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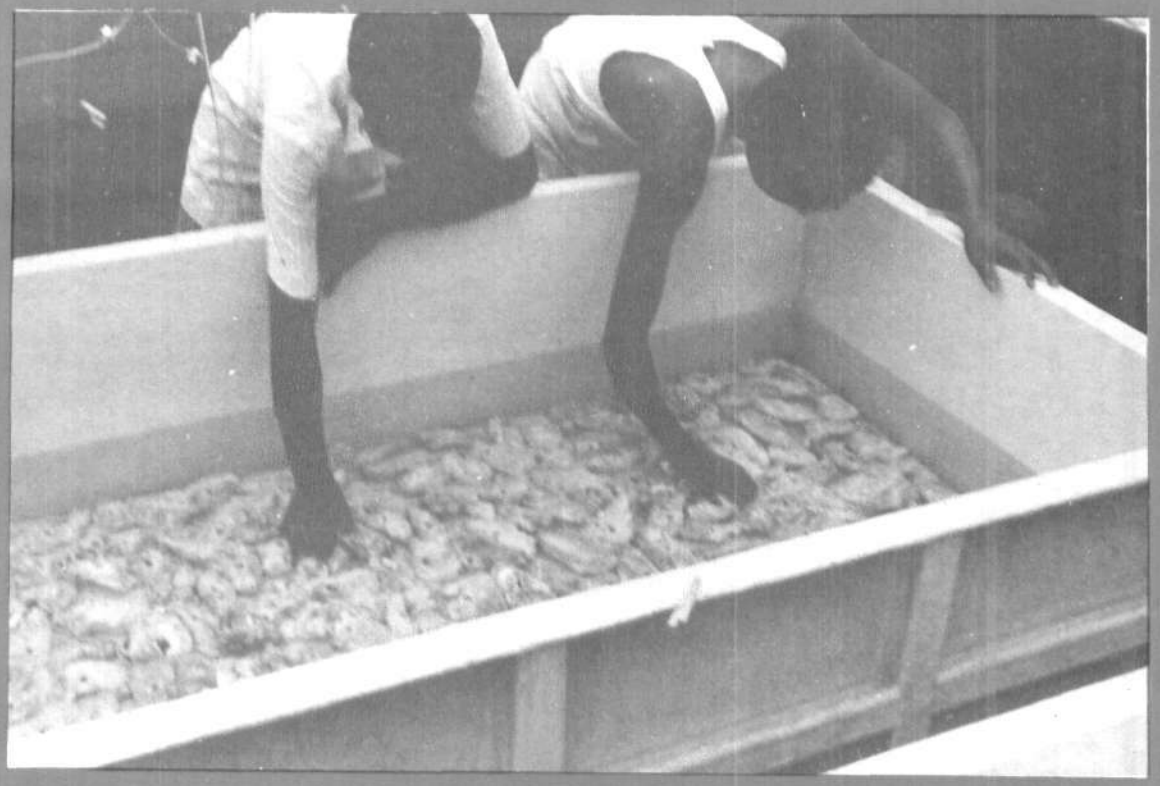

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# EDIBLE OYSTERS — PRESENT STATUS OF PRODUCT DEVELOPMENT AND DOMESTIC MARKET POTENTIAL IN INDIA

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## Introduction

The fishery for oyster is worldwide. Extensive scientific studies on this species have taken place in our country also and the fishery, though in a moderate scale, is in existence along the coasts of Maharashtra and Kerala.

It is estimated that the world production of oysters is about a million tonne per annum. U.S.A, Japan and Korea are the largest producers of oyster. U.S.A. produces about 0.3 million tonnes while Japan produces about 0.2 million tonnes. In both cases, the bulk of the production is by culture.

Oysters are highly sought after delicacy of the developed world with a great export potential. The vast potential, both for capture and culture of oysters existing in our country especially in the light of ever-increasing need for protein food, calls for greater emphasis on its harvest and post-harvest technologies. The present paper therefore is an attempt to consolidate and present the experience of the Integrated Fisheries Project with regard to post harvest handling of oyster.

