Chapter - II

Growth Performance Study
Introduction

The main intent of any aquaculture farming is to optimize growth of the farmed organism and to have a good marketable product. This can be achieved only if the organisms remained healthy throughout the culture period. In aquaculture, feed represents a major input, contributing more than 50% of the total production cost (Naik et al., 2001). Artificial feeding is an integral part of managed fishculture practices, where the focus is on maximum fish production with minimum feed cost (Jeyachandran and Raj, 1976). The quality and quantity of supplementary diets are principal factors that determine the growth of fish and cost of production in aquaculture (Love, 1980).

Nutrition plays a key role in enhancing the host’s immune system. Deficiency of any dietary component or imbalance in nutritional profile or poor quality of feed ingredients leads to suppression of the immune response in both fish and crustacean (Blazer and Wolke, 1984; Li and Lovell, 1985; Barros et al., 2002; Vivane et al., 2004). This helps opportunistic pathogens to invade the host and cause disease. Hence the improvement of the health status of the aquatic organisms is important and can be achieved through formulated feeds, which act as a prophylactic measure. Feed should provide for better immunocompetence and disease resistance, besides satisfying the dietary nutrient requirements for maximum growth (Viviane et al., 2004).

Hence the present study had been planned to improve the health status of the fish through feeding formulated feed separately with different plant leaf extracts to meet out all the nutritional requirement of the fish for better growth and to attain good food conversion ration.
This chapter deals with the growth performance of the freshwater fish, *Cyprinus carpio* fed with artificial feed incorporated separately with five different concentrations of leaf extracts of three plants namely *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta*.

**Materials and Methods**

**Preparation of leaf extract**

Five different concentrations (5, 10, 20, 25 and 50g / Kg of feed) of leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* were prepared by soaking and crushing the leaves separately in distilled water. Then the extract was centrifuged at 1000 rpm for 5 minutes and filtered through using muslin cloth to get an extract free of debris. The crude leaf extract was used for formulation of medicated fish feed.

**Feed formulation**

The experimental diets were prepared by mixing the selected ingredients according to a standard formula with 40.7 % protein (Refer general materials and methods).

**Feed preparation**

Fresh feed ingredients were procured in dry form with moisture level below 10% and their quality was tested during the initial stage to confirm their nutrient quality. The solid ingredients were ground to get uniform sized particles which facilitate homogenous mixing of ingredients. Fine powdering of materials increases
mixing of ingredients. Fine powdering of materials increases the surface area and dispose it to better digestibility besides facilitating compact pellets. The powdered ingredients were then served to required particle size through 300μ mesh. Sieving also helps in preparing feed with uniform pellet size and attractive physical appearance. The quantity of powdered ingredients incorporated in the feed was decided by the square method of Santhanam et al. (1987). The weighed ingredients were then thoroughly mixed. The heat sensitive materials were not added in the feed at this stage. The mixture was wetted with water (30%) and then the whole mass was kneaded thoroughly to wet all the particles to form stiff dough. The ingredient mixture was subjected to steam cooking at 15 lbs pressure for 30 minutes. The cooked feed was allowed to cool to room temperature and the prepared plant leaf extracts, vitamins, mineral mix and cod liver oil as fat source were added and the dough was kneaded thoroughly for proper mixing. The well mixed dough was apportioned to balls of 100g each and the dough was extruded through a hand pelletizer of about 2mm diameter with thread like shape. The extruded diet was subsequently sun dried and then they were made into crumbles of about 3mm. The crumbles were stored in a separate airtight plastic container.

**Experimental setup**

The experiments on feeding trials were conducted in plastic troughs of 50 liter capacity. Plastic troughs of uniform size and uniform color for each experiment were selected and filled with freshwater. The acclimatized fish were starved for 24 hours prior to experimentation. They were weighed accurately after wiping with blotting paper and stocked in each experimental trough. In each trough six fish were reared. The water in trough was changed daily before fresh feeding. The whole experiment was conducted in
the temperature controlled laboratory and ambient water temperature was maintained at 
28 ± 1°C during the course of experiment.

**Growth performance studies**

During 50 days of feeding trails, experimental fish were fed with feed daily at the rate of 2 % of live body weight. After feeding, the fish were allowed to feed two hours continuously and unconsumed feed was collected everyday by siphoning the water through muslin cloth for drying and weighing. After 24 hours faecal matter was collected by filtering the water through the muslin cloth and dried. The weight gain or loss in fish was observed at regular intervals of 10 days. Various growth parameters were also analyzed from the data obtained.

**Growth Parameters**

To study the growth performance of fish, *Cyprinus carpio* fed with feeds having different concentrations of leaf extracts of *Aegle marmelos, Andrographis paniculata* and *Euphorbia hirta*, various growth parameters such as feeding rate, assimilation rate, metabolic rate, food conversion ratio, feed conversion efficiency, protein efficiency ratio and specific growth rate were determined for every 10 days up to 50 days using the standard formula.

1. **Feed consumption (FC)**
   \[
   \text{FC} = \text{Total amount of any feed given (g)} - \text{amount of uneaten food (g)}.
   \]

2. **Feeding rate % bd wt / day**
   \[
   \text{Feeding rate} = \frac{100 \times \text{feed consumption}}{\text{Initial wet weight (g) } \times \text{Number of days}}
   \]
3. Assimilation (A): \[ A = FC - F \]
   \( FC \) = Total dry weight of feed consumed (g)
   \( F \) = Total faecal output (mg)

4. Assimilation rate (mg/g/day) = \[ \text{Feed assimilated} \]
   \[ \text{Initial wet weight (g)} \times \text{Number of days} \]

5. Metabolism (M): \[ M = A - G \]
   \( A \) = Assimilation in terms of dry feed assimilated (g)
   \( G \) = Growth in terms of wet weight gain (g).

6. Metabolic rate (mg/g/day) = \[ \text{Feed metabolized} \]
   \[ \text{Initial wet weight (g)} \times \text{Number of days} \]

7. Feed conversion ratio (FCR) = \[ \text{Feed consumption (g)} \]
   \[ \text{Total wet weight gain (g)} \]

8. Feed conversion efficiency = \[ \text{Total wet weight gain (g)} \]
   \[ \text{Feed consumption (g)} \]

9. Protein efficiency ratio = \[ \text{Total wet weight gain (g)} \]
   \[ \text{Protein intake (g)} \]

10. Specific growth rate (SGR) = \[ 100 \times \frac{\ln \text{final body weight} - \ln \text{initial body weight}}{\text{Experimental days}} \]
Statistical analysis

The data collected were statistically analyzed using one way analysis of variance (ANOVA) to test the effects of experimental diets for all parameters. Duncan's multiple range test had been used to test differences among individual means as described by Mason et al. (1998). The difference was regarded as significant when \( P < 0.01 \) and \( P < 0.05 \).

The data were statistically analysed and given in appendix 4.
Results

The growth performance of the freshwater fish, *Cyprinus carpio* fed with feeds incorporated with five different concentrations of leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* were studied for an epoch of 50 days and the data observed are presented in tabular and graphical form here under.

Feeding rate (FR)

The mean values of feeding rate of *Cyprinus carpio* fed with feeds incorporated with five different concentrations of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* leaf extracts for a period of fifty days are given in table 2.1. It is observed from the table 2.1 that the feeding rate was found to be low in the fish which consumed feed incorporated with 50g leaf extract/kg feed of *Aegle marmelos*, the value being 16.5±0.38 mg/g/day, followed by 10, 5, 20 and 25g leaf extracts /kg feed and the values were 17.6±0.33, 18.4±0.38, 18.7±0.30 and 18.8±0.26 mg/g/day respectively. Feeding rate of 16.9±0.15 mg/g/day was noticed in fish, which consumed control feed.

Statistical analysis reveals that significant increase (P<0.01) in the feeding rate was noticed in fish fed with different concentrations of leaf extracts of *Aegle marmelos*, expect the fish fed with feed having 50g leaf extract, which showed a significant decrease in the feeding rate, when compared with control (Table 2.1).

