

A Nutritional Evaluation of Some Imported and Indigenous Shrimp Feeds

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Biochemical composition and water stability of six imported and five indigenous shrimp feeds were evaluated. Indigenous feeds had lower water stability and lower crude protein content (30-40%) compared to imported feeds. Feeding experiments were conducted using *Penaeus indicus* juveniles (200 mg) to determine daily growth increment, feed conversion ratio and protein efficiency ratio. Significant variation ($p < 0.05$) existed in average daily growth rate among feeds of both imported and indigenous origin. The results indicate the need for improvements in feed technology and formulation of high quality indigenous feeds at commercial levels.

Key words : Shrimp feed, nutritional evaluation

Shrimp culture is changing rapidly in India from an extensive to semi-intensive and intensive practice. Thus, the role of supplementary feeding becomes more important (Sedgewick, 1979) and development of low cost artificial diets, a necessity.

One of the major constraints experienced by shrimp farmers for the development of intensive culture of shrimp in many developing countries is the lack of nutritionally adequate and low cost feeds. Although, a number of feed industries have been established recently, they are confronted with problems such as non-availability of raw material and lack of standardised technology.

The present investigation was conducted to evaluate some imported feeds with a view at possible simulation and adoption of their favourable biochemical characteristics, if any, for the formulation of a successful practical shrimp diet on a commercial scale locally, while taking into consideration, the limitations of available infrastructure and indigenous raw

materials. A few local feeds were also studied for comparison.

Materials and Methods

Indigenous feeds were procured from small scale shrimp farmers at Tuticorin and Cochin while the imported feeds were obtained from either the parent firms or their Indian counterparts.

Six brands of imported shrimp feeds were analysed of which the feeds designated as F_1 and F_2 were feeds used for extensive shrimp culture, feeds F_3 , F_4 and F_5 were (grower) feeds used for intensive shrimp culture and F_6 was a maturation feed (Fig. 1a). The other five feeds analysed were unclassified local brands which served as general shrimp feed. These feeds were designated as IF_1 , IF_2 , IF_3 , IF_4 and IF_5 , respectively (Fig. 1b). The physical characteristics of the feeds are given in Table 1.

Biochemical investigations were performed on the eleven feeds in order to assess their nutritive value. Dry matter,

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crude protein, crude fat and ash were analysed by following the standard AOAC methods (1980). The method of Pearson (1976) was followed to analyse crude fibre. Carbohydrate content was calculated as nitrogen free extract (NFE) by the difference method of Hastings (1976). Calcium, available phosphorous, sodium and potassium were estimated according to New (1987). Chitin in feed samples was estimated according to the method of Richards (1978).

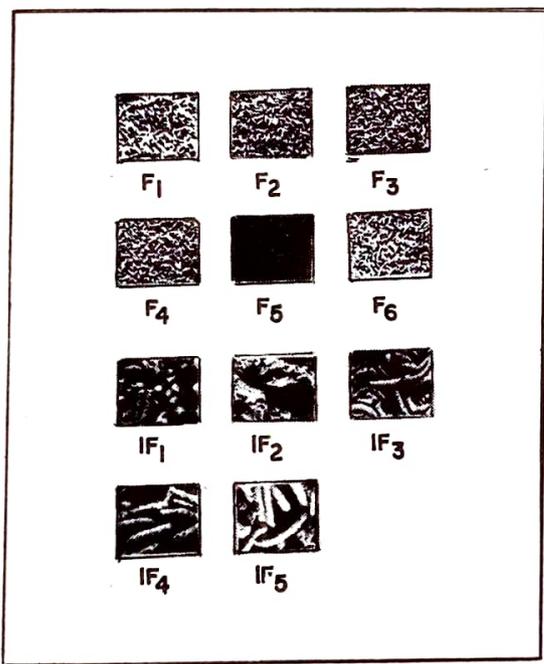


Fig. 1. The imported and indigenous shrimp feeds
 F_1 to F_6 = Imported shrimp feeds IF_1 to IF_5 =
 Indigenous feeds

The water stability of the feed (F_4 could not be tested on account of small sample size) were determined using wet durability test described by Jayaram & Shetty (1981) with slight modifications. Five grams of each feed were taken in 10x10 cm size No. 30 bolting silk cloth and the edges were stapled to form a pouch. The pouches were immersed separately in plastic troughs containing 10 litres of 32‰ sea water provided with aeration. At set time intervals of 1, 3 and 5 h respectively

three pouches for each feed were removed from the trough and after carefully draining the excess water the residue was dried in a hot air oven at 105°C for 30 min, followed by further drying at 65°C to a constant weight and then cooled in a desiccator. The mean differences in weights of pouches containing the feed before immersion and after drying were used to calculate the percentage dry matter loss, which is a measure of the water stability of the pellets for the corresponding intervals.

