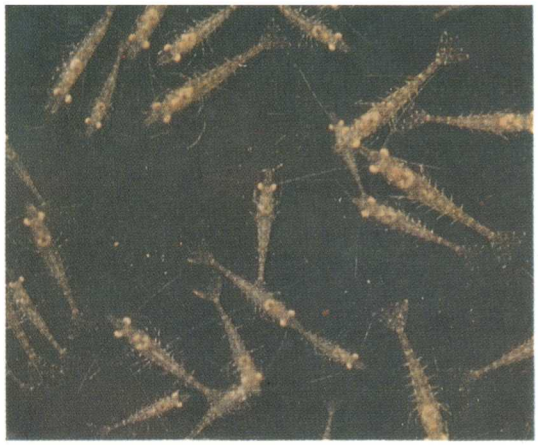
MICROPARTICULATE FEED FOR POSTLARVAE OF SHRIMP *PENAEUS INDICUS*



CIBA BULLETIN No. 5
JANUARY 1995

केन्द्रीय खारापानी जलजन्तु पालन संस्थान
(भारतीय कृषि अनुसंधान परिषद)
नं.१४१, मार्शल्स रोड, एगमोर, मद्रास – ६०० ००८

CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE
(Indian Council of Agricultural Research)
141, MARSHALLS ROAD, EGMORE, MADRAS-600 008.

MICROPARTICULATE FEED FOR POSTLARVAE OF SHRIMP *PENAEUS INDICUS*

S. AHAMAD ALI and A. LAXMINARAYANA

CIBA BULLETIN No. 5
JANUARY 1995

केन्द्रीय खारापानी जलजन्तु पालन संस्थान
(भारतीय कृषि अनुसंधान परिषद)
नं.१४१, मार्शल्स रोड, एगमोर, मद्रास – ६०० ००८.

CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE
(Indian Council of Agricultural Research)
141, MARSHALL'S ROAD, EGMORE, MADRAS - 600 008

Restricted Circulation

Published by: Dr. K. Alagarswami
Director
Central Institute of Brackishwater Aquaculture
Madras-600 008.

Edited By: Shri K. N. Krishnamurthy
Principal Scientist
Central Institute of Brackishwater Aquaculture
Madras-600 008.

Cover Photos:

Top Left	:	Feed ingredients.
Top Right	:	Preparation of stock feed.
Bottom Left	:	Microparticulate feed.
Bottom Right	:	Postlarvae of shrimp.

Printed at: Prints & Proofs, Madras-8.

PREFACE

Almost all the shrimp hatcheries in India need imported feeds for larval and postlarval rearing in the form of microbound particles, commercially called 'artificial plankton', and brine shrimp (Artemia) nauplii hatched from cysts. These feeds are very expensive and form a good percentage of the operational cost of hatcheries. The Central Institute of Brackishwater Aquaculture has carried out extensive research in finding indigenous 'replacement' diets for shrimp larval and postlarval rearing.

The nutritional requirement of the life history stages have been studied and appropriate locally available raw mateirals were selected and balanced feeds formulated, produced and tested on a laboratory scale and pilot scale. In this process, we have sucessfully developed two formulations for postlarval feeds for the white prawn, Penaeus indicus for stages PL 1 to PL 20. It has been ensured that readily available raw materials are chosen as ingredients and simple machineries are used in feed production. The feed particle size ranges from 200 - 1000 microns to suit the growth stages. These microparticulate feeds have been tested over a period of time with reliable results and the technology can be used for hatchery-based production.

Through the present Bulletin, we are disseminating the state-of-art indigenous technology of shrimp postlarval feeds. The technology is for integrating a feed production unit with any medium-scale shrimp hatchery. It is hoped that the information will be used for replacing the imported postlarval diets. I would like to place on record my appreciation to Dr. S. Ahamad Ali and Dr. A Laxminarayana, Scientists for the preparation and to Shri K. N. Krishnamurthy, Principal Scientist for editing this Bulletin.

Madras-8
2-1-1995

K. ALAGARSWAMI
DIRECTOR

CONTENTS

1. INTRODUCTION

In the hatchery production of young ones (seed) of the Indian white prawn *Penaeus indicus*, the early larval stages, namely, protozoea and mysis, are successfully reared using mono or mixed cultures of diatoms. But, for postlarvae, the phytoplankters alone are not adequate. The postlarvae are generally fed with live-food organisms such as brine shrimp (*Artemia*) nauplii and rotifers. There is no doubt that these live-foods are good and promote better growth of postlarvae. However, they are expensive and their large scale production in synchronisation with the prawn larval stages in the hatchery not only needs extensive facilities but also skilled man power. To solve these practical problems, compounded microparticulate feeds are developed for feeding the postlarvae. Besides being economical, compounded feeds are nutritionally well balanced and are easy to prepare using locally available raw materials. The advantages of these feeds are that they can be stored in the shelf, readily transported and easily dispensed as per needs, thus simplifying the operation of postlarval rearing in the hatchery and nursery.

Through formulation of several feeds using indigenous raw materials and their testing in laboratory experiments, two feed formulations were evolved for feeding the postlarvae of *P. indicus*. Subsequently, these feeds were tested in large scale seed production trials in hatchery and very good success was achieved in raising postlarvae upto PL 20 and beyond. In this publication, the technology of preparing microparticulate feeds of different size for *P. indicus* postlarvae and economics are described.