It is clear from the table 2.1 that the maximum feeding rate of 14.3±0.70 mg/g/day was observed in fish fed with feed incorporated with 5g leaf extract of *Andrographis paniculata* /kg feed. The low feeding rate was found in fish which
Table 2.1. The mean feeding rate (mg / g / day) of freshwater fish, Cyprinus carpio fed with feeds incorporated with different concentrations of three leaf extracts of Aegle marmelos, Andrographis paniculata and Euphorbia hirta for a period of 50 days. Each value is an average of five individual observations with a standard deviation.

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<td>13.3± 0.19**</td>
<td>19.1± 0.43**</td>
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** P<0.01, * P<0.05, NS – Not Significant
Fig. 2.1. The mean feeding rate (mg / g /day) of freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of leaf extracts of *Aegle marmelos, Andrographis paniculata* and *Euphorbia hirta* for a period of fifty days. Each value is an average of five individual observations with a standard deviation.
consumed feed with 20g leaf extract of *Andrographis paniculata* /kg feed, the value being 11.5±1.15 mg/g/day. The feeding rate in fish consumed control diet was found to be 16.2±0.78 mg/g/day. Feeding rates of 13.9±0.32, 12.6±0.75 and 13.3±0.19 mg/g/day were noticed in the fish fed with feeds incorporated with 10, 25 and 50g leaf extracts of *Andrographis paniculata* /kg feed respectively.

Table 2.1 shows that fish fed with feed having different concentrations of leaf extract of *Andrographis paniculata* showed significant decrease in the feeding rate at 1% level, when compared with the control.

The data on feeding rate of the experimental fish, *Cyprinus carpio* fed with feed incorporated with different concentrations of leaf extract of *Euphorbia hirta* for a period of 50 days are included in table 2.1. From the table, it is clear that the maximum feeding rate of 19.6 ± 0.63 mg/g/day was recorded by the fish fed with feed incorporated with 20g leaf extract of *Euphorbia hirta* /kg feed, followed by the fish fed with feeds incorporated with 25, 50, 10 and 5g leaf extracts of *Euphorbia hirta* /kg feed and the feeding rates were 19.3±0.54, 19.1±0.43, 18.4±0.46 and 16.8±0.46 mg/g/day respectively. The feeding rate in control fish was found to be 16.0±0.74 mg/g/day. The fish fed with *Euphorbia hirta* incorporated feeds showed significant increase in the feeding rate at 1% level, when compared with the control fish (Table 2.1).

Fig 2.1 explicits the mean feeding rate in freshwater fish *Cyprinus carpio* fed with feeds incorporated with different concentrations of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta*. From the fig 2.1, it is clear that low feeding rate was observed in fish fed with feed incorporated with leaf extracts of *Andrographis paniculata*. The maximum feeding rate was observed in fish fed with feed incorporated
with *Euphorbia hirta* leaf extract followed by *Aegle marmelos*. The maximum value of feeding rate of 19.6±0.63 mg/g/day was observed in fish fed with feed incorporated with 20 g/kg feed of *Euphorbia hirta* leaf extract, while the least feeding rate (12.6±0.75 mg/g/day) was found in fish fed with feed having 25 g leaf extract of *Andrographis paniculata* kg feed (fig 2.1).

**Assimilation rate (AR)**

The mean values of feed assimilation rate in freshwater fish, *Cyprinus carpio* fed with feeds incorporated with five different concentrations of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* leaf extracts are included in Table 2.2. It is apparent from the table 2.2, the feed assimilation rate was found to be better in fish fed with feed incorporated with 25 g leaf extract of *Aegle marmelos* /kg feed, the value being 16.57±0.168 mg/g/day, followed by the fish fed with feeds incorporated with 20, 5, 10 and 50 g leaf extracts of *Aegle marmelos* /kg feed and the values were 16.44±0.360, 16.46±0.075, 15.38±0.368 and 14.96±0.195 mg/g/day respectively. Feed assimilation rate of 14.53±0.022 mg/g/day was observed in control fish.

Table 2.2 reveals that assimilation rate significantly increased at 1 % level in all fish fed with feed having leaf extracts of *Aegle marmelos*, when compared with the control. It is evident from the table 2.2 that the maximum average feed assimilation rate of 12.46±0.155 mg/g/day was observed in fish fed with feed incorporated with 5 g leaf extract of *Andrographis paniculata* /kg feed, followed by fish fed with feed having 10, 25
Table 2.2. The mean assimilation rate (mg/g/day) of freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of three leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* for a period of 50 days. Each value is an average of five individual observations with a standard deviation.

<table>
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<tr>
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<th>Assimilation Rate (mg/g/day)</th>
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<td><em>Andrographis paniculata</em></td>
<td><em>Euphorbia hirta</em></td>
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<tr>
<td>25</td>
<td>16.57± 0.168**</td>
<td>11.46± 0.043**</td>
<td>17.32± 0.019**</td>
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<tr>
<td>50</td>
<td>14.96± 0.195**</td>
<td>11.72± 0.069**</td>
<td>17.17± 0.020**</td>
<td></td>
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</tbody>
</table>

** P<0.01, * P<0.05, NS – Not Significant
Fig. 2.2. The mean assimilation rate (mg/g/day) of freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* for a period of fifty days. Each value is an average of five individual observations with a standard deviation.
and 50g leaf extracts of *Andrographis paniculata* /kg feed, the values being 12.33 ± 0.052, 11.46 ± 0.043 and 11.72 ± 0.069 mg/g/day respectively. The least value of feed assimilation rate of 10.36 ± 0.039 mg/g/day was observed in fish fed with feed incorporated with 20g leaf extract of *Andrographis paniculata* /kg feed. The assimilation rate of control fish was found to be 14.34 ± 0.01 mg/g/day.

Assimilation rate of the freshwater fish, *Cyprinus carpio* significantly decreased at 1% level, when it was fed with feed having *Andrographis paniculata* incorporated feed.

The average values of feed assimilation rate in *Cyprinus carpio* fed with feed incorporated with different concentrations of *Euphorbia hirta* leaf extracts are included in table 2.2 and the values ranged from 15.61 ± 0.014 to 17.82 ± 0.008 mg/g/day. The highest feed assimilation rate of 17.82 ± 0.008 was observed in fish fed with feed incorporated with 20g leaf extract of *Euphorbia hirta* /kg feed and the least feed assimilation rate of 15.61 ± 0.014 mg/g/day was noticed in fish fed with feed incorporated with 5g leaf extract of *Euphorbia hirta* /kg feed. The feed assimilation rate in fish fed with feed incorporated with 10, 25 and 50g leaf extracts of *Euphorbia hirta* /kg feed were found to be 16.81 ± 0.026, 17.32 ± 0.019 and 17.17 ± 0.020 mg/g/day respectively. The assimilation rate of 14.24 ± 0.071 mg/g/day was recorded in fish fed with control feed (Table 2.3).

Table 2.2 shows that significant increase (P<0.01) in the assimilation rate in fish, *Cyprinus carpio* fed with feed having leaf extract of *Euphorbia hirta*.

The mean feed assimilation rate in freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of *Aegle marmelos, Andrographis paniculata* and *Euphorbia hirta* for a period of fifty days are graphically shown in fig 2.2. From the
fig 2.2, it is evident that maximum feed assimilation rate of 17.82 ± 0.008 mg/g/day was observed in fish consumed feed incorporated with 20g leaf extract of *Euphorbia hirta* /kg feed. The fish fed with feed incorporated with 20g leaf extract/kg feed of *Andrographis paniculata* showed the least assimilation rate of 10.36 ± 0.039 mg/g/day, among fish fed with feeds having all plant leaf extracts, experimented. Among the three plant leaf extracts tried, *Euphorbia hirta* showed the best assimilation rate as observed in the case of feeding rate.

