A mong plant protein ingredients, *Ipil ipil* leaves are considered the most nutritious plant protein source among soybean meal in aquatic feeds. The results indicated that weight and length gain, absolute growth, specific growth rate, feed conversion efficiency, protein efficiency ratio and cost-per-unit production were also recorded to be lowest in the fourth diet. The lowest feed conversion ratio and cost-per-unit production were also recorded to be lowest in the fourth diet.

On the other hand, the higher cost-per-unit fish feed led to a significant improvement from the view of growth performance and cost-benefit. The results indicated that weight and length gain, absolute growth, specific growth rate, feed conversion efficiency, protein efficiency ratio and cost-per-unit production were also recorded to be lowest in the fourth diet.

The experiment was performed for a period of 21 days at a nursery pond of Allahwala Hatchery and Fisheries Project, Cox's Bazar, Bangladesh.

The final fish harvest was from the fourth diet, which contained a crude protein value of 30 percent, were formulated as shown in Table 1. The protein requirement was balanced using the square method (Pearson, 1976). The blended feeds were used as experimental diets and stored in an airtight polyethylene bag for longer term use. Four different ingredients: fishmeal, soybean meal (SBM), *Ipil-Ipil* leafmeal and rice bran were selected for experimental diet preparation based on their composition. The control diet (Diet-1) was formulated without mixing of *Ipil-Ipil* leafmeal. Table 2 shows the proximate composition of the four ingredients.

### Table 2: Proximate composition of feed ingredients

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Crude Fat (%)</th>
<th>Crude Protein (%)</th>
<th>Crude Fibre (%)</th>
<th>Ash (%)</th>
<th>Nitrogen Free Extract (NFE)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ipil-Ipil</em> leaf meal</td>
<td>23</td>
<td>18</td>
<td>16</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>Fish meal</td>
<td>18</td>
<td>24</td>
<td>30</td>
<td>35</td>
<td>10</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>55</td>
<td>6</td>
<td>8</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Rice bran</td>
<td>38</td>
<td>7</td>
<td>13</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td><em>Ipil-Ipil</em> leafmeal</td>
<td>11</td>
<td>10</td>
<td>11</td>
<td>13</td>
<td>25</td>
</tr>
</tbody>
</table>

### Methodology:

#### A: Experimental location

The experiment was conducted in four 'lapa' each 3.5 x 1.5 x 0.45 m (L x W x H). Each 'lapa' contained three similar chambers for replication in order to study the growth of *Monosex tilapia* fry with different experimental diets. Diet-1 (was denoted as control); Diet-2, Diet-3 and Diet-4 were respectively applied in 'lapa-2', 'lapa-3' and 'lapa-4' for comparative study of their effect on growth.

#### E: Larvae collection & stocking

The juvenile monosexual tilapias were collected from nursery pond of the research station with an average weight of 0.634 kg and length of 3.52 cm. A numerous fry were stocked in cement tank without...
feed for one day Total 2400 uniform size fry were taken into 12 polythene bags. The fry within polythene bags were acclimatised with water temperature of the ‘hapa’ for three-to-five minutes. Just after acclimatized the fry were finally stocked into ‘hapa’. Each ‘hapa’ contained 600 fry and each experimental chamber contained 200 fry.

F. Feed management
Due to the feeding behaviour of tilapia, granulated experimental diets were spread on centre of each chamber by a small plate arrangement to avoid feeding competition between exterior fish. The amount of feed supplied to the reared fry was 25 percent of the total biomass per day for the first 10 days and 20 percent of total biomass per day for second 11 days.

G. Periodical observation
The growth and survival of the reared specimen in each ‘hapa’ with three replicates were recorded at seven days interval. Ten percent of the estimated fry were sampled and collected samples were placed on the well-marked silk thread scale and recorded the total length from the extreme mouth to the tip of tail. 20 species were taken from each chamber for measuring total length. The mean weight of the sample was then determined by dividing the total weight by the numbers of animals.

H. Biological evaluation
Mean weight gain (MWG), mean length gain (MLG), absolute growth (AG) and specific growth rate (SGR) were determined as advocated by Svedrick (1979). Feed conversion ratio (FCR), feed conversion efficiency (FCE), protein efficiency ratio (PER) were calculated as described by Castell and Tiers (1980).

I. Bio-Chemical Evaluation
The economical feasibility of the experimental diets was studied by analysed unit cost and total costs of all ingredients were used in the experiments.