The details of processing and production of microparticulate feeds presented are primarily as part of medium scale hatchery operation and are not for commercial scale production.

2. NUTRITIONAL REQUIREMENTS OF *Penaeus indicus*

Investigations on the nutritional requirements of *P. indicus* resulted in gaining good knowledge on the dietary requirements of *P. indicus*. For basal nourishment and optimum growth, the prawn requires about 4000 Kcal of digestible energy per kilogram of diet. Protein requirement in diet had been studied in greater detail compared to other nutrients. The prawn is found to require 30-40% protein in its diet. While the early postlarvae (PL1) require 40% protein in their diet, it decreased to 30% as the postlarvae grew in size.

Lipids which are rich in polyunsaturated fatty acids (PUFA) are essential in the diet of *P. indicus*. Marine fish oils such as cod liver oil, sardine oil and prawn head oil promote good growth. The quantitative requirement of lipid is found to be 6 to 9%. Apart from this, the prawn also requires 1% of lecithin and 0.5 to 1.0% of cholesterol in its diet. Lecithin is beneficial for growth and survival of prawn besides playing an important role in lipid digestion, absorption and transport in the haemolymph. A mixed lipid source is superior to any of the individual lipids. Among the carbohydrates, *P.indicus* shows better utilization of disaccharides and polysaccharides compared to monosaccharides. Starch is a good source of carbohydrate and its level in diet can be varied from 20 to 35%. The prawn also requires roughage (fibre) in diet upto a maximum of 6% for achieving better food conversion ratio.

For healthy growth, vitamin requirements are: thiamine 0.01%, pyridoxine 0.02%, niacin 0.025%, riboflavin 0.008%, pantothenic acid 0.075%, inositol 0.3%, choline chloride 0.5 to 0.75% and ascorbic acid (vitamin C) 0.4 to 0.8%.

Using purified diets, the requirement of mineral elements calcium, phosphorous, copper, zinc, magnesium and manganese in the diet of *P. indicus* has been determined. While calcium and phosphorous are required at 0.5% and 1.0% respectively, copper and zinc are needed at 13.6 mg and 23.6 mg per 100 g diet respectively. Addition of magnesium in the diet has no impact on growth. Manganese levels beyond 0.2 mg/100 g diet are not desirable.

Locally available feed ingredients namely, clam meat, fish meal, mantis shrimp, prawn head meal, squid meal, silkworm pupa, groundnut cake, soybean cake, coconut cake, gingelly cake, sea weeds and *dried Spirulina* were tested for their suitability for formulating feeds for *P. indicus.* Using some of these feed stuffs, different feeds were formulated and evaluated for postlarvae, juveniles and adults of *P.indicus*. Some of the tested feed ingredients are used in formulating microparticulate feeds for postlarvae.

3. FEED FORMULATION

3.1. Raw materials

The feed materials used in formulating postlarval diets and their proximate composition are shown in Table 1.

Table 1: Proximate composition of feed materials

Ingredient	Moisture	Percent on dry basis				
		Crude Protien	Lipid	N-free extract (carbo-hydrate)	Crude fibre	Ash
Fish Meal	6.8	64.4	4.7	0.9	--	19.3
Mantis shrimp	80.0	44.1	7.6	1.3	8.2	23.6
Prawn waste	81.5	35.0	7.5	0.9	14.2	23.9
Squid	80.5	67.8	19.5	2.3	--	10.4
Soybean cake	6.0	50.3	2.5	24.8	6.6	9.8
Tapioca	4.8	2.0	0.5	72.0	19.2	1.5
Alfalfa	5.6	19.9	1.8	31.5	29.5	11.7

3.1.1. Fish meal

Fish meal is manufactured using different varieties of fish and is available commercially. Fish meal should contain at least 60% of crude protein and not more than 1% of sand (determined by acid insoluble ash content). In case, commercial fish meal is not available, dried anchovies and silver bellies can be powdered and used in place of fish meal.

3.1.2. Mantis shrimp

Mantis shrimp is a stomatopod (*Oratosquilla nepa*) which is caught in large quantities in trawl nets along with prawns. It is collected in fresh condition, washed and dried in electrical dryer at 70° C until the moisture content is reduced to less than 10%. Fresh mantis shrimp contains 80% moisture. On drying, squilla contains 40-45% crude protein, 5-7% of lipid and 20-25% of ash. It also contains 15-20% chitin (shell). Squilla is available in large quantities in the states of Kerala and Karnataka. Neendakara, Cochin, Calicut, Mangalore and Malpe are the major squilla landing places and is available during November to April.

3.1.3. Prawn head waste

Prawn head waste consists of the head with hepatopancreas, eyes, eyestalks, residual meat and exoskeleton. It is collected in fresh condition from prawn processing units and dried in a dryer at 70°C to reduce the moisture to less than 10%. Prawn head meal contains 30-35% of crude protein, of which 10-15% is due to chitin. The protein is rich in essential amino acids. The prawn head waste has 5-7% lipid rich in polyunsaturated fatty acids and pigments. It has high ash (20-25%) and crude fibre (14%). Prawn head waste is available in all the maritime states from where prawns are exported. The peak season of availablity of prawn head is October to May.