*Processed oyster products — world scenario*

Most of the edible bivalves which have acclaimed popularity in developed countries are recently becoming popular in developing countries as well. A considerable quantity of oysters are processed in frozen products, canned products, canned speciality products and dried products.

The table below indicates the quantity of processed oyster products produced worldwide during the five year period from 1985-'89.

(Qty. in tonnes)

| Products | 1985 | 1986 | 1987 | 1988 | 1989 | Countries |
|---|---|---|---|---|---|---|
| Oyster meat frozen | 3259 | 3930 | 2974 | 3978 | 3190 | Canada, Korea New Zealand, USA, other nei. |
| Oyster dried | 440 | 4175 | 3934 | 2779 | 2604 | China, Korea, other nei. |
| Oyster meat | 11595 | 9265 | 9875 | 8678 | 11618 | China, Japan, Korea, New Zealand, USA |
| Oyster specially canned | 1002 | 1531 | 1704 | 1389 | 1644 | USA |

(Source : FAO)

*Global trade in oyster meat*

Qty. in tonnes
Value in US $

| | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|
| IMPORT | | | | | |
| Fresh chilled and frozen | | | | | |
| Qty : | 9756 | 9664 | 11379 | 18660 | 22680 |
| Value : | 24448 | 29357 | 37918 | 61884 | 76349 |
| EXPORT | | | | | |
| Qty : | 11125 | 14064 | 17775 | 18406 | 20040 |
| Value : | 24308 | 37829 | 56346 | 61908 | 67283 |

*Domestic scenario*

Oysters are local delicacies along our coastal belt, where they are accepted as a popular food item as the prices are reasonable. Bivalves in fresh form are not marketed in the interior regions of the country mainly due to the difficulties in transportation and storage. Canned and pickled products however, are found enjoying very good demand in the metropolis and small towns. The availability of the above resources has to be examined carefully for commercial processing and marketing.

*Occurrence*

The edible oyster is a sedentary animal found in intertidal rocky areas, muddy bays, backwaters, lagoons and creeks and extensive

areas of the east and west coasts of peninsular India which afford excellent habitat for the settlement and growth of these organisms. Naturally, there is a very large population of different varieties of oysters growing in these areas. There are essentially four important species of edible oysters which can be cultured under controlled conditions namely;

1. *Crassostrea madrasensis* - East coast oyster
2. *Crassostrea discoidea* - West coast oyster
3. *Crassostrea gryphoides* - Kutch oyster
4. *Saccostria cucullata* - Rock oyster

Of these, *Crassostrea madrasensis* is most widely distributed all along the coast of India and also along the west coast upto Karwar and can be easily farmed. Other species also can be cultured in areas where the wild stock is found in abundance.

*Composition*

Oysters are reasonably good source of protein and glycogen though the protein content is not as high as in the case of fin-fish. Following is the chemical composition of farmed oysters in comparison to fin fishes.

| Parameters | Farmed edible oyster meat (%) | Fin fish (%) |
|---|---|---|
| Moisture | 80.05 | 66-84 |
| Protein | 12.26 | 15-24 |
| Glycogen | 2.66 | — |
| Lipids | — | 0.1-22 |
| Minerals | — | 0.8-20 |
| Ash | 11.69 | — |

Oyster contains glycogen which gives its characteristic flavour. Though several workers have reported varying values for major constituents all reports unanimously show that these are good sources of protein, minerals and fat.

**Research inputs in post-harvest care**

Depuration is one key step that should precede processing of bivalves since they are filter feeders and there is bio-concentration from surrounding waters.

For purification either continuous or discontinuous system can be resorted to. In continuous system, 16-20% of sea water in the purification tanks is continuously renewed with running filtered sea water. In the discontinuous system the frequency of the water change is from two to three times a day (Fauvel and Pons 1978). Nayar and Mahadevan (1983) have designed and operated a simple method which ensures effective purification of oysters at the rate of 14,400 oysters per day. It is also advocated that a final holding of oysters in chlorinated sea water for one hour is effective in improving the bacterial quality of the meat.

