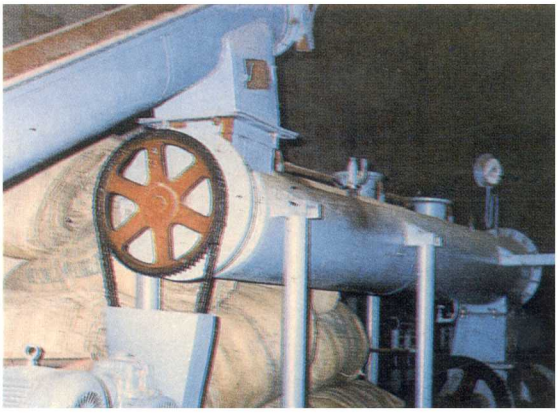
MARINE PROTEIN RESOURCE AVAILABILITY IN INDIA AS RAW MATERIALS FOR PRAWN FEEDS



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(भारतीय कृषि अनुसंधान परिषद)
नं.१४१, मार्शल्स रोड, एगमोर, मद्रास – ६०० ००८

CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE
(Indian Council of Agricultural Research)
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Cover Photos:

Top Left	:	Trashfish loaded into tricycle for transport
Top Right	:	A heap of fresh mantis shrimp *(Oratosquilla nepa)*
Bottom Left	:	Sun-dried trashfish
Bottom Right	:	Pulveriser used for powdering dried trashfish

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PREFACE

Prawn farming has shown phenomenal growth in recent years in India. Parallel to this development, the demand for prawn feed has also been on the increase. Although a few prawn feed mills have been established in the country, imported feeds are playing a dominant role in the present scenario. With the national target set for bringing one lakh hectares of area under brackishwater prawn farming by the year 2000 A.D., the requirement of prawn feed is estimated to be over three lakh tonnes per annum. Availability of feed ingredients is one of the critical factors for producing quality prawn feeds. Prawns require high protein (35-45%) in their feed and hence, marine proteins are extensively used in feed formulations to achieve these protein levels. The success of prawn farming and feed industry will depend on the availability of marine protein sources and their quality.

With the objective of assessing the availability of marine protein sources as raw materials for prawn feed, a survey was conducted by the Central Institute of Brackishwater Aquaculture during April-June 1992 in different maritime States. The survey has provided an opportunity to quantify the availability of marine protein sources in the country. The study yielded useful information and valuable data on the low value fish, fishmeal, squid and cuttlefish wastes, mantis shrimp, prawn head waste, fish oil etc., which are the protein and lipid sources for prawn feed production. The data has been collected visiting almost all major and minor fishing harbours in the country, some artisanal landing centres, godowns which collect and store these materials, fish meal plants, etc., as also based on discussions with fisheries officials, fish merchants and fishermen. The marine fish production figures available had also been consulted. The data provided in this

publication may be considered as the basis for planning, mobilisation and utilization of the materials in prawn feed production. It is earnestly hoped that this information will be useful to planners and the prawn feed industry.

I would like to place on record my deep appreciation to Scientists Dr. S. Ahamed Ali, Dr. C.P. Rangaswamy, Sri. D. Narayanaswamy and Dr. C. Gopal, of this Institute for their painstaking work in conducting the survey and preparation of this Bulletin.

Madras - 8.
25-3-1995.

K. ALAGARSWAMI,
Director

CONTENTS

1. INTRODUCTION

One of the crucial inputs that would determine successful and sustainable development of prawn culture in India is the availability of quality feed in required quantity. The National Workshop on Brackishwater Prawn Farming for Higher Production held at Bangalore in 1989 indicated that by 2000 A.D. India would bring 1,00,000 ha of brackishwater area under different farming systems and the feed requirements for this expansion was estimated to be around 3,67,500 t per annum. The combined production of prawn feed at present is estimated to be around 30,000 t per year, which does not meet the requirements of the industry. Lack of an appropriate feed has been identified as a major constraint impeding the development of prawn culture (Alagarswami, 1990, 1992). To meet the growing demand of feed for prawn culture, the above National Workshop recommended setting up of 60 feed mills with a production capacity of 6000 t per year, each in a phased manner.

Marine proteins are one of the vital requirements for the prawn feed industry. Meyers (1989) opined that for economically viable semi-intensive farming programmes of India, it is advantageous to utilize indigenous natural resources. Wood and Coulter (1988) and Wood *et al.* (1992) have made an assessment of the raw material availability in India and cautioned that there is a deficiency in marine proteins for feed manufacture. They also drew attention to the competition from the poultry feed industry for the same materials. Nevertheless, India with a vast coastline of 7,517 km and an annual marine fisheries production to the tune of 2.38 million tonnes, should have ample raw material potential to meet the requirements of feed manufacturing units. It is estimated that the potential exploitable marine fisheries resources is around 4.5 million tonnes from the Exclusive Economic Zone (E.E.Z.) (James, 1991). This calls for an objective evaluation of the availability of marine proteins for the manufacture of prawn feeds. In this context, a survey was undertaken by the Central Institute of Brackishwater Aquaculture, Madras, to broadly quantify the availability of marine proteins in the country. The data and information collected during this survey are presented in this Bulletin.

2. METHOD OF COLLECTION OF DATA

Anchovies, silver bellies, carangids, miscellaneous trash fish, mantis shrimp, prawn head waste, cuttlefish, squid, sergestid shrimp (*Acetes* spp.) and fish oil are some of the ingredients used in the preparation of prawn feeds. A survey of the availability of such marine proteins was undertaken during April-June 1992 in eight maritime states namely, Gujarat, Maharashtra, Goa, Karnataka and Kerala on the west coast and Orissa, Andhra Pradesh and Tamil Nadu on the east coast. In each state, the primary data on fish landings was collected directly from the important fisheries harbours and fish landing centres. Information on catch statistics, fishing vessels etc., was also obtained from the research and field centres of Central Marine Fisheries Research Institute and State Fisheries Departments. Besides, fish/prawn processing plants, drying yards, dry fish merchants, fish meal plants and centres of Marine Products Export Development Authority were visited and data on fish wastes, by-products, fish meal, fish oil, methods of storage and cost were collected. The data presented in this Bulletin is an overall average estimate of different resources which are not directly used as human food and could be considered as raw material available for prawn feed manufacture. The estimated marine fish landings during the years 1990-91 and 1991-92 together with the information collected as described above, formed the data base for assessing the different resources in this Bulletin.