The mean feed assimilation rate in freshwater fish, *Cyprinus carpio* fed with feed incorporated with different concentrations of leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* for a period of fifty days are given in fig 2.2. It is evident from the fig. 2.2 that in the case of fish fed with *Aegle marmelos* leaf extract incorporated feed, the feed assimilation rate increased in fish fed with having 5 g leaf extract of *Aegle marmelos* /kg feed and the assimilation rate decreased in fish fed with feed having 10 g leaf extract of *Aegle marmelos* and further the assimilation rate increased in fish feed with 20 and 25 g leaf extracts of *Aegle marmelos* /kg feed. The fish fed with *Andrographis paniculata* showed decrease in assimilation rate as the concentration of leaf extract increases and a steep decrease in the assimilation rate was noticed in fish fed with feed having 20g leaf extract of *Andrographis paniculata*. Assimilation rate increased with increase in concentration of leaf extract of *Euphorbia hirta* (fig 2.2).
Metabolic rate (MR)

The average values of metabolic rate in *Cyprinus carpio* fed with feeds incorporated with different concentrations of *Aegle marmelos, Andrographis paniculata* and *Euphorbia hirta* leaf extracts are included in Table 2.3 and the values ranged from 13.78 ± 0.015 to 16.09 ± 0.0547 mg/g/day. The highest metabolic rate of 16.09 ± 0.0547 mg/g/day was observed in fish fed with feed incorporated with 50g leaf extract of *Aegle marmelos* /kg feed and the least metabolic value of 13.78 ± 0.015 mg/g/day was observed in fish fed with feed incorporated with 10g leaf extract/kg feed, followed by fish fed with feeds having 5, 20 and 25g leaf extracts /kg feed, the values being 13.80 ± 0.030, 14.17 ± 0.428, 14.36 ± 0.074 mg/g/day respectively. The metabolic rate of 13.37 ± 0.034 mg/g/day was observed in the fish fed with control feed.

Significant increase in the metabolic rate was noticed in fish fed with feeds having *Aegle marmelos* incorporated feed, when compared with control (Table 2.3)

From the table 2.3, it is clear that the metabolic rate was found to be maximum in fish fed with feed containing 50g leaf extract of *Andrographis paniculata* /kg feed, the value being 11.24 ± 0.108 mg/g/day, followed by the fish fed with feeds having 5, 25, 10 and 20g leaf extracts of *Andrographis paniculata* /kg feed and the values were 10.99 ± 0.050, 10.87 ± 0.110, 10.71 ± 0.039 and 9.56 ± 0.105 mg/g/day respectively. The metabolic rate of 13.26 ± 0.61 mg/g/day was observed in control fish.

Statistical analysis reveals that significant decrease of the metabolic rate at 1% level for the fish fed with feed having *Andrographis paniculata* leaf extract was noticed.
Table 2.3. The mean metabolic rate (mg/g/day) of freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of three leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* for a period of 50 days. Each value is an average of five individual observations with a standard deviation.

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<tr>
<th>Concentration of leaf extract (g/kg feed)</th>
<th>Metabolic Rate (mg/g/day)</th>
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<td><em>Andrographis paniculata</em></td>
<td><em>Euphorbia hirta</em></td>
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<td>14.68± 0.033**</td>
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*P<0.01, *P<0.05, NS – Not Significant
Fig. 2.3. The mean metabolic rate (mg/g/day) of freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* for a period of fifty days. Each value is an average of five individual observations with a standard deviation.
It is apparent from the table 2.3 that the metabolic rate was found to be high in fish fed with feed incorporated with 20g leaf extract of *Euphorbia hirta* /kg feed, the value being $15.83 \pm 0.008$ mg/g/day. The metabolic rate in fish fed with feeds incorporated with 5, 10, 25 and 50g leaf extracts of *Euphorbia hirta* /kg feed were $14.28 \pm 0.009$, $15.17 \pm 0.006$, $14.89 \pm 0.022$ and $14.68 \pm 0.033$ mg/g/day respectively. The control fish showed the metabolic rate of $13.29 \pm 0.058$ mg/g/day, which is higher than that of few plant leaf extract incorporated feeds.

From table 2.3, it is evident that metabolic rate significantly increased at 1% level in fish fed with feed having *Euphorbia hirta*, when compared with control fish.

Fig 2.3 manifest the metabolic rate of *Cyprinus carpio* fed with feeds incorporated with different concentrations of leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta*. In the case of *Aegle marmelos*, the metabolic rate increased with increase in concentrations of leaf extract. The fish fed with feed incorporated with *Andrographis paniculata* leaf extract incorporated feed showed a decreasing trend in metabolic rate, when compared with control fish. Peak metabolic rate was noticed in fish fed with feed having 20 g leaf extract of *Euphorbia hirta* and further increase in concentration of leaf extract, the metabolic rate decreased.

**Feed conversion ratio (FCR)**

The over all mean values of feed conversion ratio observed in *Cyprinus carpio* fed with feeds incorporated with different concentrations of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* leaf extracts for a period of 50 days are included in table 2.4. It is examined from the table 2.4 that the lowest feed conversion ratio was observed in fish fed with feed incorporated with 5g leaf extract of *Aegle marmelos* /kg feed, the
Table 2.4. The mean feed conversion ratio of freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of three leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* for a period of 50 days. Each value is an average of five individual observations with a standard deviation.

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<td>25</td>
<td>22.59± 0.053**</td>
<td>21.88± 0.107**</td>
<td>7.78± 0.225**</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>28.61± 0.097**</td>
<td>27.87± 0.201**</td>
<td>7.61± 0.253**</td>
<td></td>
</tr>
</tbody>
</table>

**P<0.01, *P<0.05, NS – Not Significant**
Fig. 2.4. The mean feed conversion ratio of freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* for a period of fifty days. Each value is an average of five individual observations with a standard deviation.
value being 6.88 ± 0.063. The highest feed conversion ratio of 28.61 ± 0.097 was recorded in fish which consumed feed incorporated with 50g leaf extract of *Aegle marmelos* /kg feed. The feed conversion ratio in fish, fed with feeds incorporated with 10, 20 and 25g leaf extracts of *Aegle marmelos* /kg feed were found to be 10.72 ± 0.179, 8.88 ± 0.093 and 22.59 ± 0.053 respectively. Control fish showed feed conversion ratio of 17.79 ± 0.130, which is better than that of fish fed with some medicated feeds.

Feed conversion ratio significantly increased at 1% level, when compared with control fish fed with feeds having *Aegle marmelos* leaf extracts/kg feed.

It is observed from the table 2.4 that the feed conversion ratio was very low in fish fed with feed having 10g leaf extract of *Andrographis paniculata* /kg feed and the value was found to be 8.51 ± 0.056, followed by the values of 9.72 ± 0.103, 14.79 ± 0.048, 21.88 ± 0.107 and 27.87 ± 0.201 respectively recorded by the fish fed with feeds incorporated with 5, 20, 25 and 50g leaf extracts of *Andrographis paniculata* /kg feed. The highest feed conversion ratio of 27.87 ± 0.201 was noticed in fish fed with feed having 50g leaf extract/kg feed. In the case of control fish, the food conversion ratio of 17.77 ± 0.065 was observed.

Table 2.4 reveals that fish fed with lower concentrations (5, 10 and 20g) of *Andrographis paniculata* showed significant decrease in the feed conversion ratio at 1% level, whereas the fish fed with higher concentrations showed significant increase in the feed conversion ratio at 1 % level.

The result on the feed conversion ratio of feeds incorporated with different concentrations of leaf extracts of *Euphorbia hirta* are presented in table 2.4. From the table 2.5, it is clear that lowest feed conversion ratio of 7.61 ± 0.253 was noticed in fish
which consumed feed incorporated with 50g leaf extract of *Euphorbia hirta* /kg feed, followed by the fish fed with feeds incorporated with 25, 20, 10 and 5g leaf extracts/kg feed and the values were 7.78 ± 0.225, 9.55 ± 0.237, 11.37 ± 0.341 and 12.62 ± 0.357 respectively. Feed conversion ratio of 17.49 ± 0.309 was found in fish which consumed control feed.

Significant decrease in the feed conversion ratio at 1% level was noticed in fish fed with feed having leaf extracts of *Euphorbia hirta*.

