STUDIES ON CANNING OF OYSTER

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C E R T I F I C A T E

This is to certify that this thesis is an authentic record of the work carried out by Shri.N.John Chellappan, under my supervision and guidence and that no part thereof has been submitted for any other degrees.

Cochin-16,

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DECLARATION

I hereby declare that the findings provided in the thesis were not previously formed the basis of the award of any degree, diploma, associateship, fellowship or other similar title of recognition in any university or institution.

Cochin-16,

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1. INTRODUCTION

Oysters, the bivalve molluscs, have a long history in the culture and civilization of human race. According to Borgstrom (1962) the shell fishes including oysters were used as food from time immemorial. History shows that around 2000 B.C. Japanese started oyster farming in their waters (Milne 1979). Aristotle clearly mentioned about the importance of oysters in the life of Greeks and Pliny narrated the details of oyster farming in Rome (Milne 1979).

Countries like United States of America, United Kingdom, Union of Soviet Socialist Republics and Japan are the pioneers in developing modern techniques of farming and utilization of oysters. At present Japan is the leading nation in the culture and utilization of fishes and shell fishes and they have introduced various methods of culture such as Rack culture, Raft culture, Ring culture etc.

Hansen and Aagaard (1969) indicated that Crassostrea virginica and C.gigas are the main species utilized in United States of America. The importance of Ostrea edulis in the culture field of United Kingdom

and Norway are discussed by Milne (1979). According to Tanikawa (1971) and Motohiro (1974) Japan extensively culture and consume the species of O.leperousei, O.rivularis, C.gigas and C.denselamellosa. In Canada the wild oysters are caught by esculators. Macphail (1961) and Medcof (1961) describes the different types of fishing methods adopted by them like hand picking, racking, toughing and dredging.

The oyster farming in India is in the developing stage and very little work has been carried out on the culture, processing and utilization. The oyster culture is carried out in an organized way at the Central Marine Fisheries Research Institute unit of Tuticorin, South India (Fig.1).

Various authors have dealt with the systematics, biology, distribution and abundance of oysters of our coasts. Awati & Rao (1931) has described more than 11 species of edible oysters from the Indian coasts while Rao (1974) discussed on four commercially important species of oysters, Viz. Crassostrea madrasensis (Preston), C.cucullata (Born), C.gryphoides (Schlotheim) and C.discoidea (Gould). Rao (1974), Rajapandian & Rajan (1987), Narashimham (1987), Rao

et al (1987), Sarvesan et al (1987), Sundaram (1987) and Mahadevan (1987) are mainly dealt with the biology and distribution of various species of oysters. Among the many species of oysters only C.madrasensis enjoy the widest distribution along the east and west coasts of India.

The nutritive values of the raw oyster meat and their processing methods in United States of America have narrated by Galtsoff (1960), Nowak (1970), Anon (1971). Stroud (1980) and Connell (1980) have discussed on the processing methodology of oysters in United Kingdom and Tanikawa & Doha (1965) and Tanikawa (1971) on the processing and canning methods of shell fishes in Japan. Some notable works are available on the nutritive and mineral values of the raw oyster meat in India, Venkataraman & Chari (1951) have studied on the nutritive components like moisture, protein, fat, ash, glycogen and minerals like phosphorus, calcium, iron and copper of C.madrasensis, Suryanarayanan & Alexander (1972) have studied on the nutrients and minerals of O.cucullata like moisture, protein, fat, glycogen, ash, phosphorus and iron. The Integrated Fisheries Project has described the processing methodology

adopted for C.madrasensis (Anon 1982). Balachandran et al (1984) dealt with the proximate composition of the raw oyster meat like moisture, protein, glycogen, ash, and alpha-amino nitrogen with yield at various stages of processing and described the canning methodology for C.madrasensis.

Shell fishes are always loaded with huge amount of bacteria and it is very necessary to reduce the quantity of the same as well as to defecate the alimentary system before processing (Anon 1974, Balachandran & Surendran 1984). Usually the oysters are depurated in unpolluted, filtered sea water for a specific period for defecation (Galtsoff 1960, Medcof 1961). The disinfecting agents like Chlorine water, ozone, utraviolet, infrared rays etc. are applied for reducing the bacterial count (Gillies 1975). The depurated oysters are shucked after the heat treatment (Nowak 1970, Rajapandian & Muthiah 1987). The shucked meat is washed in chilled water to remove shell pieces, and also to reduce the drip loss (Tarr 1962, Hansen & Aagaard 1969, James & Olley 1974, Ciobanu 1976). The meat is then usually dipped in a solution containing 2% brine and 0.2%

citric acid for about 10 minutes to minimise the thaw loss as well as to increase the shelf-life (Baumgartner & Hersom 1956, Tarr 1960, Frazier 1967, Dyer 1969, Okada 1969, Gould & Peters 1971). The meat is then drained and packed in suitable packs (Ciobanu 1976) and quick frozen to avoid the drip loss (Connell 1980). Before canning the frozen meat has to be thawed. Methods adopted for the thawing of the products, the loss while thawing and the composition of the thaw-drip were discussed by various authors (Anon 1965, Merritt 1969, Kelly 1969 and Ciobanu 1976).

The shucked fresh meat as well as the thawed (frozen) meat are utilized for canning. They are blanched before canning in order to reduce the moisture content, to keep up the appearance of the product, to minimize the loss of nutritive value and to reduce the chemical changes during the heat process and storage (Causeret 1962, Venugopalan et al 1970, Lawrie 1974, Ward et al 1983, Lopez et al 1983 and Gall et al 1983).

Brining is necessary for smoked products in order to give firmness, good appearance and salty

taste to the product. The changes during brining and smoking are studied by many authors like Voskresensky (1965), Dyer (1969) and Kandoran et al (1971).

The blanched fresh and the frozen meat as well as the smoked meat are then packed in suitable type of cans in different media. The merits and demerits of both the Tin and Aluminium cans are discussed by authors like Baumgartner & Hersom (1956) and Kozlova (1983). The procedure for packing of meat and using of different mediums like brine, refined oil, Tomato sauce, wine etc. are discussed by many authors like Hollett (1947), Tanikawa & Doha (1965), Nowak (1970), Anon (1971), Nair et al (1977), Connell (1980), Balachandran et al (1984) and Raghunath & Solanki (1986). The cans are then exhausted and seamed in order to reduce the volume of oxygen by creating sufficient vacuum which will in turn increase the shelf-life of the product. The cans are then washed to remove the adhering oil on the surface and send for heat processing in order to reduce the amount of bacteria and the vegetative phase and spores of pathogens in the meat. The duration and temperature of the heat process is mainly depend on the type of product, size of can etc. (Frazier 1967, Tanikawa 1971).

Integrated Fisheries Project has started processing of oysters during 1982 and the raw materials, C.madrasensis, obtained from the sub-station of the Central Marine Fisheries Research Institute unit at Tuticorin. Every effort has been made to standardise the methods from harvesting of materials to the preparation of finished products. The main products developed are the frozen meat, smoked meat and canned meat in different media.