3.1.4. Squid meal

Squid meal, prepared from whole squid is a good source of high quality protein (60-70%) rich in essential amino acids. It is also having high lipid content of 13-19%, rich in PUFA. Besides these, squid meal contains short chain polypeptides which are found to be good feed attractants and growth promoters for prawn. Squid is available in the states of Andhra Pradesh, Kerala, Gujarat and Maharashtra. The peak season of availability is July to October.

3.1.5. Soybean cake

Soybean cake is the residue after extraction of oil from soybeans. It has 50% of good quality protein. It is available commercially in Tamil Nadu, Madhya Pradesh, Gujarat and Maharashtra.

3.1.6. Tapioca

Tapioca (*Manihot* sp.) is a tuber rich in starch (70-75%). It is cut into chips, sun dried and powdered. It is available commercially as chips and powder in Kerala and Tamil Nadu. Wheat or rice flour may be used in the formulation in place of tapioca where it is not available.

3.1.7. Alfalfa

Alfalfa (*Medicago* sp.) is a forage legume. It is sun dried and powdered, and is available commercially in Tamil Nadu.

3.1.8. Lecithin

Lecithin is a phospholipid (Phosphatidyl choline). It is extracted from soybeans. Lecithin is commercially available in crude form which can be used in the feeds.

3.1.9. Vitamin mixture

Vitamin mixture is prepared by obtaining individual vitamins using cellulose as filler. Individual vitamins are weighed according to the composition of the mixture and homogenised in a mixer grinder. It should be stored in air tight containers. Vitamin mixture can also be obtained commercially as per the requirements from formulating companies.

3.1.10. Mineral mixture

Mineral mixture is prepared by mixing individual pure grade chemical salts according to the composition. The mineral mixture is properly homogenised before mixing with feed.

3.1.11. BHA

Butylated hydroxy anisole (BHA) is available as pure chemical. It is used as an antioxidant in oils and fats to prevent oxidation of poly-unsaturated fatty acids.

3.2. Feed composition

Using the above feed materials two feeds have been developed. The proximate composition of these two feeds CIBA/WPL/1 and CIBA/WPL/2 are given in Table 2. The two feeds are evolved as alternative formulations, which can be adopted in any region depending upon the availability of ingredients. Formula 1 does not contain squilla while it is present in formula 2. The former can be preferred in the region where squilla is not available freely while formula 2 may be used in the region where squilla is available abundantly and fish meal is scarce. Practically there is no difference in the performance of both the feeds in rearing postlarvae of *P.indicus* in hatchery and nursery.

Table 2: Proximate Composition of microparticulate feeds

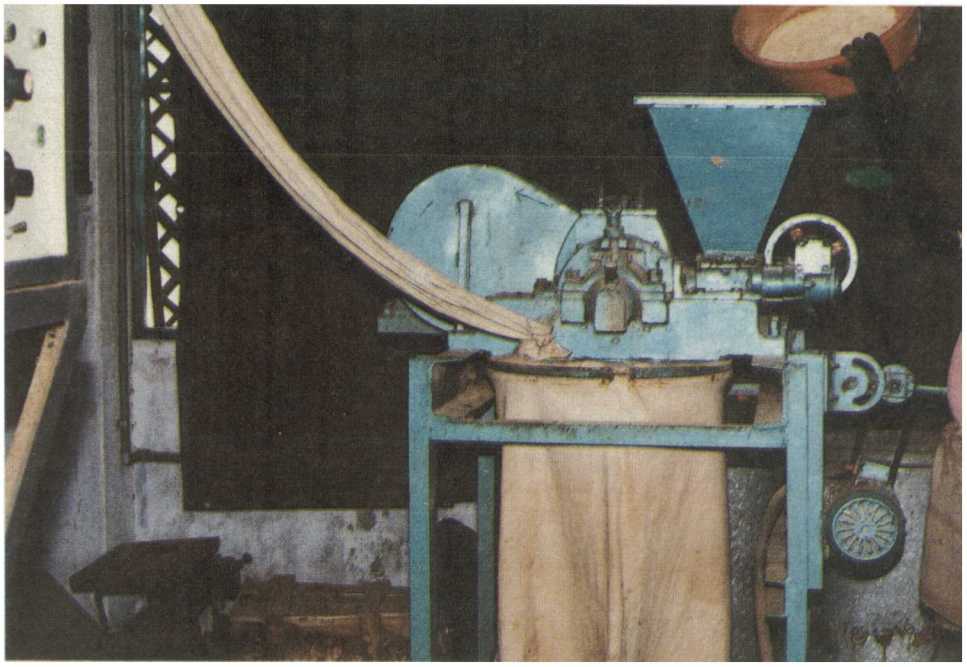
Constituent (Percentage)	Feed	
	CIBA/WPL/1	CIBA/WPL/2
Moisture	5.20	5.20
Crude Protien	39.50	39.50
Lipid	8.00	8.90
Carbohydrate	26.80	24.30
Crude fibre	6.70	6.20
Ash	13.80	16.20