3. MARINE PROTEIN SOURCES

3.1. Total availability

The total marine fish landings were estimated to be 2.16 million tonnes in 1991 and 2.29 million tonnes during 1992 (Anon.,1991-93). Out of these total landings, 5,58,652 t of marine fish (3,35,191 t in dry weight) may be considered as resource for feed manufacture (Table 1). The contribution of finfish (dry) is 1,76,593 t, crustaceans (mantis shrimp, prawn head waste, small miscellaneous crabs and sergestid shrimps) 1,43,223 t, cephalopods (cuttlefish and squid whole) 10,913 t and other molluscs (clam and mussel meat) 4,462 t per annum.

Table 1 Estimated availability of selected marine protein sources in India for prawn feed

Sl. No.	Marine protein resources	Quantity estimated (dry weight) (tonnes per annum)
1.	Finfish	1,76,593
2.	Crustaceans	
	Mantis shrimp *(Squilla)*	57,942
	Prawn head waste	31,235
	Small crabs	6,046
	Sergestid shrimp *(Acetes)*	48,000
	Sub Total	1,43,223
3.	Cephalopods	
	Cuttlefish	3,936
	Squid	6,977
	Sub Total	10,913
4.	Other molluscs	
	Clam meat	3,687
	Mussel meat	775
	Sub Total	4,462
	Grand Total	3,35,191

3.2. Statewise availability

Table 2 presents the estimated availability of marine protein sources per annum in different states. Gujarat (87,790 t), Maharashtra (71,786 t) and Tamil Nadu (47,598 t), together accounted for about 60% of the total availability of marine proteins. Kerala (23,911 t), Karnataka (39,732 t) and Orissa (37,095 t) accounted for about 32%, while the rest is shared by Andhra Pradesh (13,625 t) and Goa (13,654 t).

3.3. Availability of marine protein resources

3.3.1. Finfish

By far, finfish is the most important ingredient required by the feed industry. The total availability of finfish is estimated at 1,76,593 t/annum (dry weight), which accounts for about 50% of the total marine proteins. Trash fish is auctioned by boat owners in open market to dry fish merchants. Thereafter, it is transported to the adjoining beaches and sun-dried. Gujarat is leading in dry fish production (34,000 t), followed by Tamil Nadu (34,942 t) and Maharashtra (33,732 t). About 90% of the total finfish resource is estimated to be available in Gujarat, Maharashtra, Tamil Nadu, Orissa and Karnataka (Table 2).

In all the fish landing centres visited during the survey, trash fish was observed in large quantities as by-catch of shrimp trawling. These by-catches are generally brought to the landing centres by trawlers in a decomposed condition due to the non-availability of cold storage facilities on the vessel. Further, the shortage of space on the deck for storage, often necessitates the disposal of the miscellaneous fish back into the sea. According to an estimate, nearly 1,30,000 t of prawn by-catch are discarded every year on the east coast (Gordon, 1988). Instead, if these fish are brought to the shore, they can be utilised for fish meal manufacture. However, no solution has emerged so far to utilise these enormous quantities of fish either for human consumption or for fish meal, due to logistic problems (Alagarswami, 1990).

3.3.2. Mantis shrimp

The mantis shrimp is a stomatopod *(Oratosquilla* sp.*)* caught in large quantities along with prawns, in trawl nets. It is an important source of marine protein. The total mantis shrimp availability is estimated to be about 57,942 t per annum, forming 15% of the total marine proteins. Karnataka state is leading in its landings (14,760 t), followed by Gujarat (13,964 t) Maharashtra (10,400 t), Tamil Nadu (5,548 t), Goa (3,812 t), Kerala (3,256 t) and Andhra Pradesh (2,440 t) (Table 2).

Table 2 Statewise availability of marine protein sources for prawn feed (tonnes per annum)

Marine protein resources	Gujarat	Mahara-shtra	Goa	Karna-taka	Kerala	Orissa	Andhra Pradesh	Tamil Nadu	Total
Finfish	34,000	33,732	8,455	23,545	6,382	32,447	3,090	34,942	1,76,593
Mantis shrimp	13,964	10,400	3,812	14,760	3,256	3,762	2,440	5,548	57,942
Prawn head waste	8,200	6,300	1,261	500	4,023	800	6,271	3,880	31,235
Cuttlefish	545	–	–	311	3,022	42	16	–	3,936
Squid	508	–	–	341	3,299	38	1,332	1,459	6,977
Clam meat	16	158	78	275	3,159	1	–	–	3,687
Crabs	2,557	1,196	48	–	–	–	476	1,769	6,046
Sergestid shrimp	28,000	20,000	–	–	–	–	–	–	48,000
Mussel meat	–	–	–	–	770	5	–	–	775
Total	87,790	71,786	13,654	39,732	23,911	37,095	13,625	47,598	3,35,191

3.3.3. Prawn head waste

Prawn head waste is a by-product of prawn processing plants. Larger prawns are processed as headless and smaller varieties are peeled and made into meat. The yield of prawn head from the larger prawns (headless) is 35%, whereas, from the peeled prawns, the wastage is 40%, which includes the head and the shell. Prawn head waste is collected by vendors and sun-dried. It is estimated that the average production of prawn head waste is 31,235 t per annum. Gujarat contributes about 26%, Maharashtra and Andhra Pradesh 20% each, while Tamil Nadu and Kerala each accounts for 12% of the total. Orissa and Goa account for 3% and 4% respectively of this resource.

3.3.4. Crabs

Small miscellaneous crabs are estimated to be available to the extent of 6,046 t per annum, constituting 2% of the total marine protein resources. Gujarat, Maharashtra and Tamil Nadu account for 2,557, 1,196 and 1,769 t respectively (Table 2). Small crabs are invariably added to fish meal by dry fish merchants.

3.3.5. Sergestid shrimp *(Acetes* spp.*)*

A good fishery of sergestid shrimp has been recorded from Gujarat and Maharashtra where the combined landings are estimated to be around 48,000 t per annum (Table 2). Boats operating from Veraval to Jakku and Kutch, take about four days to return with sergestid shrimp catches along with other trash fish in partly decomposed state. These are generally used for fish meal manufacture. Sergestid shrimp is also used in the preparation of protein isolated powder and other value added products for human consumption.

3.3.6. Cuttlefish and squid

Among the cephalopods, the quantity of cuttlefish and squid was estimated. The total production of cuttlefish during 1991- 92 was estimated at 19,680 t. The frozen cuttlefish exported during that year was 12,437 t. Cuttlefish is processed as whole for

export (only viscera and stomach are removed), and the availability of this resource is expected to be 3,936 t.