To assess the suitability of the feeds for shrimp feeding, preliminary experiments were carried out. Juveniles of *Penaeus indicus* (average initial weight : 200 mg) caught from the wild were selected at random for the feeding experiments. Animals were stocked in plastic troughs containing 15 l of filtered (No. 20 bolting silk cloth) sea water. Animals were measured individually for length but initial average weight was taken from a sample of 50 animals sacrificed for this purpose. Ten animals were stocked in each trough and two replicates were run for each feed. Aeration was provided continuously and water changed every third day. The animals were fed at the rate of 15% of the body weight once a day at 16:00 h. The left over feed was collected, dried and weighed and sediments removed daily before feeding. The experiment was continued for a period of 30 days. A set of animals maintained on meat of fresh clam (*Sunneta scripta*) served as control.

Salinity, oxygen and pH of the water were monitored throughout the experiment and the range of these parameters was salinity, 32±1‰, pH 7.4 to 8.0 and temperature 27.4 to 28°C. Feed conversion ratios (FCR) were determined as the grams of air-dry weight of feed fed per gram of wet weight gain. The protein efficiency ratio (PER) was calculated as the grams of

Table 1. Physical characteristics of feeds

Feed	Diameter, mm	Length, mm	Colour	Appearance
Imported Feeds				
<i>Extensive feeds</i>				
F ₁	2.0	1-10	Pale whitish brown	Compact
F ₂	2.0	2-6	Light brown	Compact
<i>Intensive feed</i>				
F ₃	2.0	2-9	Light brown	Compact
F ₄	2.0	3-6	Light brown	Compact
F ₅	2.0	3-8	Light brown	Compact
<i>Maturation feed</i>				
F ₆	2.4	3-9	Brown	Compact
Indigenous feeds				
IF ₁	4.0	3-25	Blackish	Coarsely bound
IF ₂	3.5	5-30	Brown	Coarsely bound
IF ₃	Irregular	Irregular	Blackish	Coarsely bound
IF ₄	4.0	5-50	Blackish	Coarsely bound
IF ₅	3.0	5-60	Light brown	Compact

wet weight gain per gram of protein consumed.

The data obtained in the feeding experiments was subjected to Analysis of Variance following the method of Snedecor & Cochran (1971).

Results and Discussion

A review of earlier literature suggests that the efficiency of a shrimp feed depends upon different factors like composition of the diet, water stability, palatability and conversion ratios (Goodwin & Hanson, 1975; New, 1976). Observations on the physical characteristics of the imported and Indigenous feeds (Table 1) made in the present study showed the most obvious and striking characteristics of the imported feeds to be their compactness, uniformity

and colour; an observation very much in agreement with New (1990) who analysed eight brands of commercial foreign feeds. Uniformity in size and pellet shape maintained by the imported feeds was lacking in the indigenous brands which is perhaps attributable to the nature of machinery used in manufacture.

Biochemical composition of the imported feeds (Table 2 and 3) showed several of them to be nutritively more potent than their respective companies claimed them to be with regard to protein, ash and crude fibre contents. The crude protein level of the extensive compounded feed was 34% with lipid varying from 5-8%. The protein level in intensive feeds was relatively higher at 39-41%, but with lipid levels similar to those of the extensive feeds. The maturation feed

Table 2. Proximate composition of the imported and indigenous feeds (% on as is basis) (Average of duplicates)

