LABORATORY EXPERIMENTS ON GROWTH OF PENAEID PRAWNS FED WITH ARTIFICIAL PELLETS

ABSTRACT

Artificial feeds were compounded using wheat flour, tapioca powder, coconut cake, groundnut cake, fishmeal, prawnmeal and mineral supplement in different proportions, in pellet form, with agar-agar as binding agent. Feed numbers 1 to 19 were with protein contents ranging from 15.31% to 30.63%. Starch contents varied from 7.31 to 44.32% while fat contents were much less (0.04 to 4.35%). Feeding experiments of 60 days duration were conducted with postlarvae (TL=5.10 to 5.69 mm) and juveniles (TL=21.0 to 36.0 mm) of *Metapenaeus dobsoni* and *Penaeus indicus* (TL=10.10 to 14.60 mm) in aquarium tanks of 30 × 30 × 60 cm, containing 25 litres of sea water and plastic pools of 1 m diameter, containing 150 litres of seawater. The prawns exhibited average growth rates ranging from 0.225 to 0.574 mm per day. Feed number 15 containing 22.41% protein gave best results. The average growth rate per day in length and in weight were 0.505 mm and 0.015 g respectively. The cost of these feeds varied from Rs. 1.80 to 3.80 per kilogram.

SELECTION of appropriate feed is one of the major tasks in the culture of prawns, as it is directly responsible for the growth and survival. The feed should be cheap so as to make large scale intensive prawn culture economical. Usually, raw food materials such as minced meat of mussels and clams, rice bran, coconut cake, etc. are used individually or in combination for feeding the cultured prawns in countries like Japan, Taiwan, the Philippines, United Kingdom and the United States of America. Due to the shortage in the supply of these food items, their high cost and their deficiency in some of the nutrients, attempts were made to develop suitable artificial feed to meet the nutritional requirements of the cultivable species. Considerable research in this line has been carried out in Japan, United States of America and the United Kingdom (Kanazawa *et al.*, 1970, 1971 a, b; 1972; Kitabayashi *et al.*, 1971; Subramanyam and Oppenheimer, 1970; 1972; Deshimaru and Shigeno, 1971; Meyer and Zein-Eldin, 1972; Shigeno *et al.*, 1972; Sick *et al.*, 1972; Sick 1973; Forster and Beard, 1973). The present account deals with the preparation of different dry artificial feeds and the estimation of their efficiencies in promoting the growth of important cultivable species of penaeid prawns of India *viz. Metapenaeus dobsoni* and *Penaeus indicus* under laboratory conditions.

The help rendered by the Central Institute of Fisheries Technology, Cochin, in the analysis of the feeds is gratefully acknowledged.

Material and methods

The ingredients used for the preparation of the feeds were wheat flour, tapioca powder, coconut cake, groundnut cake, prawnmeal, fishmeal and mineral supplement (Starmin PS). Agar-agar was used as binding agent. The seived ingredients in different proportions were mixed thoroughly with sufficient quantity of hot 1% solution of agar-agar to make a soft dough and extruded through a meat mincing machine having a die with 3 mm holes. The strings were dried in a hot air oven at 70°C and crumbled into small pieces of 3-5 mm length with 5-10% moisture content and kept in air-tight polyethelene containers. Nineteen combinations of artificial feeds (No. 1-19) were prepared and the different proportions of the various ingredients are summarised in Table 1.

The chemical composition of these feeds were analysed and the results are given in Table 2.

Juveniles of *Metapenaeus dobsoni* of size range 21-36 mm in total length (length between the tip of the rostrum and tip of telson), collected from Cochin Backwater and postlarvae of the same species (TL = 5.1-5.6 mm) as well as those of *Penaeus indicus* (TL = 10.1-14.6 mm) obtained from Narakkal Prawn Farm of the Institute were used in the feeding experiments. Soon after collection they were acclimatised in the glass aquarium tanks for a day or two. They were weighed on an electric monopan balance to the nearest milligram. In each of the tanks (Size : 30 × 30 × 60 cm) 10 to 15 juveniles or 25 to 30 postlarvae were kept in 25 litres of seawater collected from the inshore areas of Cochin. In plastic pools of 1 m diameter, containing 150 litres of seawater 65 postlarvae of *P. indicus* measuring 10.1-14.6 mm in total length were kept. The experiments were conducted in duplicate, for a period of 60 days and the mean values of the lengths were taken. The prawns were fed once a day in sufficient quantities, *ad libidum* and the excess feed, dead animals and exuviae, if any, along with excreta were siphoned out the next day morning. Total lengths were taken at fortnightly intervals. The temperature and salinity ranges of the rearing medium were 26.9-30.0° C and 20.6-32.4 pp respectively. These experiments were carried out during the period October, 1972 to November, 1976.