The available literature clearly indicates that very little work has been carried out on the biochemical aspects of the raw materials during different stages of processing and on the canned products of oysters. In view of the paucity of sufficient information especially on the nutritive and mineral composition of the oyster meat, a programme was made to carry a detail study on the following line.

Biochemical analysis and estimation of total protein and moisture of the meat drip/liquid collected during different stages of processing.

Biochemical analysis and estimation of general components like K. calorie value, moisture, ash and insoluble ash, nutritional components like protein,

alpha-amino nitrogen, lipid glycogen and mineral components like sodium, potassium, calcium, phosphorus and iron for the meat samples of different stages of processing such as fresh meat, blanched fresh meat, frozen meat, blanched frozen meat and canned meat in different media and of different period.

2. MATERIAL AND METHOD

As stated earlier the oyster of the species C.madrasensis were obtained from the sub-station of Central Marine Fisheries Research Institute at Tuticorin during September 1984 and April 1985 (Fig.1).

The collected samples were washed for clay, mud and other fouling organisms and depurated in the depuration tank as described by Nayar et al (1983) (Fig.2 & 3). After seggregating the dead specimans, the depurated oysters were weighed and dipped in boiling water for about 3 to 4 minutes. Then they were spreaded over an Aluminium table for shucking (Fig. 4, 5 & 6).

Eventhough various methods of shucking were available, the one which was discussed by Rajapandian & Muthiah (1987) was followed here. The shucked meat was collected in bowls containing crushed ice (Fig.7 & 8). The meat thus collected was washed in chilled tap water and the shucking knife was usually cleaned in potable water. The meat was inspected organoleptically for texture, colour, odour etc.

The meat drip collected during shucking was also kept aside for further study. The fresh meat thus obtained was taken for canning immediately after blanching. But in some cases the washed meat further processed and kept in frozen storage.

The washed meat which was to be kept in frozen storage was dipped in a solution containing 2% common salt and 0.2% citric acid I.P. in the ratio of 1:1 for about 10 minutes. Then drained over a perforated stainless steel table for about 3 to 4 minutes and made them in to 2 kg packs in polyethene bags or in wax coated cartons after keeping a polyethene lining. The packed meat was immediately transferred to the horizontal contact plate freezer and frozen at - 30.0°C. The frozen blocks of meat were then packed in master cartons and stored in the cold storage at - 20.0°C (Fig. 9 to 15).

In the present study the thawing was carried out before canning in the following way, the frozen blocks were kept over night in the chill room at a temperature of about 2.0 to 5.0°C (Baines et al 1969) and placed in the circulating tap water during the following day after wrapping in two layers of polyethene

paper (Anon 1965, Merritt 1969). The process continued till the meat separated from each other. Then the meat was weighed and the texture, colour, taste etc. were recorded. The drip collected during thawing was kept for further study.

The fresh and the thawed meat usually blanched in a boiling solution containing 3% iodised common salt and 0.2% citric acid I.P. for 3 to 4 minutes before canning (Varma et al 1969, Anon 1982). Then the meat was drained, cooled to room temperature, weighed and packed in suitable cans for canning. The colour, texture, appearance, taste and weight of the meat and the blanched liquid collected during blanching were preserved for further study.

For preparing the smoked oyster for canning, the thawed meat was soaked in 5% brine solution for about 5 minutes (solanki et al 1970, Anon 1982) in the ratio of 1:1 meat and brine. After draining and weighing, the brined meat was spreaded over the nylon wire mesh trays and placed inside the smoking chamber at a temperature of 42.0 to 45.0°C for cold smoking for about 30 minutes and for about 70 to 75 minutes at 72.0 to 75.0°C for

hot smoking in a dense smoke. The procedure continued till the meat becomes golden brown in colour, then cooled and the weight was recorded. The smoking unit used in the study was the type made by 'Varma Industri Kben haun, Norway (Fig. 16 to 18).

The packing were made in two types of cans, the Tin cans as well as the Aluminium cans. The tin cans were used to pack only the fresh blanched meat while the frozen blanched meat and the smoked meat were packed in the Aluminium cans. To retain a better appearance for the product, the meat was packed in longitudinal rows with uniform weight in each can (Fig.19 & 20). Different medium was added to the meat like brine (contains 3% salt with 0.2% citric acid), refined oil, tomato sauce, wine etc. (Varma et al 1969, Nowak 1970, Nair et al 1977, Balachandran et al 1984).

The product in Tin cans were exhausted for about 10 to 15 minutes in boiling water and sealed manually while the Aluminium cans were seamed without exhausting with an automatic machine of the make the 'Trio automat' type double seamer, stavanger-Norway' (Fig.21 & 22).

In all the cases the lids were marked with manufacturing details like date, batch number, type of product etc., before seaming. Then all the cans were washed and taken for heat processing. The heat processing was done in a vertical type of autoclave for Tin cans while an horizontal type manufactured by 'GENDA - Sestri (Italia)' for Aluminium cans (Fig.23). The processing was done at about 115.0°C temperature for about 25 to 30 minutes. The cans were then cooled, wiped for adhering water, oil, rust and dust particles labelled and stored at room temperature and tested periodically (Fig.24 & 25). Both physical and chemical analysis were made for each canned product.

2.1 Physical analysis:

The procedure adopted for the physical analysis for the materials canned in Tin and in Aluminium cans were the same. The cans were first observed for rusting, bulging, leaking etc. and sampling were made from each lot for further cut open analysis. The cans were opened after weighing and recorded the volume of the liquid and the weight of the meat. The meat was observed for its appearance, colour, texture and flavour. The inner

surface of the cans were also checked for corrosion, colour change etc. The meat, after wiping out the media with blotting paper, was used for chemical analysis.

2.2 Chemical analysis:

Chemical analysis were done for the meat drip/ liquid as well as for the meat collected during different stages of processing and also after canning.

The liquid dripped out was collected for the study of chemical composition like moisture content and total protein, during different stages of processing, the drip collected during shucking - "nectar", the liquid used to soak the meat in order to minimise the dripping loss before freezing - "dipping solution", the liquid collected during thawing- "thawed drip", the liquid obtained during blanching-"blanched liquid", and the liquid collected in the cans along with different media during different storage period- "can liquid". The methods adopted were, as described by the Association of Official Analytical Chemists (1975).

The fresh meat immediately after shucking has directly blanched in acid and canned in oil and in

brine. The meat were analysed in fresh condition as well as after blanching in acid and after storage for 3 and 9 months in brine and in oil.

The frozen meat after one month in frozen storage was blanched in acid after thawing and were analysed. The blanched meat were packed in brine and in oil medium and were analysed after 3 months, 9 months and 24 months of storage. The thawed meat of the above was brined, smoked and then canned in oil, in tomato sauce and in wine medium. The oil packed meat were analysed after one month, 8 months, 26 months and 41 months of storage. The meat packed in tomato sauce and in wine medium were tested only after 41 months.