*Transportation of live oysters*

Oysters will remain alive for several days if kept moist and wet. They can be packed in gunny bags which are kept moist from time to time. The method of packing should depend on the value of the product, journey time and the market for which it is sent (Stroud, 1980).

Samuel *et al.* (1987) have studied the possibility of transportation of live oysters over longer distances. About 21 kg of oysters were packed in gunny bags moistened with sea water and another 27 kg were kept in a rectangular aluminium fish box. Both were transported from Tuticorin to Cochin by road covering a distance of 340 km. The rate of mortality due to transportation and storage of live oysters outside sea water upto 24 hours at ambient temperature were found to be 0.45%, which is very negligible. Rajapandian (1987) has reported that no mortality was observed on transporting the material from Tuticorin to Madras covering a distance of 560 km.

*Transportation of frozen oyster meat*

IFP has conducted trials on frozen oyster meat transportation. The frozen oyster meat slabs were packed in master cartons and transported in an insulated truck from Tuticorin to Cochin covering a distance of 340 kilometres in about 14 hrs time. The frozen oyster meat was found to be in hard frozen condition on arrival at Cochin.

*Shucking*

Shucking is the removal of the meat from the shell of oysters either manually or by immersing the live animals in boiling water/sea water or by steam cooking for a minute until the shell of the animal gape or open.

Several methods have been devised to reduce the labour of hand shucking. These

include shearing of the hinge of beak of the oysters by guillotine and a wide range of treatments that cause the shell to gape open, including the use of chemicals, heat, cold vacuum, microwaves and lasers. Freezing of oysters before shucking is suggested by Stroud (1980) and placing the oysters in water just hot enough to open them as suggested by Nowak (1970). Yield of shucked meat is 3-4%.

*Pre-treatment*

Prior to freezing the shucked meat is given a pre-treatment. The meat is washed well and dipped in 1% salt solution containing 0.2% citric acid in 1:1 proportion for 10 minutes to reduce drip loss which is found to be in excess of 20% in the untreated oyster meat. Subsequently, the meat is frozen in slabs at —40°C.

In yet another method the shucked oyster meat is boiled in water for 1-2 minutes, cooled and packed with polythene lining and quick frozen to —30°C.

Studies on shelf life have shown frozen whole oyster to be in good condition after six months of cold storage at —30°C. The liquid within the shell acts as a glaze to protect the meat from dehydration. The meat of frozen whole oysters is suitable for preparing various dishes.

*Research update on quality control*

Many researchers have made in-depth study on the toxicological and bacteriological aspects of oysters and processed products thereof.

*Heavy metal contents*

Green discolouration of oysters has been attributed to copper and zinc pollution. Nambisan and Lakshmanan (1977, 1979, 1980 and 1983) have done extensive investigation in the heavy metal content of molluscan fish and toxicity. Lakshmanan (1988) studied the concentrations of Hg, Cu, Zn, Cd, Pb and Sn in commercially processed canned and frozen molluscan products and found that copper and zinc are comparatively in higher concentration, the overall mean being 56.88 and 178.6 ppm respectively. Toxic metals like Hg, Pb and Cd were below the permitted levels.

Indira Jasmine *et al.* (1988) have done the chemical analysis of the meat of *Crassostrea madrasensis* and found that the level of mercury was less than the accepted standard limit of 0.5 ppm in the edible meat.

*Bacteriological sanitation*

Being filter feeders the oysters harbour greater load of bacteria from the environment. The most common bacterial flora found in oysters are coliformes, *E. coli*, *Faecal streptococci* and occasionally pathogens like *Salmonella*, *Shigella*, *Vibrio parahaemolyticus* and *Vibrio cholerae*. Surendran *et al.* (1985) and Balachandran *et al.* (1984) have done extensive studies on the nature of molluscan microflora which reveal that oysters can create health hazards, if not properly processed. It has been observed that the bacterial count of cultured oysters and wild bed edible oysters ranged between $10^3$ and $10^4$ organism/ml of oysters fluid.

