MATERIALS & METHODS

feeds after 60 days of experimental period and are summarized in the Table 24.

Feed conversion ratio

Feed conversion ratio showed significant variation ranging from 1.71 to 2.51%. Maximum feed conversion ratio (2.51%) was noticed in the control fishes, followed by T_1 (2.35 %), T_4 (2.21 %), T_3 (1.75 %), T_2 (1.72 %) and T_6 (1.71 %). Minimum feed conversion ratio of 1.70% was recorded in fishes grown in T_5 feed. The difference in feed conversion ratio found among fishes of different treatments was found to be statistically significant ($P<0.05$).

Protein efficiency ratio

Protein efficiency ratio was significantly varied from 1.58 to 2.34 % in the control and experimental fishes. The highest protein efficiency ratio (2.34%) was obtained in *C.catla* grown in T_5 diet and lowest protein efficiency ratio (1.58%) was noticed in control fishes. Fishes fed with different experimental diets vary significantly in their protein efficiency ratio.

Protein productive value

Among the six different treatments and control, protein productive values were ranged from 3.00 to 5.72%. The highest protein productive value (5.72%) was observed in T_5 fishes, followed by T_2 (5.67 %), T_6 (4.60%), T_3 (4.60 %), T_4 (3.80 %) and T_1 (3.78 %). The lowest protein productive value (3.004%) was recorded in the control fishes. Protein productive values observed in the six different treatments were found to be statistically significant ($P<0.05$) when compared with control.

content (3.05%), followed by T_6 (3.01%), T_2 (3.00%), T_3 (2.96%), T_4 (2.71%) and T_1 (2.67%). The lowest fat content (2.55%) was recorded in the control fishes.

Ash

Figure 23 revealed ash content in the muscle tissues of *C.catla* in the control and six different treatments. At the beginning of the experiment, ash content recorded in the muscle tissues of *C.catla* was 1.90 %. After 60 days feeding of veterinary growth promoters supplemented diet, fishes fed with 10% Supplevite® supplemented feed showed maximum ash content (2.83%) and minimum ash content (2.31%) was recorded in *C.catla* grown in control.

Calorific content

Before experiment, calorific content estimated in the muscle tissues of *C.catla* was 135.27 Kcal/gm (Figure 24). Highest calorific content (157.98 Kcal/gm) was recorded in T_5 fishes after 60 days of the experimental period and lowest calorific content (144.01 Kcal/gm) was estimated in *C.catla* grown in control diet.

Veterinary growth promoters Vimeral® and Supplevite® incorporation enriched the muscle proximate composition in the experimental fishes. All these biochemical parameters when analysed statistically, the results were found to be significant at $P< 0.05$.

4.4.4 Feed utilization efficiencies

Feed conversion ratio (FCR), protein efficiency ratio (PER), protein productive value (PPV) and feed efficiency (FE) were analysed in *C.catla* fed with control and six different experimental

3.0 MATERIALS AND METHODS

The materials and methods used for this present investigation, "Efficacy of formulated feeds on growth, nutritional indices and feed utilization efficiencies of Indian major carp, *Catla catla*" are presented below.

3.1 Experimental fish

The Indian major carp, *Catla catla* (Family: Cyprinidae), is a fresh water edible fish has been selected for the present investigation (Plate 1).

3.1.1 Biological features

Catla catla has short and deep body, somewhat laterally compresses, its depth is more than head length, head very large, its depth exceeding half the head length, body with conspicuously large cycloid scales, head devoid of scales, snout bluntly rounded, eyes large and visible from underside of the head, mouth wide and upturned with prominent protruding lower jaw, upper lip absent, lower lip very thick, lower jaw with movable articulation of sysphysis, gill rakers long and fine, dorsal fin inserted slightly in advance of pelvic fins, anal fin short, pectoral fins long extending to pelvic fins, caudal fin forked, lateral line with 40-43 scales. Greyish on back and flanks and silvery-white in below and fins dusky.

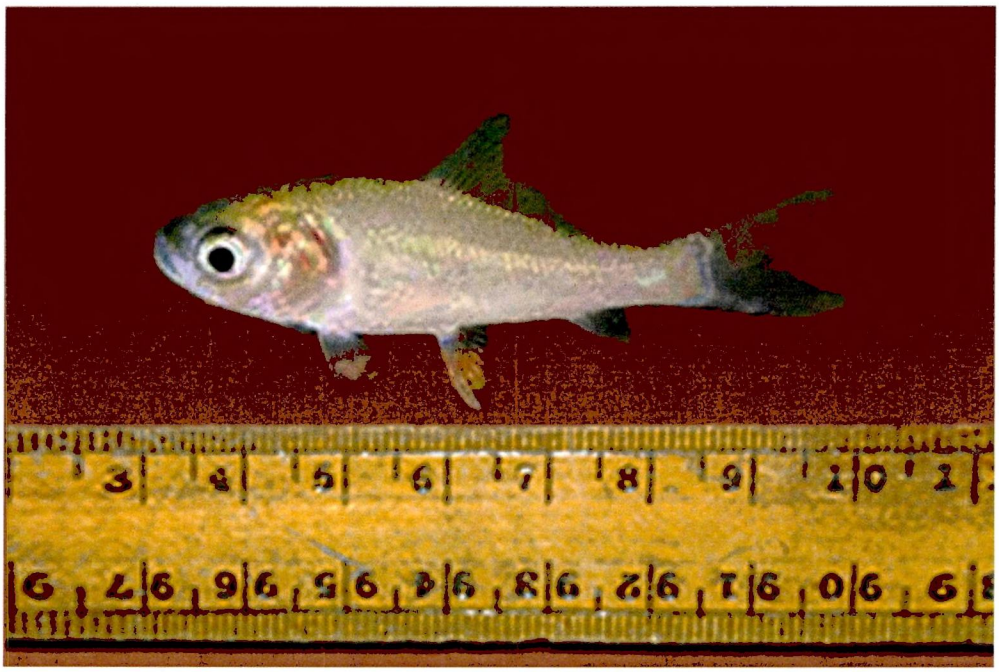

PLATE-1 Indian Major Carp, *Catla catla*

3.1.2 Historical background

Catla catla is endemic to the riverine system in northern India, Indus plain and adjoining hills of Pakistan, Bangladesh, Nepal, and Myanmar and has been introduced later into almost all riverine systems, reservoirs and tanks all over India.