4. FEED PROCESSING

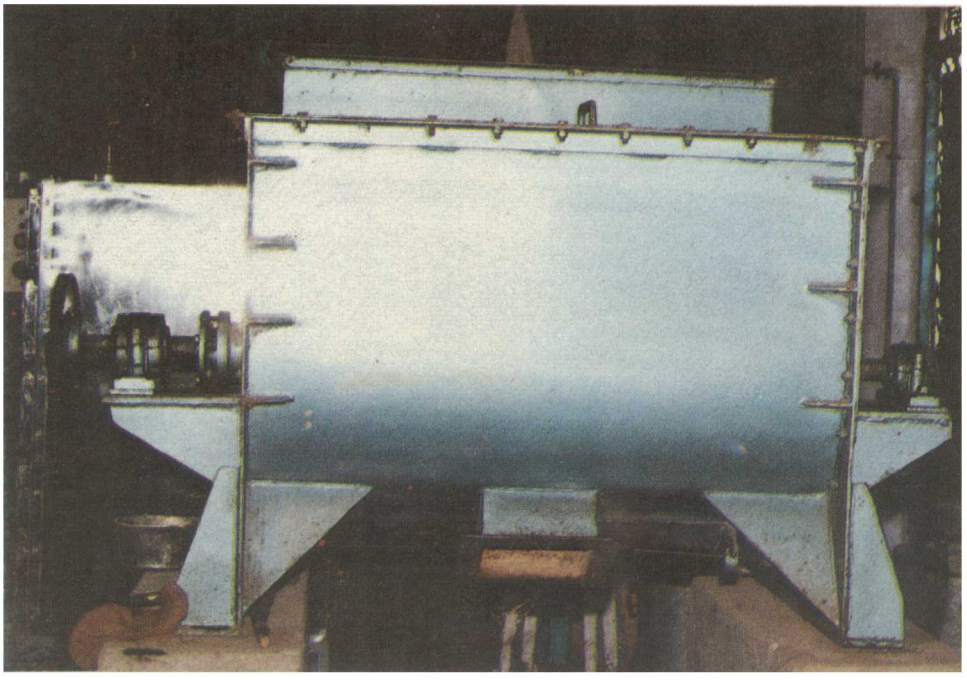
4.1. Processing of raw materials

4.1.1. Drying

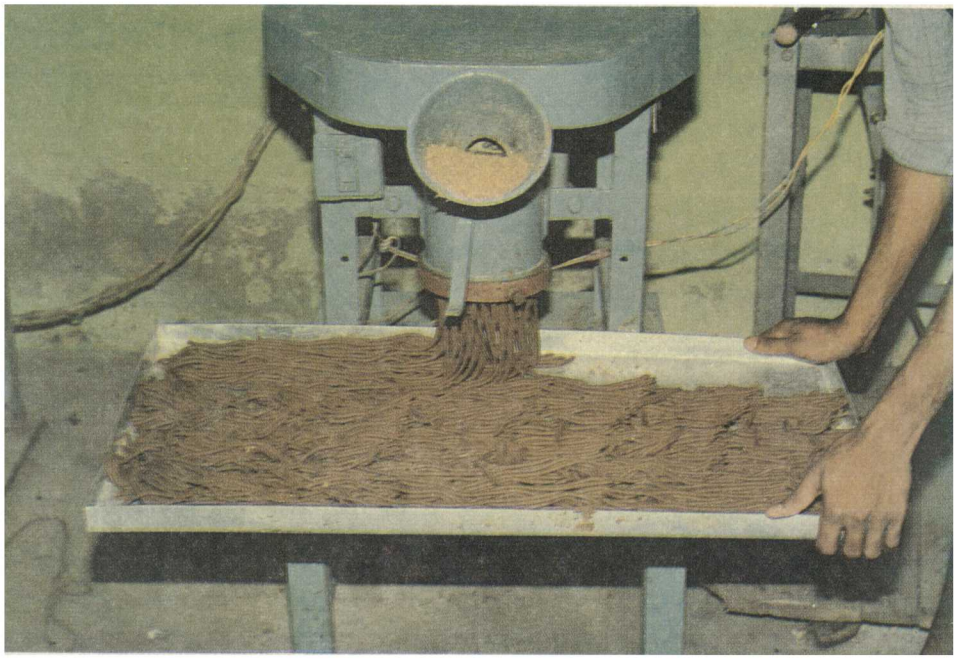
Mantis shrimp, prawn head and squid are obtained in fresh condition which contain about 80% of moisture. These are loaded in trays, and dried in electrical dryer at 60-70^{o}C until the