The meat samples taken from different stages of processing after physical observations, were homogenized and used for the analysis of k.calorie value, moisture and ash contents, nutrients like protein, alpha-amino nitrogen, lipids, glycogen and minerals like sodium, potassium, calcium, phosphorus and iron.

The k.calorie value per 100 gm was determined from the values of the gm/100 gm of the protein, lipid

and glycogen. These values were multiplied with the conversion factors of the same, 4,9 and 4, as suggested by Burton (1980) and Kleimannov (1982).

The moisture content was estimated as described by Joslyn (1970) and AOAC (1975). The homogenized samples were weighed using an electric balance model 'Sarcorious 2004 MP'.

$$\text{Moisture content} = \frac{\text{weight of meat (gm) - weight of dried meat(gm) x 100}}{\text{weight of meat (gm)}}$$

$$= \text{.....gm/100 gm.}$$

The dried matter was calculated by substracting the total moisture content from the total material.

$$\text{Dry matter} = \text{100 gm of homogenate - Moisture content}$$

$$= \text{.....gm/100 gm.}$$

The ash content was estimated as detailed by Joslyn (1970) and AOAC (1975) and calculated as

$$\text{Ash content} = \frac{\text{weight of ash (gm)}}{\text{weight of wet sample (gm)}} \times 100$$

$$= \text{.....gm/100 gm.}$$

The insoluble ash was estimated, as described in AOAC (1975), by dissolving the ash in 1:2 conc HCl and water and filtered through ashless watman No. 40 Filter paper and made up to 100 ml. The crusible with the filter paper was ashed to get the insoluble ash.

$$\text{Insoluble ash} = \frac{\text{weight of acid treated ash}}{\text{weight of sample}} \times 100$$

$$= \text{.....gm/100 gm.}$$

The total protein content of the meat was estimated as detailed by Joslyn (1970) and AOAC (1975). The homogenate was digested and steam distilled.

$$\text{Total Protein content} = \% \text{ of protein} \times 6.25$$

$$= \text{.....gm/100 gm.}$$

$$\% \text{ of protein} = \frac{\text{Vol.N } H_2SO_4 \times 0.28 \times \text{Vol. made up} \times 100}{\text{weight of sample (gm)} \times \text{vol.distilled} \times 1000}$$

Where N = Normality of H_2SO_4

0.28 = Nitrogen content of the sample.

(1 ml. of N/50 H_2SO_4 = 0.28 mg of N_2).

1000 = Calculated/litre

6.25 = Nitrogen factor for fish and meat (100/16)

The alpha-amino nitrogen content of the sample was estimated as described by Pope & Stevens (1939). Here known quantity of the homogenate was mixed in 10% Trichloroacetic acid solution and filtered. The extract was used to prepare phosphate suspension and the filtered sample was used to titrate against 0.1 N thiosulphate solution.

Alpha-amino nitrogen content

$$= \frac{\text{vol. of thiosulphate x 0.28 x vol. made up x vol. made up}}{\text{weight of sample x vol.pipetted x vol.pipetted for titration}}$$

= .....mgm x 100 = ...mgm/100 gm.

where 0.28 mgm of alpha-amino nitrogen = 1 ml of 0.1 N Thiosulphate.

The lipid content was estimated according to Joslyn (1970) and AOAC (1975) using Soxhlet apparatus and petroleum ether of 60.0 to 80.0°C.

Lipid content on moisture basis.

= % of lipid x dried matter

= .....gm/100 gm.

$$\% \text{ of lipid content} = \frac{\text{weight of lipid (gm)}}{\text{weight of dried sample (gm)}} \times 100 \text{ gm}$$

The glycogen was estimated after Anon (1983). The homogenized sample was digested using 30% KOH and the green colour developed by Anthronsulphate reagent was measured using a spectrophotometer model Hitachi 556-0008. at 620 nm.

$$\text{Glycogen content} = \frac{\text{O.D. x 100 x 2 x 1}}{\text{K x weight of sample (gm) x 0.1 x 0.2}} \times 9$$

$$= \text{.....gm/100 gm.}$$

$$\text{Constant (K)} = \frac{\text{Optical density (O.D)}}{\text{Concentration (C)}}$$

Where 2, 1 = the dilution

9 = glycogen factor.

0.2, 0.1 = the aliquot used.

The glycogen content of the can liquid was determined by the colour reaction as discussed by Oser (1976), Garard (1976), and Lee (1983). In this experiment 0.5 ml of the opalescent liquid (with brine or with oil) was added to 1 ml saturated lodine solution, in the case of smoked oyster 1 ml of liquid was diluted to 5 ml and 1 ml of the dilution was then added to 2 ml of saturated lodine solution and observed the colour developed (red, brown, blue or purple).

The sodium, potassium and calcium contents were estimated as described by Oser (1976) and Anon (1983). The diluted aliquot were charged in the flame photometer of the model "systronic" and the readings were plotted against the concentration and the quantity of the minerals were calculated as

$$\text{Mineral} = \frac{\text{PPM x vol. of Ash solution x 100 dil.}}{\text{weight of the sample x 1000}}$$

$$= \text{.....mgm/100 gm wet weight.}$$

The phosphorus was estimated according to Anon (1983). The TCA extract prepared for alpha-amino nitrogen was used and the colour developed by 1,2,4 aminonaphtholsulphonic acid was measured at 660 nm in spectronic clinical analyser, 2100 Banch and Lamb and calculated as

$$\text{Inorganic phosphorus} = \frac{\text{O.D. of sample x 100 x vol.made up}}{\text{K x weight of wet sample x vol.used}}$$

$$= \text{.....mgm/100 gm wet weight.}$$

$$\text{Constant (K)} = \frac{\text{Optical density (O.D.)}}{\text{Concentration(C)}}$$

The iron content was estimated from the ash solution Anon (1983). The colour developed after adding potassium thiocyanate was measured immediately at 540 nm using the instrument of the previous experiment. The iron content was calculated as

$$\text{Iron content} = \frac{\text{OD of sample x 100 x vol.made up}}{\text{K. x weight of the sample x 6.5}}$$

$$= \text{.....mgm/100 gm wet weight}$$

$$\text{Constant (K)} = \frac{\text{Optical density (O.D.)}}{\text{Concentration (C)}}$$

Where 6.5 ml is the volume of sample used.

3. OBSERVATIONS AND RESULTS

In the harvested oysters the rectum were greenish in colour. But after depuration the rectum became colourless in some cases and white in some other cases. After the depuration process the faeces were seen collected on the floor of the depuration tank.

The shucking of fresh oyster was a labourious and difficult process. To overcome this difficulty the oysters were shucked after heat treatment. The fresh shucked oyster meat were creamy white in colour, tender, fatty, having seaweedy smell and covered with mucous. But after heat dipping the meat became creamy in colour, firm, devoid of mucous with slight shrinkage, seaweedy flavour and bleeded like the fresh meat.

As stated earlier the meat drip as well as the meat samples collected during different stages of processing were analysed for their physical changes as well as for the changes in their chemical constituents.

3.1 Physical Analysis.

The physical analysis were mainly related to the colour, odour, characteristic nature etc. of the

drip/liquid and the colour, texture, firmness, yield of meat etc. of the samples of different stages.

