73

16-30th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	0.20858	0.05214	162.505*
Within treatments	15	0.00481	0.00032	
Total	19			

S Em± = 0.00895 CD = 0.0269 CV = 3.43

31-45th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	0.18685	0.04671	94.459*
Within treatments	15	0.00741	0.00049	
Total	19			

S Em± = 0.01111 CD = 0.0335 CV = 4.42

46-60th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	0.11846	0.02961	59.343*
Within treatments	15	0.00748	0.00049	
Total	19			

S Em± = 0.01117 CD = 0.0336 CV = 4.56

0-60th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	0.30279	0.07570	396.079*
Within treatments	15	0.00287	0.00019	
Total	19			

S Em± = 0.0069 CD = 0.0208 CV = 2.39

***** **Significant at 5% level of significance**

APPENDIX-1II

ANOVA for Specific Growth Rate (SGR) of *Labeo rohita* (Ham.) fingerlings fed with varying levels of Gokhru mixed diet

0-15th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	0.04954	0.01238	187.577*
Within treatments	15	0.00099	0.00006	
Total	19			

S Em± = 0.00406 CD = 0.0122 CV = 3.61

16-30th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	0.03401	0.00850	165.230*
Within treatments	15	0.00077	0.00005	
Total	19			

S Em± = 0.00358 CD = 0.0108 CV = 3.29

31-45th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	0.03074	0.00768	94.491*
Within treatments	15	0.00122	0.00008	
Total	19			

S Em± = 0.00450 CD = 0.0315 CV = 4.29

46-60th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	0.01956	0.00489	58.998*
Within treatments	15	0.00124	0.00008	
Total	19			

S Em± = 0.00455 CD = 0.0137 CV = 4.44

0-60th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	0.03242	0.00810	417.593*
Within treatments	15	0.00029	0.00001	
Total	19			

S Em± = 0.00220 CD = 0.0066 CV = 2.05

***** **Significant at 5% level of significance**

APPENDIX-1V

ANOVA for Food Conversion Ratio (FCR) of *Labeo rohita* (Ham.) fingerlings fed with varying levels of Gokhru mixed diet

0-15th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	23.87366	5.96841	172.215*
Within treatments	15	0.51984	0.03465	
Total	19			

S Em± = 0.09308 CD = 0.2805 CV = 4.71

16-30th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	16.25253	4.06313	295.685*
Within treatments	15	0.20612	0.01374	
Total	19			

S Em± = 0.05861 CD = 0.1766 CV = 2.93

31-45th days

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	18.78248	4.69562	76.869*
Within treatments	15	0.91628	0.06108	
Total	19			

S Em± = 0.12357 CD = 0.3725 CV = 5.94

46-60th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	12.68075	3.17018	36.896*
Within treatments	15	1.28882	0.08592	
Total	19			

S Em± = 0.14656 CD = 0.4417 CV = 6.95

0-60th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	17.18935	4.29733	652.640*
Within treatments	15	0.09877	0.00658	
Total	19			

S Em± = 0.04057 CD = 0.1222 CV = 1.99

***** **Significant at 5% level of significance**

APPENDIX-V

ANOVA for Gross Conversion Efficiency (GCE) of *Labeo rohita* (Ham.) fingerlings fed with varying levels of Gokhru mixed diet

0-15th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	0.07619	0.01904	187.895*
Within treatments	15	0.00152	0.00010	
Total	19			

S Em± = 0.00503 CD = 0.0151 CV = 3.73

16-30th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	0.05214	0.01303	162.505*
Within treatments	15	0.00120	8.022	
Total	19			

S Em± = 0.00447 CD = 0.0134 CV = 3.43

31-45th days

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	0.04671	0.01167	94.459*
Within treatments	15	0.00185	0.00012	
Total	19			

S Em± = 0.00556 CD = 0.0167 CV = 4.42

46-60th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	0.02961	0.00740	59.343*
Within treatments	15	0.00187	0.00012	
Total	19			

S Em± = 0.00558 CD = 0.0168 CV = 4.56

0-60th day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	4	0.04793	0.01198	398.679*
Within treatments	15	0.00045	3.006	
Total	19			

S Em± = 0.00274 CD = 0.0082 CV = 2.14

***** **Significant at 5% level of significance**