	Moisture	Dry matter	Crude protein	Lipid	Ash	Fibre	Nitrogen free extract ^a	Organic matter ^b	Acid insoluble ash
Imported feeds									
<i>Extensive feeds</i>									
F ₁	7.26	92.74	34.20	4.95	12.40	2.33	38.86	80.34	1.02
F ₂	7.89	92.11	34.20	7.85	13.23	1.01	35.82	78.88	0.94
<i>Intensive feeds</i>									
F ₃	5.13	94.87	41.03	5.61	7.54	2.53	38.16	87.33	0.92
F ₄	2.68	97.32	41.03	7.61	12.18	1.41	35.09	85.14	1.12
F ₅	6.54	93.46	39.32	7.05	14.50	0.95	31.64	78.96	0.87
<i>Maturation feed</i>									
F ₆	5.36	94.64	47.87	12.00	12.57	2.86	19.34	82.07	0.32
Indigenous feeds									
IF ₁	2.15	97.85	20.52	2.41	25.32	5.36	44.24	72.53	5.00
IF ₂	3.68	96.32	27.36	5.45	29.11	7.30	27.10	67.21	7.00
IF ₃	6.32	93.68	34.20	6.38	29.77	2.32	21.01	63.91	6.30
IF ₄	4.56	95.44	29.46	3.46	16.23	4.39	41.90	79.21	4.20
IF ₅	3.32	94.68	31.09	6.72	21.74	6.32	28.81	72.94	5.92

^a = Calculated by difference; ^b = Dry matter % - Ash %

recorded both a high protein and a high lipid content of 47.87% and 12.00%, respectively. Crude protein and crude lipid contents of the indigenous feeds showed a wide variation from 20 to 34% and from 2 to 6%, respectively.

Chitin content in one of the extensive imported feeds was 1.32% but only 0.34% in the other, and negligible in the intensive grower feeds. A fairly high chitin content of 2.34% was recorded in case of the maturation feed. In all the indigenous feeds, chitin content ranged from 1 to 2%.

The imported intensive culture feeds recorded sodium and potassium values similar to that of the extensive feeds. Though calcium level was similar to the

extensive and intensive feeds in the case of the maturation feed, levels of available phosphorous, sodium and potassium were comparatively higher at 0.91, 0.77 and 1.26%, respectively. All the indigenous brands analysed, recorded a very high ash content as well as high acid insoluble ash.

While the imported feeds were consistent physically and biochemically, the indigenous shrimp feed brands proved to be of inferior quality in comparison and were also not in keeping with the standards prescribed for shrimp nutrition.

One of the major bottlenecks in the growth of prawn farming in the country is the non-availability of nutritively potent supplementary feed for semi-intensive and

Table 3. Chitin and mineral content of the imported and indigenous feeds (%)

	Chitin	Calcium	Available Phosphorous	Sodium	Potassium
Imported Feeds					
<i>Extensive feeds</i>					
F ₁	1.32	2.25	0.64	0.54	0.96
F ₂	0.34	2.95	0.71	0.62	0.84
<i>Intensive feeds</i>					
F ₃	0.00	1.29	0.62	0.59	0.92
F ₄	0.13	2.46	0.81	0.62	0.89
F ₅	0.00	2.65	0.78	0.63	0.95
<i>Maturation feeds</i>					
F ₆	2.34	2.86	0.91	0.77	1.26
Indigenous feeds					
IF ₁	1.06	4.71	0.43	0.96	1.46
IF ₂	2.28	2.96	0.37	1.32	1.44
IF ₃	1.09	4.08	0.30	1.37	1.57
IF ₄	1.62	3.62	0.42	1.23	1.27
IF ₅	2.13	3.17	0.39	0.86	1.36

intensive shrimp culture. Improved feed manufacturing techniques and necessary alterations in the ingredients used for feed preparation, in the near future would definitely lead to more efficient feeds in terms of quality.