Squid is an important component in shrimp feeds for its growth promoting and attractant properties. The estimated landings during 1991-92 were 34,885 t. The frozen squid exported during the year was 25,528 t. The availability of squid was estimated at 6,977 t. Since squid and cuttlefish are in great demand for export, their availability to the feed industry is limited.

3.3.7. Clam and mussel meat

Clams and mussels are used in shrimp feeds for their protein value, growth promoting and attractant properties. The estimated landings of clam (meat) and mussel (meat) are 3,687 t and 775 t per annum respectively. Kerala, Karnataka and Maharashtra are the states having sufficient clam and mussel resources. But these form only 1% of the total marine proteins and there is a good demand for human consumption. Hence, their availability to the feed industry is limited, as in the case of cuttlefish and squid.

The proximate composition of the selected protein sources is given in Annexure I.

3.4. Observations on marine protein resources in the different states

3.4.1. Gujarat

Gujarat is well known for its bombay-duck and pomfret fisheries. There are about 216 landing centres in the state. Among these, Veraval, Porbandar and Mongrol are important ones. Veraval accounts for 20% of the fish landings (Table 3). The main fish landings are from trawlers, accounting for 90% of the total catch, with a peak fishing activity from October to January. The fish are segregated into three categories *viz.*, for export, local consumption and dry fish trade. Most of the quality fishes are processed for export. The remaining small fishes and non-export items, forming about 40% of the total catch, are sold to dry fish merchants as trash fish. As per the estimates of State Fisheries Department, 36,593 t of dry fish were marketed in 1990-91.

Table 3 Estimated availability of marine protein sources from important centres in Gujarat (tonnes per annum)

Marine protein sources	Veraval	Other centres	Total
Finfish	10,613	23,387	34,000
Mantis shrimp	1,040	12,924	13,964
Prawn head waste	786	7,414	8,200
Cuttlefish	545	–	545
Squid	500	–	500
Clam meat	–	16	16
Crabs	–	2,557	2,557
Sergestid shrimp (*Acetes* sp.)	14,000	14,000	28,000

Veraval has a good potential for trash fish (10,613 t), mantis shrimp (1,040 t), sergestid shrimp (14,000 t), prawn head waste (786 t) and cuttlefish and its waste (545 t) (Table 3). The main components of trash fish, locally called 'Kutta', are small croakers, (*Nemipterus* sp.) ribbon fish, *Acetes* sp., threadfin bream, small prawns, catfish, *Oratosquilla* sp., bombay-duck, clupeids, goatfish, crabs and cephalopods. The trash fish is sun-dried either on sand or cement platforms. The dried raw material is sold to merchants at Rs 1,000-3000/t. This is utilized for the manufacture of fish meal using pulverisers. The fish meal is sent to Indore, Bombay and Hyderabad for use in poultry feed. It is sold at Rs 6,000-9,000 / t depending upon the protein value. To raise the protein content of fish meal to 40 - 42%, the merchants mix quality fish during pulverising. Further, to reduce the moisture content of 'Kutta', prawn shells are added. There are about 16 registered godowns used by dry fish merchants, with a total storage capacity of about 1843 t.

3.4.2. Maharashtra

The coastline of Maharashtra is spread over 720 km in five districts namely, Bombay, Thane, Raigad, Ratnagiri and Sindhudurg. There are about 6,797 mechanised boats operating, of which 1,845 are trawlers. The fishing season is from July to June of the following year. Bombay-duck, penaeid prawns, mackerel, ribbon fish and anchovies are important fish components of the landings.

Table 4 Estimated availability of marine protein sources in Maharashtra (tonnes per annum)

Marine protein sources	Bombay	Other centres	Total
Finfish	15,711	18,021	33,732
Mantis shrimp	–	10,400	10,400
Prawn head waste	3,641	2,659	6,300
Clam meat	–	158	158
Crabs	–	1,196	1,196
Sergestid shrimp	9,717	10,283	20,000

The marine proteins available in Maharashtra are trash fish (15,711 t), sergestid shrimp (9,717 t) and prawn head waste (3,641 t) (Table 4). Maharashtra has a good potential for sergestid shrimp locally called 'Jawala'. Most of the catches are sold fresh for human consumption (50%). Rest of the catches are sun-dried (35%) and salted (5%). Sun-drying of fish is done on raised bamboo scaffoldings or cement platforms set up along the beach. Small pomfrets, clupeids, croakers and sergestid shrimp are dried on these platforms, which ensures a hygienic product with less sand contamination. At Ratnagiri, Maharashtra Industries Development Corporation (MIDC) has set up a small fish meal plant of 3 t/day capacity and about 400 tonnes of fish meal is produced per year.

3.4.3. Goa

Among the different fish landing centres of Goa, Betal is the major centre, followed by Benaulin, Panaji, Talpona and Cotbona (Table 5). The major species constituting the landings are penaeid prawns, croakers, mackerel, perches and sardines. There are about 250 mechanised boats operating from Goa. Unlike Maharashtra and Gujarat, sun-drying of fish is not a common practice in Goa. Almost 80% of the catch is used for human consumption. There are no fish meal or pulverising plants in Goa.

Table 5 Estimated availability of marine protein sources in Goa (tonnes per annum)

Marine protein sources	Quantity
Finfish	8,455
Mantis shrimp	3,812
Prawn head waste	1,261
Clam meat	78
Crabs	48

3.4.4. Karnataka

The details of landings of various marine protein sources in the different landing centres of Karnataka are shown in Table 6. The major landing centres in the Dakshina Kannada district are Mangalore, Malpe, Gangoli and Bhatkal, accounting for 90% of the trash fish landings. Honavar, Kumta, Tadri and Karwar are the important centres in Uttara Kannada, which account for the rest of the 10% trash fish landings.

The main fishing season is from July to October. The important fishes constituting the trash fish are juveniles of sardines, mackerel, anchovy, carangids, flat head, lizard fish, ribbon fish and silver bellies. During August to November, huge quantities of sardines and mackerel are landed by purse seine boats. These are utilised for fish meal preparation. Trash fish is collected in an organised way. There are a number of dry fish merchants near the fishing harbours who employ women labourers for the collection of trash fish from landing centres. At the landing centres, trash fish is sold at Rs 1,000 - 1,500 per tonne. This is transported by vans, auto-rickshaws and trucks to adjoining areas for sun-drying. The village Ullal, near Mangalore, is well known for dry fish trade. It is estimated that about 6,000 t per year of trash fish are traded from this centre alone. The dry fish is sent to the neighbouring states for the feed industry.