C.catla is preferable in mono and polyculture systems in view of its fast growth, adaptation and easy breeding and it is used as the surface feeder component in Indian major carp polyculture system. This fish is very hardy and it can tolerate large variations in temperature, salinity and other environmental fluctuations. *C.catla* is preferable among Indian major carps because of its wide economic value, easy availability and wide consumption by the people and it is also the important component of sewage fed carp culture systems. It attains sexual maturity in two years and harvesting of large size fish (over 500 gm) is usually initiated after 6-7 months of culture.

India is far the largest producer of *C.catla*. India had already drawn up a strategic plan for doubling fresh water aquaculture production through increases in productivity and area. Since *C.catla* forms an important component of the carp polyculture systems, it can be expected that there will be a significant increase in its production in India by 2015 (Bandyopadhyay, 2006). The high growth potential of Indian major carps has attracted the attention of several tropical South-Eastern, Asian and Middle-Eastern countries.

C.catla exhibit their best growth rates when they are fed a balanced diet that provide proper mix of proteins, carbohydrates, lipids, vitamins, minerals and fibre. Fry and fingerlings of fish require a diet higher in protein, lipid, vitamins and minerals and lower in carbohydrates as they are developing muscle, internal organs and bone with rapid growth. Supplementary feed constitutes over 50 percent of the total input cost in carp polyculture. Therefore judicious feed management is of prime importance for enhancing profits.

3.2 Collection and maintenance of *Catla catla*

Normal and alive fingerlings were collected from Aliyar dam (Plate 2), near Pollachi at Coimbatore, Tamil Nadu. The collected fishes were transported to the laboratory in a polythene bag containing oxygenated water. The fish were kept in large aquarium tanks and acclimatized in the laboratory condition for one month in non-chlorinated water (Plate 3). Fishes of both sexes weighing 4 ± 0.5 gm were used. During acclimatization fishes were fed once a day with control feed prepared in the laboratory and water was changed on alternative days.

The present experiment was conducted in four phases.

PLATE-2 Fish catchments area of Aliyar dam

PLATE-3 Acclimatization of *Catla catla* in the laboratory condition

3.3 PHASE - 1

3.3.1 Experimental feeds

In phase-1 plant wastes (vegetable and fruit wastes) and animal wastes (broiler and fish wastes) were selected as experimental feeds.

3.3.2 Preparation of experimental feeds

The freshly collected vegetable and fruit wastes were dried and ground into fine powder. Likewise, broiler and fish wastes were collected from local market and dried in sunlight until the moisture was totally removed and then ground well and made into fine powder. The feed ingredients used in the fish feed were rice bran, groundnut oil cake, vegetable, fruit, broiler and fish wastes. In addition to this tapioca powder was also added as a binding agent.

The ingredients of each diet were mixed thoroughly and separately. The dry powder constituents were blended at first to make a homogenous mixture and cooked well by adding tapioca powder with required quantity of hot water to form soft dough. The pellets were prepared by feeding the dough through an extruder having a perforated disc with 0.8 cm diameter holes. The moist noodles were dried in the hot sun and were broken into pieces of approximately 0.5 cm in length. The pellets were stored in polyethylene airtight container to prevent fungal contamination (Plate 4).

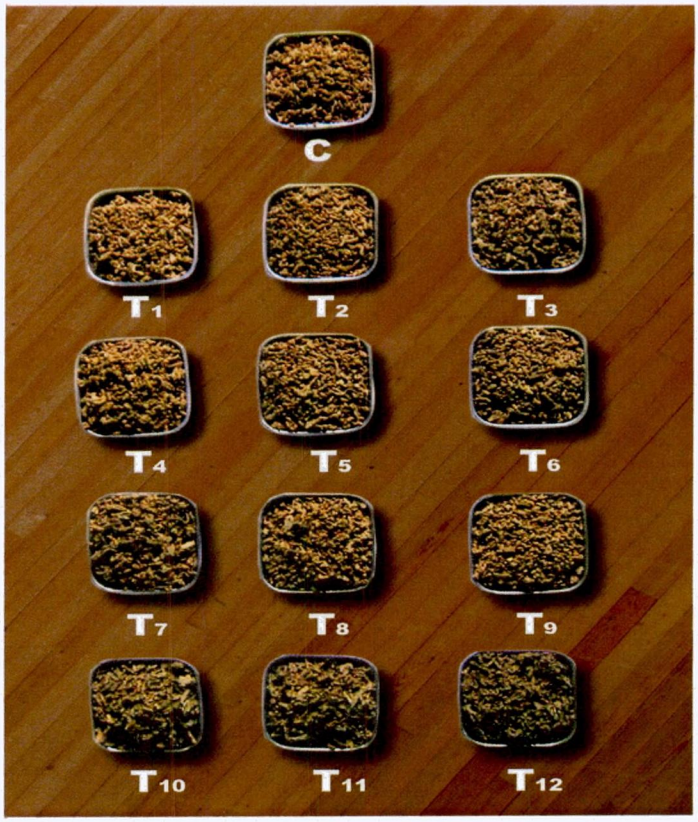

PLATE-4 Fish feed prepared from rice bran, groundnut oil cake, plant and animal wastes