TABLE 1. *Composition of artificial prawn feeds by percentage weight of ingredients*

Feed number	Wheat flour	Groundnut cake	Coconut cake	Tapioca powder	Rice bran	Fishmeal	Prawnmeal	Mineral supplement	Cost per kg
1	50.00	25.00	25.00	—	—	—	—	—	2.00
2	75.00	—	25.00	—	—	—	—	—	2.00
3	75.00	25.00	—	—	—	—	—	—	2.00
4	45.50	22.75	22.75	—	—	—	—	—	2.00
5	62.50	—	25.00	—	—	12.50	—	—	1.80
6	56.56	—	22.23	—	—	22.23	—	—	2.50
7	50.00	—	20.00	—	—	30.00	—	—	2.50
8	50.00	—	20.00	—	—	—	30.00	—	3.80
9	60.00	—	25.00	—	—	15.00	—	—	2.30
10	50.00	—	25.00	—	—	25.00	—	—	2.40
11	—	—	—	57.00	9.50	23.75	—	9.50	1.80
12	—	—	—	47.50	19.00	23.75	—	9.50	1.80
13	—	—	—	40.00	30.00	20.00	—	10.00	1.80
14	—	—	—	40.00	20.00	30.00	—	10.00	1.95
15	—	—	—	33.33	16.67	41.67	—	8.33	2.10
16	—	—	—	16.67	16.67	49.99	—	8.33	2.10
17	—	—	—	16.67	8.33	58.33	—	8.33	2.20
18	—	—	—	24.99	24.90	41.67	—	8.33	1.80
19	—	—	—	41.67	8.33	41.67	—	8.33	1.85

The increase in total length and weight were considered as indicators of efficiency of the feed during the present investigations.

Results

The growth attained by postlarvae and juveniles of *P. indicus* and *M. dobsoni* during 60 days of the experiment, when fed with

different feeds (Nos. 1-19) are shown in Fig. 1 and Table 3. Among the first fifteen types of feeds, Feed No. 15 was found to be the best, giving an average growth rate of 0.505 mm per day for *M. dobsoni* and 0.565 mm per day for *P. indicus*. In order to find out whether the increase in protein content of the feed was directly proportional to the growth rate or not, feed No. 16 and 17 with 49.9% and 58.33% respectively, of fishmeal, by weight, were compounded and fed to the postlarave of *M. dobsoni*. Feed No. 16 gave 0.396 mm increase per day with a survival rate of 43.33% while the growth realised with feed No. 17 was only 0.342 mm per day, the survival rate being only 23.33%. Similarly, two more feeds (Nos. 18 & 19) were also prepared with 25% and 41.67% of tapioca powder, by weight, to determine the effect of increase of carbohydrate in the diet on the growth of these prawns. Although the survival rate was as high as 95% with feed No. 18, the growth was less (0.253 mm per day). But, feed No. 19 exhibited a slightly better growth rate (0.360 mm per day) with lesser survival rate (33.33%). Thus it was found that feed No. 15 containing 41.67% of fishmeal and 33.33% of tapioca powder, by weight, gave the best results.

Increase in weight of the experimental prawns were measured for feed Nos. 9 to 19. It will be seen from Fig. 1 and Table 4 that feed No. 15 was the best in the order of efficiency, giving an average growth of 0.015 g per day for 60 days period. Feed No. 17 with 63.33% of fishmeal was the least in efficiency (0.003 g per day) while the one with 25% of tapioca powder (Feed No. 18) was slightly better (0.007 g per day). Feed No. 10 with 50% wheat flour was second best.

The growth increment in relation to the size of the container in which the prawns were reared was also determined by another set

TABLE 2. *Chemical composition of artificial prawn feeds* (%)

Feed number	Protein	Starch	Fat	Ash	Moisture
1	21.60	38.00	0.99	3.28	11.80
2	16.60	7.31	1.05	3.33	3.14
3	16.60	37.05	2.00	2.33	4.66
4	20.10	12.40	4.35	3.11	6.68
5	20.50	28.40	4.21	9.29	6.49
6	21.88	26.15	3.89	11.34	7.15
7	30.63	27.95	2.90	7.54	8.00
8	27.13	16.15	4.04	15.05	5.35
9	17.97	40.66	0.58	1.07	9.48
10	25.36	36.56	0.67	1.60	8.78
11	16.72	34.48	0.16	4.47	7.37
12	17.50	31.95	0.08	7.54	5.71
13	15.31	44.32	0.40	7.57	4.86
14	21.88	33.13	0.42	22.01	7.54
15	22.41	18.27	0.91	22.54	6.40
16	26.77	14.14	0.55	27.94	5.42
17	34.30	7.83	1.09	40.14	6.61
18	22.82	15.00	1.29	26.17	6.77
19	22.28	22.77	0.72	26.88	7.69