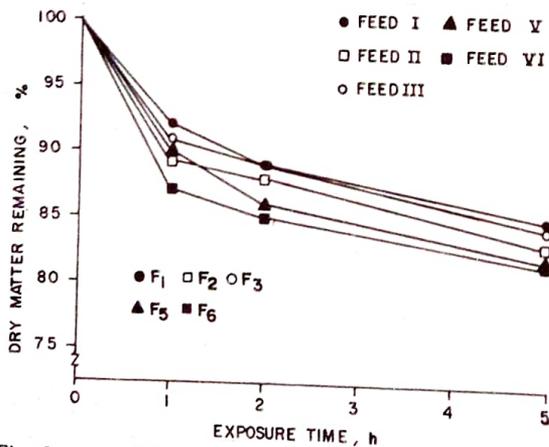


Fig. 2a. Stability of the imported feeds in water

A pre-requisite for shrimp feeds along with formulation of balanced feeds and technology for processing and production

is the physical stability under water for considerable time. Hydrostability experiments showed the extensive and intensive imported feeds (Fig. 2a) to be stable in sea water with 9-11% loss in dry matter at the end of 1 h and an additional 14 to 18% at 5 h. The loss in dry matter in sea water in the case of indigenous feeds (Fig. 2b) ranged from 9-14% at 1 h which increased to 21% at 5 h. The lower physico-chemical characteristics of the indigenous feeds suggest the need for further improvement of feed mill equipment and design.

Biological evaluation tests performed as feeding experiments with *Penaeus indicus* juveniles showed a statistically significant variation in the average daily growth with both the imported ($F_{6,13}; 7.413; p < 0.05$) and Indian feeds ($F_{4,9}; 14.254; p < 0.05$). Feed F₁ of the imported brands of shrimp feed gave maximum increase in average weight and average growth of 266% and 19.1 mg day⁻¹

Table 4. Growth, feed conversion ratio, protein efficiency ratio and survival of *Penaeus indicus* after 30 days of feeding with imported feeds

	Experimental feeds*					
	F ₁	F ₂	F ₃	F ₄	F ₅	F ₆
Initial average body weight, mg	200	225	210	216	220	212
Final average body weight, mg	690	590	600	790	700	610
Increase in average body weight, mg	490	365	390	574	480	398
Percentage increase in average body weight	245	164	186	266	218	188
Average growth mg day ⁻¹	16.3 ^{ab}	12.3 ^c	13.0 ^{bc}	19.1 ^a	16.0 ^{ab}	13.3 ^{bc}
Total food consumption, g	8.72	8.97	8.79	8.88	7.05	7.29
Food ingestion, mg animal ⁻¹ day ⁻¹	29.10	29.90	29.30	29.60	23.50	24.30
FCR	1.79 ^{bc}	2.57 ^a	2.25 ^{ab}	1.55 ^c	1.50 ^c	1.84 ^{bc}
Protein consumed, g	2.98	3.07	3.61	3.64	2.77	3.49
PER	0.164 ^a	0.120 ^a	0.108 ^a	0.158 ^a	0.173 ^a	0.114 ^a
Survival, %	100	95	100	100	100	100

FCR (Feed Conversion Ratio) calculated as feed intake/weight gain

PER (Protein Efficiency Ratio) calculated as the live weight gain per gram of protein consumed

* Means with common superscripts in the same row do not differ significantly ($p > 0.05$)

followed by feeds F₁ and F₅, F₆ and F₃ and F₂ (Table 4).

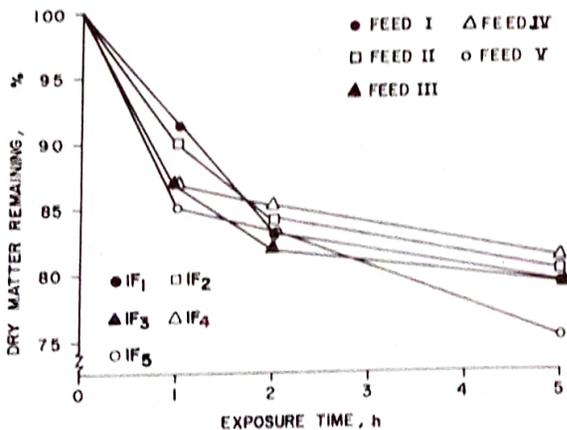


Fig. 2b. Stability of the indigenous shrimp feeds in water

Of the indigenous feed IF₅ and IF₄ (Table 5) performed the best with the ani-

mals having an average weight increase of 218 and 205% and an average growth of rate 16.00 and 14.00 mg day⁻¹, respectively, followed by IF₂ and IF₁. However, excepting for feed IF₃ which gave a very poor growth 4.40 mg day⁻¹, all the imported and indigenous feeds performed much better in comparison to the fresh clam meat control group (average increase in weight of 150% and an average growth of 10 mg day⁻¹).