Micropulverizer



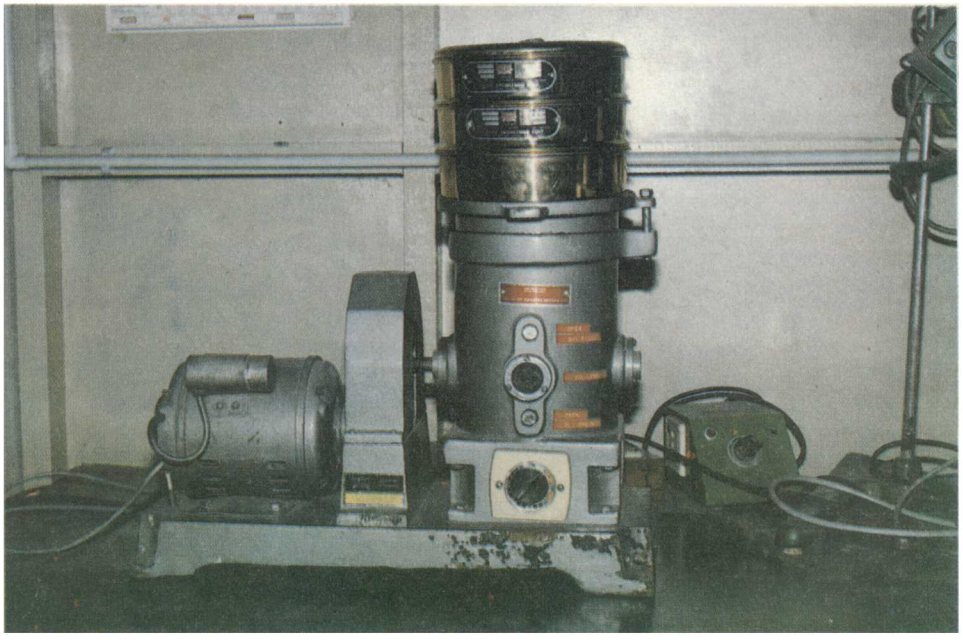
Homogenizer (Mixer)



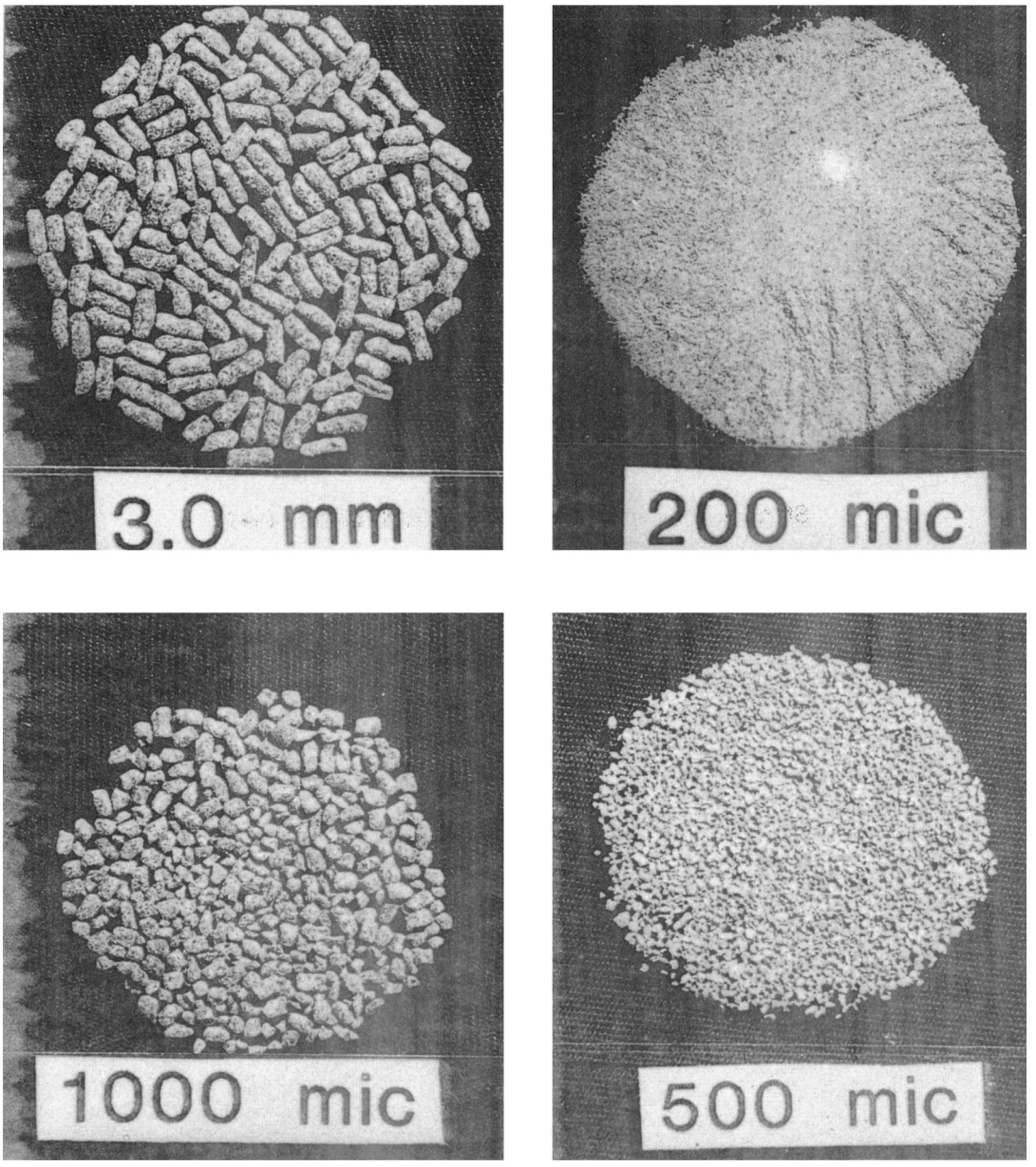
Pelletization

Drying of feed pellets

Standard sieves for preparing micro-particulate feeds



Seive shaker assembly



Stock feed and microparticulate feeds of different sizes.

moisture is less than 10%. The drying time depends upon the quantity of material loaded in each tray and drying temperature. The typical flavour of these materials and their quality are preserved to the maximum by drying them at 60-70°C. The flavour may be lost if they are subjected to higher temperature for longer time. However, these raw materials can also be sun dried on mats or cement platform under hygienic conditions. All the other ingredients are obtained generally in dry form.