The mean feed conversion ratios in freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* are sketched in fig 2.4. From the fig 2.4, it is clear that the feed conversion ratio values decreased in fish fed with feed having 5g leaf extract of *Aegle marmelos* incorporated feed and increased in 10g leaf extract incorporated feed and slight decrease in 20g leaf extract of *Aegle marmelos* incorporated feed fed fish and further the values increased as the concentration of leaf extract of *Aegle marmelos* in feed increases. In the case of fish fed with *Andrographis paniculata* incorporated feed showed a decreased feed conversion ratio in 5 and 10g leaf extract and further the feed conversion ratio showed a increasing trend with increase in concentrations of leaf extracts, whereas in the fish fed with feeds having *Euphorbia hirta* leaf extract the feed conversion ratio decreased with increase in the concentration of leaf extract of *Euphorbia hirta*, with the best feed conversion ratio at the highest concentration of leaf extract experimented.
Feed conversion efficiency (FCE)

The result on the feed conversion efficiency of feeds incorporated with different concentrations of leaf extracts of *Aegle marmelos, Andrographis paniculata* and *Euphorbia hirta* are presented in table 2.5. From the table 2.5, it is clear that the highest feed conversion efficiency of $0.127 \pm 0.042$ was found in the fish which consumed feed incorporated with 5g leaf extract of *Aegle marmelos* /kg feed. The food conversion efficiency of *Cyprinus carpio* fed with feeds incorporated with 10, 20, 25 and 50g leaf extracts of *Aegle marmelos* / kg feed were found to be $0.096 \pm 0.003$, $0.113 \pm 0.003$, $0.048 \pm 0.004$ and $0.37 \pm 0.003$ respectively. Feed conversion efficiency of $0.057 \pm 0.002$ was found in control fish.

Feed conversion efficiency significantly increased at 1% level in fish fed with feeds having 5, 10 and 20g leaf extracts of *Aegle marmelos*, whereas the other concentrations (25 and 50g) was found to be not significant.

The result on feed conversion efficiency of *Cyprinus carpio*, fed with feeds incorporated with different concentrations of *Andrographis paniculata* leaf extract for a period of fifty days are given in table 2.5. Feed conversion efficiency (FCE) of $0.118 \pm 0.006$ was noticed in fish, which consumed feed incorporated with 10g leaf extract of *Andrographis paniculata* /kg feed. The least food conversion efficiency of $0.039 \pm 0.003$ was found in fish fed with 50g leaf extract of *Andrographis paniculata* /kg feed. The fish which consumed control feed showed the feed conversion efficiency of $0.056 \pm 0.005$. The feed conversion efficiency value in fish, fed with feed incorporated with 5, 20 and 25g leaf extracts of *Andrographis paniculata* /kg feed were found to be $0.105 \pm 0.006$, $0.070 \pm 0.009$ and $0.049 \pm 0.003$ respectively.
Table 2.5. The mean feed conversion efficiency of freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of three leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* for a period of 50 days. Each value is an average of five individual observations with a standard deviation.

<table>
<thead>
<tr>
<th>Concentration of leaf extract (g/kg feed)</th>
<th>Feed Conversion Efficiency</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>Aegle marmelos</em></td>
<td><em>Andrographis paniculata</em></td>
<td><em>Euphorbia hirta</em></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0.057± 0.002</td>
<td>0.056± 0.005</td>
<td>0.053± 0.003</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.127± 0.042**</td>
<td>0.105± 0.006**</td>
<td>0.078± 0.004**</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>0.096± 0.003**</td>
<td>0.118± 0.006**</td>
<td>0.087± 0.005**</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>0.113± 0.003**</td>
<td>0.070± 0.009**</td>
<td>0.108± 0.004**</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>0.048± 0.003NS</td>
<td>0.049± 0.003NS</td>
<td>0.126± 0.002**</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>0.037± 0.003NS</td>
<td>0.039± 0.003**</td>
<td>0.132± 0.001**</td>
<td></td>
</tr>
</tbody>
</table>

** P<0.01, * P<0.05, NS – Not Significant
Fig. 2.5. The mean feed conversion efficiency of freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of three leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* for a period of fifty days. Each value is an average of five individual observations with a standard deviation.
Table 2.5 reveals that fish fed with lower concentrations (5, 10 and 20g) of _Andrographis paniculata_ showed significant increase in the feed conversion efficiency at 1% level, whereas the fish fed with 25g leaf extract was found to be not significant and the fish fed with feed having 50g leaf extract showed significant decrease in feed conversion efficiency in common carp at 1% level.

The overall mean values of feed conversion efficiency observed in _Cyprinus carpio_ fed with feed incorporated with different concentrations of leaf extract of _Euphorbia hirta_ for a period of 50 days are included in table 2.5. It is clear from the table 2.5 that the lowest feed conversion efficiency value of 0.078 ± 0.004 was noticed in fish fed with feed incorporated with 5g leaf extract of _Euphorbia hirta_ /kg feed. The highest feed conversion efficiency was recorded in fish fed with feed incorporated with 50g leaf extract of _Euphorbia hirta_ /kg feed. The feed conversion efficiency in fish fed with feeds incorporated with 10, 20 and 25g leaf extracts of _Euphorbia hirta_ /kg feed were found to be 0.087 ± 0.005, 0.108 ± 0.004 and 0.126 ± 0.002 respectively. The control fish showed the feed conversion efficiency of 0.053 ± 0.003.

Significant increase in the feed conversion efficiency at 1% level was noticed in fish fed with feeds having _Euphorbia hirta_ (Table 2.5).

Fig 2.5 depicts the mean feed conversion efficiency in freshwater fish, _Cyprinus carpio_ fed with feeds incorporated with different concentrations of _Aegle marmelos_, _Andrographis paniculata_ and _Euphorbia hirta_. From the fig 2.5, it is evident that the fish, _Cyprinus carpio_ fed with feeds incorporated with leaf extract of _Aegle marmelos_ showed better feed conversion efficiency and the efficiency of 0.127 ± 0.402 was noticed in 5g leaf extract/kg feed fed group. In the case of _Euphorbia hirta_, the concentrations found
effective were 50 and 5g leaf extracts/kg feed, the efficiency were 0.132 ± 0.001 and 0.126 ± 0.002 respectively. Feed conversion efficiency of 0.118 ± 0.006 was found in the fish fed with feed incorporated with 10g leaf extract/kg feed (Table 2.5).

The feed conversion efficiency showed an increasing trend in fish fed with feed having 5 g leaf extract of *Aegle marmelos* / kg feed and further the feed conversion efficiency decreased in fish fed with 10 g leaf extract and then the efficiency increased in fish fed with feed having 20 g leaf extract of *Aegle marmelos* / kg feed and the feeds with higher concentrations (25 and 50 g leaf extracts of *Aegle marmelos*) showed a decreasing trend in feed conversion efficiency. In the case of *Andrographis paniculata* fed fish, the feed conversion efficiency increased in fish fed with feeds having 5 and 10 g leaf extracts of *Andrographis paniculata* / kg feed. When the concentrations of leaf extract in the feed increases, the feed conversion efficiency decreased. The feed conversion efficiency value in freshwater fish, *Cyprinus carpio* fed with feeds having different concentrations of *Euphorbia hirta* showed an increasing trend with increase in the concentrations of leaf extracts in feed (fig. 2.5).

**Protein efficiency ratio (PER)**

The data on protein efficiency ratio (PER) of the experimental fish *Cyprinus carpio* fed with feeds incorporated with different concentrations of leaf extracts of *Aegle marmelos, Andrographis paniculata* and *Euphorbia hirta* for a period of 50 days are included in table 2.6. The table 2.6 indicates that the highest protein efficiency ratio of 0.409 ± 0.101 was recorded by the fish fed with feed incorporated with 5g leaf extract of *Aegle marmelos* /kg feed. This was followed by the fish fed with feeds incorporated with 20, 10, 25 and 50g leaf extracts of *Aegle marmelos* /kg feed and the values were 0.283 ±
Table 2.6. The mean protein efficiency ratio of freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of three leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* for a period of 50 days. Each value is an average of five individual observations with a standard deviation.