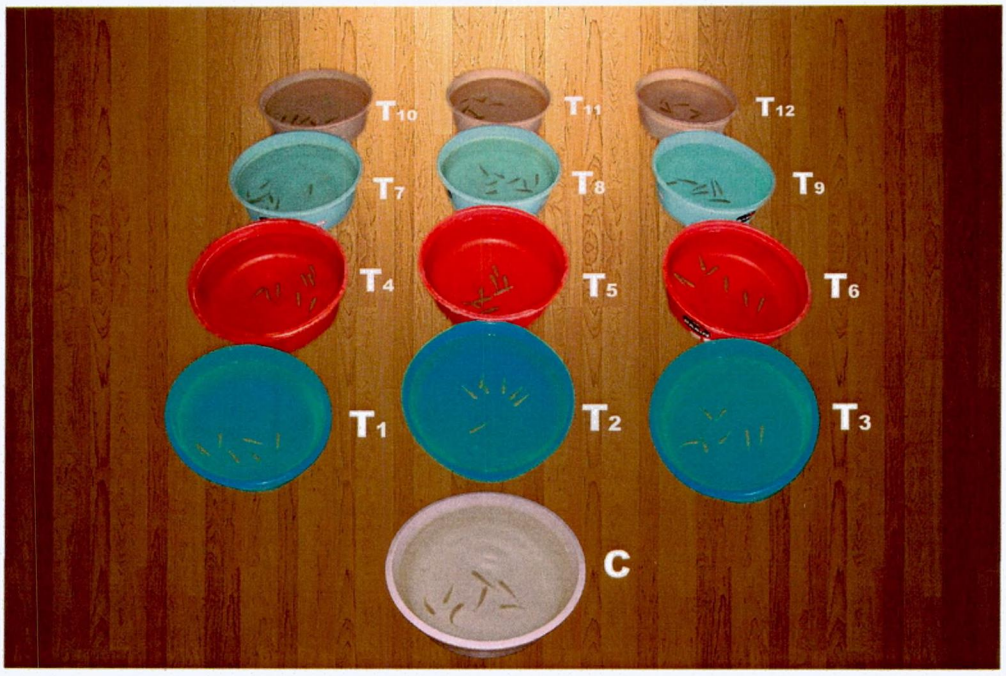

PLATE-5 Experimental setup shows *Catla catla* grown in the control, plant and animal wastes supplemented feeds

3.3.3 Feed formulation

Three different combinations of each experimental diet with control feed were prepared and feed formulation is presented below.

Ingredients	Treatments	Composition (%) of rice bran and groundnut oil cake (1:1 ratio)	Composition (%) of plant and animal wastes
Control	C	100	-
Vegetable wastes	T_1	90	10
	T_2	80	20
	T_3	70	30
Fruit wastes	T_4	90	10
	T_5	80	20
	T_6	70	30
Broiler wastes	T_7	90	10
	T_8	80	20
	T_9	70	30
Fish wastes	T_{10}	90	10
	T_{11}	80	20
	T_{12}	70	30

3.4 PHASE - 2

3.4.1 Experimental feeds

The commercially available probiotic strains such as Sporlac®, Provisacc®, Bioboost® and Eubioz® were selected and tested for their efficacy in the experimental fishes. These commercial probiotics contain live cultures of either bacteria or yeast or both.

Probiotics	Contents
Sporlac®	*Lactobacillus sporogens*
Provisacc®	*Saccharomyces cerevisiae*
Bioboost®	*L.sporogens* and *S.cerevisiae*
Eubioz®	*L.acidophilus, L.rhamnosus, Bibidobacterium longum, B.bifidum, S.boulardii* and *Streptococcus thermophilus*

3.4.2 Preparation of experimental feeds

The different probiotic tablets were collected from the local pharmaceutical store, ground well using mortar and pestle and made into a fine powder. The feed ingredients used in fish feed were rice bran, groundnut oil cake, powdered probiotics and tapioca flour (as a binder). All the ingredients except probiotics were mixed thoroughly in a mix blender. The required amount of water was added to mixed ingredients to form soft dough. Then the dough was kept in an airtight polyethylene packet for one hour for proper

conditioning followed by steam cooking for 20 minutes. Powdered probiotics were added to the feed after cooling, mixed well and passed through an extruder with 0.8 mm diameter holes. Pellets thus obtained were dried in the hot sun and stored in airtight polyethylene container to prevent fungal contamination (Plate 6).

3.4.4 Feed formulation

Three different combinations of the different probiotic supplemented diets with control feed were prepared and feed formulation is presented below.

Feed	Treatments	Composition (%) of rice bran and groundnut oil cake (1:1 ratio)	Composition (%) of probiotic strains
Control	C	100	-
Sporlac®	T_1	99	1
	T_2	98	2
	T_3	97	3
Provisacc®	T_4	99	1
	T_5	98	2
	T_6	97	3
Bioboost®	T_7	99	1
	T_8	98	2
	T_9	97	3
Eubioz®	T_{10}	99	1
	T_{11}	98	2
	T_{12}	97	3

