Studies on Lantern Fish *(Benthosema pterotum)* II. Nutritional Evaluation

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Various methods for processing and utilization of lantern fish *(Benthosema pterotum)* are reported. Nutritional evaluation of fish meal and fish hydrolysate from lantern fish has been carried out. Growth rate and PER of lantern fish meal are similar and better than that of the reference protein, casein. Lantern fish meal can therefore be extensively used for the formulation of poultry, fish and other animal feeds as a good protein supplement with beneficial effects.

The biochemical and microbiological characteristics of lantern fish, caught from the Gulf of Oman have been reported. (Gopakumar *et al.*, 1982). The present study was undertaken to evaluate the various methods of processing and utilization of lantern fish. Fish meal, dry fish and fish hydrolysate were prepared and their chemical properties tested. The nutritional quality of the fish meal was also evaluated in rat experiments, using casein as the reference protein.

Materials and Methods

Conversion to dry fish

The frozen lantern fish was thawed, salted, cured and dehydrated to a moisture level of 16.7% to get the dried product.

Conversion to fish meal

2 kg of thawed lantern fish was cooked under steam at 0.7 kg/sq cm for 30 min, stick water was drained off and the press cake dried in the sun for 14–16 hours. In another batch, as much fat as possible was removed by pressing after cooking and the cake dried in a tunnel drier at 50°C. Moisture, protein, fat, ash and acid insoluble ash were estimated according to the methods of AOAC (1975).

Conversion to fish hydrolysate

The fish was cooked in water (1:1 w/w) cooled to 55°C and the pH was adjusted to 6.5. It was transferred to a reaction vessel maintained at 55°C and mixed with 0.25% papain (activity 10 units/mg enzyme) under continous stirring. After 30 min, the reaction was stopped by boiling the contents, the hydrolysate was filtered off, pH adjusted to 7, concentrated on a water bath and finally dried under vacuum.

Estimation of amino acid composition and PER

The amino acid composition of both fish meal and fish hydrolysate were determined by microbiological assay methods of Shockman (1963). Chemical score was calculated using the amino acid scoring pattern proposed by FAO/WHO (1973). The PER of lantern fish meal was measured using rats at 4 week period by the method of Chapman *et al.* (1959). Casein was used as the standard reference protein and the amount of protein was kept at 10 per cent level in both diets. Adequate quantities of mineral mixture (Hubbel *et al.*, 1937) and vitamins (Chapman *et al.*, 1959) were also added. Ten male weaning albino rats (Wistar strain) were assigned to each test diet. Food and water were supplied *ad libitum*. Records of daily food intake and weekly weight increase of the rats were maintained for 28 days and PER was calculated as g weight gain/g consumed protein. After the feeding experiment, the rats were killed and liver, kidney and spleen were examined and respective weights were measured after removing the connective tissues. Total nitrogen of the liver and kidney was also determined.

Results and Discussion

The conversion ratio of lantern fish to meal was 4.8:1. The data is comparable to the conversion ratios for other species of the same family (Teutscher, 1979). Proximate composition of fish meal from different batches is given in Table 1. The meals had very high protein and mineral content, although the fat content is slightly more than the maximum limit prescribed for in the relevant specifications (IS: 4307-1973) for the first sample. This can be eliminated by better pressing and removal of stick water from the cooked fish. The salted and dehydrated lantern fish was black in colour, which makes it unappealing and highly unacceptable to consumers. Both the dried product and meal had good shelf life of over six to twelve months respectively at ambient temperature (28±2°C). Conversion of lantern fish to hydrolysate gave an extremely hygroscopic powder with a golden yellow colour which had a shelf life of over ten months in proper air tight containers.

Table 1. *Proximate composition of lantern fish meal (average of three samples)*

	Sample 1[a]	Sample 2[b]
Moisture %	5.8±0.2	6.1±0.1
Protein %	65.6±1.5	68.5±0.5
Fat %	10.4±0.4	6.2±0.4
Ash %	16.0±1.0	17.9±0.9
Acid insoluble ash %	0.2±0.01	0.1±0.01

a: cooked and sun dried

b: cooked, pressed and tunnel dried

Yield of the hydrolysate was around 5% of the wet fish.

The amino acid composition of both lantern fish meal and hydrolysate is presented in Table 2. The results showed that the composition is comparable to that of many fish species studied here so far (Arul James, Personal communication). The essential amino acid pattern of the two products in comparison with that of casein (Craig *et al.*, 1978) and the 1973 FAO/WHO reference protein is given in Table 3. Lysine was found to

Table 2. *Amino acid composition of lantern fish meal and hydrolysate (g/100 g of protein)*

Amino acid	Lantern fish meal		Lantern fish hydrolysate
	Sample I	Sample II	
Arginine	5.82	5.61	3.53
Histidine	2.79	6.23	6.48
Lysine	5.55	5.62	7.34
Tyrosine	2.26	3.24	5.18
Phenylalanine	5.03	4.57	2.40
Methionine	3.45	3.69	5.09
Cystine	1.39	1.00	2.26
Threonine	4.16	4.12	5.71
Leucine	5.09	5.70	9.77
Isoleucine	4.07	4.07	6.70
Valine	5.79	5.23	6.67
Glutamic acid	13.41	15.24	14.48
Aspartic acid	4.21	6.23	5.47
Glycine	4.80	3.67	3.70
Proline	5.08	6.89	4.54
Serine	4.27	5.98	5.67
Tryptophan	0.8	0.8	0.76