Penaeid prawn landings are in the order of 6,480 t in Karnataka. However, there are logistic problems in the collection of prawn head waste, because the peeling sheds are

Table 6 Estimated availability of marine protein sources from important centres in Karnataka (tonnes per annum)

Marine protein sources	Mangalore	Malpe	Gangoli	Bhatkal	Honavar	Kumta	Tadri	Karwar	Total
Finfish	10,000	6,200	5,000	460	450	325	470	640	23,545
Mantis shrimp	4,005	5,100	4,000	360	350	265	380	300	14,760
Prawn head waste	154	101	83	38	24	21	31	48	500
Cuttlefish	196	–	–	–	–	–	–	115	311
Squid	216	–	–	–	–	–	–	125	341
Clam meat	210	–	–	–	–	–	–	66	275

distributed over a large area. Nevertheless, prawn head waste is available in Mangalore (154 t), Malpe (101 t) and Gangoli (83 t) which is more than that in other centres (21 to 48 t). The cost of prawn head waste ranges from Rs 250 - 300 / t which is sold at Rs 2,000 - 3,000 / t after drying.

Mantis shrimp is landed during November to May, to the extent of 14,760 t/year in Karnataka. Out of this, 90% is landed in Mangalore, Malpe, Gangoli and Bhatkal centres. The remaining 10% is found in Uttara Kannada. Mantis shrimp is procured at Rs 250 - 500/t at the landing centre by the fish merchants and the dry product is sold at Rs 2,000 - 3,000 per tonne.

Cephalopod (cuttlefish and squid) landings in Karnataka (2007 t/year) are mainly from Mangalore and Karwar. Most of these are exported. The availability of cuttlefish and squid waste from these resources is 652 t/year. The average price of squid is Rs 15 per kg. Due to their export potential, their availability for prawn feeds is subjected to high competition.

3.4.5. Kerala

The availability of marine proteins in Kerala at different landing centres, namely, Vizhinjam, Quilon, Alleppey, Cochin, Trichur, Malapuram, Calicut, Cannanore and Kasargod, is presented in Table 7. Among these centres, Calicut and Quilon are important in terms of trash fish landings. About 950 trawlers are operated from Neendakara and Sakthikulangara centres at Quilon. The peak fishing season is during June to September. On an average, each boat brings 100 kg of trash fish every day. The trash fish consists of juveniles of lizard fish, silver bellies, carangids, anchovies, sciaenids and flat head. The catches are sun-dried on beaches. The cost of trash fish at the landing centre is Rs 500 - 1000 / t. This is sold at Rs 4,000 - 6,000 / t after drying. Trash fish is mainly exported to other states such as Tamil Nadu and Andhra Pradesh, for the feed industry.

Table 7 Estimated availability of marine protein sources from important centres in Kerala (tonnes per annum)

Marine protein sources	Vizhin-jam	Quilon (Neen-dakara)	Alle-ppey	Cochin	Trichur	Mala-puram (Ponnani)	Calicut	Canna-nore	Kasar-god	Total
Finfish	225	1,765	114	812	240	70	2,604	552	–	6,382
Mantis shrimp	–	125	70	681	508	260	772	545	295	3,256
Prawn head waste	–	1,014	282	1,175	417	352	345	120	318	4,023
Cuttlefish	217	1,344	4	1,191	26	76	142	6	16	3,022
Squid	237	1,467	5	1,301	28	83	154	7	18	3,299
Clam meat	–	–	1974	1,185	–	–	–	–	–	3,159
Mussel meat	–	–	–	–	–	–	770	–	–	770

Fairly large quantities of prawn head waste is available at Quilon and Cochin centres compared to Trichur, Calicut, Alleppey, Ponnani and Kasargod (Table 7). It is used in fresh condition as feed for ducks and poultry and as fertiliser for coconut plantations by local farmers. It is also used for the manufacture of chitosan. The cost of prawn head waste is Rs 300 - 500/t at the processing centres. This is sold at Rs 3,000/t after drying.

Mantis shrimp is available at Quilon, Cochin, Trichur, Ponnani, Calicut, Cannanore and Kasargod. Quilon and Cochin are the major centres of cephalopod landings, followed by Vizhinjam and Calicut (Table 7).

Green mussel (*Perna viridis*) beds are found along the Malabar coast of Kerala. Calicut and Cannanore are the important places where the fishery for *Perna* is concentrated. The annual exploitation is estimated to be around 3,000 t against the estimated stocks of 15,000 t. Vembanad and Ashtamudi lakes with a potential of 5,000 t and 3000 - 4000 t respectively, are the important grounds in Kerala, for clams (*Vellorita* sp., *Meretrix* sp., *Katelysia* sp., *Paphia* sp.). In recent years, fresh clam meat is used for feeding prawns in grow -out ponds.

3.4.6. Orissa

The availability of marine proteins in Orissa is shown in Table 8. Paradeep, Puri and Balasore are the important landing centres. Chilka lake produces about 4,000 tonnes of fish and prawns per annum. The landings from trawl catches account for 60% of the total marine fish landings. At Balasore 15,170 t of trash fish is annually landed, followed by Paradeep (8,021 t), Puri (5,646 t) and Ganjam (3,610 t). Mantis shrimp is estimated to be available around 1,480 t/year at Balasore, followed by at Paradeep (1,436 t), Puri (516 t) and Ganjam (330 t). Prawn head waste is estimated to be available around 250 t/year from Paradeep, 200 t/year from Puri and 200 t/year from Balasore. The resources of cephalopods and clam meat are meagre.

Table 8 Estimated availability of marine protein resources in Orissa (tonnes per annum)

Marine protein sources	Paradeep	Puri	Balasore	Ganjam	Total
Finfish	8,021	5,646	15,170	3,610	32,447
Mantis shrimp	1,436	516	1,480	330	3,762
Prawn head waste	250	200	200	150	800
Cuttlefish	13	11	12	6	42
Squid	14	10	8	6	38
Mussel meat	2	2	1	–	5
Clam meat	–	1	–	–	1

3.4.7. Andhra Pradesh

In Andhra Pradesh, Visakhapatnam, Kakinada and Machilipatnam are the important fish landing centres. Fishing is carried out throughout the year. At Visakhapatnam, trash fish is available to the extent of 1,420 t/year followed by Kakinada (707 t) and Machilipatnam (963 t) (Table 9). Mantis shrimp is available in larger quantities in Kakinada (1400 t/year) than in Visakhapatnam (354 t/year) and Machilipatnam (686 t/year). The availability of prawn head waste is 3,000 t/year in Kakinada while at Machilipatnam and Visakhapatnam it is 2,750 and 521 t/year respectively.