*Update on processing and product formulation*

Excellent possibilities in product formulation with oysters exist. In Japan both frozen and canned oyster products are in vogue. To mention a few are canned boiled oysters, canned smoked oysters in oil, canned seasoned oysters, boiled dried meat of oyster, battered and breaded frozen oyster meat.

In India, studies on the canning of edible oyster meat was carried out by Balachandran *et al.* (1984) . A variety of product has also been developed by Jayachandran (1988) of which oyster soup, oyster nectar, oyster curry and oyster sweat and sour pickle are commendable novel products.

**Work done by IFP**

Two products namely, canned smoked oyster in oil and oyster in brine from the farmed oysters have been developed and marketed by IFP. Various aspects of live transportation, frozen transportation, depuration, shucking, pre-treatment before freezing were all studied in detail.

*Depuration and shucking*

Depuration was done by laying the oysters in filtered sea water for 24 hours and relaying the oyster for one hour in sea water containing 3 ppm chlorine and finally keeping immersed in running filtered sea water for 3 hours for dechlorination.

Shucking was carried out manually after dipping the oysters in boiling water for 3 minutes.

*Pre-treatment*

The shucked oyster meat was washed well prior to freezing and dipped in 1% salt solution containing 0.2% citric acid for 10 minutes in the ratio 1:1. This is found to reduce drip loss from 20% to 16%.

*Yield of frozen meat*

| | | |
|---|---|---|
| Qty. of live oysters | : | 1721 kgs |
| No. of oysters | : | 9900 Nos |
| Boiling | : | 3 mts. at 100°C |
| Qty. of frozen meat | : | 78 kgs |
| Yield of frozen meat | : | 4. 53% |

Heavy metal contents and bacterial load were found to be within the acceptable limits as shown below :

*Analysis of the oyster meat*

| *Texicological test* | | | *Bactertological tests* | | | |
|---|---|---|---|---|---|---|
| Mercury ppm | Copper ppm | Cadmium ppm | TPC/gm | *E. Coli*/gm | *Staphylo-coccus*/gm | *Salmo-nella*/gm |
| 0.017 | 0.020 | 0.12 | 18000 | N.D | N.D | N.D |

N.D : Not detected

The procedure adopted for canning was as follows :

*Oyster in brine*

The shucked oyster is blanched in 3% brine containing 0.1% citric acid for 3-4 minutes and the blanched meat is cooled to room temperature. If frozen the meat is thawed at 0°C overnight and then blanched for 2-3 minutes. 85-90 gm of blanched meat is packed in quarter dingly cans (112 g net wt.) and a hot 2% brine with 0.1% citric acid is added to net weight. The packed cans were exhausted for 4-5 minutes, seamed and sterilized at 115°C for 22-25 minutes. The cans are cooled immediately, wiped to remove water on the can and warehoused.

*Smoked oyster in oil*

Frozen blocks of oyster meat is gradually thawed by keeping overnight in chill room at 0°C. The next morning, the oyster slabs are further thawed by immersing in water at 5°C for such duration just sufficient to thaw the slab so that meat can be separated from one another. The separated oyster meat is then immersed in 5% salt solution for 5 minutes and arranged on wire-mesh trays and smoked in a smoking chamber.

The smoking chamber has a smoke generating unit in which saw dust is burnt in an electrical hot plate. The smoke so generated is circulated inside the chamber where the oysters are arranged on trays. Thermostatic controls are provided inside the smoking chamber.

Smoking of oysters was done initially at 40°C for 30 minutes and subsequently at 70°C for 80-90 minutes. During the smoking operation, flavour of the oyster was improved due to the absorption of the volatile and other substances from the smoke, texture improved due to the partial dehydration and the colour of the oyster changed from bluish green to light brown.

The oysters thus smoked were packed in quarter dingly aluminium cans with tear off lid. Pack weight was 80 g in each can. Hot, double refined ground nut oil was used as canning medium, seamed, sterilized and warehoused.

These canned products were found highly acceptable to consumers when test marketed.

**Potential for new product development**

The R & D work done on oyster product development at IFP yielded a few promising products as described below.