The physical observations on the drip/liquid collected during various stages of sampling were as follows:-

The 'Nectar' was opalescent with sea weedy odour.

The "dipping solution" changed to opalescent and became turbid with a sour taste when the meat dipped in it. The colour of this liquid changed to pale blue when it was kept in room temperature for about 20 to 30 minutes.

The 'thawed-drip' was opalescent, slightly sticky with slight acidic smell and taste.

The 'blanched liquid' was opalescent, saltish with slight bitter smell.

The 'can liquid' collected from the products packed in brine was opalescent. The opalescency increased as the storage period increased. A slight turbidity observed from 9th month of storage. The colour of the liquid changed to pale yellow at room temperature. The sulphur odour was more for the liquid collected from the

Tin cans than from the Aluminium cans. It gave a pink colour with iodine solution but the colour density was increased as the storage period increased.

The 'can liquid' collected from the canned products in oil was also opalescent. The colour of the oil was slight yellowish after 3 months, light yellowish after 9 months and cream yellowish after 24 months of storage. The pink colour developed with iodine solution was denser than that for the liquid obtained from the cans contained brine.

The quantity of 'can liquid' obtained from the canned smoked oyster in oil was very little. It was brownish in colour. It gave a purple pink colour with iodine solution. The colour of the oil media changed to yellowish after 1 month, slight cream yellowish after 8 months, cream yellowish after 26 months and greenish cream after 41 months of storage.

Observations on the yield of meat showed that the average yield of meat from the depurated oysters was between 4.7% and 5.8%.

The meat became whitish when it dipped in acid and had developed good appearance. The weight loss of the meat was between 0.9% and 1.1% during acid treatment.

The acid dipped meat after freezing showed an average weight loss of 3.6%. The meat while thawing developed greenish white colour with good appearance. The taste did not differ much from the fresh state except for slight acidity.

The blanching in acid solution made the meat firm, tasty and developed good appearance. The meat was half-cooked, with greenish colour and with fatty flavour. The average yield of the blanched meat was about half of the original weight.

The frozen meat while brining for smoked product became firm, tender with glossy appearance. The meat weight showed an increase of about 1.8%.

During cold smoking the golden brown colour formation for the above brined meat was less but to avoid any detrimental effect to the products, as indicated by Gerasimov & Antonova (1979) 30 minutes cold smoking was provided. The ripe oysters usually developed colour

very easily with glossy appearance and smoke flavour. The weight loss after smoking for the material was about 42.3%.

The fresh meat in oil and in brine media after 3 months and 9 months of storage was appeared to be soft with firm texture. The colour of the liver side changed from brown to dark brown while the other side was pale. The meat became brittle and the seaweedy odour was replaced by the sulphur odour and it was more as the storage period increased. The oil packed meat was greenish in colour with an oil based seaweedy odour. The weight loss of the meat in brine pack was about 8.7% and 12.9% after 3 months and 9 months of storage respectively. The oil packed material showed an average weight loss of about 11.6% after 3 months of storage (Table I).

The brine packed blanched frozen meat after 3 months, 9 months and 24 months of storage was soft with firm texture and with good appearance. The seaweedy odour retained even after 3 months of storage. The meat was not sticking to each other in all the

3 stages of samples. The brown colour of the liver side was turned to dark brown. The weight loss after the respective storage period were 6.7%, 8.3% and 11.1% (Table II).

The oil packed blanched frozen meat after 3 months, 9 months and 24 months of storage period gave the following results. The meat was with good appearance, greenish in colour, oil flavoured and was not sticking to one another. The firmness of the meat decreased as the storage period increased and was tastier than the meat canned in brine. The weight loss of the meat after respective storage period were 17.0%, 19.0% and 21.5% (Table II).

The smoked oyster meat canned in oil had good appearance and was not sticking to one another. The golden brown colour changed to brown and become brittle as the storage period increased. The taste, firmness and colour were good up to 26 months and decreased thereafter. The smoke flavour was also changed. The weight loss for the meat was appeared as 4.1%, 4.7%, 7.4% and 10.4% after one month, 8 months, 26 months and 41 months of storage period respectively (Table III).

The pink colour of the tomato sauce was changed to brown and the meat became soft with smoke flavour. The weight loss of the meat was about 2.1% after 41 months of storage (Table III).

The meat packed in wine was good in appearance with faded colour and with a mixed flavour of wine and smoke. There was no softness and the meat was easily crumbled to pressure with a weight loss of about 23.5% after 41 months of storage (Table III).

3.2 Chemical Analysis.

3.2.1 Chemical Observations on drip/liquid samples.

The meat drip/liquid collected during different stages of processing as stated earlier was utilized for the study of their moisture content and total protein.

The "Nectar" had an average value of 94.966 gm/ 100 gm moisture and 1.286 gm/100 gm protein (Table IV).

The "dipping solution" contained about 94.150 gm/ 100 gm moisture and 0.470 gm/100 gm protein (Table IV). The pH value of the acid solution was 2.6 before dipping the meat and the acidity decreased to 4.2 after the dip treatment.

The "thawed-drip" collected had 90.820 gm/100 gm moisture and 1.645 gm/100 gm protein (Table IV).

The "blanched liquid" from the fresh meat had an average moisture content of 95.245 gm/100 gm and 1.017 gm/100 gm of protein (Table IV).

The 'blanched liquid' of the frozen meat showed about 94.920 gm/100 gm moisture and 0.669 gm/100 gm protein (Table IV).

The 'can liquid' from the fresh blanched meat packed in brine showed about 91.400 gm/100 gm and 92.120 gm/100 gm moisture content respectively for 3 months and 9 months of storage. The protein contents were 1.405 gm/100 gm and 1.772 gm/100 gm for 3 months and 9 months respectively. The fresh blanched meat packed in oil after 3 months of storage showed 82.550 gm/100 gm moisture and the protein value was 5.163 gm/100 gm (Table IV).

The 'can liquid' of the frozen blanched meat packed in brine gave the following results. The moisture contents were 91.240 gm/100 gm, 90.260 gm/100 gm and 89.620 gm/100 gm respectively after 3 months,

9 months and 24 months of storage. The moisture contents showed decreasing values as the storage period increased. The protein contents were 2.749 gm/100 gm, 3.114 gm/100 gm and 4.470 gm/100 gm respectively for the above 3 periods. The protein content increased as the storage period increased (Table IV).

The 'can liquid' from the frozen blanched meat packed in oil gave the following results. The moisture contents of the liquid were 85.350 gm/100 gm, 83.150 gm/100 gm and 79.900 gm/100 gm respectively after 3 months, 9 months and 24 months of storage. The moisture content decreased as the storage period increased as in the case of brine liquid. The protein values were 3.838 gm/100 gm, 4.900 gm/100 gm and 7.121 gm/100 gm respectively for the above 3 storage periods (Table IV).

The difference in moisture and protein content of the can liquids obtained from brine and oil pack were compared. The moisture content showed higher values for the brine packs while the protein content was more for oil packs (Table IV).