Table 9 Estimated availability of marine protein resources in Andhra Pradesh (tonnes per annum)

Marine protein sources	Visakha-patnam	Kakinada	Machili-patnam	Total
Finfish	1,420	707	963	3,090
Mantis shrimp	354	1,400	686	2,440
Prawn head waste	521	3,000	2,750	6,271
Cuttlefish	11	3	2	16
Squid	18	720	594	1,332
Crabs	384	47	45	476

3.4.8. Tamil Nadu

The estimated availability of marine proteins from different landing centres of the state are presented in Table 10. Trash fish locally called 'Kalasal' are generally available in many landing centres. These are transported by tri-cycles to the adjoining beaches where they are segregated into fish and crustaceans and sun-dried. However, dry mantis shrimp invariably contained small crabs and squid contained small prawns locally called 'Koonee'. The fishes that are generally encountered in trash fish landings are anchovies, clupeids, red baits, soles, flat head, perches, carangids, sardines, catfish, sand whiting, upenoids, mantis shrimp, and small miscellaneous crabs. Drying of trash fish, mantis shrimp, small crabs and prawn head waste is carried out in an organised way. The sun-dried material is stored in gunny bags. Majority of the dry fish are sent to Namakkal for poultry feed manufacture.

Rameswaram is the major trash fish landing centre accounting for 33% of the total in the state. Adiramapattinam, Jagathapattinam, Tuticorin and Nagapattinam are the other centres for trash fish, which together contribute about 37% of the total landings (Table 10).

Mandapam and Tuticorin are important centres for prawn head waste. Mantis shrimp is available at Mallipattinam, Adiramapattinam and Jagathapattinam besides miscellaneous crabs and squid. At Tuticorin, squid waste and crab are dried and used in fish meal manufacture.

Table 10 Estimated availability of marine protein sources in Tamil Nadu (tonnes per annum)

Marine protein source	Tuticorin	Manda-pam	Pamban	Rame-swaram	Mallipat-tinam	Adirama-pattinam & Jagatha-pattinam	Naga-pattinam	Pazha-yar	Cudda-lore	Madras	Total
Finfish	3,392	2,272	1,080	11,600	2,320	6,152	3,290	1,548	1,188	2,100	34,942
Prawn head waste	440	700	180	520	360	360	540	180	360	240	3,880
Mantis Shrimp	–	72	150	136	2,320	2,300	108	180	252	30	5,548
Crabs	235	118	–	469	234	234	140	118	117	104	1,769
Squid	152	76	–	154	304	304	112	154	76	127	1,459

4. FISH MEAL PLANTS AND PULVERISING UNITS

The fish meal produced in India is largely dry fish, pulverised into meal. Trash fish landed along with the marine fish/prawn catches are collected from fishing harbours by fish merchants, transported to nearby beaches, dried and then sold to the feed industry. The end users powder this dry fish into meal. During drying on the sand beaches, the trash fish is contaminated with sand along with other materials. The fish meal so obtained is of poor quality, with protein content ranging from 38 to 45%. The ash content is very high (25 to 30%), of which a considerable proportion is acid-insoluble ash, indicating the presence of sand and earthen matter. Since the major consumer of these marine products is the poultry feed industry which does not require high quality meal as in the case of shrimp feed, there is good market even for such low quality material. As a result, there is no organised effort to produce quality fish meal using the trash fish.

However, a few fish meal plants situated in Gujarat and around Mangalore in Karnataka are producing sterile fish meal which has 50 - 55% protein content. Along with the trash fish, other fishes such as sardine and mackerel, landed in large quantities during peak season, are used for fish meal production. The basic method employed in producing the sterile fish meal is that the trash fish is minced and steam cooked in fresh condition. It is then subjected to a hydraulic press to extract oil and water. The residue is drum -dried and pulverised. During drying, due to direct contact with the open flame, the material is over- dried and charred. Production of bio-amines such as histamine takes place, which reduces the quality of fish meal. Thus, there is need to produce good quality fish meal with atleast 60% crude protein for shrimp feeds as the fish meal presently available in the country is not up to the mark for the manufacture of shrimp feeds.

In Gujarat, there are two fish meal plants, with a production capacity of 13 t/day of sterile fish meal and 38 fish pulverising units with a total capacity of 516 t (Annexure II). The state of Gujarat produced 32,931 t of fish meal in 1990-91 and 42,635 t in 1992-93.

The Maharashtra Industrial Development Corporation (MIDC) had set up a fish meal plant at Ratnagiri. But production has not commenced due to high cost of raw material. Bhagvati Industries situated at Mirjole produces about 400 t/year of fish meal (Annexure III).

There are two fish meal plants at Vijayawada in Andhra Pradesh with a total capacity of 9 t/day of fish meal (Annexure IV). Three more fish meal units are under installation in Nellore. In Orissa state also there are two fish meal plants, one at Balasore with a production capacity of 8 t / day and another at Paradeep with a production capacity of 1 t/day (Annexure IV).

In Kerala there are five fish meal plants with a capacity to produce 10,600 t of fish meal (Annexure V). But as on today, no fish meal is produced by any of the plants which is reported to be due to non-availability of raw materials. The fish meal plant of Amalgam Foods, Cochin produces prawn meal (800 t/yr), squid meal (20 t/year) and clam meal (100 t/year). All these products are utilised for prawn feed manufacture by their own company, Higashimaru Feeds India Ltd.

In Karnataka there are five fish meal plants with a combined capacity of 9,300 t/year of fish meal production (Annexure VI). But the total production of fish meal from these plants, at present, is only 4,037 t which is less than 50% of the installed capacity. This is reported to be due to non-availability of adequate raw material round the year. In Tamil Nadu there are about 23 dry fish pulverising mills producing fish meal (Annexure VII).