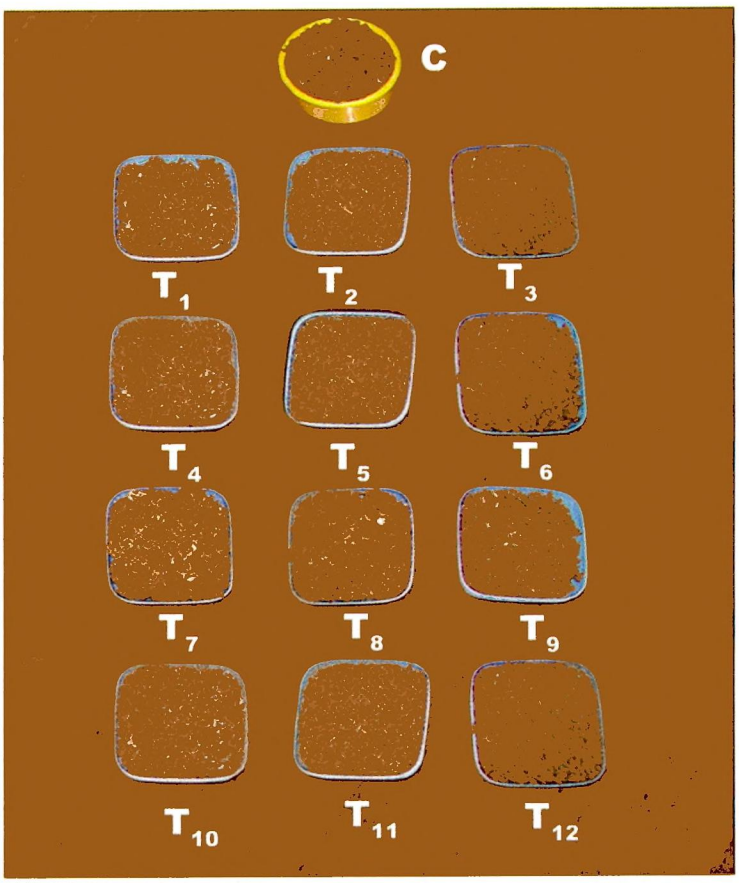

PLATE-6 Fish feed prepared from rice bran, groundnut oil cake and probiotics

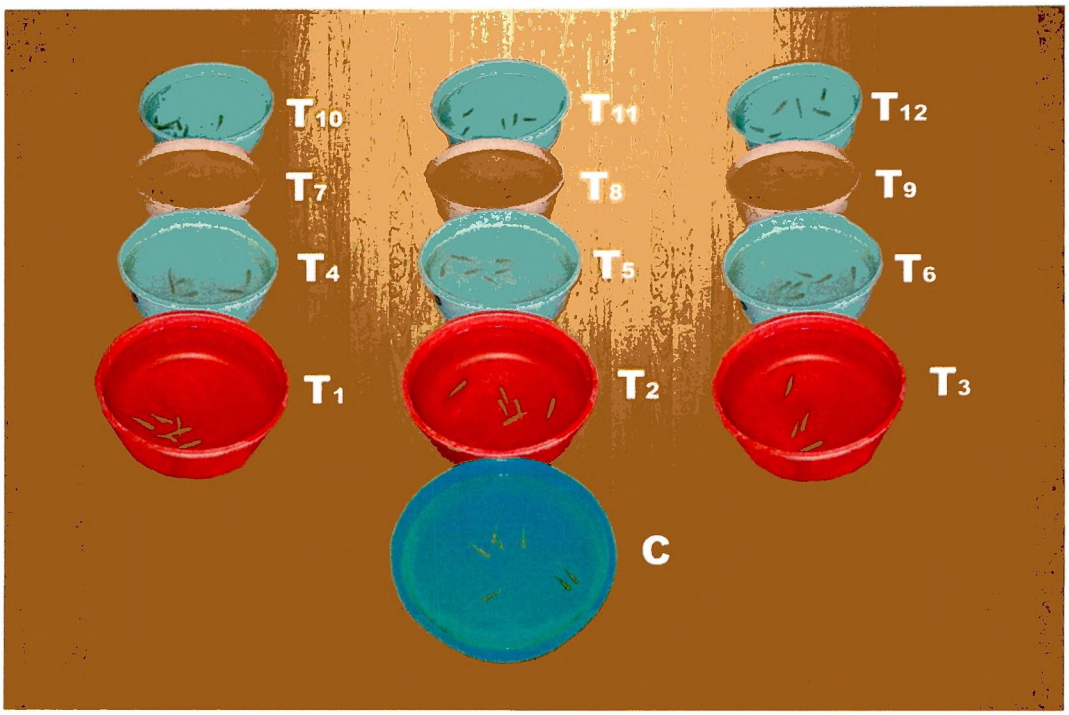

PLATE-7 Experimental setup shows *Catla catla* grown in the control and probiotics supplemented feeds

3.5 PHASE - 3

3.5.1 Experimental feeds

The medicinal herb, *Cynodon dactylon* and *Phyllanthus emblica* were selected for the present study (Plate 8). *Cynodon dactylon* (bermuda grass/couch grass), the whole plant was collected from the campus of Avinashilingam University for Women, Coimbatore, Tamilnadu and the fruits of *Phyllanthus emblica* (Indian gooseberry/amla) were collected from the local market. The plants were identified and authenticated at the Department of Botany, Avinashilingam University for Women, Coimbatore, Tamil Nadu, India.

3.5.2 *Phyllanthus emblica/ Emblica officinalis* (Amla/ Indian gooseberry)

Amla or Indian gooseberry (Family: Euphorbiaceae) is the fruit of this deciduous tree found mainly in India. The fruit of this plant is round shaped with vertical stripes. It is greenish yellow in colour and tastes sour. The fruit is fibrous in nature. Amla is rich in natural vitamin C. This fruit is used as the main ingredient in the ayurvedic tonic chyavanprash. It is also used along with several other herbs as an ayurvedic tonic.

Chemical composition

The fruit pulp contains rich source of vitamin C, 70.5% moisture, 3.28% acidity on pulp basis, 5.09% total sugars, 5.08% reducing sugars, 2.73% tannins, 0.59% pectin, 0.75% protein, 0.027% phosphorus, 0.368% potassium, 0.059% calcium, 10.248% magnesium, 0.004% iron and

Cynodon dactylon

Phyllanthus emblica

PLATE-8 Medicinal herbs used for fish feed preparation

ascorbic content is 1094.53 mg/ml of juice. Fruits and leaves contain 1.3.6 - trigalloyl contains glucose, terchebin, corilagin, phyllenbic acids and alkaloids phyllantidine and phyllantine. Leaves and stem have lupeol and beta sitosteerol. Seeds contain linoleic acid and it closely resembles linseed oil. Roots contain ellagic acid and lupeol.