The can liquid of the smoked oysters in oil showed about 73.600 gm/100 gm moisture after one month

of storage. Since the quantity of can liquid was very little, only protein was estimated for the remaining periods. The protein contents of the can liquids were 4.119 gm/100 gm, 5,400 gm/100 gm, 10.555 gm/100 gm and 19.104 gm/100 gm after one month, 8 months, 26 months and 41 months of storage respectively. The results showed an increase in protein content for the liquid as the storage period increased (Table IV).

3.2.2 Chemical Observations on meat samples.

The meat sampled at different stages of processing was collected and estimated for its general composition like calorific value, moisture and ash content including insoluble ash, nutritional and mineral components.

3.2.2.1 General Composition.

3.2.2.1.1 Calorific Value.

The average calorie value of the fresh meat was 97.669 k.Cal/100 gm (Table V). The fresh meat after blanching gave the value 140.006 k.cal/100 gm. The meat canned in brine gave 124.468 k.cal/100 gm and 118.582 k.cal/100 gm respectively after 3 months and 9 months of storage (Table V). It increased to about 43.3% after blanching but

decreased to about 11.1% and 15.3% after 3 months and 9 months of storage. The k.calorie value of the blanched meat after 3 months of storage in oil showed 167.259 k.cal/100 gm (Table V). The results showed that the value increased to 19.5% than in blanched fresh meat. The value decreased to 11.1% for the meat in brine and increased to 19.5% for the meat in oil. The k.calorie value of the materials packed in oil gave 34.4% value more than in the materials packed in brine.

The meat after one month in frozen storage showed that the value increased from 97.669 k.cal/100 gm to 109.754 k.cal/100 gm and after blanching the value again increased to 148.219 k.cal/100 gm (Table V). The results showed that the values increased while thawing to about 12.4% and it was further increased after blanching to 35.0%. It was observed that the calorie value was more in frozen blanched meat and the increase of the value was 5.9%.

The above blanched meat after packing in brine gave the following values, 150.651 k.cal/100 gm, 140.693 k.cal/100 gm and 138.180 k.cal/100 gm respectively after 3 months, 9 months and 24 months of storage (Table V).

But the value increased to 1.6% in 3 months stored meat in brine than in frozen blanched meat. It decreased to 5.1% and 6.8% after 9 months and 24 months of storage than in the frozen blanched meat.

The frozen blanched meat in oil showed that the k.calorie value increased from 148.219 k.cal/100 gm to 180.642 k.cal/100 gm, 175.549 k.cal/100 gm, 169.118 k.cal/100 gm respectively after 3 months, 9 months and 24 months of storage. The values showed an increase of 21.9%, 18.4% and 14.1% after the respective storage period (Table V).

The difference of k.calorie value between the oil and the brine packed meat of the same period of storage gave the following results. The values were more in oil packed meat as 19.9%, 24.8% and 22.4% for the respective storage samples (Table V).

The smoked meat canned in oil gave the following k.calorie values as 205.988 k.cal/100 gm, 219.951 k.cal/100 gm, 222.057 k.cal/100 gm and 224.237 k.cal/100 gm respectively for 1 month, 8 months, 26 months and 41 months of storage. The original value of the sample was 109.754 k.cal/100 gm, and the values increased to 87.7%, 100.4%, 102.3%, and 104.3% than for the frozen meat after the above storage period (Table V).

The 41 months stored smoked oyster in tomato sauce showed that the k.calorie value was 180.308 k. cal/100 gm. The value was 71.6% more than in the frozen meat. The value was 16.0% less than in the smoked oyster canned in oil for the same storage period (Table V).

The 41 months stored smoked oyster in wine showed that the k.calorie value was 186.306 k.cal/100 gm. The value was 69.7% more than in the frozen meat. The value was 1.1% less than in the oyster canned in tomato sauce of the same storage period (Table V).

3.2.2.1.2 Moisture content.

The average value of the moisture content of the fresh meat was 76.422 gm/100 gm. The moisture content of the fresh meat after blanching decreased to 68.998 gm/ 100 gm. But after canning in brine it was increased to 75.193 gm/100 gm and 73.542 gm/100 gm respectively after 3 months and 9 months of storage. The moisture value decreased to 65.101 gm/100 gm after canning in oil and after 3 months of storage (Table V). The result showed that the blanching caused 9.7% moisture loss than in the fresh meat. But after canning in brine the moisture increased to 9.0% and 6.6% after 3 months and 9 months and in oil pack it decreased to 5.6% during

3 months of storage. The results showed that about 15.5% more moisture present in the brine packed meat.

The frozen meat had 75.411 gm/100 gm moisture content and it had come down to 68.715 gm/100 gm after blanching (Table v). The frozen meat showed a loss of nearly 1.3% moisture than for the fresh meat and further decreased to 8.9% after blanching.

After canning the frozen blanched meat in brine, it had 70.507 gm/100 gm, 70.586 gm/100 gm and 71.139 gm/100 gm of moisture content respectively after 3 months, 9 months and 24 months of storage (Table V). The meat of the brine pack showed that the moisture content increased to 2.6%, 2.7% and 3.5% after the respective storage period of 3 months, 9 months and 24 months.

The frozen blanched meat in oil after the storage period of 3 months, 9 months and 24 months had 65.234 gm/100 gm, 65.313 gm/100 gm and 65.430 gm/100 gm of moisture respectively (Table V). The moisture content decreased to 5.1%, 5.0% and 4.8% after the respective storage period.

The difference in moisture content in oil and in brine showed that the moisture content in oil pack

was less ie. 7.5%, 7.5% and 8.0%, after the respective storage period of 3 months, 9 months and 24 months (Table V).

The moisture content of the smoked oyster meat in oil was 57.019 gm/100 gm, 53.163 gm/100 gm, 51.623 gm/100 gm and 49.864 gm/100 gm respectively after one month, 8 months, 26 months and 41 months of storage (Table V). The results showed that the moisture content decreased to 24.4%, 29.5%, 31.5% and 33.9% respectively for the above storage period than in the frozen meat.

The smoked oyster in tomato sauce after 41 months of storage had 59.698 gm/100 gm moisture (Table V). It was 20.8% less than in frozen meat. It was further revealed that the moisture content was 19.7% more in the meat packed in tomato sauce when compared with the oil packed meat of the same storage period of 41 months.

The smoked oyster in wine had 58.990 gm/100 gm moisture after 41 months of storage (Table V). It was 21.8% less than in the frozen meat. It was further revealed that the moisture content was 18.3% more than in wine packed meat when compared with the oil packed meat of the same storage period of 41 months.

3.2.2.1.3 Ash content

The average value of ash content of the fresh meat was 2.755 gm/100 gm. The ash content of the fresh meat after blanching increased to 3.397 gm/100 gm. After canning and storage in brine it had 2.589 gm/100 gm and 3.382 gm/100 gm ash respectively after 3 months and 9 months of storage (Table V). The results showed that after blanching it was increased to 23.3% and decreased to 23.8% and 0.4% after 3 months and 9 months of storage of brine. The ash content of the blanched fresh meat was increased to 3.616 gm/100 gm in oil after 3 months of storage (Table V). The ash content of the meat was 6.4% more than the blanched meat. The difference between the two packs ie. in oil and in brine showed that 39.7% more ash was present in oil packed meat.

