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Ipil-ipil (*Leucaena leucocephala*) leaves as a plant protein source in prawn diets

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Penaeus monodon juveniles weighing between one to two g were fed diets containing fish meal, shrimp head meal and ipil-ipil leaves soaked and unsoaked, local and Peruvian varieties. Each protein source contributed 1/3 of the calculated 30% protein content. They were fed for 8 weeks in fiberglass aquaria, with continuous aeration and flowthrough water. A diet without ipil-ipil served as the control (FS). Commercially dried and ground ipil-ipil was incorporated in one of the diets, CIL. Peruvian leaves soaked, (PILS), Peruvian unsoaked, (PILU) + local unsoaked (LILU) and local soaked (LILS) were incorporated in diets PILS, PILU, LILU and LILS, respectively.

Mean weight gain at the end of 8 weeks was significantly highest ($P < 0.05$) among those given the diet (CIL) containing commercial ipil-ipil leaves, 124.1% (Table 2) while mean weight gain of the animals fed the fish meal, shrimp meal (FS) diet, 78.8% was slightly higher but was not significantly different from those fed the diets containing soaked Peruvian ipil-ipil leaves (PILS), unsoaked Peruvian ipil-ipil leaves (PILU) and soaked local ipil-ipil leaves (LILS).

Gain in length followed the same pattern as mean weight gains. Those fed the CIL significantly gained in length by 31.5% ($P < 0.05$). The increase in length of the animals fed the non-ipil-ipil containing diet (FS) was not significantly different from those fed diets containing the local or Peruvian leaves, soaked or unsoaked.

Nevertheless, some attempts were made to measure the protein intake of the shrimps. The juveniles fed the diet without ipil-ipil (FS) apparently absorbed the highest amount of protein compared to those fed the diets containing ipil-ipil (Table 3). Generally, protein efficiency ratios were low for all treatments but diet CIL was significantly the highest, 0.12 ($P < 0.05$). The efficiency of the protein of diet CIL was twice those of the other diets including the diet that did not contain ipil-ipil. Mean protein intake, 25.8 mg, of those fed diet CIL was similar to those fed FS, 25.5 mg, but protein efficiency was not the same.

The number of survivors per week started to decline after the first week of feeding in those fed LILU diet and continued to decline rapidly. After four weeks of feeding only half of the original population had survived and by five weeks only two survived. At the end of the experiment only one prawn in the four replicates survived. In contrast to diet LILU mortality was observed in those fed PILS and LILS only after the third week. After the second week of feeding there were deaths observed in those fed PILU, CIL and FS.

Among the treatment diets that contained ipil-ipil leaves, there was a direct relationship in the amount of mimosine in the diet and survival rate. The prawns fed the diet that contained 1.52% mimosine gave 0% survival rate at the end of the experiment, whereas the diet that contained the soaked local ipil-ipil leaves with a computed mimosine value of 0.26% gave a survival rate of 87.5%. Survival rate was not significantly different among those groups fed the Peruvian variety regardless of whether the leaves were soaked or unsoaked ($P < 0.05$). Of those fed the commercial ipil-ipil leaves survival rate was the lowest, 43.8%, but was not significantly different from those fed diets PILS and PILU. Replicate tanks for diets PILU and PILS did not have similar survival rates. Survival rate of those fed the non-ipil-ipil containing diet (FS) was slightly lower than those fed local ipil-ipil soaked leaves but was not significantly different ($P < 0.05$).

Table 1. Chemical composition of diets in percent (dry weight basis)[1].

	PILS	PILU	LILS	LILU	CIL	FS
Dry matter	91.50	91.50	91.50	94.00	93.50	91.50
Moisture	8.50	8.50	8.50	6.00	6.50	8.50
Crude protein	29.56	27.34	27.65	29.48	26.03	28.34
Crude fat	10.08	10.39	7.88	8.87	8.94	7.76
Crude fiber	6.62	6.87	11.86	8.27	7.08	10.73
Ash	.02	22.19	19.46	20.28	30.32	28.18
Nitrogen free extract	31.84	31.6	36.5	35.4	22.13	16.49
D.E. Kcal/100 g[2]	265.00	259.00	252.85	264.53	218.8	203.3
Mimosine in the diet	0(0.4)[3]	0(0.69)	0(0.26)	1.52	0.76	–
Mimosine in pure leaves	1.14	1.96	0.88	5.06	1.90	–

[1] Analyzed by the Chemistry section, SEAFDEC.

[2] Calculations were based on the D.E. for channel catfish: Protein 3.5, Carbohydrate 2.5, Fat 8.1 KCal/g.

[3] Values in parentheses were calculated from mimosine content in leaves.