Medicinal properties

Amla has antibacterial properties and helps in preventing infections and healing ulcers. It helps in maintaining a healthy digestive system and improves food absorption. The high content of vitamin C helps to boost the functioning of immune system of the body and thereby helps in preventing a wide range of diseases. Amla improves body weight and it also helps in increasing the total protein level due to positive nitrogen balance. Thus it is known to give an anabolic effect in the body. Apart from vitamin C, amla also provides many other essential minerals such as chromium, zinc and copper. These minerals help in maintaining proper functioning of the metabolic activities of the body. The chromium present in it helps in its antidiabetic effect to the body. Natural vitamin C lends cementing support to the intercellular spaces of the cells, thereby enhancing skin integrity, texture and sheen of the epidermal layer. Ayurveda describes it as one of the best herbs for bleeding disorders, strength and stamina promoter. With its anti-oxidant and detoxification properties, amla is well known for treating skin disorders.

3.5.3 *Cynodon dactylon* (Bermuda grass / Couch grass)

Cynodon dactylon (Family: Poaceae) is the most sacred plant of India next to tulasi (*Ocimum sanctum*). The plant has been recognized for its cooling, haemostatic, diuretic, depurative and tonic properties since ancient times. *C.dactylon* grows wild throughout India and is commonly cultivated as lawns, for decorative purpose. It is a perennial creeping grass, rooting at every node, forming matted tufts. The leaves are variable in length from 1-10 cm, 0.5-1 cm broad, tapering towards the apex. The flowers are green or brinjal - coloured, in terminal spikes 2 to 8 in number. The fruit grains are tiny and greyish in colour.

Chemical composition

Green bermuda grass contains (on dry matter basis) protein 10.47%, enzymes 28.17% and ash 11.79%. Ash contains calcium 0.77%, phosphorus 0.58%, manganese 0.34%, sodium 0.23% and potassium 2.08%. The digestible nutrients per 100lb of dry material are crude proteins 6.04%, carbohydrates 36.16% and starch equivalent to 28.7%. The whole plant affords sitosterol, carotene and other compounds like vitamin C, cartone, palmitic acid, triterpenoids, alkaloids ergonovine and ergonovinine etc.

Medicinal properties

Bermuda grass is reported to be an alternative anabolic, antiseptic, aperient, astringent, cyanogenetic, demulcent, depurative, diuretic, emollient, sudorific and vulnerary. A decoction of the root is used as diuretic in the treatment of dropsy and secondary syphilis. The plant is a folk remedy for anasarca, calculas, cancer, carbuncles, convulsions, cough, cramps, cystitis, diarrhoea, dropsy, dysentery, epilepsy, haemorrhage, hypertension, sores, wounds etc. It helps in adhesion, wound healing and improves skin texture. It improves neurological functioning. It promotes digestion and improves the peristallitic movements. It purifies blood and fades away the infection. It also removes toxins from the body. The alcoholic extract of the entire plant produced antiviral activity against the vaccinia virus.

3.5.4 Preparation of experimental feeds

The freshly collected whole plant of *C.dactylon* and fruits of *P.emblica* were washed thoroughly, cut into small pieces, shade dried, ground well and made into fine powder. The feed ingredients used in the fish feed were groundnut oil cake, rice bran, powdered medicinal herbs and tapioca powder. All the ingredients were cooked well with required quantity of hot water to form soft dough. Then the dough was fed through an extruder having perforated disc (0.8 cm diameter). The moist noodles were dried in hot sun and were broken into small pieces and stored in polyethylene container to avoid fungal contamination (Plate 9).

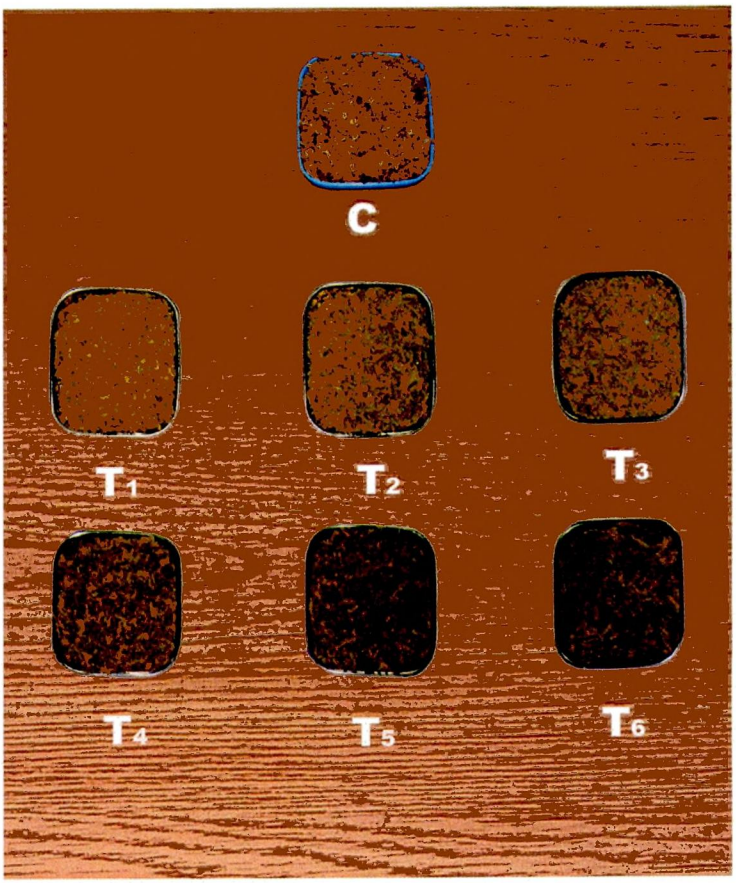

PLATE-9 Fish feed prepared from rice bran, groundnut oil cake and medicinal herbs