<table>
<thead>
<tr>
<th>Concentration of leaf extract (g/kg feed)</th>
<th>Protein Efficiency Ratio</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><em>Aegle marmelos</em></td>
<td><em>Andrographis paniculata</em></td>
<td><em>Euphorbia hirta</em></td>
</tr>
<tr>
<td>0</td>
<td>0.148± 0.004</td>
<td>0.144± 0.005</td>
<td>0.146± 0.004</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.409± 0.101**</td>
<td>0.259± 0.006**</td>
<td>0.192± 0.002**</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>0.236± 0.007**</td>
<td>0.295± 0.005**</td>
<td>0.219± 0.011**</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>0.283± 0.006**</td>
<td>0.167± 0.006**</td>
<td>0.255± 0.003**</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>0.122± 0.018NS</td>
<td>0.146± 0.003NS</td>
<td>0.315± 0.004**</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>0.087± 0.003**</td>
<td>0.089± 0.004**</td>
<td>0.327± 0.001**</td>
<td></td>
</tr>
</tbody>
</table>

** P<0.01, * P<0.05, NS – Not Significant
Fig. 2.6. The mean protein efficiency ratio of freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of three leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* for a period of fifty days. Each value is an average of five individual observations with a standard deviation.
0.006, 0.236 ± 0.007, 0.122 ± 0.018 and 0.087 ± 0.003 respectively. The protein efficiency ratio in control fish was found to be 0.148 ± 0.004 (Table 2.6).

Statistical analysis reveals that protein efficiency ratio significantly increased at 1% level in fish fed with feeds having 5, 10 and 20g leaf extracts of *Aegle marmelos*, whereas the fish fed feed with 25g leaf extract showed significant decrease (P>0.05) in the protein efficiency ratio and the fish fed with feed having 50g leaf extract showed significant decrease in the protein efficiency ratio at 1% level.

The highest protein efficiency ratio of 0.295 ± 0.005 was recorded by the fish fed with feed incorporated with 10g leaf extract of *Andrographis paniculata* /kg feed, followed by the fish fed with feeds incorporated with 5, 20 and 25g leaf extracts of *Andrographis paniculata* /kg feed, the values being 0.259 ± 0.006, 0.167 ± 0.006 and 0.146 ± 0.003 respectively. The least protein efficiency ratio of 0.089 ± 0.004 was recorded by fish fed with feed incorporated with 50g leaf extract/kg feed of *Andrographis paniculata*. Protein efficiency ratio of 0.144 ± 0.005 was noticed in control fish.

Table 2.6 shows that fish fed with feeds incorporated with 5, 10 and 20g leaf extracts of *Andrographis paniculata* showed significant increase in the protein efficiency ratio at 1% level, whereas the protein efficiency ratio was found to be not significant in fish fed with feeds having 25 and 50g leaf extracts of *Andrographis paniculata*.

It is observed from the table that the low protein efficiency ratio of 0.192 ± 0.002 was found in fish fed with feed incorporated with 5g leaf extract of *Euphorbia hirta* /kg feed. The best protein efficiency ratio of 0.327 ± 0.001 was found in fish fed with feed incorporated with 50g leaf extract of *Euphorbia hirta* /kg feed. Protein efficiency ratio of 0.214 ± 0.011, 0.255 ± 0.003 and 0.315 ± 0.004 were recorded in fish fed with feeds
incorporated with 10, 20 and 25g leaf extracts of *Euphorbia hirta* /kg feed. The fish which consumed control feed recorded the protein efficiency ratio of 0.146 ± 0.004.

Significant increase in the protein efficiency ratio at 1% level was noticed in fish fed with feeds incorporated with *Euphorbia hirta* leaf extract/kg feed.

The average values of protein efficiency ratio of the fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of *Aegle marmelos, Andrographis paniculata* and *Euphorbia hirta* for a period of 50 days are given in fig 2.6. The fig 2.6 reveals that, the better protein efficiency ratio was found for the fish which consumed feed incorporated with 5g leaf extract of *Aegle marmelos* /kg feed followed by the fish fed with *Euphorbia hirta* and *Andrographis paniculata*.

From the fig 2.6, it is clear that the protein efficiency ratio in fish fed with feed having 10g leaf extract decreased from the value of fish fed with feed having 5g leaf extract and further the protein efficiency ratio increased in fish fed with feed having 20g followed by a decrease in fish fed with feeds having 25 and 50g leaf extracts of *Aegle marmelos*. In the case of *Andrographis paniculata*, the protein efficiency ratio showed an increase in trend in fish fed with feeds having 5 and 10g leaf extracts and further the protein efficiency ratio showed a decreasing pattern with increase in the concentration of leaf extracts. The fish fed with feeds having *Euphorbia hirta* showed an increase in protein efficiency ratio with increase in the concentration of leaf extract in feed (fig.2.6).
Specific growth rate (SGR)

The data on specific growth rate of *Cyprinus carpio* fed with feeds incorporated with different concentrations of leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* for a period of 50 days are included in Table 2.7. It is apparent from the table that the fish fed with control feed showed the specific growth rate of about 0.093 ± 0.004 g %/day. The least specific growth rate value of 0.0013 ± 0.000 g %/day was observed in fish fed with feed incorporated with 50g leaf extract of *Aegle marmelos* /kg feed. The maximum specific growth rate value of 0.253 ± 0.010 g %/day was recorded by the fish fed with feed incorporated with 5g leaf extract of *Aegle marmelos* /kg feed, followed by that in fish fed with feeds having 20, 10 and 25g leaf extracts of *Aegle marmelos* /kg feeds, the values being 0.206 ± 0.038, 0.158 ± 0.009 and 0.084 ± 0.026 g %/day respectively.

The fish fed with feeds incorporated with 5, 10 and 20g leaf extract of *Aegle marmelos* showed significant increase in the specific growth rate at 1% level, whereas the fish fed with feed having 25g leaf extract was not found to be significant increase at 5% level and the fish fed with feed having 50g leaf extract showed significant decrease in the specific growth rate at 1% level (Table 2.7).

It is also evident from the table 2.7 that the fish fed with feed incorporated with 10g leaf extract of *Andrographis paniculata* /kg feed showed the maximum value of 0.156 ± 0.004 g %/day, followed by fish fed with feeds having 5 and 20g leaf extracts and the specific growth rate values were 0.142 ± 0.006 and 0.078 ± 0.008 g %/day respectively. The specific growth rate of 0.092 ± 0.004 g %/day was found in
Table 2.7. The mean specific growth rate (\%/day) of freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of three leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* for a period of 50 days. Each value is an average of five individual observations with a standard deviation.

<table>
<thead>
<tr>
<th>Concentration of leaf extract (g/kg feed)</th>
<th>Specific Growth Rate (%/day)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>Aegle marmelos</em></td>
<td><em>Andrographis paniculata</em></td>
</tr>
<tr>
<td>0</td>
<td>0.093±0.004</td>
<td>0.092±0.004</td>
</tr>
<tr>
<td>5</td>
<td>0.253±0.010**</td>
<td>0.142±0.006**</td>
</tr>
<tr>
<td>10</td>
<td>0.158±0.009**</td>
<td>0.156±0.004**</td>
</tr>
<tr>
<td>20</td>
<td>0.206±0.038**</td>
<td>0.078±0.008**</td>
</tr>
<tr>
<td>25</td>
<td>0.084±0.026&lt;sup&gt;NS&lt;/sup&gt;</td>
<td>0.058±0.005**</td>
</tr>
<tr>
<td>50</td>
<td>0.0013±0.000**</td>
<td>0.047±0.004**</td>
</tr>
</tbody>
</table>

** P<0.01,  * P<0.05,  NS – Not Significant
Fig. 2.7. The mean specific growth (%/day) of freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of three leaf extracts of *Aegle marmelos*, *Andrographis paniculata*, and *Euphorbia hirta* for a period of fifty days. Each value is an average of five individual observations with a standard deviation.
control fish. The least specific growth rate of 0.047 ± 0.004 g %/day was observed in fish fed with feed incorporated with 50g leaf extract.