4.1.2. Grinding

The dry ingredients are individually powdered in micro pulverizer or grinder and passed through a 200 micron sieve. Grinding the raw materials to uniform particle size is essential for preparing a homogeneous feed mixture and for achieving compact pellets. Grinding characteristics of materials are governed by moisture and oil present in them. Moisture should be less than 10% and oil must be below 8% for proper grinding. Very often it is possible to grind materials with higher oil content by mixing them with ingredients having low oil content.

4.2. Preparation of stock feed

4.2.1. Feed compounding

The feed is compounded by weighing powdered ingredients, vitamin and mineral mixtures according to the formula. Lecithin is added to solid ingredient mixture and thoroughly homogenised in dough mixer (homogeniser). To this, water is added at the rate of 450 ml per kg of dry feed and further mixed into a dough. At a time 10 to 25 kg feed may be mixed.

4.2.2. Steam cooking

The dough feed is taken into vessels of a pressure cooker and the cooker is heated on an electrical heater with minimum water at the bottom of the cooker. After the commencement of steam, the time is noted and steaming is continued for 10 minutes without keeping pressure weight in the nozzle. During this process, the feed is steam cooked at 98°-100°C and the starch is gelatinised imparting water stability to the feed. The feed should not be cooked at higher temperature for longer time.

4.2.3. Pelletization

The steam cooked feed is then fed into a pelletizer fitted with 3 mm diameter die. The feed quickly passes through the die and comes out as pellets in long strands. If a cutting device is attached to the pelletizer, the strands can be cut into pellets of 3 to 5 mm length. These pellets are collected in aluminium trays for drying.

4.2.4. Drying of feed pellets

The trays with moist feed pellets are transferred to an electrical dryer and the feed is dried at 60-70° C until the moisture content is reduced to less than 10%. Depending upon the material loaded and drying conditions, it takes about 3 to 4 hours for drying the feed.

The dry feed is stored in polythene bags kept in air tight containers as stock feed.

4.3. Preparation of micro-particles of feed

4.3.1. Crumbling

The pelleted feed is prepared into micro-particles of different sizes by crumbling. Small quantities of stock feed is taken and crushed in a crumbler which results in mixed size particles.

4.3.2. Sieving

The crumbled particulate mixture is first sieved through 200 micron mesh sieve using a sieve shaking machine. The fine material obtained is passed through a 50 micron sieve to remove very fine particles. The feed particles retained by this sieve are taken as 200 micron particles. The residue from 200 micron sieve is passed through 500 micron sieve and the residue from this sieve is sifted through 1000 micron sieve for obtaining the required size particulate feeds. The entire operation of sieving can be completed in one step by arranging the sieves one below the other at a time in a sieve shaker. The finer particles obtained in the process are recycled into the fresh batch of feed. The flow chart of entire feed processing is shown in Fig.1.

4.3.3. Storage

Proper storage of feed is very essential to prevent deterioration of its nutritional quality. The feed should be stored in good polythene lined containers away from insects and rodents. It is advantageous to store the stock feed and prepare particulate feed as and when required. The stock feed also may be prepared which is required for one month at a time. The moisture of the feed and humidity play an important role in storage and feed quality. Moisture content above 10% may lead to mould growth which may render the feed susceptible to aflatoxin contamination. This can be prevented by keeping moisture content of feed around 5 to 6% and storing in air tight containers. Preservatives such as sodium propionate can be used at 100 ppm to inhibit mould growth.

5. FEEDING POSTLARVAE IN HATCHERY AND NURSERY

5.1. Hatchery

In prawn hatchery, early larvae, namely, protozoea and mysis of *P.indicus* are fed with mixed culture of algae predominated by *Chaetoceros* sp. and reared up to one-day old postlarvae (PL 1). The density of stocking of larvae in hatchery is 100 nauplii per litre of water and the larval tanks are kept under translucent roof. Microparticulate feed of 200 micron size is introduced to PL 1 in hatchery tanks and the postlarvae are weaned away from live- food to particulate feed in five days as they reach PL 5. The PL 5 are transferred to nursery tanks.

5.2. Nursery

In nursery tanks kept under translucent roof or in open area, PL 5 are stocked at the rate of 10 to 20 PL per litre of water and rearing is continued until they become PL 20 or older, feeding them with particulate feed. The PL 5 are fed with a mixture of 200 and 500 micron particles (1:1 ratio) until they reach PL10 and after that they are fed with 500 micron particles upto PL15. Later a mixture of 500 and 1000 micron particles (1:1 ratio) is used until PL 20, beyond which they are

fed with 1000 micron particles. The postlarvae should be fed at least three times a day dividing the daily ration equally. The quantity of feed and schedule of feeding of different size postlarvae are summarised in Table 3.

It has been observed that when the postlarvae are fed with particulate feed, some algal cells and copepods invariably develop in rearing tanks as a result of the presence of some un- eaten particulate feed. These food organisms also act as supplements to the particulate feed for the postlarvae. Under these conditions the postlarvae are found to grow faster and healthy.