*Oyster pickle*

The procedure involves frying of the depurated, shucked and washed meat in edible oil until the meat becomes light brown in colour. The fried meat is kept apart. Required quantities of ingredients like mustard, garlic, ginger, green chilly and curry leaves are fried together in refined oil for 2-3 minutes. At this stage, predetermined quantities of pepper powder, chilly powder, turmeric powder etc. are added followed by fried meat. The entire mass is boiled under stirring for a few seconds and removed from flame. When sufficiently cooled, vinegar is added, mixed and stored in glass bottles.

*Dried oyster*

The depurated, shucked and washed meat from oyster are blanched in 3-5% boiling brine

*Analytical report on the organoeptic and bacteriological soundness of the products over a period of one year*

| Product | Parameters | Period | | | | |
|---|---|---|---|---|---|---|
| | | 0 | 3 month | 6 month | 9 month | 12 month |
| Smoked oyster in oil | 1. Appearance | A | A | A | A | A |
| (Alum. cans) | 2. Colour | B+ | B+ | B+ | B+ | B |
| | 3. Flavour | A | A | B+ | B+ | B+ |
| | 4. Texture | A | A | A | A | A |
| | 5. Disintegration | Nil | — | — | — | — |
| | 6. pH | 6.2 | 6.2 | 6.1 | 6.1 | 6.1 |
| | 7. Sulphide blackening | Nil | Nil | — | — | — |
| | 8. Saltiness | Normal | Normal | Normal | Normal | Normal |
| | 9. Colour of oil | Golden yellow | golden yellow | Golden yellow | Golden yellow | Golden yellow |
| | 10. Turbidity | Nil | Nil | Nil | Nil | Nil |

*Overall score* : A vey good product.

*Microbiological examination*

| | | | |
|---|---|---|---|
| 1. Mesophilic Aerobes | Nil | 3. Thermophilic Aerobes | Nil |
| 2. Mesophilic Anaerobes | Nil | 4. Thermophilic Anaerobes | Nil |

*Analytical report of canned oyster in brine over a period of one year*

| | Oyster in brine | Period | | | | |
|---|---|---|---|---|---|---|
| | (Alum. cans) | 0 | 3 months | 6 months | 9 months | 12 months |
| 1. | Appearance | B+ | B+ | B+ | B+ | B+ |
| 2. | Colour | B+ | B+ | B+ | B+ | B+ |
| 3. | Flavour | A | A | B+ | B+ | B |
| 4. | Texture | A | A | A | A | A |
| 5. | Disintegration | Nil | Nil | Nil | Nil | Nil |
| 6. | Sulphide blackening | Nil | Nil | Nil | Nil | Nil |
| 7. | Saltiness | B+ | B+ | B+ | B | B |
| 8. | Clarity of brine | Clear | Clear | Clear | Clear | Clear |
| 9. | Turbidity | Nil | Nil | Nil | Nil | Nil |

*Overall score* : A vey good product.

*Microbiological examination*

| | | | |
|---|---|---|---|
| 1. Mesophilic Aerobes | Nil | 3. Thermophilic Aerobes | Nil |
| 2. Mesophilic Anaerobes | Nil | 4. Thermophilic Anaerobes | Nil |

| | | | |
|---|---|---|---|
| A+ | - Excellent | C+ | - Satisfactory |
| A | - Very good | C | - Average |
| B+ | - Good | D | - Below average |
| B | - Fair | | |

for 2-5 minutes depending on the size of the meat. The purpose of blanching is mainly to inactivate the enzymes, to reduce the bacterial load, and moisture content from the meat. The meat is dried in a hot air-drier. Drying is spread over 10 hrs to reduce the moisture content to the level of 10-15% in order to have sufficient shelf life. A shelf life of 6-8 months is observed for this product. Being a relatively new product, enough data on consumer preference is yet to be gathered.

*Minced meat products*

The oyster meat is sent through a meat cutter or meat mincer having a screen of 3 mm dia. to obtain coarse pieces of minced meat. Mincing may be done after blanching the meat in 2.3% salt solution for 3-4 minutes. The minced meat thus obtained may be packed in duplex cartons with polythene lining and frozen in a contact plate freezer and stored below —20°C.