Statistical analysis reveals that fish fed with feeds having 5 and 10g leaf extracts of *Andrographis paniculata* showed significant increase in the specific growth rate at 1% level, whereas the fish fed with feeds incorporated with 20, 25 and 50g leaf extracts of *Andrographis paniculata* showed significant decrease in the specific growth rate at 1% level.

The table 2.7 shows that the maximum specific growth rate of 0.234 ± 0.014 g%/day was noticed in fish fed with feed incorporated with 50g leaf extract of *Euphorbia hirta* /kg feed. The least specific growth rate of 0.136 ± 0.013 %/day was observed in fish fed with feed incorporated with 5g leaf extract of *Euphorbia hirta* /kg feed, followed by fish fed with feeds incorporated with 10, 20 and 25g leaf extracts/kg feed the values being 0.158 ± 0.007, 0.194 ± 0.007 and 0.228 ± 0.009 g %/day respectively. The specific growth rate of 0.098 ± 0.009 g %/day was observed in control fish.

Table 2.7 shows that specific growth rate significantly increased at 1% level in fish fed with feeds having leaf extracts of *Euphorbia hirta*, except the fish fed with feed having 5g leaf extract/kg feed, which showed significant increase at 5% level.

Among the three plant leaf extracts tried, the maximum specific growth rate of 0.253 ± 0.010 g %/day was found in fish fed with feed incorporated with 5g leaf extract of *Aegle marmelos* /kg feed, followed by the fish fed with feeds incorporated with 50 and 25g leaf extracts of *Euphorbia hirta* /kg feed and the values were found to be 0.234 ± 0.014 and 0.228 ± 0.009g %/day respectively. The fish fed with feed incorporated with
10g leaf extract of *Andrographis paniculata* /kg feed showed the lower specific growth rate of $0.156 \pm 0.004g \%/day$.

The mean specific growth rate was found to be high in fish fed with feed having 5g leaf extract of *Aegle marmelos* followed by a decrease in fish fed with feed having 10g leaf extract and a slight increase in fish fed with feed having 20g leaf extract with a decrease at 25 and 50g leaf extracts of *Aegle marmelos* / kg feeds. In the case of *Andrographis paniculata*, the specific growth rate showed an increasing trend in fish fed with feed having 10g leaf extract / kg feed and subsequently the specific growth rate decreased with increase in the concentrations of leaf extracts, whereas in the case of *Euphorbia hirta* the specific growth rate increased with increase in the concentrations of leaf extracts (fig. 2.7).
Growth performance of the freshwater fish, *Cyprinus carpio* incorporated with different concentrations of leaf extracts of *Aegle marmelos, Andrographis paniculata* and *Euphorbia hirta*

Growth performance of the freshwater fish, *Cyprinus carpio* incorporated with different concentrations of leaf extracts of *Aegle marmelos, Andrographis paniculata* and *Euphorbia hirta* with 10 days intervals are plotted in fig 2.8, 2.9 and 2.10 respectively. The plots are fitted with respective regression equations, given in table 2.9.

It is clear from the fig. 2.8 that the fish fed with feed incorporated with 50g leaf extract of *Aegle marmelos* /kg feed showed better growth performance, as evident from steep curve and higher ‘b’ value of 0.1125. This is also supported by the fact that the same group of fish showed better feed conversion efficiency (fig. 2.5) and specific growth rate (fig. 2.7). The least growth was observed in the fish which consumed feed with 50g leaf extract of *Aegle marmelos*/kg feed, followed by 25, 10 and 20g leaf extracts/kg feed fed groups and the ‘b’ values were 0.0365, 0.0756 and 0.0893 respectively.

It is clear from the fig. 2.9 that the maximum growth was noticed in the fish which consumed feed incorporated with 10g leaf extract of *Andrographis paniculata* /kg feed, followed by fish fed with feeds having 5, 20, 50 and 25 g leaf extracts/kg feed and the respective ‘b’ values were 0.0837, 0.0443, 0.0287 and 0.0275 (Table 2.8).

The fig. 2.10 indicates that the least growth was noticed in fish fed with feed incorporated with 5g leaf extract of *Euphorbia hirta* /kg feed and the respective ‘b’ value was 0.0533 (Table 2.8), whereas the maximum growth was recorded by the fish, fed with feed incorporated with 25g leaf extract/kg feed, the ‘b’ value being 0.1047, followed by
Table. 2.8. Regression equation ($Y = a + bx$) for the growth performance of the freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* for 50 days

<table>
<thead>
<tr>
<th>Concentration of leaf extracts(g/kg feed)</th>
<th><em>Aegle marmelos</em></th>
<th><em>Andrographis paniculata</em></th>
<th><em>Euphorbia hirta</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$y = 43.227+0.0484x$</td>
<td>$y = 58.134+0.0462x$</td>
<td>$y = 40.094+0.0469x$</td>
</tr>
<tr>
<td>5</td>
<td>$y = 46.135+0.1125x$</td>
<td>$y = 59.868+0.0837x$</td>
<td>$y = 43.995+0.0533x$</td>
</tr>
<tr>
<td>10</td>
<td>$y = 48.777+0.0756x$</td>
<td>$y = 59.809+0.0925x$</td>
<td>$y = 43.832+0.0639x$</td>
</tr>
<tr>
<td>20</td>
<td>$y = 45.065+0.0893x$</td>
<td>$y = 60.169+0.0443x$</td>
<td>$y = 39.719+0.0804x$</td>
</tr>
<tr>
<td>25</td>
<td>$y = 42.969+0.0365x$</td>
<td>$y = 61.437+0.0275x$</td>
<td>$y = 43.234+0.1047x$</td>
</tr>
<tr>
<td>50</td>
<td>$y = 46.676+0.0274x$</td>
<td>$y = 60.377+0.0287x$</td>
<td>$y = 40.449+0.0976x$</td>
</tr>
</tbody>
</table>
Fig. 2.8 Growth performance of the freshwater fish, *Cyprinus carpio* fed with feed incorporated with different concentrations of leaf extract of *Aegle marmelos* for 50 days.

Fig. 2.9 Growth performance of the freshwater fish, *Cyprinus carpio* fed with feed incorporated with different concentrations of leaf extract of *Andrographis paniculata* for 50 days.
Fig. 2.10 Growth performance of the freshwater fish, *Cyprinus carpio* fed with feed incorporated with different concentrations of leaf extract of *Euphorbia hirta* for 50 days.
that in fish fed with 50, 20 and 10g leaf extracts/kg feed and the ‘b’ values were 0.0976, 0.0804 and 0.0639 respectively.

Among the three plant leaf extracts incorporated in feeds, 5g leaf extract of *Aegle marmelos* in feed showed the maximum growth as evidenced from the steep growth curve (fig. 2.8), followed by 25 g leaf extract of *Euphorbia hirta* and 10g leaf extract of *Andrographis paniculata*. 
Feed utilization of the freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* for about fifty days

Considering the total feed given for 50 days as 100%, the percentage of feed consumed, assimilated, metabolised and feed converted into flesh were calculated and plotted in fig 2.11, 2.12 and 2.13 for the fish consumed feeds having different concentrations of leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* respectively. It is clear from the fig.2.11 that the maximum feed consumption of 93.33% was noticed in fish fed with feed incorporated with 25g leaf extract of *Aegle marmelos*/kg feed, followed by the fish fed with 20, 5, 10 and 50g leaf extracts of *Aegle marmelos*/kg feed and the feed consumed percentage were 92.75, 92.74, 87.65 and 80.94% respectively.

The percentage of feed assimilation of 82.45, 77.31, 82.32, 82.6 and 73.21 were obtained in fish fed with feeds incorporated with 5, 10, 20, 25 and 50g leaf extracts of *Aegle marmelos*/kg feed. Maximum and minimum assimilation percentages were noticed for 25 and 50g leaf extracts/kg feed respectively.