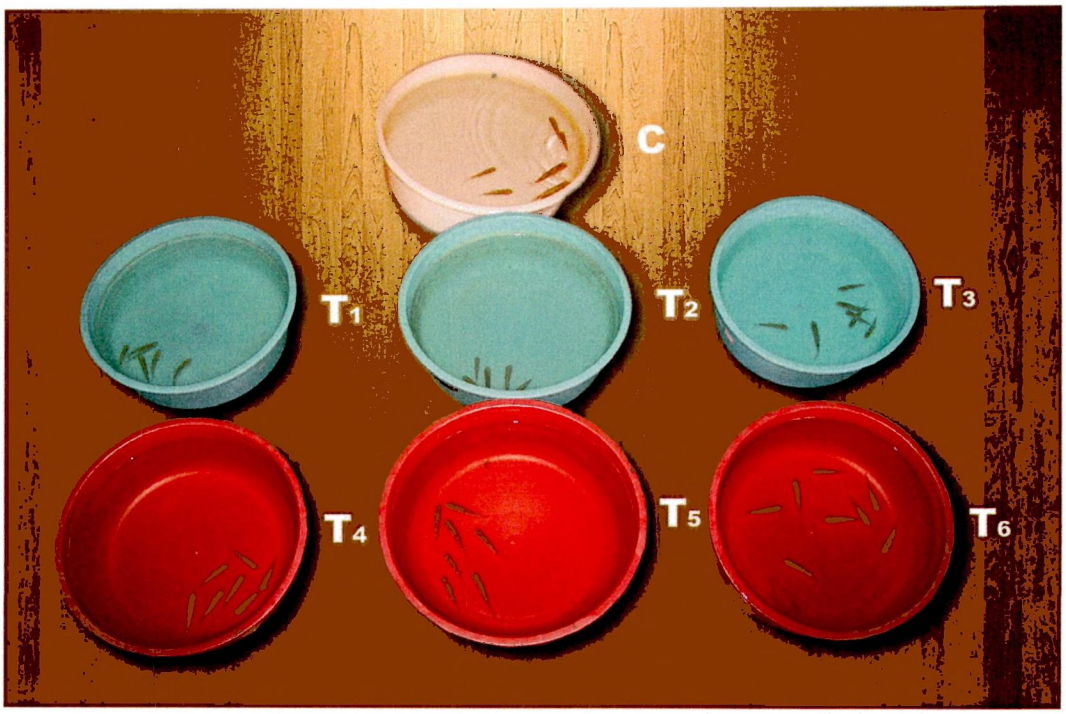

PLATE-10 Experimental setup shows *Catla catla* grown in the control and medicinal herbs supplemented feeds

3.5.5Feed formulation

Three different combinations of *C.dactylon* and *P.emblica* incorporated feeds with control feed were prepared for the present feeding experiment and feed formulation is presented below.

Feed	Treatments	Composition (%) of rice bran and groundnut oil cake (1:1 ratio)	Composition (%) of medicinal herbs
Control	C	100	-
Cynodon dactylon	T_1	95	5
	T_2	90	10
	T_3	85	15
Phyllanthus emblica	T_4	95	5
	T_5	90	10
	T_6	85	15

3.6 PHASE - 4

3.6.1 Experimental feeds

Veterinary growth promoters Vimeral® and Supplevite® were selected as supplementary feed for *C.catla.* Vimeral® is a vitamin mixture, which contains vitamin A, D_3, E and B 12. Supplevite® is a vitamin and mineral mixture, which contains vitamin A, D3, E, K, B12, pantothenate, nicotinamide, choline chloride, calcium, manganese, iodine, iron, zinc, copper and cobalt.

3.6.2Preparation of experimental feeds

The basel diet rice bran and groundnut oil cake were dried and powdered. Veterinary growth promoters were collected from the local veterinary shop. The feed ingredients used for the preparation of fish feed were rice bran, groundnut oil cake, tapioca flour (binder) and veterinary growth promoters, Vimeral® and Supplevite®. All the feed ingredients were mixed thoroughly and separately. The required amount of hot water was added to mixed ingredients to form soft dough. The dough was then pelleted in a hand pelletizer having perforated disc (0.8 cm diameter). The moist noodles were dried in the hot sun and were broken into small pieces and stored in airtight polyethylene container to avoid fungal contamination (Plate 11).