Table 3: Details of feeding rate and feeding schedule of Postlarvae in hatchery & nursery

Stage of Postlarvae	Particle size of feed (microns)	Quantity of feed to be fed to 1000 postlarvae per day	Schedule of feeding
PL 1 to PL 5	200	200 mg	Divide the total quantity of feed into three equal parts and broadcast on the surface of water in morning, afternoon and evening
PL 6 to PL 10	200 + 500 (in 1:1 ratio)	600 mg	--- do ---
PL 11 to PL 15	500	600 mg	--- do ---
PL 16 to PL 20	500 + 1000 (in 1:1 ratio)	2 to 6 g	--- do ---

The quantity of feed advocated above is only a guideline. It has to be adjusted according to consumption, water quality and other conditions in nursery tanks.

The survival of postlarvae during their culture in nursery, their size and overall quality depends upon feed and water quality management in rearing tanks. About one third of water is exchanged daily in the tanks. Aeration is provided at least for 15 minutes for every one hour. While the salinity of water in hatchery tanks is 30-32 ppt, it should be reduced to 25 $\pm$ 2 ppt in nursery tanks. Dissolved oxygen, pH and temperature are generally maintained both in hatchery and nursery tanks at 5mg/l, 8.2 $\pm$ 0.5 and 28 $\pm$ 2°C respectively.

5.3. Feeding trials on postlarvae

Feeding trials were conducted on *P.indicus* postlarvae using the feeds No.1 and No.2 in the hatchery at Narakkal Research Centre of CIBA, Narakkal, during the years 1987 to 1990.

The survival rates observed were 70-85% from PL 1 to PL 5, and 40 to 90% from PL 5 to PL 20. The average survival rate for PL 1 to PL 20 was not less than 50%.

5.4. Quality of postlarvae

The quality of PL 20 produced in hatchery is tested by subjecting them to sudden stress. Samples of twenty postlarvae are taken and subjected to sudden drop of salinity from 20 to 5 ppt and also exposed to 100 to 150 ppm formalin (37%). Strong and healthy postlarvae generally withstand these treatments without any mortality. The physical condition of PL 20 is also tested by measuring the muscle to gut ratio. The width of muscle and gut at the tail portion are measured and the muscle-gut ratio is determined. In healthy postlarvae it is generally 4:1. The postlarvae PL 20 of *P.indicus* fed on the micro-particulate diet are very active and healthy, withstand well when subjected to above stress tests and conform to the muscle-gut ratio test. The feed back information received from farmers to whom the prawn seed has been supplied also confirmed the good quality of postlarvae produced in the hatchery through their good survival in grow-out ponds.

5.5. Suitability of the feeds for postlarvae of other shrimp species

The micro-particulate feeds described above can also be used for feeding postlarvae of other penaeid prawn species as in the case of *P.indicus*.

6. COST STRUCTURE

6.1. Cost of feeds

The material cost of the feeds is computed based on the prevailing prices of feed materials, which works out to Rs. 21.00/ kg.

6.2. Requirement of feed for rearing Postlarvae in hatchery and nursery

The quantity of feed required for producing one million postlarvae PL 20 is worked out as follows:

No.of Postlarvae PL 1 to start with in hatchery		2 million
No.of Postlarvae PL 5 expected (@80% recovery from PL1 to PL 5)		1.6 million
No.of Postlarvae PL 20 expected (62.5% recovery from PL5 to PL 20)		1.0 million
Quantity of feed required from PL 1 to PL 5 (@ 200 mg/1000)		2.0 kg
Quantity of feed required from PL 6 to PL 15 (@ 600 mg/1000 at PL 6 to PL 15 and 6 g/1000 at PL 16 to PL 20)		55.68 kg
Total quantity of feed required from PL 1 to PL 20		57.68 kg
	Say	60 kg

7. MICROPARTICULATE FEED PRODUCTION FOR PRAWN HATCHERY

It is advantageous to have feed production unit in synchronisation with hatchery operations for uninterrupted production of seed. A medium-scale prawn hatchery with a target production of 20 to 40 million seed (PL 20) per annum can have a hatchery scale feed production unit. The

details of equipment, manpower, infrastructure facilities required and cost structure for establishing such feed production unit are given in Annexure 1.

8. ACKNOWLEDGEMENTS

We are grateful to Dr. K. Alagarswami, Director, Central Institute of Brackishwater Aquaculture, Madras for his encouragement for preparing this Bulletin. Sincere thanks are due to Shri K. N. Krishnamurthy, Principal Scientist, for his help in bringing out this publication. Thanks are also due to Shri M. Kathirvel, Senior Scientist, for his help in preparatien of photographs.