High percentage of metabolism of 78.46 was observed in fish consumed feed with 25g leaf extract of *Aegle marmelos*/kg feed. The lowest metabolic rate of 68.97% was noticed in fish fed with feed with 5g leaf extract of *Aegle marmelos*/kg feed. The metabolic rate of *Cyprinus carpio* fed with feeds incorporated with 10, 20 and 25g leaf extracts of *Aegle marmelos*/kg feed were found to be 69.03, 71.87 and 78.46% respectively.
Fig 2.11 Feed utilization of the freshwater fish, *Cyprinus carpio* fed with feed incorporated with different concentrations of leaf extract of *Aegle marmelos*, for a period of fifty days.

![Graph showing feed utilization](image1)

Fig.2.12 Feed utilization of the freshwater fish, *Cyprinus carpio* fed with feed incorporated with different concentrations of leaf extract of *Andrographis paniculata*, for a period of fifty days.

![Graph showing feed utilization](image2)
Among the different concentrations of leaf extract of *Aegle marmelos* tested maximum feed utilized for conversion into flesh was found for the fish consumed 5g leaf extract / kg feed followed by the fish which consumed feeds incorporated with 20, 10, 25 and 50g leaf extracts/ kg feed.

The data on feed utilization of the freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations of leaf extract of *Andrographis paniculata* are given in fig 2.12. From the fig 2.12, it is clear that the maximum percentage of feed consumption (94.21) was observed in fish fed with feed incorporated with 5g leaf extract of *Andrographis paniculata* / kg feed and the minimum percentage of feed consumption (77.02) was observed in fish fed with feed incorporated with 20g leaf extract of *Andrographis paniculata* / kg feed. The percentage of feed consumed (93.43) was observed in control fish (fig 2.10).

The fish which consumed 5g leaf extract of *Andrographis paniculata* / kg feed incorporated feed showed the maximum assimilation percentage of 88.15 followed by the fish fed with feeds having 10, 50, 25 and 20g leaf extracts / kg feed and the assimilation percentages were 82.23, 78.19, 76.43 and 76.43 respectively. The percentage of feed assimilation of 79.77 was noticed in control fish.

The fish which consumed control feed showed 75.47% of metabolism, where as in the experimental group, the maximum feed metabolic percentage of 75.03% was noted for the fish which consumed feed with 50g leaf extract /kg feed, followed by the fish fed with feeds incorporated with 5, 25, 10 and 20g leaf extracts of *Andrographis paniculata* / kg feed and the rate of metabolic percentages were 73.27, 72.56, 71.37 and 63.8 respectively.
Fig 2.13 Feed utilization of the freshwater fish, *Cyprinus carpio* fed with feed incorporated different concentrations of leaf extract of *Euphorbia hirta*, for a period of fifty days.
Maximum value of 10.86% of feed was converted into flesh in fish fed with feed having 10g leaf extract /kg feed and the least food conversion into flesh of 3.16% was noticed in fish fed with feed incorporated with 50g leaf extract / kg feed.

From the fig 2.13, it is clear that the fish fed with feeds incorporated with 20 and 25g leaf extracts of *Euphorbia hirta* / kg feed consumed 98% of the feed given. The fish, *Cyprinus carpio* fed with feeds incorporated with 5, 10 and 50g leaf extracts of *Euphorbia hirta* / kg feed, consumed 86.46, 92.05 and 95.23% of feed given.

The percentage of maximum feed assimilation and metabolism was found in the fish which consumed 20g leaf extract of *Euphorbia hirta* / kg feed and the values were 89.35 and 79.39% respectively.

The percentages of least feed assimilation and metabolic rate of 78.20 and 71.54 respectively were observed in fish which consumed feed incorporated with 5g of *Euphorbia hirta* / kg feed and its feed consumption percentage was 86.46%.

Among the different concentrations of *Euphorbia hirta* leaf extract incorporated feed, maximum feed of 12.47 % was utilized for conversion into flesh in fish consumed 50g leaf extract of *Euphorbia hirta* / kg feed.
Discussion

In the present investigation, experiments were carried out to find out the growth performance of the freshwater fish, *Cyprinus carpio* fed with feeds incorporated with different concentrations (5, 10, 25 and 50g) of leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* for a epoch of 50 days and the respective data are discussed here under.

On perusal of the results of experiments conducted with different levels of leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* in the diet of freshwater fish, *Cyprinus carpio*, it is observed that the feeding rate was low at higher concentrations (25 and 50g) of leaf extracts of *Aegle marmelos* and *Andrographis paniculata* incorporated feeds, but this decrease in feeding rate at higher concentrations of leaf extract incorporated feed was not observed in fish fed with *Euphorbia hirta* (Table 2.1 and Fig. 2.9 to 2.11). It is evident that the inclusion of optimum level of plant leaf extract in the feed might have attracted the fish and or the palatability of the feed might have been increased due to the incorporation of plant extract at lower dose, resulting in better feeding rate. This is supported by the fact that plant leaf extracts may contain certain organic acids and aromatic compounds, which might have attracted the fish at lower concentrations of plant extract, but when the quantity of extract is more than optimum level it may act as repellant resulting in lower feeding rate. The experiments conducted with feed incorporated with *Acalypha indica*, fed to *Oreochromis mossambicus* (Anita, 1998), *Aegle marmelos*, fed to *Catla catla* (Madasamy, 2003) and *Phyllanthus emblica*, fed to *Cirrhinus mrigala* (Diana, 2006) also indicated that feed intake was high at lower concentrations of the plant extract and it decreased at higher concentrations as observed in the present study. Victor *et al.* (2004) supplemented α and β – chitosan in the
diet of common carp as feed additive for better growth and they found that 1 % α-chitosan showed better result in growth performance. Kaur et al. (2004) in their study find that 30% brewery waste in the feed showed better feed absorption and feed utilization in Catla catla, Labeo rohita and Cirrhinus mrigala. Kumari et al. (2005) added Vitamin C in the feed as feed additive in the diet of Clarias batrachus for better growth. Sahu et al. (2007) used Magnifera indica kernel in feed as a feed additive for the fish Labeo rohita and found that the group fed with 5g kernel/ kg dry diet showed the best growth performance. Silvia Peris and Jose J. Asensio (2002) observed that pig’s sense of smell is strongly involved in feed intake and so the aroma of herbs and spices can provide a valuable stimulus for higher attraction towards feed.

The result of the present study also reveals that better feed consumption of 98% was computed in fish fed with feed having 25g leaf extract/ kg feed of Euphorbia hirta (Fig. 2.9). But in the present study maximum specific growth rate of 0.253 ± 0.010 was observed in fish, which consumed only 92.75% of feed incorporated with 5g leaf extract of Aegle marmelos /Kg feed, indicating that feeding rate had no relation with the growth rate as observed by Georgopoulus et al. (1999) in sea bream, Sparus aurata.

Better feed assimilation rate was noticed for the fish fed with feed incorporated with lower concentrations of leaf extract of Aegle marmelos and Andrographis paniculata and with the higher concentration of Euphorbia hirta (table 2.2). The results indicate that fish were more attracted towards the above concentrations, which was also supported by the feed consumption of the above plant leaf extract incorporated feed (Fig 2.9, 2.10 & 2.11). Similar pattern of better feed assimilation for feed with lower concentrations of leaf extract was observed in the experiments conducted with feed incorporated with Acalypha indica, fed to Oreochromis mossambicus (Anita, 1998), Aegle marmelos fed to
Catla catla (Madaswamy, 2003) and Phyllanthus emblica, fed to Cirrhinus mrigala (Diana, 2006). Pappathi and Samuel Paulraj (1990) reported that Cirrhinus mrigala fed with Clitoria ternatea leaf extract incorporated feed showed better assimilation rate of 24.75 mg/gm wt day, among the seven wild leaves tested and they reported that the apparent protein digestibility (APD) values decreased with increasing levels of raw seed meal in the diets. Bairagi et al. (2002) and Ramachandran et al. (2005) fed Labeo rohita with Lemna polyrhiza and Lathyrus sativus leaf meal and observed that APD values decreased with increasing levels of raw seed meal in the diets as observed in the present study.