5. FISH OIL

Fish oil is produced in the states of Kerala, Karnataka and Andhra Pradesh. A total quantity of 262 t of fish oil is produced in Kerala. The raw materials used for the extraction of oil are sardines and shark liver. Fish oil is sold at Rs 30/kg in Kerala. In Karnataka, a total of 297 t/year of fish oil is estimated to be produced by various fish meal plants. The raw materials used are sardines, mackerel, shark liver and assorted fish. The oil is sold at Rs 22/kg in Karnataka. Andhra Pradesh Fisheries Development Corporation (APFDC)

is producing shark liver oil at Kakinada. It is sold at Rs 40 per kg. Annexures VIII to X give the list of fish oil manufacturers in various states.

6. DISCUSSION

The assessment of the availability of marine protein resources as raw materials for shrimp feed manufacture carried out in the present study, yielded very useful information and valuable data that can be used by the researchers and the feed industry. Similar studies to assess these resources were conducted earlier by Wood and Coulter (1988). In terms of coverage of area and the data base used in this assessment, the present study is clearly more comprehensive with detailed estimates of various marine resources as raw materials for prawn feed. The estimated availability of dry finfish is 1,76,593 t/year as against 1,10,000 t/year of fish meal estimated by Wood and Coulter (1988). in the latter case, the estimates were made mainly taking the by-catches of prawn landings, whereas in the present study, the estimates were arrived at by taking into account the total marine landings as a whole in the country, which has given a clear picture of this resource. In other cases, there is a good agreement between the estimates made in the present study and those made by the earlier study. For example, the estimated availability of prawn head was 31,235 t/year and that of mantis shrimp was 57,942 t/year in the present study as against 30,000 t/year and 40,000 t/year respectively, estimated by Wood and Coulter (1988). Additionally, the present study has brought out the assessed availability of sergestid shrimp *Acetes*, cuttlefish, clams, crabs, mussels, squid and fish oil, which were not covered in detail in the earlier studies.

It is envisaged that by 2000 A.D., India would bring about 1.0 lakh ha of brackishwater area under different prawn farming systems (Anon., 1989). The demand for feed by this development is estimated to be 3,67,500 t per annum. Assuming about 40% of marine protein sources will be used in feed production, the total marine protein requirement for prawn feed manufacture by 2000 A.D., would be around 1,47,000 t. Poultry feed industry is estimated to require 2,00,000 t at an inclusion rate of 5-7% (Wood and Coulter, 1988) and the remaining protein source of 1,35,191 t may become available for prawn feed manufacture, which is short of roughly by 12,000 t.

The prices of marine proteins in different states indicate that among the raw materials, trash fish, mantis shrimp and prawn head waste are sold at comparatively lower rates than fish meal (Annexure VI). Cuttlefish, squid, clam and mussel meat are more expensive ingredients. Sergestid shrimp is a potential protein source available in Maharashtra and Gujarat which can be used in prawn feed. The availability of mussel and clam meat for prawn feed is limited as they are used for human consumption. Similar is the case with cuttlefish and squid as they are exported. The remainder *viz.*, trash fish, prawn head waste mantis shrimp and sergestid shrimp can be tapped for prawn feed manufacture. There is competition for marine proteins from the poultry feed industry. In the present survey, many fish merchants were contacted,and it was confirmed that most of the trash fish is sold to poultry feed industry.

Despite the above projections of availability of marine protein sources in the country, difficulties are encountered by fish meal manufacturers, which include the non-availability of raw material round the year and cost of transportation from distant places to the plant site. Perhaps, these reasons preclude the fish meal plants from operating to their installed capacities. Hence, there is a need for finding out ways and means to improve the raw material availability for fish meal manufacture. One way to overcome this shortage is to increase the landings from prawn by-catches. About 6,90,000 t of by-catches are estimated to be annually discarded at sea which is equal to 1,72,000 t of fish meal (Wood *et al.*, 1992). If these catches are brought to the fishing harbours, a great deal of it can be utilised for fish meal production and the scarcity of marine protein sources for prawn feed production can be reduced to a large extent. Similarly, trawl net operators may be encouraged to bring the by-catch to the shore, instead of discarding them in the sea, by creating facilities for proper handling and storage of trash fish and securing higher returns for the low value fish. Thus, there is scope for expansion of trash fish landings for fish meal manufacture.

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ANNEXURE I

PROXIMATE COMPOSITION OF SELECTED MARINE PROTEIN SOURCES

S.No.	Protein source	%				
		Moisture	Crude protein	Fat	Ash	Acid insoluble ash
1.	*Ambassis* sp. (dried)	14.8	35.0	15.6	34.8	22.9
	Ambassis sp.	79.72	18.63	1.28	1.12	–
2.	Anchovy (dried)	14.8	52.1	11.5	21.6	22.4
	Anchovy meal (dried)	6.7	77.0	7.7	10.0	–
3.	Bombayduck (*Harpodon nehereus*)	89.30	9.10	0.70	1.10	–
4.	Oil sardine (*Sardinella longiceps*)	67.01	19.38	11.65	1.73	–
5.	Silver belly (*Equula* sp.)	73.40	17.39	4.02	5.58	–
6.	*Caranx* sp.	77.09	20.97	0.38	1.56	–
7.	Mackerel *(Rastrelliger kanagurta)*	71.9	21.21	7.51	1.33	–
8.	Ribbon fish (*Trichurus savala*)	74.46	22.66	0.42	1.96	–
9.	Rock cod (*Epinephelus* sp.)	67.40	24.30	0.30	2.60	–
10.	White bait (*Anchoviella* sp.)	77.98	18.50	0.46	2.06	–
11.	Clam (*Vellorita cyprinoides*)	81.82	10.94	0.47	0.85	–
	Clam (*Meretrix casta*)	79.51	10.74	0.43	0.9	–
12.	Squid (*Loligo* sp.)	83.00	14.50	0.80	0.50	–
13.	Prawn head waste					
	Dried on ground	10.6	34.8	14.8	28.9	0.7
	Dried on mat	6.7	35.7	7.6	15.7	7.2
14.	Squilla	11.7	43.1	8.9	19.4	7.2
15.	Mussel (*Perna viridis*)	76.69	12.55	2.57	2.06	–
16.	Crab (*Scylla serrata*)	79.23	17.15	0.21	1.39	–
17.	Cuttlefish (*Sepia* sp.)	75.83	18.06	0.22	0.53	–
18.	Sergestid shrimp (*Acetes* sp.)	78.80	68.13	4.85	15.57	–
19.	Fish meal (commercial)Sterile A	10.4	59.9	1.7	14.6	1.6
	Fish meal (commercial)Sterile B	14.3	55.7	3.8	10.4	7.4
	Fish meal (commercial)Sterile C	12.7	55.4	3.6	13.2	1.4