Results
The nutrient elements such as crude protein, crude fat, crude fibre, ash contents, moisture contents and NFE were evaluated for each of the isonitrogenous diets for the suitability of their finished product for monosex tilapia fry. The four experimental diets were contained 35 percent crude protein. The higher moisture content 13.6 percent was recorded for Diet-3. The higher fat 7.63 percent was recorded for Diet-1 and lower fat 7.4 percent was recorded for Diet-3. The higher Ash 9.24 percent was recorded for Diet-1 and lower Ash 9.24 percent was recorded for Diet-2. The higher NFE 19.7 percent was recorded for Diet-3. The lower FCR, FCE and PER were observed for Diet-4, Diet-3 and Diet-2 respectively.

In the present experiment, feed preparation cost (Tk/kg) and proportional benefit among different experimental diets (Tk/kg) were observed in the Table 4 and while the least FCR, FCE and PER was observed for Diet-4, Diet-3 and Diet-2 respectively.

Discussion:
Ingredients selection is one of the most important factors for formulation and commercial production for supplemental quality feed of aquatic species. In the present study ingredient were selected to consider their nutritional quality and cost effectiveness.

Jackson et al (1982) reported that the success of commercial aquaculture system depends on proper selection of feed ingredients that should be contain optimum level of protein and energy necessary for the growth of the respective culture species and the ingredients should also be low cost. In the present study, ingredients were selected to considered their nutritional quality and cost effectiveness.

Pascual (1980) reported that not only the quantity of protein but also the quality of protein matter can be obtained through use of Ipil ipil leaf as a protein source in Indian major carp, Labeo rohita. Hassan et al (1994) observed a trend of reduced performance with the highest growth, in terms of weight in fish fed diets with 25 percent soaked leucaena diets. Vag et al (1986) found that growth and survival of the tiger prawn was better fed diets in which 20 percent of the soybean was replaced with Leucaena leucocephala leaves. Ghatak et al (1983) reported that diets with 30-65 percent Leucaena leucocephala had no adverse effects on growth or survival.

In evaluating the nutritional quality and cost effectiveness of feeds, the isonitrogenous experimental diets were used in the experiments. The higher NFE, lower MWG, MLG, SGR, ADG, FCE and PER were found in fish fed Diet-4. The least MWG, MLG, SGR, ADG, FCE and PER were observed for Diet-1 (see Table-1).

Table 4: Feed formulation cost (Tk/kg) and cost per unit production (Tk/kg)

<table>
<thead>
<tr>
<th>Diet</th>
<th>Feed formulation cost (Tk/kg)</th>
<th>Total feed cost (Tk)</th>
<th>Total fish production at the end of exp. (kg)</th>
<th>Cost per unit production (Tk/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet 1</td>
<td>20.82</td>
<td>2.523</td>
<td>52.53</td>
<td>1.152</td>
</tr>
<tr>
<td>Diet 2</td>
<td>18.33</td>
<td>2.354</td>
<td>46.45</td>
<td>1.31</td>
</tr>
<tr>
<td>Diet 3</td>
<td>17.85</td>
<td>2.271</td>
<td>48.57</td>
<td>1.36</td>
</tr>
<tr>
<td>Diet 4</td>
<td>19.15</td>
<td>2.714</td>
<td>51.97</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Table 5: Comparative Benefit Analysis among different experimental diet

<table>
<thead>
<tr>
<th>Diet</th>
<th>Cost per unit production of fish (Tk/kg)</th>
<th>Total Benefit (Tk)</th>
<th>% of Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet 1</td>
<td>45.6</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Diet 2</td>
<td>35.46</td>
<td>10.14</td>
<td>22.24</td>
</tr>
<tr>
<td>Diet 3</td>
<td>35.71</td>
<td>10.89</td>
<td>21.69</td>
</tr>
<tr>
<td>Diet 4</td>
<td>34.65</td>
<td>10.95</td>
<td>24.01</td>
</tr>
</tbody>
</table>

Table 5: The lowest production cost indicating economic viability of the feed. The higher price of feed ingredients was 37.06% for fishmeal and lower price for ingredients was 3.06% for Ipil-ipil leafmeal. The higher formulation cost was 17.85% for Diet-1 and lower formulation cost was 17.85% for Diet-3. The estimated higher cost for production of 100kg juvenile monosex tilapia was four 36.45% for Diet-1 and lower cost for production of 100kg juvenile monosex tilapia was 3465 Tk/kg for Diet-4. The higher benefit was 40.7% and the lowest benefit was 21.69% for Diet-3 when compared with Diet-1.