The low survival rate but superior growth of those fed the CIL diet seems to bear out the theory that growth is a function of population density as well as diet (Shewbart, et al., 1973). Therefore, the assessment of animals fed diets that caused variable survival rates is difficult. However, low survival rates and weight gains were observed in those fed PILS and PILU. Thus, although stocking density was a factor that could have caused growth differences, diet played a role in the growth process. Not only the quantity of protein but also the quality of the protein could cause the difference in weight gain between the animals fed the commercial ipil-ipil leaves and other groups. Since the amino acid patterns of the diets were not analyzed, one can only surmise that the amino acid pattern of the CIL diet was better than the other diets. The efficiency of the protein depends on many factors such as protein contents, protein quality and protein digestibility (Kakade, 1974).

Results in a study by Deshimaru and Shigueno (1972) showed that a high proportion of fish meal in the diet gave poor growth to *P. japonicus* and was probably due to a deficiency in basic amino acids. The FS had more fish meal than the CIL diet by 9%.

Table 2. Mean weights, lengths, and percent survival[1].

Diet	Mean initial wt (g)	Mean final wt (g)	Increase in wt %	Mean initial length (mm)	Mean final length (mm)	Increase in length %	Survival %
PILS[2]	1.34	2.04	52.0[b]	56.7	64.8	14.2[b]	54.2[b]
PILU	1.26	2.07	63.9[b]	56.4	66.0	17.2[b]	50.0[b]
LILS	1.24	2.00	62.2[b]	54.8	65.4	19.5[b]	87.5[a]
LILU	1.36	–	–	52.0	–	–	0
CIL	1.30	2.90	124.1[a]	55.6	73.1	31.5[a]	43.8[c]
FS	1.32	2.34	78.8[b]	55.2	67.7	22.6[b]	79.2[a,b]

[1] Mean of 4 replicate tanks

[2] Values with the same superscripts are not significantly different from each other ($P<0.05$).

Poor growth might not only be due to the quality of the protein but also to the quantity of protein in the diet. New (1976) reported that there are conflicting results for optimum dietary protein levels in the literature. Data presented indicated that 27-35% was optimum depending on the species. Preliminary studies in the laboratory show dietary protein requirement of juvenile *P. monodon* to range between 30 to 40% (Parreno, 1977, Khannapa, 1977), while Alava (1979) reported protein requirement of *P. monodon* juveniles to be 40 to 50% depending on the type of protein source. Shigueno and Deshimaru (1972) reported a protein requirement for *P. japonicus* to be 60%. However, the ability to provide a balanced amino acid profile might reduce the amount of protein needed. They noted that the amino acid pattern of the artificial diets that they found highly efficient were similar to that of clams and prawns. In this study, 30% protein content was chosen on the assumption that if ipil-ipil leaves could support growth in a diet containing relatively low amounts of protein it should be beneficial in slightly higher protein diets. A lower than 40% protein diet would also cost less.

The fact that a survival rate of 100% was obtained in 2 out of 4 replicates in those fed the soaked local variety of ipil-ipil leaves shows that mimosine can be extracted and the leaves can be incorporated in the diet without causing harmful effects.

The relatively good growth of the prawns on the diet containing commercial ipil-ipil leaves (CIL) and the high survival rate of those fed soaked local leaves proves that the addition of ipil-ipil leaves to the diet is not detrimental but rather beneficial. For as long as the mimosine content of the leaves is drastically reduced by soaking, ipil-ipil leaves can be used in prawn diets. A kg of shrimp head meal or fish costs more than two or four times respectively that of ipil-ipil foliage. Therefore, inclusion of ipil-ipil leaves in the diet would reduce the cost of the diets considerably. The optimum amount of leaves and protein in the diet is yet to be determined.

Table 3. Protein consumed, excreted mean protein intake per day and protein efficiency ratio.

Treatment	Protein consumed 8 weeks (g)	Protein excreted & in food unconsumed (g)	Mean protein intake/day mg)	PER[4]
1. PILS	24.1	7.7	28.2	.04[d]
2. PILU	19.4	5.7	23.0	.06[b]
3. LILS	21.3	6.6	22.3	.05[c]
4. LILU	–	–	–	–
5. CIL	19.8	5.7	25.8	.12[a]
6. FS	20.5	4.3	25.5	.06

[1]Dry weight of food offered X % protein in the diet.

[2]Dry weight of feces and unconsumed food X % protein in feces and unconsumed food.

[3]Protein assumed absorbed = Protein offered – Protein excreted and unconsumed food.

$$\text{Mean protein intake} \quad \frac{\dfrac{\text{Protein assumed absorbed}}{\text{56 days}}}{\text{Mean No. of animals each day}}$$

$$^{4}\text{PER} = \text{Protein efficiency ratio} - \frac{\text{Weight gain}}{\text{Protein assumed absorbed}} = \frac{\text{Weight gain}}{\text{Protein consumed} - \text{protein in excreted and unconsumed feed}}$$

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