The frozen meat had 2.088 gm/100 gm of ash and during blanching it was increased to 2.448 gm/100 gm (Table V). The result showed that the ash content was decreased to 24.2% in the frozen meat but it was increased to 17.2% after blanching.

The frozen blanched meat canned in brine had 2.337 gm/100 gm, 2.416 gm/100 gm and 2.475 gm/100 gm respectively after 3 months, 9 months and 24 months of storage (Table V). The meat in brine showed that the ash content was 4.5% and 1.3% less in 3 months and 9 months of storage respectively but was 1.1% more in the 24 months stored meat than for the frozen blanched meat.

The frozen blanched meat in oil showed that it had 2.431 gm/100 gm, 2.443 gm/100 gm and 2.490 gm/100 gm of ash respectively after 3 months, 9 months and 24 months of storage (Table V). The results showed that the ash content was 0.7% and 0.2% less and 1.7% more after the respective storage period than for the frozen blanched meat.

The difference in value during the same period of storage in oil and in brine showed that the ash contents were 4.0%, 1.1% and 0.6% more for the oil packed meat (Table V).

The smoked oyster meat canned in oil showed that it had 4.003 gm/100 gm, 4.314 gm/100 gm, 4.746 gm/100 gm and 5.301 gm/100 gm ash after 1 month, 8 months,

26 months and 41 months of respective storage (Table V). The above values showed that it increased to 91.7%, 106.6%, 127.3% and 153.9% than for the frozen meat.

The tomato sauce pack of the smoked oyster after 41 months of storage showed that the ash content was 3.692 gm/100 gm (Table V). It was 76.9% more than for the frozen meat and was 30.4% less than for the oil packed meat of the same storage period.

The wine pack of the smoked oyster meat after 41 months of storage had 2.045 gm/100 gm. It was 2.1% less than for the frozen meat and 61.4% less than for the oil packed meat of the same storage period (Table V).

3.2.2.1.4 Acid insoluble ash

The acid insoluble ash content of the fresh meat canned in brine and in oil was 0.041 gm/100 gm 0.060 gm/100 gm after 3 months and 0.018/100 gm after 9 months of storage. The results for the fresh meat and the blanched meat were negative (Table V).

The insoluble ash was not present in the frozen meat but after blanching it showed a value of about 0.044 gm/100 gm (Table V).

The frozen blanched meat canned in brine after 3 months and 9 months of storage had no insoluble ash content. But in the 24 months stored meat in brine had 0.043 gm/100 gm of insoluble ash. The oil packed meat after 3 months and 24 months of storage gave nil value but for the 9 months stored meat had 0.013 gm/100 gm insoluble ash. The insoluble ash content for the 8 months old smoked oyster in oil was 0.009 gm/100 gm but was not present in other samples. The insoluble ash was not detected in the smoked oyster canned in tomato sauce as well as in wine (Table V).

3.2.2.2 Nutritional Components

The following nutritional components were estimated for the oyster meat:-

1. Protein 2. Alpha-amino nitrogen 3. Lipids and 4. Glycogen.

3.2.2.2.1 Protein.

The average value of the protein content of the fresh meat was 11.188 gm/100 gm. During blanching the protein increased to 14.366 gm/100 gm and after canning and storage in brine for 3 months and 9 months it was

further increased to 15.331 gm/100 gm and 17.177 gm/100 gm respectively (Table VI). The results showed that the protein content was increased after blanching to 28.4% and further increased to 6.7% and 19.6% respectively after 3 months and 9 months of storage in brine. The value of protein showed a high increase of 21.058 gm/100 gm for the meat canned in oil after 3 months of storage (Table VI). The meat in oil media showed an increase of 46.6% for protein for the same storage period.

The frozen meat had 13.515 gm/100 gm protein but after blanching the value increased to 17.010 gm/100 gm (Table VI). The frozen meat showed that the value of protein increased than for the fresh meat for about 20.8% and further increased for about 25.9% after blanching. The result showed an increase of 18.4% for the frozen meat.

The frozen blanched meat in brine showed a further increase of 20.830 gm/100 gm, 23.145 gm/100 gm and 24.438 gm/100 gm after 3 months, 9 months and 24 months of storage respectively (Table VI). The results showed that the protein values increased

to 22.5%, 36.1% and 43.7% after the respective storage period than for the frozen blanched meat.

The frozen blanched meat in oil gave the following results after 3 months, 9 months and 24 months of storage, as 22.560 gm/100 gm, 23.231 gm/100 gm, and 24.013 gm/100 gm respectively (Table VI). The above results showed that the protein value increased to 32.6%, 36.6% and 41.2% than for the frozen blanched meat.

The results showed an increase in value for the oil packed meat about 8.3% and 0.4% after 3 months and 9 months of storage and 1.8% increase for brine packed meat after 24 months of storage (Table VI).

The smoked oyster meat packed in oil gave the following results. The protein values were 23.251 gm/100 gm, 26.045 gm/100 gm, 27.731 gm/100 gm and 29.361 gm/100 gm respectively after 1 month, 8 months, 26 months and 41 months of storage (Table VI). The values showed an increase of 72.0%, 92.7%, 105.2% and 117.2% than for the frozen meat after the above storage period.

The tomato sauce pack of the smoked oyster after 41 months of storage had 26.518 gm/100 gm protein (Table VI). It was 96.2% more than for the frozen meat but was 9.7% less than for the oil packed meat of same storage period.

The wine pack of the smoked oyster after 41 months of storage had 28.780 gm/100 gm protein (Table VI). It was 112.9% more than for the frozen meat but about 2.0% less than for the oil packed meat of the same storage period.

3.2.2.2.2 Alpha-amino nitrogen.

The average value for the alpha-amino nitrogen content of the fresh meat was 176.400 mg/100 gm. The value after blanching decreased to 100.800 mg/100 gm. The value further decreased in meat canned in brine to 20.160 mg/100 gm and 49.200 mg/100 gm after 3 months and 9 months of storage (Table VI). The value showed a decrease of 42.9% after blanching and it was further decreased to 80.0% and 51.2% after 3 months and 9 months of storage. The meat after canning and storage for 3 months in oil showed that it contained 50.400 mg/100 gm alpha-amino nitrogen (Table VI). The oil packed value was 50.0% less than for the blanched meat.

The value for the frozen meat was 156.800 mg/ 100 gm and after blanching it was decreased to 89.600 mg/ 100 gm (Table VI). The results showed that the frozen meat loss nearly 11.1% than for the fresh meat and a further loss of 42.9% was occured during blanching. The result showed that the alpha-amino nitrogen content of the fresh blanched meat was 12.5% more than for the frozen blanched meat.