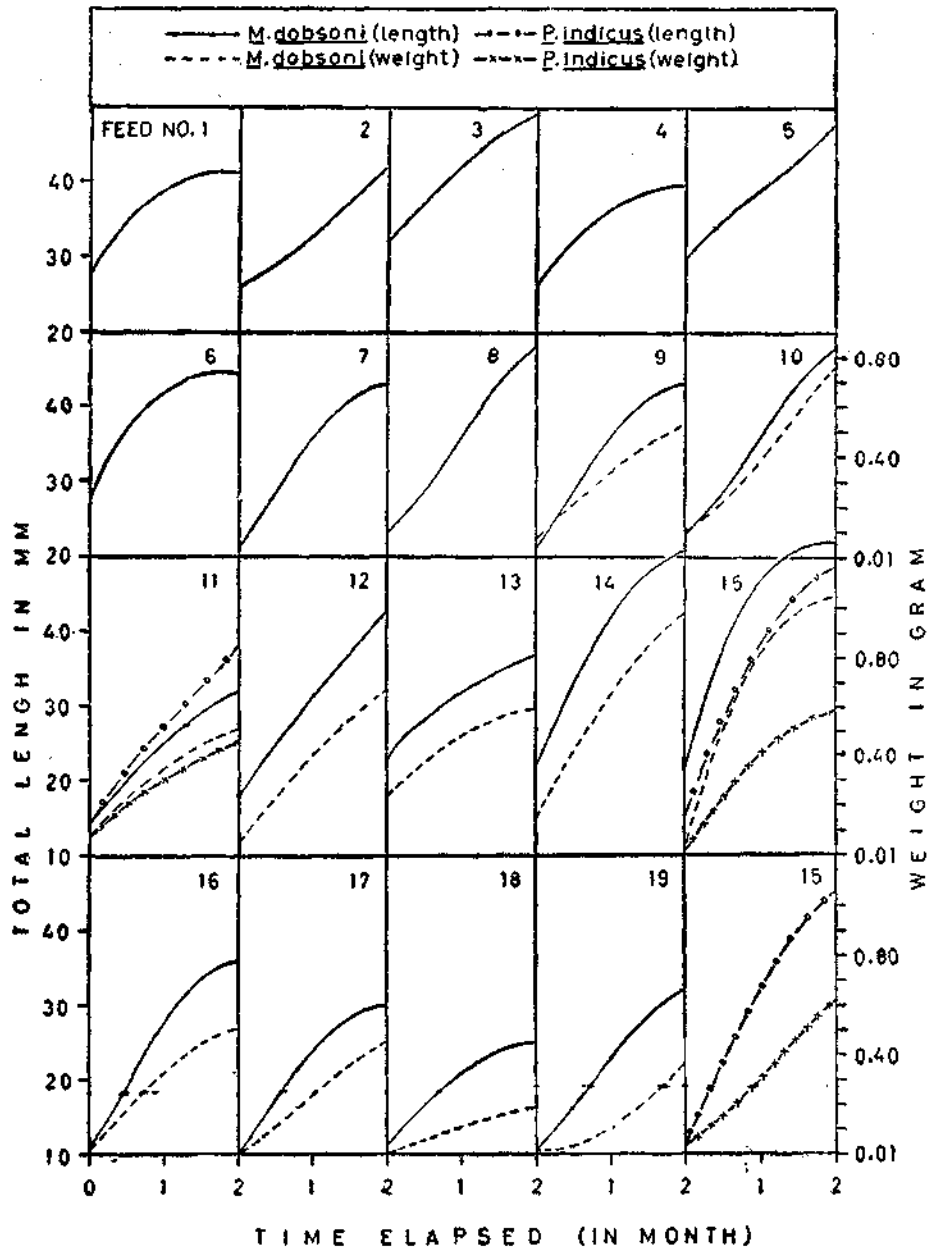

FIG. 1. Growth of postlarvae and juveniles of *M. dobsoni* and *P. indicus* fed on different artificial feeds.

of experiments. For this purpose, the growth rate shown by postlarvae of *P. indicus* (with feed No.15), reared in plastic pool and in glass aquarium tanks was compared and the higher growth rate of 0.574 mm per day was observed in the plastic pool than the slightly lesser growth of 0.468 mm per day in the aquarium.