Table 3. *Essential amino acid level and chemical score of lantern fish meal and hydrolysate (g/100 g of protein)*

Amino acid	FAO/WHO scoring pattern (1973)	Casein	Lantern fish meal	Lantern fish hydrolysate
Isoleucine	4.0	16.7	4.1	6.7
Leucine	7.0		5.7	9.8
Lysine	5.5	8.2	5.6	7.3
Methionine + Cystine	3.5	3.7	4.7	7.4
Phenylalanine + Tryosine	6.0	10.7	7.8	7.6
Threonine	4.0	4.5	4.1	5.7
Tryptophan	1.0	1.4	0.8	0.8
Valine	5.0	7.4	5.2	6.7

be adequate in the fish meal and 7.3g/100g protein in the fish hydrolysate. Limiting amino acid in the hydrolysate was tryptophan and the chemical score was 80. This product can be extensively used as a protein supplement to combat protein malnutrition. For the fish meal limiting amino acids were tryptophan and leucine, the chemical score being 80 and 81 respectively. All the other essential amino acids were present in adequate to excessive quantities in both cases.

Growth rate of rats fed with lantern fish meal (Fig. 1) was similar and slightly better than that of rats fed with casein diet. No untoward symptoms like diarrhoea, seborrhoea or stunting effect were seen during the experimental period.

The weight gain, protein intake and protein efficiency ratio values for casein and lantern fish meal are listed in Table 4. The fish meal had higher PER compared to the reference protein. After 28 days of feeding, the animals were observed to be in a healthy state without any obvious physiological disturbances. The PER data coincide with the amino acid values, thus confirming the high quality of lantern fish meal.

The relative organ weights and liver and kidney nitrogen levels of the animals fed on the two diets are presented in Table 5. The organ weights were comparable and no significant difference was observed in the nitrogen levels of various organs. Negative effects were not seen. The increase in body weight, PER and nitrogen content of liver of the animals in both groups were similar. It may be concluded that the lantern fish meal could therefore be extensively used for the formulation of poultry, fish and other animal feeds and as a good protein supplement with beneficial effects.

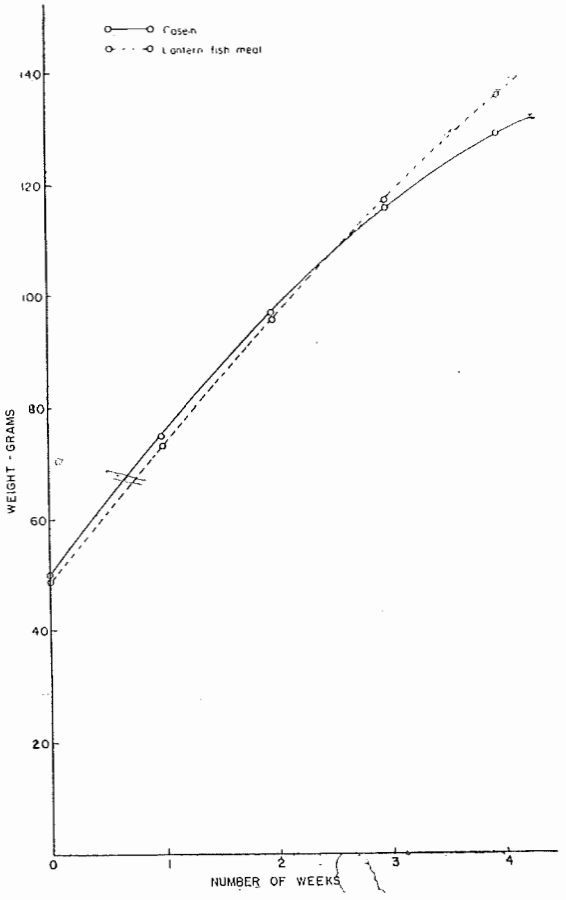

Fig. 1. Growth rate of rat fed with lantern fish meal

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Table 4. *Protein efficiency ratio of lantern fish meal**

Protein source	Initial body wt g	Final body wt g	Gain in body wt g	Diet intake g	Protein intake g	True PER	Adj PER
Casein	49.75 ±7.51	129.75 ±11.87	80.0 ±9.43	255.40 ±15.49	25.54 ±1.55	3.13 ±0.21	2.50
Lantern fish meal	48.30 ±5.58	136.40 ±8.41	88.10 ±5.98	262.80 ±13.29	26.28 ±1.33	3.35 ±0.14	2.68

* Adjusted the PER value of the control diet containing casein to 2.50

Table 5. *Relative organ weights and organ nitrogen levels of rats fed with experimental diets*

Protein source	Liver wt Total g	Liver wt g/100 g body wt	Kidney wt Total g	Kidney wt g/100 g body wt	Liver nitrogen mg/total liver	Kidney nitrogen mg/total kidney
Casein	5.72 ±0.63	4.41 ±0.22	1.09 ±0.07	0.84 ±0.05	145.33 ±6.17	34.44 ±1.87
Lantern fish meal	5.55 ±0.70	4.02 ±0.42	1.09 ±0.06	0.80 ±0.04	152.05 ±9.64	33.70 ±2.68

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