This meat of oyster can be mixed with mince fish in the ratio 1:2 and new products like cutlets, kababs and fish balls can be developed.

*Battered and breaded IQF meat*

Oyster meat is useful for production of battered and breaded products. The shucked oyster meat is to be blanched mildly in boiling brine of 2-3% for 2-3 minutes. The blanched meat is dipped in a batter mix made of wheat flour, salt, sugar, spices, vegetable oil etc. as required and breaded with bread powder and frozen to —30°C and stored below —25°C.

*Canned products*

Oyster meat can be canned in curry, in masala and also with mixed vegetables. Experiments at IFP yielded good tasty products.

*Minced meat*

The shucked meat may be used for mincing directly or after mild blanching using a meat mincer. The minced meat is packed in suitable containers. The juice that runs out of the minced meat my be collected, boiled and added into the cans as liquid medium and subsequently exhausted, seamed and sterilised.

The canned minced meat may be used for making soups, cutlets, meat balls etc.

*Soups/soup stock*

During the mincing operation of oyster a considerable quantity of liquid flows out from the meat. Some quantity of this liquid is added into the containers as the medium but a good quantity of liquid may still be wasted.

This liquid may be boiled with spices, tomatoes, onions, salt etc. and canned as soup or nectar. The hot liquid is filled into the containers, seamed and sterilised.

The soup/nectar may be used as a soup stock for preparing soup or as a flavouring agent for other preparations.

*Oyster chowder*

The shucked oyster meat is thoroughly washed and then chopped in a grinder or meat cutter. Diced potatoes and bacon are added. Other ingredients like tomatoes, onions, white pepper and salt are also added in stages. Then the ground oyster meat together with all the ingredients is boiled for 10 minutes and filled into the containers under stirring. The containers are then exhausted, seamed and sterilised.

*Oyster extracts*

When oysters are shucked by steaming and also where the oyster meat is blanched, considerable amount of liquid/juice is released from the meat. The liquid is collected, filtered and concentrated by boiling. The concentrated extract is filled into the containers, exhausted, seamed and sterilised. Oyster extract can be used as a food for convalescents and invalids.

**Domestic marketing of oyster products**

Edible oysters are usually marketed as live oysters with shell, shucked oyster meat, frozen oyster meat and canned oyster meat.

*Marketing of live oysters*

Eating oysters in live condition is a fancy in alien countries. With number of tourists visiting India increasing every year marketing of live oysters will be highly profitable and would fetch comparatively higher prices. The purchasers of live oysters will be mainly star hotels in metropolitan cities.

In the experiments conducted on transportation of live edible oysters packed in gunny bags

moistened in the seawater, it was found that oysters remained alive outside sea for upto 30 hours at ambient temperature. The oysters on reaching the destination can be relaid in seawater and utilised for marketing in live condition. Hence, it is thought that marketing of live oysters has a good scope when done on a commercial basis, with proper technical backing.

*Marketing of canned oyster meat*

Marketing of canned oysters was a great success despite the novelty of the product. The canned oyster meat in brine and smoked oyster in oil were released for sale in many cities and towns in India along with other canned products of the Project. Both the products met with appreciable offtake and the same often ran into short supply due to limited raw material availability.

**Marketing strategy adopted**

*Pricing policy*

The selling price for canned oyster products was fixed on no-loss no-profit basis taking into consideration the cost of inputs only with intention of popularising the non-conventional types of fishery products in the domestic market.