The frozen blanched meat of the above in brine gave the following results. The values increased to 42.600 mg/100 gm, 86.800 mg/100 gm and 120.800 mg/100 gm respectively after 3 months, 9 months and 24 months of storage (Table VI). The meat in brine showed that the values were 52.5% and 3.1% less after 3 months and 9 months and 34.8% more after 24 months of storage than for the frozen blanched meat.

The frozen blanched meat in oil gave the following results. The values obtained were 38.720 mg/100 gm, 64.400 mg/100 gm and 95.000 mg/100 gm respectively for 3 months, 9 months and 24 months of storage (Table VI). It showed that the values were 56.8% and 28.1% less

after 3 months and 9 months and 6.0% more after 24 months of storage than for the frozen blanched meat.

The values were more for the brine packed meat than for the oil packed meat of the same storage period, and were 10.0%, 34.8% and 27.2% (Table VI).

The smoked oyster meat canned in oil gave 42.560 mg/100 gm, 91.200 mg/100 gm, 112.200 mg/100 gm and 128.800 mg/100 gm values respectively after one month, 8 months, 26 months and 41 months of storage (Table VI). The results showed that the values were 72.9%, 41.8%, 28.4% and 17.9% less in the frozen meat of the above storage period.

The smoked oyster meat in tomato sauce for 41 months storage period had 159.200 mg/100 gm alpha-amino nitrogen (Table VI). It was about 1.5% more than for the frozen meat and 23.6% more than for the oil packed meat of the same storage period.

The smoked oyster meat in wine for 41 months storage period had 103.600 mg/100 gm (Table VI). It was about 33.9% less than in the frozen meat and 24.3% more in the oil packed meat of the same storage period.

3.2.2.2.3 Lipids.

The average value of the lipids for the fresh meat was 2.485 gm/100 gm. The lipid value increased to 4.342 gm/100 gm after blanching and further increased after canning and storage to 4.580 gm/100 gm and 4.518 gm/100 gm respectively after 3 months and 9 months of storage (Table VI). It was observed that after blanching the values increased to about 74.7% and further increased to 5.5% and 4.1% respectively after 3 months and 9 months of storage in brine. The value increased to 5.483 gm/100 gm in oil packed meat of 3 months stored can (Table VI). The oil pack had more lipid value than for the brine pack and the blanched meat and it was about 19.7% and 26.3% respectively.

The frozen meat had 2.890 gm/100 gm lipid and after blanching it increased to 4.175 gm/100 gm (Table VI). The results showed that the value for frozen meat increased for about 16.3% than for the fresh meat and a further increase of 44.5% after blanching. But the value decreased for the frozen blanched meat than for the fresh blanched meat to about 3.8%.

The frozen blanched meat canned in brine gave the following results. The values were 4.459 gm/100 gm, 4.109 gm/100 gm and 3.760 gm/100 gm respectively after 3 months, 9 months and 24 months of storage (Table VI). The lipid content of the brine pack showed that it was 6.8% more after 3 months and 1.6% and 9.9% less after 9 months and 24 months of storage than for the frozen blanched meat.

The frozen blanched meat in oil contained 6.342 gm/100 gm, 5.565 gm/100 gm and 4.862 gm/100 gm lipid respectively after 3 months, 9 months and 24 months of storage (Table VI). The results showed that the lipid content was 51.9%, 33.3% and 16.5% more than for the frozen blanched meat.

The results indicated that the lipid showed higher values for the meat stored in oil and the values were 42.2%, 35.4% and 29.3% respectively for the same storage period (Table VI).

The smoked oyster canned in oil had the following results for the lipid and the values were 7.190 gm/100 gm, 7.663 gm/100 gm, 7.901 gm/100 gm and 8.089 gm/100 gm respectively for 1 month, 8 months, 26 months

and 41 months of storage (Table VI). The values showed that it was 148.8%, 165.2%, 173.4% and 179.9% more than for the frozen meat for the above storage period.

The smoked oyster meat canned in tomato sauce had 5.292 gm/100 gm lipid after 41 months of storage (Table VI). It was 83.1% more than in the frozen meat and 52.9% more in the oil packed meat than in the tomato sauce pack of the same storage period.

The smoked oyster meat canned in wine had 5.242 gm/100 gm lipid after 41 months of storage (Table VI). It was 81.4% more than for the frozen meat. The oil packed meat of the same storage period had 54.3% more lipid than for the wine pack.

3.2.2.2.4 Glycogen.

The fresh meat had an average value of 7.638 gm/100 gm glycogen. In the fresh meat after blanching the value increased to 10.866 gm/100 gm. After canning in brine the values decreased to 5.481 gm/100 gm and 2.303 gm/100 gm respectively after 3 months and 9 months of storage (Table VI). The above results showed that the value increased to 42.3% during

blanching and decreased to 49.6% and 78.8% respectively after 3 months and 9 months of storage in brine. The fresh meat after canning in oil and 3 months storage had 8.420 gm/100 gm of glycogen (Table VI). The results showed that after 3 months storage the value decreased to 22.5% in the oil packed meat.

The frozen meat had 7.421 gm/100 gm glycogen and after blanching the value increased to 10.651 gm/100 gm (Table VI). The result showed that the glycogen content decreased in the frozen meat for about 2.8% than in the fresh meat. After blanching it was increased to 43.5%. The differences between the fresh and frozen blanched meat was about 2.0% but this was more in the fresh blanched meat.

The values of glycogen for brine packs were decreasing to about 6.800 gm/100 gm, 2.783 gm/100 gm and 1.647 gm/100 gm respectively after 3 months, 9 months and 24 months of storage (Table VI). The results from the brine pack showed that the loss was about 36.2%, 73.9% and 84.5% respectively after the above storage period than for the frozen blanched meat.

The frozen blanched meat in oil had 8.331 gm/100 gm, 8.135 gm/100 gm and 7.327 gm/100 gm of glycogen respectively after 3 months, 9 months and 24 months of storage (Table VI). The glycogen values decreased to 21.8%, 23.6% and 31.2% respectively during the above storage period than in the frozen blanched meat.

The difference in glycogen content for the same storage period in oil and in brine pack showed that it was 22.5%, 192.3% and 344.9% more for the oil packed meat (Table VI).

The smoked oyster meat in oil had the following glycogen values, 12.071 gm/100 gm, 11.701 gm/100 gm, 10.006 gm/100 gm and 8.498 gm/100 gm respectively for 1 month, 8 months, 26 months and 41 months of storage (Table VI). The values were 62.7%, 57.7%, 34.8% and 14.5% respectively more, than for the frozen meat of the above storage period.

The smoked oyster meat canned in tomato sauce had 8.652 gm/100 gm glycogen after 41 months of storage (Table VI). It was about 16.6% more than for the frozen meat and 1.8% more than for the oil packed meat of the same storage period.

The smoked oyster meat in wine had 6.002 gm/ 100 gm glycogen after 41 months of storage (Table VI). The result showed that it was 19.1% less than for the frozen meat and 29.4% less than for the oil packed meat of the same storage period.