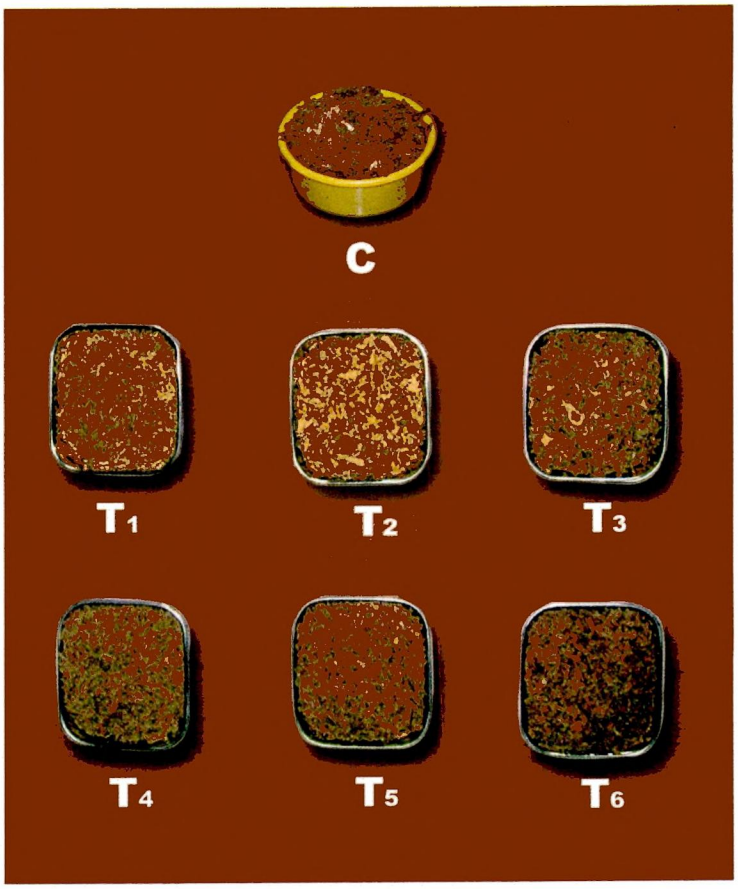

PLATE-11 Fish feed prepared from rice bran, groundnut oil cake and veterinary growth promoters

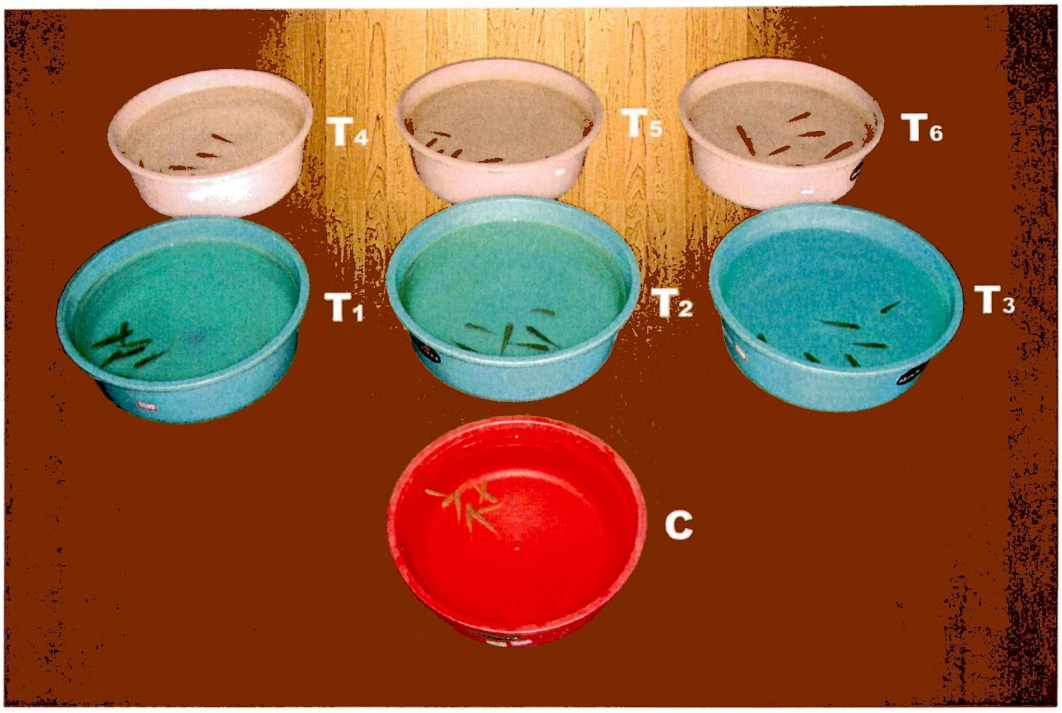

PLATE-12 Experimental setup shows *Catla catla grown* in the control and veterinary growth promoters supplemented feeds

3.6.3 Formulation of experimental feeds

Three different combinations of Vimeral® and Supplevite® incorporated diets along with control feed were prepared for the present experiment and feed formulation is presented below.

Feed	Treatments	Composition (%) of rice bran and groundnut oil cake (1:1 ratio)	Composition (%) of veterinary growth promoters
Control	C	100	-
Vimeral ®	T_1	95	5
	T_2	90	10
	T_3	85	15
Supplevite®	T_4	95	5
	T_5	90	10
	T_6	85	15

3.7 Experimental procedure

The feeding trial was conducted in circular plastic trough for a period of 60 days. Each experiment was tried in triplicates. At the beginning of the experiment 8 uniform sized fish in good health and condition were stocked in each trough. Each diet was randomly assigned to replicate groups of fish and fed by hand once a day (Plate 5, 7, 10 and 12).

During the experimental period, fishes in control and different treatments were initially fed at a rate of 5% of body weight per day (dry-matter basis), which approached apparent satiation. The feeding rate was gradually reduced among all dietary treatments over the course of the experiment to ensure a rate close to apparent satiation without over feeding. The unutilised feed and faecal matter were collected before each morning feeding and stored for further analysis. Half of the water in the tanks was replaced daily throughout the experimental period after siphoning out the leftover feed and faecal matter. Troughs were thoroughly cleaned every two weeks when the fish were removed for weighing. Mortality was checked daily.