The economical feasibility of the experimental diet was studied by analysed unit cost and total costs of all ingredients were used in the experiments. The economical feasibility of the experimental diets was studied by analysed unit cost and total costs of all ingredients were used in the experiments.
It was found that Ipil ipil leafmeal at 15 percent level used in the diets have good nutritive values and have a significant role on the growth, FCR, FCE and all of the performance measure of Oreochromis niloticus. It also found that FCR increased with increased in ipil ipil leafmeal level in the diet, being highest in Oreochromis niloticus fed 25 percent IILM and lowest in tilapia 15 percent for both optimum and high energy diets. Tilapia showed very poor growth when Leucaena leucocephala constituted 25 percent or more of the dietary protein. The reduced value of FCR is very significant for commercially and economically and also prove the better growth performance.

Better performance in growth, nutrient utilisation and proximate composition in O. niloticus fed diets with leaf protein concentrates showed that leaf proteins made from leucaena could be viable means of improving fish feed specially for Oreochromis niloticus. The proximate composition of the feed ingredients and ipil ipil leafmeal used in the experimental diets in the present studies were within the expected ranges (Ayuk et al 2002; Nas, 1977; Mutuyoba et al 2003; Adeparusi et al 2005).

In the present experiment, feed preparation cost of experimental diets were found highest 20.82tk/kg for Diet-1 and lowest 17.85tk/kg for Diet-3 and the amount of cost per unit production was highest 43.6tk/kg for Diet-1 and lowest 34.65tk/kg for Diet-3. The highest production cost indicating economic viability of the feed (Table 3 and 4). Partial replacement of fishmeal or marine animal protein and soybean meal by ipil ipil leafmeal resulted in better growth performance, indicating an economical profit for juvenile tilapia.

In commercial aquaculture, feed cost is the major part of overall production cost. Benefit of aquaculture is calculated with per unit production and cost of feed for it. The achievement of the present study was that 24 percent feed cost were reduced by using experimental Diet-4 which contained 15 percent IILM (non conventional feed ingredients) in the diet.

Conclusions

Tilapia culture in rural area of developing countries requires strategies for better performance.

From the overall discussion of the present experimental results it has established that better growth and minimum feed cost of reared species may also be obtained using the feed with mixed protein of plant and animal origin. Supplementation of artificial diets to the natural food may further increase the growth and survival and decrease the feed conversion of the rearing species. To achieve a balance nutritional composition in fish feed, a more diverse choice should be made in selecting feed ingredients. A mixture of feed ingredients will provide more balance nutrients than only limited feed ingredients to formulate fish feed.

Products derived from ipil ipil have been shown to be important ingredients for practical feeds for tilapia. This is primarily because of the high level of protein, its low price and the case of incorporation into feeds and the low level of anti-nutritional elements. The findings in the present study showed that ipil ipil leafmeal could be used as protein substitute up to 25 percent and optimum level 15 percent in diet of growing tilapia. IILM at 15 percent level used in the diets have good nutritive values and have a significant role on the growth, FCR, FCE and all of the performance measure of O. niloticus.

Acknowledgement:

The authors are deeply indebted and grateful to Master Abul Kalam, project manager and managing director Allahwalla Hatchery and Fisheries Project, Cox’s Bazar, Bangladesh, for offering permission and reproductive behaviour of Mossabique tilapia (S. mossambicus) and Indian major carps (C. rui, C. r. catla) although the diets did not improve their performance over that of a standard diet.

When Rahman et al (1988) fed Nile tilapia (T. niloticus) a diet containing Leucaena leucocephala leaves; the fish grew more slowly than those on a standard rat diet. The leaves also caused alterations in the female gonads. In the present study it was found that Ipil ipil leafmeal at 15 percent level used in the diets have good nutritive values and have a significant role on the growth, FCR, FCE and all of the performance measure of Oreochromis niloticus. It also found that FCR increased with increased in ipil ipil leafmeal level in the diet, being highest in Oreochromis niloticus fed 25 percent IILM and lowest in tilapia 15 percent for both optimum and high energy diets. Tilapia showed very poor growth when Leucaena leucocephala constituted 25 percent or more of the dietary protein. The reduced value of FCR is very significant for commercially and economically and also prove the better growth performance. Better performance in growth, nutrient utilisation and proximate composition in O. niloticus fed diets with leaf protein concentrates showed that leaf proteins made from leucaena could be viable means of improving fish feed specially for Oreochromis niloticus. The proximate composition of the feed ingredients and ipil ipil leafmeal used in the experimental diets in the present studies were within the expected ranges (Ayuk et al 2002; Nas, 1977; Mutuyoba et al 2003; Adeparusi et al 2005).

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