ANNEXURE II

FISH PULVERISING UNITS IN GUJARAT

S.No.	Name of Company	Capacity (tonnes/day)	No. of Units
1.	Noorsons, Bhidya, Veraval 382269	20	1
2.	Rahul Enterprises, Bhidya, Veraval 382269	30	2
3.	Favourite Seafood, Bhidya, Veraval 382269	8	1
4.	Circar Marine Industries, Bhidya, Veraval 382269	5	2
5.	Viceroy, Bhidya, Veraval	20	1
6.	Fertilisers & Industries, Bhidya, Veraval	3	1
7.	N.R.H., Mongrol	15	1
8.	Bahulal Govind, Porbandar	15	1
9.	Amar Fish Grinder, Porbandar	10	1
	Total	126	11

ANNEXURE III

FISH PULVERISING UNITS IN DIFFERENT DISTRICTS OF MAHARASHTRA

S.No.	Name of Company	Capacity (tonnes/day)
BOMBAY		
1.	Abdul Hameed Ahmed & Co. P.B.No.6357, Sewree Cross Rd., Bombay 400 015.	6.0
2.	Favourite Fisheries & Fertilisers P.B.No.6354 Sewree Cross Rd., Bombay 400 015.	10.0
3.	Patel Grinding Industries P.B.No.6356, Sewree Cross Rd., Bombay 400 015.	5.0
4.	Noorsons Cresent Industries 22(a), Sewree Cross Rd., Bombay 400 015.	10.0
5.	Machiomar Saharkari Sang Sewree Cross Rd., Bombay 400 015.	10.0
6.	Towakhal Marine Products Pvt. Ltd., Jetti Road	2.5
7.	Ammol Industries, Sewree Road Bombay 400 015.	5.0
8.	Fardi Grinding Industries, Sewree Road, Bombay 400 015.	5.0
9.	H.E.Grinding Industries, Sewree Road Bombay 400 015.	3.0
10.	Habib Brothers, Sewree Road, Bombay 400 015.	3.0
THANE		
11.	Bhaflekar Fish Powder Manufacturers	6.0
RATNAGIRI		
12.	More Industries, Kuwanbao	10.0
13.	Ratnagiri Sea Foods, Karla	5.0
14.	Sara Product, Bhatye	6.0
	Total	86.5

Contd....

ANNEXURE III Contd....

S.No.	Name of Company	Capacity (tonnes/day)
15.	Bhagvati Industries, Mirjole	2.0
16.	Gangajati, Dapoli	6.0
17.	Donson Industries, Jalagoan, Dapoli Taluk	6.0
18.	Renuka Enterprises, Mirjole	0.6
19.	Ratnagiri Fish Meal, Kasarval	0.5
20.	Ratna Sea Food, Mirjole	3.0
21.	Kohinoor Fish Meal Musakaji, Taluk Rajpur	1.4
22.	Atlantic Fish Meal and Allied Products, Mirjole	10.0
23.	Favourite Sea Food, Sakrinate	2.3
24.	Sea Shore Softies, Mirjole	3.0
SINDHUDURG		
25.	R.J.Parker & Co., Deogad	5.0
26.	Quality Sea Enterprises, Vijayadurg, Deogad	5.0
27.	Memon Grinding Co., Jamsande	7.0
28.	Jagunath Sea Foods, Deogad	2.5
	Total	54.3

ANNEXURE IV

FISH MEAL PLANTS IN ORISSA & ANDHRA PRADESH

S.No.	Name of Company	Capacity (tonnes/day)
ORISSA		
1.	Akash Traders, Balaramgudi, Srikona Industrial Area, Balasore	8.0
2.	International Food Syndicate, Paradeep, Cuttack	1.0
ANDHRA PRADESH		
3.	Laxmi Agro Product, Jawahar Auto Nagar, Vijayawada -520 007	8.0
4.	Ganesh Nutrient Products, Jawahar Auto Nagar, Vijayawada	10.0
UNDER INSTALLATION		
5.	Aargee Formulated Feeds, Gangapatnam Village, Indukurpet Mandal, Nellore Dist.	
6.	Shyamala Feeds, B-3, B-4 Industrial Estate, Nellore	
7.	Mr.N.Dolendra Prasad, Feed Manufacturer, Nellore	

ANNEXURE V

FISH MEAL PLANTS IN KERALA

S.No.	Name of fish meal plant	Installed capacity tonnes/year	Present production tonnes/year	Raw material used	Grade
1.	Amalgam Foods Ltd. Nima House, 4th Main Road, Willingdon, Island, Cochin 682 003.	1000	Prawn head meal-800 Squid meal-20 Clam-100 Fish meal-Nil	Prawn head Squid waste Clam meat	1 1 1
2.	Fish Meal Plant Matsyafed, West Hill, Calicut - 5.	3000	Nil	–	Sterile
3.	Fish Meal Plant Matsyafed, Azhikode P.O., Trichur District	3000	Nil	–	Sterile
4.	Seaking Fish Meals & Fertilizers Canal Road, Aleppy	3000	Nil	–	Sundried fish Pulverised
5.	Integrated Fisheries Project, Cochin - 682 016.	6000	Nil	–	Sundried fish Pulverised

ANNEXURE VI

FISH MEAL PLANTS IN KARNATAKA

S.No.	Name and address of fish meal plant	Installed capacity tonnes/yr	Present production tonnes/yr	Season available	Fish used	Grades of fish meal	Cost per tonne Rs	Moisture %	Protein %
1.	Bawa Fish Meal and Oil Company P.B.No.235, Warf St. Mangalore-575 001.	2400	1500	September October November	Sardine Mackerel & Mixed fish	A Sterile B Non sterile	8000 5500 to 6000	5–10 5–10	55–60 45–50
2.	Coronet Canning Co. (Raj Fish Meal & Oil Co.) Malpe-576 118. Dakshin Kannada Karnataka State	650	250	September October November	Sardine Mackerel & Misc. fish	1 Sterile 2 Sterile	7000 6200	5–7.5 5–7.5	55 50
3.	Janatha Fish Meal & Oil Products Manur Fisheries Road, Kota-576 221. South Canara, Karnataka State	2100	200	September October November	Sardine Mackerel Tuna	1 Sterile 2 Sterile	6500 to 8000 5500 to 7000	7.0 7.0	60–65 50–55
4.	Karnataka Fisheries Development Corporation,Baithkole Fish Meal Plant Karwar-581 302. Karnataka	1800	100	September October November	Mixed fish except flat fish and ribbon fish	1 Sterile	7000 to 8000	–	60–65
5.	Mukka Oil & Seafood Industries, Mission Street Mangalore-575 001.	2400	1987	September October November	Sardine Mackerel	A Sterile B Sterile	9,250 7500	10 10–12	58 45–55