3.8 Collection of unutilised feed and faecal matter

Before feeding and water exchange daily, the unutilised feed and faecal matter were collected separately on a preweighed Whatman No.1 filter paper, cleaned with distilled water and dried in an oven at 60^0 C for 24 hrs and then weighed using a monopan electronic balance (Aslep Ex.200 A.A and D. Co. Ltd., Japan)

3.9 Analytical methods

3.9.1 Growth parameters

Weight and length of the control and experimental fishes were taken just before starting the experiment, followed by 15 days interval till the end of the experiment. The growth parameters in terms of weight gain, length gain and specific growth rate (weight and length) were evaluated as follows.

$$\text{Percentage weight gain} = \frac{\text{Final weight (gm)} - \text{Initial weight (gm)}}{\text{Initial weight (gm)}} \times 100$$

$$\text{Percentage length gain} = \frac{\text{Final length (cm)} - \text{Initial length (cm)}}{\text{Initial length (cm)}} \times 100$$

$$\text{Specific growth rate (weight) (\% day -1)} = \frac{\text{In Final weight (gm)} - \text{In Initial weight (gm)}}{\text{Days of experiment}} \times 100$$

$$\text{Specific growth rate (length) (\% day -1)} = \frac{\text{In Final length (cm)} - \text{In Initial length (cm)}}{\text{Days of experiment}} \times 100$$

3.9.2 Biochemical analysis

The proximate composition such as protein, carbohydrate and fat contents were analysed in the control feed and different experimental feeds prepared from plant wastes, animal wastes, probiotics, medicinal herbs and veterinary growth promoters.

Before starting the experiment and at the termination of 60 days of feeding trial, fishes from each experimental unit were killed and analysed for their biochemical composition such as water content, protein, carbohydrate, fat, ash and calorific content using standard procedures.

Water content (A.O.A.C., 1975)

Clean porcelain crucible of a known weight with fresh homogenised fish muscle (100mg) was taken. The crucible with its contents was placed in a hot air oven, thermostatistically controlled at $105^0C \pm 2^0C$ for 5-7 hours. Intermittent cooling and weighing was done till the weight remain constant. The percentage of water content was calculated by the following formula.

$$\text{Percentage of water content} = \frac{W_3 - W_1}{W_2 - W_1} \times 100$$

Where,

W_1 = Weight of empty crucible

W_2= Weight of crucible with tissue before heating

W_3 = Weight of crucible with tissue after drying

Protein (Lowry *et al.*, 1957)

100 mg of prepared feeds and muscle tissues were homogenised with 1ml of 0.9% sodium chloride solution.1 ml of 5% trichloroacetic acid was added, and then centrifuged at 8000 rpm for 20 minutes. The precipitate was dissolved in 1ml of 0.1N sodium hydroxide. 0.1ml of this aliquot was taken and made up to a final volume of 1ml with distilled water. 5 ml of alkaline copper reagent was added, mixed and allowed to stand for 10 minutes at room temperature. 0.5ml of 1N Folin-Ciocalteau reagent was then added and shaken well. After 30 minutes the blue colour developed was read at 720 nm and percentage of protein content was calculated.

Carbohydrate (Hodge and Hofreiter, 1962)

100 mg of prepared feeds and muscle tissues were homogenised in 1ml of 0.9% sodium chloride solution. 1 ml of 5% trichloroacetic acid was added to 1ml of each extract. The homogenate was centrifuged at 8000 rpm for 20 minutes. To 1ml of the supernatant 5 ml of anthrone reagent was added. The series of test tubes were kept in boiling water bath for 10-15 minutes and then cooled in dark. After 30 minutes the OD value was read at 620nm and percentage of carbohydrate was calculated.

Fat (Folch *et al.*, 1957)

100 mg of prepared feeds and muscle tissues were weighed and ground well with 5 ml of chloroform methanol mixture. The homogenate was centrifuged, taken in a small weighed beaker and the beaker was placed inside a large beaker and filled with water along the sides and kept overnight in hot air oven without any disturbance. In between the methanol with dissolved protein layer and chloroform with dissolved fat, a white precipitate was formed. The methanol layer was removed without disturbing the chloroform layer. The chloroform was evaporated in an oven at about 60^0C. The beaker was weighed. The difference between the final weight and initial weight of the beaker elucidate the fat content of the tissues and its percentage was calculated.

Ash (A.O.A.C., 1975)

An accurately weighed dry sample of 100mg was taken in hot porcelain crucible and heated at 100^0C until the water was completely evaporated. Then a bunsen burner charred the material in the crucible. The crucible was transferred to a muffle furnace kept at a temperature at 700^0 C and allowed to remain until white ash was obtained. The crucible was then transferred to a desiccators containing fresh sulphuric acid, cooled and as soon as the room temperature was obtained. This process of ashing, cooling and weighing was repeated till the weight was constant. The ash content was calculated in the following manner.

$$\text{Percentage of ash content} = \frac{W_3 - W_1}{W_2 - W_1} \times 100$$

Where,

W_1 = Weight of empty crucible

W_2= Weight of crucible with sample

W_3 = Weight of crucible with ash.

Calorific content (Brody, 1945)

Calorific content (Kcal/gm) was determined by using calorific equivalents of 5.65 for protein, 9.45 for lipid and 4.1 for carbohydrate.

3.9.3 Estimation of feed utilization efficiencies

Feed utilization efficiencies in terms of feed conversion ratio (FCR), protein efficiency ratio (PER), protein productive value (PPV) and feed efficiency (FE) were estimated after 60 days of the experimental period in *C.catla* fed with control and different experimental feeds.

Feed conversion ratio (%)

$$\text{Feed conversion ratio} = \frac{\text{Feed given*}}{\text{Weight gain**}} \times 100$$

*As fed basis i.e., dry weight

* * Wet or fresh weight gain

Protein efficiency ratio (%)

$$\text{Protein efficiency ratio} = \frac{\text{Weight gain (gm)}}{\text{Protein intake (gm)}} \times 100$$

Protein productive value (%)

$$\text{Protein productive value} = \frac{Pb - Pa}{Pi} \times 100$$

Where,

P_b = Total body protein at the end of the feeding trial

P_a = Total body protein at the beginning of the feeding trial

P_i = Amount of protein consumed over the feeding trial

Feed efficiency (%)

$$\text{Feed efficiency} = \frac{\text{Weight gain (gm)}}{\text{Feed intake (gm)}} \times 100$$

3.10 Statistical analysis

The results of the entire study were analysed statistically using one way ANOVA and the level of significance was defined at $P < 0.05$.