TABLE 3. *Average growth in length of* M. dobsoni *and* P. indicus *fed on different artificial feeds*

Feed No.	Average initial length of prawns (mm)	Initial number of prawns	Average final length of prawns (mm)	Final number of prawns	Survival percentage	Average growth per day (mm)
M. dobsoni						
1	27.67	9	44.25	6	66.67	0.243
2	26.50	8	42.00	2	25.00	0.225
3	32.50	8	50.00	6	65.00	0.291
4	26.00	8	38.00	4	50.00	0.200
5	30.60	10	49.00	2	20.00	0.273
6	28.20	10	44.20	5	50.00	0.262
7	21.50	10	45.33	6	60.00	0.397
8	23.40	10	48.00	3	30.00	0.410
9	21.20	10	42.67	5	50.00	0.425
10	23.40	10	48.00	3	30.00	0.410
11	13.64	25	31.57	19	76.00	0.265
12	18.40	10	43.00	5	50.00	0.410
13	23.00	15	37.67	10	66.67	0.245
14	22.48	11	51.20	9	81.82	0.462
15	22.10	20	52.40	14	70.00	0.505
16	10.48	25	36.23	13	52.00	0.396
17	9.20	25	29.71	7	28.00	0.342
18	10.08	30	25.26	19	63.33	0.253
19	10.20	25	31.80	15	60.00	0.360
P. indicus						
15 (in aquarium)	14.56	25	48.50	5	20.00	0.468
15 (in pool)	10.48	65	45.00	14	21.63	0.574

The estimated cost of the feeds prepared and utilised in the present investigations ranged between Rs. 1.80 to Rs. 3.80 per kilogram (Table 1). The increase in the cost of feed No. 1 to 10 was due to the use of wheat flour as a source of carbohydrate. Subsequently, tapioca powder which was the cheapest starch available, was substituted and the price was brought down considerably. Prawnmeal was replaced by fishmeal as the former was costlier and less efficient. The cost of compounding the feed can be still reduced when it is manufactured on a large scale.

Discussion

An attempt is made here to compare the growth rate of *M. dobsoni* attained during

the present investigations with those given for the species by earlier workers, as no control had been kept. Menon (1951) observed a growth rate of 0.233 mm per day (7 mm per month) in the laboratory reared juveniles of *M. dobsoni* while Mohamed and Rao (1971) recorded a higher growth rate of 8 to 11 mm per month for the juveniles of the same species based on length frequency studies. The present record of still higher growth rate (0.550 mm per day) can be attributed to the quality of the feed, especially the optimum protein content. For *P. indicus*, Sultan *et al.* (1973) reported a growth of 0.70 mm per day when juveniles were reared in the plastic pool of 3.5 m diameter in 1 m depth of water for 60 days, while Sampath and Menon (1975) recorded a slightly higher growth of 1.2 mm per day when reared in large sized rectangular cages of size 4.5 m × 2 m × 1 m for 2 months. The lesser growth rate (0.574 mm/day) noticed in *P. indicus* during the present studies may perhaps be due to the smaller size of the container in which the juveniles of this species were reared.

The protein content of the feed used by Kanazawa *et al.* (1970) is 50% and those of the feeds prepared by Deshimaru and Shigeno (1972) and Balazs *et al.* (1973) are 69% and 40% respectively. These authors have recorded different growth rates in reared prawns : 20 to 72% in *P. japonicus* (Kanawaza *et al.*, 1970), 106 to 109% in *P. japonicus* (Deshimaru and Shigeno, 1972), 107% in *P. aztecus* (Balazs *et al.*, 1973) and 105 to 329% in *P. japonicus* (Balazs *et al.*, 1973). In the present study 1,681.5% increase in weight was observed for *M. dobsoni* and 1,550.0% for *P. indicus* when fed with feed containing 22.41% of

TABLE 4. *Average growth in weight of* M. dobsoni *and* P. indicus *fed on artificial feeds and percentage of increase in body weight*

	Feed number	Average initial weight (g)	Average final weight (g)	Average growth per day (g)	Percentage increase in body weight
M. dobsoni					
	9	0.078	0.550	0.007	579.5
	10	0.105	0.773	0.011	636.2
	11	0.018	0.269	0.004	1394.4
	12	0.043	0.440	0.006	923.3
	13	0.006	0.368	0.005	457.5
	14	0.052	0.718	0.011	1280.7
	15	0.054	0.962	0.015	1681.5
	16	0.012	0.113	0.002	841.6
	17	0.008	0.054	0.001	575.0
	18	0.018	0.160	0.002	788.8
	19	0.029	0.218	0.003	990.0
P. indicus					
	15 (in aquarium)	0.040	0.662	0.040	1555.0
	15 (in pool)	0.032	0.624	0.010	1850.0

protein. Though Deshimaru and Shigeno (1972) and Balazs *et al.* (1973) opined that feed containing 40 to 60% of protein gave good results. the present feed No. 15 containing 22.41% of protein has recorded the highest increase in weight (1,681.5%) which agrees with the optimum protein level recommended for faster growth by Andrews *et al.* (1972).

The results presented here indicate the possibility of fabricating less expensive as well as efficient artificial feed which can be used as a supplementary feed in large scale prawn culture operations.

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