1) *Cost of production of canned smoked oyster in oil*

| | | |
|---|---|---|
| 1. Name of product | : | Smoked oyster in oil (200 gm) No. 6 |
| 2. Raw material | | |
| i) Oyster meat 200 kg @ Rs. 30/kg | : | Rs. 6000.00 |
| ii) Refined oil 27 kg x 60 | : | 1620.00 |
| iii) HSD oil 470 l x 7/- | | 3290.00 |
| iv) cost of cans No. 6, 540 x 9/- | | 4860.00 |
| v) Labels 534 x 0.75 | | 400.50 |
| vi) Teepol, cotton waste etc. | | 30.00 |
| | | : Rs. 16,200.50 |
| 3. Handling charges - Rs. 230/t (included in the raw material) | | |
| 4. Labour charges | | Rs. 574.20 |
| 5. Canning overheads @ Rs. 4.76/kg for 200 kg | | 952.00 |
| 6. Marketing overhead @ Rs. 2/kg for 534x0.2 kg | | 213.60 |
| | | Rs. 17,940.30 |
| 7. Product obtained :534 cans (No.6) of smoked oyster in oil | | |
| 8. Price per can of smoked oyster in oil : | | |
| = Rs. $\frac{17940}{534}$ | | = Rs. 33.59 |
| Rounded to Rs. 33.60 | | |

2. *Cost of production of canned oyster in brine*

| | | |
|---|---|---|
| 1. Name of product | : | Oyster in brine No. 6 |
| 2. Raw materials : | | |
| i) Oyster meat 100 kg @ Rs. 30/kg. | | Rs. 3000.00 |
| ii) HSD oil 230 lit. x 7/- | | 1610.00 |
| iii) Cost of cans 380 x 9/- | | 3420.00 |
| iv) Labels 380 Nos. x 0.75 | | 285.00 |
| v) Teepol, cotton waste etc. | | 20.00 |
| vi) Powder salt 2 kg x 2/- | | 4.00 |
| | | Rs. 8339.00 |
| 3. Handling charges (included in the cost of raw material) | | |
| 4. Labour | | 287.10 |
| 5. Canning overheads @ 4.76/kg | | 476.00 |
| 6. Marketing overheads @ Rs. 2/kg | | 152.00 |
| | | Rs. 9254.10 |
| 7. Product obtained : 380 cans (No. 6) of oyster in brine | | |
| 8. Price per can of oyster in brine : | | |
| Rs. $\frac{9254.10}{380}$ | | = Rs. 24.35 |
| Rounded to Rs. 24.40 | | |

*Marketing through fisheries corporations/ departmental stores*

The IFP is marketing its fish and fishery products by direct sales to consumers and also through State Fisheries Development Corporation, departmental stores, super bazars etc. on a preferential basis in order to make available the products at reasonable prices.

Efforts are also made to supply the products through private retail outlets in order to ensure wider availability of products throughout the country.

*Seafood special drive*

The IFP has been organising 'seafood special drives' in various cities and towns, as a part of product popularisation on non-conventional varieties of fish and fishery products in the domestic markets in India. During the special drive period, advertisements were inserted in dailies having wide circulation in the region both in vernacular and in English, giving details of the rage of products, stores/shops where they are sold, nutritional qualities of the product, advantages of using canned food etc. This type of publicity had very good effort as could be judged from the following days' clientele. Catching posters were prepared and displayed in the shops and stalls and consumers were also provided with recipe leaflets.

Thanks to the efforts taken by IFP, the canned oyster products, other canned fish and dried fish products are being very well accepted in places like Delhi, Bombay, Calcutta, Madras, Bhopal, Patna, Ranchi, Dehradun, Mussourie, Chandigarh, Manipur, Nagaland, Poona, Bangalore, Mysore, Mangalore, Ooty etc. It is proposed to further intensify the projects' efforts in this direction.

## Conclusions and recommendations

From the foregoing, it can be seen that processed oyster products enjoy a good domestic demand and also have great export potential. The infrastructure available for large scale ventures in oyster culture could be effectively exploited only when the marketability of the processed oyster products are adequately demonstrated. It is essential that the R & D efforts already made in the areas of processing and marketing of oysters by CIFT, IFP and other agencies are synthesized into economically and technically perfect process flows. A pilot scale product development and marketing campaign could then be taken up by IFP consuming a substantial portion of the wild oyster landed and those being cultured at present by CMFRI. The results of such a sustained work after an year would be made available to potential entrepreneurs with all data on the component activities so as to enthuse them into taking up the vocation of oyster culture.

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