ANNEXURE VII

FISH MEAL PULVERISING UNITS IN TAMIL NADU

S.No.	Name of mill owner
1.	Mr.Christy, Near Alankar Theatre, Tuticorin.
2.	St.Vinister, 115 Bhoopalarayapuram, Tuticorin-1.
3.	Mr.S.S.F., New Fishing Harbour, Tuticorin-1.
4.	Mr.Chandran, S/o Mr.Duraisami Nadar, Bhoopalarayapuram, Tuticorin-1.
5.	Mr.M.Athimuthu, Sambai Merchant, 339-B, South Beach Road, Tuticorin-1. Ph:23279-23769
6.	Mrs.Alamelu Ammal, P.K.A.Dry Fish Merchant, Annathanapatti, Salem.
7.	M/s.Ruminant Feeds, 12-C, Airaj St., Saminathapuram, Salem 636 009. Ph.54080
8.	M/s.Provimi Products Pvt. Ltd., 42 Bharathi Street, Gobichettypalayam 638 452
9.	Lakshmi Feeds, Fish Meal Merchant, Erode.
10.	M/s.Elumalayan Traders, Dry Fish Merchant, Namakkal.
11.	M/s.Nallathambi Traders, Dry Fish Merchant, Namakkal.

Contd.....

ANNEXURE VII (Contd...)

S.No.	Name of mill Owner
12.	M/s.Vaigai Traders, Dry fish merchant, Namakkal.
13.	Mr.Kumaraswami, 10 K.S.Pettai St., Namakkal.
14.	M/s.Vijay Foods, 167/A/1, Salem Road, Namakkal.
15.	M/s.Remy Ice Factory, MGS Co., Verkod, Rameswaram.
16.	Mr.Rajgopal, Near Dharga, Uchipuli, Ramnad Taluk, Ramnad Dist.
17.	Mr.Nizam Ali Khan, Dry fish merchant, Ramnad. Ph.613.
18.	Sakthi Agency & Thuraiyur, Sethubasumudram, Peravoorni 614 802
19.	M/s.S.K.M.Energy Feeds Pvt. Ltd., 49-C Gandhi Road, P.B.No.415, Erode 638 002. Branch: 18, Canal Cross St., Adyar, Madras.
20.	Mr.S.Natarajan, Junglobal Exporters, 65 C.N.Krishnaswamy Road, Madras 600 005.
21.	M/s.Raj Impex, Raj Villa, 17 Melony Road, Madras 600 017
22.	M/s.Om Muruga Energy Feeds, 122 Sidco Industrial Estate 3rd Main Road, Ambattur, Madras 600 058.
23.	Mr.M.S.A.Kabeer, Royal Trading Co., Royal House, I Floor, 75 Harris Road, Madras 600 002.

ANNEXURE VIII

FISH OIL RESOURCES IN KERALA

S.No.	Name of firm with address	Name of product	Raw material used	Quantity produced (tonnes/yr)	Cost Rs/Kg
1.	Kruse Joseph, Dry fish merchant Pallimannel Neendakara Quilon-691 582.	Sardine oil & Shark liver oil	Oil sardine & Shark liver	10.0	15 to 25
2.	Naramerdan Albert, Port Road Shaktikulangara Quilon-691 581.	Sardine oil & Shark liver oil	Oil sardine & Shark liver	10.0	15 to 25
3.	Seaking fish meal & Fertilizers, Door No.XXII/55 A Canal Road Aleppy-688 007.	Sardine oil	Oil sardine	192	25 to 35
4.	Amalgam Food, Nima House Willingdon Island Cochin-682 003.	Fish oil	–	–	–
5.	Kerala Soaps & Oils Ltd., 3/31, Gandhi Road, Calicut-673 011.	Shark liver oil	Shark liver	50	–

ANNEXURE IX

FISH OIL RESOURCES IN KARNATAKA

S.No.	Name of firm and address	Name of product	Raw material used	Quantity produced (tonnes/yr)	Cost Rs/Kg	Available seasons
1.	Karnataka Fisheries Dev. Corporation. Fish meal plant Baithkole Karwar-581 302	Fish oil	Mixed fish including Oil sardine & Mackerel	12.0	20 to30	August Sep. Oct.
2.	Janatha Fish Meal & Oil Products, Manur FIsheries Road Kota-567 221. South Kannada Karnataka	Fish oil	Oil sardine, Mackerel and Tuna	40.0	15 to 25	August Sep. Oct.
3.	Mukka Oil & Seafood Industries Mission Street, Mangalore-575 001.	Fish oil	Mixed fish Sardine & Mackerel	45.0	20 to 25	August Sep. Oct.
4.	Bawa Fishmeal & Oil Co. PB 235 Warf street, Mangalore - 575 001.	Fish oil	Mixed Fish	100.0	25 to 30	August Sep. Oct.
5.	Raja Fish Meal & Oil Co. (Coronet Canning Co.) Malpe-576 118.	Fish Oil	Mixed fish	90.0	15 to 20	August Sep. Oct.
6.	Sterling Sea Foods Tadri-581 437. North Canara Dist. Karnataka	Shark liver oil	Shark liver	10.0	—	—

ANNEXURE X

FISH MEAL / FISH OIL EXPORTERS IN MAHARASHTRA

S.No.	Name of Exporter
1.	G.T.C.Industries Ltd., Tobacco House, Vele Parle, Bombay - 400 056
2.	Gadre Marine Export, Mirkarwada, Ratnagiri - 415 612
3.	Gareware Nylons Ltd., Chanan Mukhi, Nariman Point, Bombay - 400 021
4.	Gift and Kraft Works, Bussaudyog Bhavan, Units 21 & 22 Tokersi Jenraj Road, Seuri, Bombay - 400 015.
5.	Goel Brothers, 36 Atlanta 3rd Floor, 209, Nariman Point, Bombay - 400 021.
6.	Gold Star Exporters, 645 Girgaun Road, Dhobi Talao, Bombay - 400 002.
7.	Gopal Das Pardhandas, 5 Arab Building, Sewri Cross Road, Sewri, Bombay - 400 015.

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