A statistically significant variation ($F_{5,11} : 5.747; p < 0.05$) was observed in the FCR obtained with imported feeds and feeds F₅ and F₄ gave the best FCRs of 1.50 and 1.55 followed by feeds F₁, F₆, F₃ and F₂ (1.79, 1.84, 2.25, 2.57, respectively). Three Indian feeds IF₅, IF₂ and IF₄ gave more or

Table 5. Growth, feed conversion ratio, protein efficiency ratio and survival of *Penaeus indicus* after 30 days of feeding with indigenous feeds

	Experimental feeds*				
	IF ₁	IF ₂	IF ₃	IF ₄	IF ₅
Initial average body weight, mg	218	215	280	200	220
Final average body weight, mg	590	600	412	610	700
Increase in average body weight, mg	372	385	132	410	480
Percentage increase in average body weight	171	179	47.14	205	218
Average growth mg day ⁻¹	12.4 ^a	12.83 ^a	4.40 ^b	13.67 ^a	16.00 ^a
Total food consumption, g	8.20	7.60	3.30	8.10	8.82
Food ingestion mg animal ⁻¹ day ⁻¹	27.30	25.33	11.00	27.00	29.40
FCR	2.20 ^a	1.97 ^a	2.51 ^a	1.98 ^a	1.84 ^a
Protein consumed, g	1.68	2.08	1.13	2.39	2.74
PER	0.221 ^a	0.185 ^a	0.117 ^a	0.172 ^a	0.175 ^a
Survival, %	90	100	80	100	100

FCR (Feed conversion ratio) calculated as feed intake/weight gain

PER (Protein Efficiency Ratio) calculated as the live weight gain per gram of protein consumed

* Means with common superscripts in the same row do not differ significantly ($p > 0.05$)

less similar feed conversion values of 1.84, 1.97 and 1.98 followed by feeds IF₁ and IF₃ which gave values of 2.20 and 2.51 but the variation was not statistically significant ($p < 0.05$). The FCR of the fresh clam meat control group could not be determined due to heavy mortality.

Among all the feeds evaluated, the Indian feed IF₁ gave the highest PER of 0.221, followed by feeds IF₂, IF₅, IF₄ and IF₃ (0.185, 0.175 and 0.172 respectively) but the differences were not statistically significant. Among imported feeds, feed F₅ gave the highest PER of 0.173. However, the differences in PER were not significant statistically ($p < 0.05$).

The average rate of food ingestion was the highest (average 29 mg animal⁻¹ day⁻¹) in the case of imported feeds F₂, F₄ and F₁ and indigenous feed IF₅ and lowest in the case of feed IF₃ (hand made balls).

Weight gain increased with time in general and was the highest in the case of feed F₄ and lowest in the case of feed IF₃. The animals were attracted to all the feeds, through exchange of water in the tubs had to be carried out every second day for the indigenous feeds when compared to every third day in the case of imported feeds, which was attributed to the poor water stability of the former. All the feeds gave

a high survival (> 90%) except for feed IF₃ where only 80% survival was recorded. As more than 60% mortality was observed in the clam control group, the growth data could not be incorporated in the tables. Thus, it is evident that both the imported and Indigenous feeds were in a consumable and highly assimilable form (feed conversion ratios ranging from 1.50 to 2.5) excepting for IF₃ which being in the form of odd sized balls gave comparatively poor growth. The relatively poor performance observed in the case of animals maintained on fresh clam meat in the present study is in agreement with earlier studies (Ali, 1982). Protein efficiency ratios of decapod crustaceans have been reported to decrease with increasing dietary protein levels (Colvin, 1976). The low PER values of all the imported feeds in the present study could be attributed to their comparatively higher protein contents.

In conclusion, a further elaboration of this work to determine the levels of essential fatty acids (FFA), polyunsaturated fatty acids (PUFA), essential amino acids (EAA), carotenoids and cholesterol contents would give a more precise and comprehensive picture on the ingredient profile and nutritive quality of successful prawn feeds. Such information would enable the required improvements in feed technology leading to formulation of high quality indigenous feeds on commercial levels.

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