The least value of metabolic rate was observed in fish fed with feed incorporated with lower concentration of leaf extracts of Aegle marmelos, Andrographis paniculata. But increase in metabolic rate in fish fed with feed incorporated with increase in the concentration of Euphorbia hirta leaf extract was not observed (Table 2.3). This clearly indicates that even though better feeding rate and assimilation rate were found in the same fish, the amount of feed utilized for metabolism was found to be less and thereby the excess feed was diverted for their growth as evidenced from the specific growth rate (Table 2.7 and Fig 2.7). Moreover in the case of the fish fed with feeds incorporated with higher concentrations of leaf extracts, utilized more energy through metabolism (fig 2.9 to 2.11). This rise in metabolic rate may be caused for diverting more energy to compact with the stress due to higher concentration of plant extract in the feed. Similarly rise in the metabolic rate was seen in fish fed with feeds incorporated with leaf extracts of Acalypa indica in tilapia (Anita, 1998) and Aegle marmelos in Catla catla (Madaswamy 2003) and Phyllanthus emblica in Cirrhinus mrigala (Diana, 2006). They suggested that this rise in metabolic rate may be due to the stress factors present in the plant leaf extract.
The feed conversion ratio increased with increase in concentrations of plant leaf extracts (Table 2.4). This trend was not seen in the fish fed with feed having *Euphorbia hirta* leaf extract (Table 2.4). The high FCR values obtained in fish fed with higher concentration of leaf extract incorporated feed (Table 2.4 and fig 2.4) implies that the experimental fish, *Cyprinus carpio* in this group ate more feed to overcome energy inadequacies. Similar results had also been obtained by Santiago *et al.* (1983) in *Chanos chanos*. Gopal *et al.* (1999) in *Liza macrolepis* and Kalla *et al.* (2003) in *Mugil cephalus*. Cheng and Hardy (2002) indicated that the weight gain and feed conversion ratio were significantly reduced when cotton seed meal constituted 15 or 20% in the diets of Juvenile rainbow. Jana *et al.* (2006) in their study found that FCR values decreased with increase in the dietary protein content of the diet up to 40% and thereafter increased dietary protein (42 and 45%) levels resulted in an increase in FCR value.

In the present study, the feed conversion efficiency was found to be the best in the fish fed with feed incorporated with lower concentrations of leaf extracts of *Aegle marmelos* and *Andrographis paniculata* and with higher concentrations of *Euphorbia hirta*. Jayaprakas *et al.* (1999) in their study found that the fish, *Etroplus suratensis* fed with feed having 40% protein showed decreased feed conversion efficiency and reported that at higher protein levels, the excess protein was catabolised to provide energy with consequent reduction in feed conversion efficiency as noticed in the present study. This fact is also supported by the feed utilization studies conducted in the present experiments with *Aegle marmelos* and *Andrographis paniculata* (Fig. 2.11 and 2.12) in which the maximum feed conversion efficiency was noticed in fish fed with feed having higher concentrations of leaf extract with reduction in the growth and high metabolic rate (fig 2.3).
Barros et al. (2002) in Channel catfish and Luo et al. (2006) in rainbow trout reported that weight gain and feed efficiency ratio significantly decreased as the dietary cotton seed meal levels increased as in the present study that the low feed efficiency ratio was observed in fish fed with feed incorporated with the higher concentrations of leaf extract of *Aegle marmelos* and *Andrographis paniculata* (fig. 2.5).

The protein efficiency ratio decreased at higher concentrations of leaf extracts of *Aegle marmelos* and *Andrographis paniculata* (Table 2.6 and Fig. 2.6). This decrease in protein efficiency ratio might be due to the decrease in feed intake (Table 2.1). From the results obtained, it is evident that poor nutrient utilization by fish fed diets containing higher concentrations of leaf extracts of *Aegle marmelos* and *Andrographis paniculata*, when compared with lower concentrations of plant leaf extract. On perusal of the literature, it is evident that, similar growth pattern and nutrient utilization was also noticed by many authors, Viola et al. (1983); Wilson and Poe (1995) and Sadiku et al. (2002). Izquiredo et al., 2005 found reduction of growth in gilt head sea bream, *Sparus aurata*, when 80% soybean of oil substituted with fish oil. Recently Silvia et al. (2007) also noticed the least growth performance in sea bream, *Sparus aurata*, which consumed 72% of soybean in the diet.

The results of growth in common carp in the present study indicate that the higher concentrations of leaf extracts of *Aegle marmelos* and *Andrographis paniculata* lowered the growth, when compared with the control, whereas the lower concentrations of this plant leaf extract enhanced the growth of common carp when compared to the control fish. Dabrowskie et al. (1989) found that 25% of cotton seed meal (CSM) depressed the growth and 50% of CSM arrested the growth when rainbow trout fed with different concentrations (13, 25 and 50%) of cotton seed meal.
Reigh and Ellis (1992) fed fingerlings of red drum with different concentrations (71, 53, 35.5 and 18%) of solvent extracted soybean meal (SSBM) and showed that inclusion level of 53.2% of SSBM in diet suppressed the feed intake, lower the feed consumption, higher feed efficiency and lower the growth in red drum.

A perusal of the literature indicates that leaf extract of *Acalypha indica* fed to *Oreochromis mossambicus* (Anita, 1998) decreased the growth at higher concentrations. The feed incorporated with lower concentration of *Aegle marmelos* in *Catla catla* suppressed the growth for first 20 days of experiment and later increased the growth rate (Madasamy, 2003). In the case of *Phyllanthus emblica* fed to *Cirrhinus mrigala* showed better growth rate at lower concentrations as observed in the case of feeds incorporated with *Aegle marmelos* and *Andrographis paniculata* in the present study. Decreased growth rate at higher concentrations of leaf extracts of *Aegle marmelos* and *Andrographis paniculata* might be due to the presence of any antinutritional factors such as protease, phytate, glucosinolate, saponins, tannins, phytoestrogens or alkaloids. Similar result had occurred when the nile tilapia was fed with feed incorporated with Leucaena leaf meal (Wee et al., 1987) and cassava leaf meal (Ng et al., 1989), whereas a contrasting result in fish fed with feeds incorporated with higher concentrations (25 and 50 g leaf extracts) of *Euphorbia hirta* was observed that the growth rate increased with increase in the concentration of leaf extracts in feed indicating that the optimum concentration of this plant leaf extract had to be found out by increasing the concentrations of the leaf extracts further.

Growth performance study (Table: 2.8) shows that better growth performance in fish was noticed for 5, 10, and 25g leaf extracts of *Aegle marmelos*, *Andrographis paniculata* and *Euphorbia hirta* incorporated feeds respectively. Nandeesha et al. (2001)
fed *Catla catla* with 25% *Spirulina platensis* showed better growth. Bairagi *et al.* (2002) and Ramachandran *et al.* (2005) fed *Labeo rohita* with different concentrations (10, 20, 30 & 40%) of fermented *Lemna polyrhiza* leaf meal and *Lathyrus sativus* seed meal respectively and they found that the diet with 30% of leaf meals showed better and they reported that in general growth and feed utilization efficiencies of fish fed fermented leaf meal containing diets were superior to those fed diets containing raw leaf meal. The presence of antinutritional factors in untreated plant feed stuffs usually results in loss of appetite, reduced growth and poor feed efficiency when used at high dietary concentrations (Tacon, 2002).

The growth results obtained, indicated that the fish fed with 50g leaf extract of *Euphorbia hirta* showed higher feeding rate and higher feed conversion efficiency than that of the fish fed with feed having 5g leaf extract of *Aegle marmelos*. James *et al.*, (1992) observed that better feed consumption rate resulted in simultaneous increase in weight gain and protein efficiency ratio as observed in the case of common carp fed with feed having 5g leaf extract of *Aegle marmelos*.

The growth performance irrespect to specific growth rate, protein efficiency ratio, feed conversion efficiency obtained in the present study indicates that 5g leaf extract of *Aegle marmelos*, 50 and 25 g leaf extracts *Euphorbia hirta* followed by 10g leaf extract of *Andrographis paniculata* can be incorporated in the feed of *Cyprinus carpio* for better growth.