ANNEXURE 1

Infrastructure facilities and cost for establishing microparticulate feed production unit

A.	**Building :** Asbestos roofed building of 500 sq.ft area @ Rs 150/sq.ft			Rs.75,000
B.	**Machinery and Equipment**	Quantity		Approximate Cost(Rs.)
	1. Pulverizer (20 kg output/hr)	1		25,000
	2. Blender 25 kg (capacity per batch)	1		20,000
	3. Pelletizer (20kg capacity/hr)	1		20,000
	4. Sieve assembly (laboratory type along with standard sieves of 50, 200, 400, 500 and 1000 micron)	1		20,000
	5. Dryer (Electrical tray holding type)	1		25,000
	6. Pressure cooker (12 lt.capacity)	2		10,000
	7. Electrical heater (coil type 1000 to 1500 watts)	2		10,000
	8. Gas Stove with gas cylinder	1		5,000
	9. Aluminium trays (suitable to keep in dryer)	10		5,000
	10.Plastic bins, basins and other miscellaneous items			10,000
		Total		1,50,000
			Grand Total(A + B)	**2,25,000**

C. Manpower required

1. Technician	1	@ Rs.2000/p.m.
2. Skilled worker	1	@ Rs.1500/p.m.

(These personnel may be drawn from hatchery staff who will prepare required feed in batches every week. One third of their wages may be accounted for feed preparation activities.)

D. Cost Structure (for producing 20 million PL 20)

	(Rs.)
1. Cost of feed materials for preparing 1200 kg of particulate feed @ Rs.21/kg	25,200
2. Over head charges (10%)	2,520
3. Electricity and water charges	3,600
4. Wages (1/3 of total wages of Rs 42,000 per annum)	10,500
5. Maintenance costs	2,000
Total	**43,820**
Cost of production of feed per kg.	**36.50**

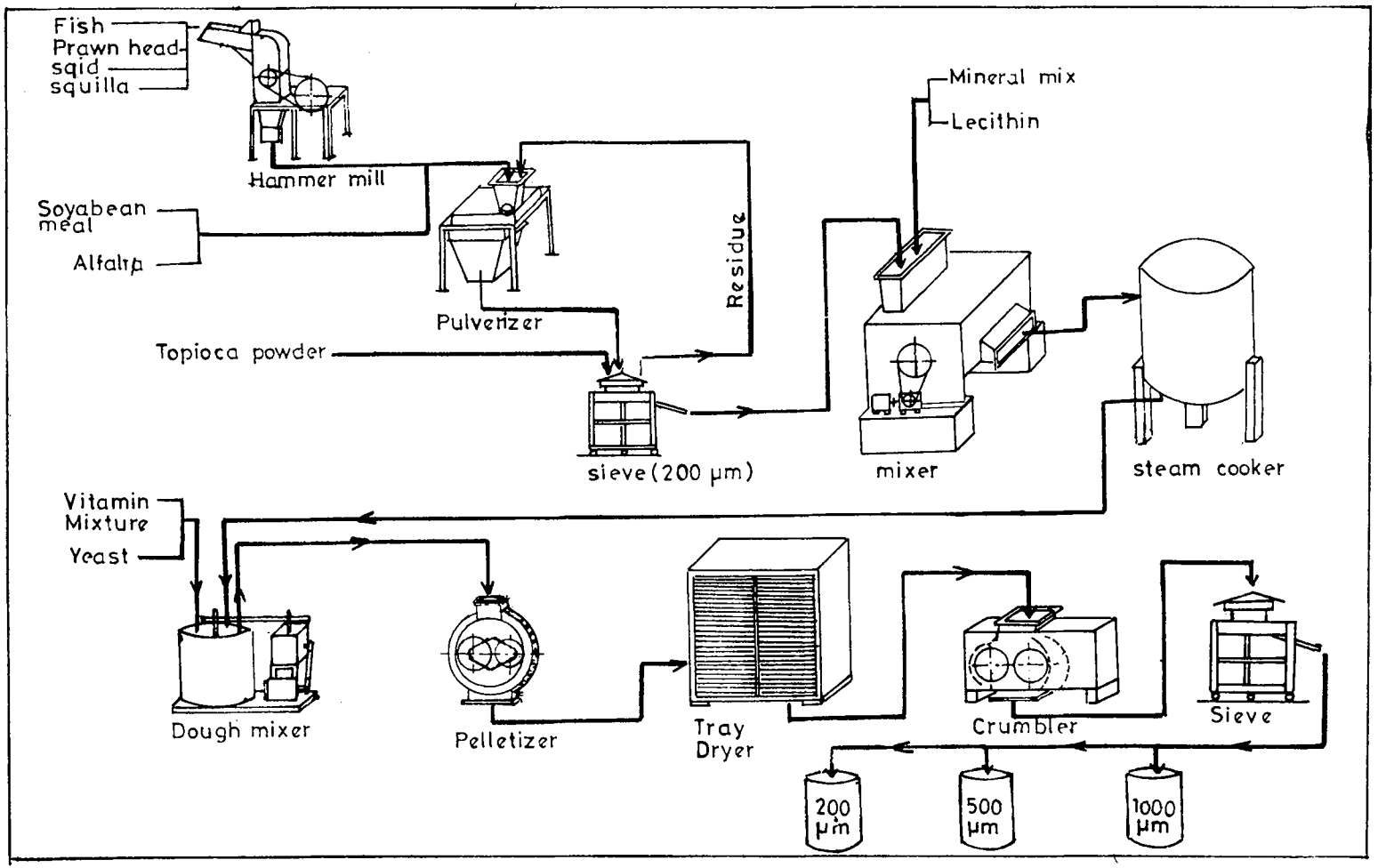


Fig. 1. Flow chart of micro-particulate feed processing and production.