3.2.2.3. Mineral Composition

The following five minerals 1) Sodium, 2. potassium, 3. calcium, 4. phosphorus and 5. iron were estimated for the oyster meat, sampled at different stages of processing, during the study.

3.2.2.3.1. Sodium

The fresh meat had an average value of 769.832 mg/100 gm for sodium. The sodium content of the fresh meat increased to 985.171 mg/100 gm after blanching and decreased to 804.369 mg/100 gm and 798.422 mg/100 gm respectively after 3 months and 9 months of storage (Table VII). The sodium content of the blanched meat was increased to about 28.0% than for the fresh meat. But after canning and 3 months and 9 months of storage the values decreased to 18.4% and 19.0% respectively than in the blanched meat. The sodium content of the canned meat was

decreased to 844.156 mg/100 gm after 3 months in oil (Table VII). The oil packed meat contained 14.3% less sodium than for the fresh blanched meat.

The frozen meat had 673.845 mg/100 gm sodium and after blanching the value increased to 831.523 mg/100 gm (Table VII). The result showed that the frozen meat had a loss of about 12.5% sodium than in the fresh meat. But the sodium content increased to 23.4% after blanching. The value of the blanched meat showed that the sodium content was 15.6% less in the frozen blanched meat than the fresh blanched meat.

The frozen blanched meat canned in brine give the following results. The values were 863.072 mg/100 gm, 814.876 mg/100 gm and 789.586 mg/100 gm respectively after 3 months, 9 months and 24 months of storage (Table VII). The above results showed that the value of sodium was 3.8% more after 3 months but 2.0% and 5.0% less after 9 months and 24 months of storage respectively than for the frozen blanched meat.

The frozen blanched meat canned in oil gave the following values, 819.032 mg/100 gm, 797.205 mg/100 gm and 792.218 mg/100 gm respectively for sodium

after 3 months, 9 months and 24 months of storage (Table VII). The results showed that the sodium content was 1.5%, 4.1% and 4.7% less than for the frozen blanched meat of the above storage period.

The sodium content of the meat packed in brine showed 5.4% and 2.2% increase than for the oil packed meat after 3 months and 9 months and 0.3% increase for oil packed meat after 24 months (Table VII).

The smoked oyster meat in oil gave the following values for the sodium content as 1561.257 mg/100 gm, 1661.000 mg/100 gm, 1742.821 mg/100 gm and 1833.821 mg/100 gm respectively after 1 month, 8 months, 26 months and 41 months of storage (Table VII). The results showed that the sodium content was increased to 131.7%, 146.5%, 158.6% and 172.1% respectively than for the frozen meat after the above respective storage periods.

The smoked oyster meat in tomato sauce had 992.218 mg/100 gm sodium after 41 months of storage (Table VII). It showed that the sodium content was 47.2% more than in the frozen meat. The oil pack had 84.8% more sodium content than in the tomato sauce pack of the same storage period.

The smoked oyster meat in wine had 876.339 mg/100 gm sodium after 41 months of storage (Table VII). It showed that the value was 30.1% more than that for the frozen meat. The oil pack meat had 109.3% more sodium content than for the wine pack of the same storage period.

3.2.2.3.2 Potassium

The fresh meat had an average value of 98.217 mg/100 gm for potassium. The fresh meat after blanching contain 40.153 mg/100 gm. The blanched meat canned in brine after 3 months and 9 months of storage had 11.420 mg/100 gm and 9.637 mg/100 gm respectively (Table VII). The results showed that the potassium content of the meat after blanching decreased for about 59.1% and it was again decreased to 71.6% and 76.0% respectively after 3 months and 9 months of storage. The potassium value in oil showed 38.338 mg/100 gm after 3 months of storage (Table VII). The value decreased to 4.5% in oil packed meat after 3 months of storage.

The frozen meat had 31.813 mg/100 gm potassium and after blanching it had 16.219 mg/100 gm (Table VII).

The results showed that the frozen meat had a decrease of about 67.6% potassium than for the fresh meat. It further decreased to 49.0% after blanching. The difference in potassium showed that it was 59.6% less for the frozen blanched meat than for the fresh blanched meat.

The frozen blanched meat in brine contained 9.831 mg/100 gm, 15.533 mg/100 gm and 29.479 mg/100 gm of potassium respectively after 3 months, 9 months and 24 months of storage (Table VII). The results showed that the values were 39.4% and 4.2% less after 3 months and 9 months and 81.8% more after 24 months than for the frozen blanched meat.

The potassium content of the frozen blanched meat of the oil packs were 12.549 mg/100 gm, 16.589 mg/100 gm and 22.412 mg/100 gm respectively after 3 months, 9 months and 24 months of storage (Table VII). The results showed that the meat in oil contained 22.6% less after 3 months and 2.3% and 38.2% more after 9 months and 24 months of storage than in the frozen blanched meat.

The difference between the meat in brine and in oil showed that the potassium content was 27.6% and 6.8% more in oil after 3 and 9 months of storage while 31.5% more in brine after 24 months of storage (Table VII).

The smoked oyster meat in oil showed that it had 17.551 mg/100 gm, 21.877 mg/100 gm, 28.992 mg/100 gm and 34.669 mg/100 gm after 1 month, 8 months, 26 months and 41 months of respective storage period (Table VII). The results showed that the values were 44.8%, 31.2% and 8.9% less after 1 month, 8 months and 26 months and 9.0% more after 41 months of storage than for the frozen meat.

The smoked oyster meat in tomato sauce had 117.405 mg/100 gm of potassium after 41 months of storage (Table VII). The result showed that potassium increased to about 269.0% than for the frozen meat and also 238.6% than for the oil packed meat of the same storage period.

The smoked oyster meat in wine had 28.043 mg/100 gm of potassium after 41 months of storage (Table VII). The result showed that the value was about 11.9% less

than for the frozen meat and was about 19.1% less than for the oil packed meat of the same storage period.

3.2.2.3.3. Calcium

The fresh meat had about 346.542 mg/100 gm calcium content. The blanched meat had 100.251 mg/100 gm calcium. The blanched meat canned in brine had 29.592 mg/100 gm and 27.270 mg/100 gm respectively after 3 months and 9 months of storage (Table VII). The results showed that after blanching the calcium content decreased to 71.1% and further decreased to 70.5% and 72.8% respectively in the brine packed meat than in the blanched meat after 3 months and 9 months of storage. The meat had 65.519 mg/100 gm calcium in the oil packed meat after 3 months of storage (Table VII). The results showed that the calcium content decreased to 34.6% for the oil packed meat after 3 months of storage than in the blanched meat.

The calcium content of the frozen meat had 74.696 mg/100 gm, which after blanching decreased to 44.022 mg/100 gm (Table VII). The result showed that the calcium content in the frozen meat decreased to 78.4% than in the fresh meat and was further decreased to 41.1% after blanching. The result further revealed

that 56.1% calcium was less in the frozen blanched meat than in the fresh blanched meat.

The frozen blanched meat canned in brine had 24.758 mg/100 gm, 34.518 mg/100 gm and 74.691 mg/100 gm calcium respectively after 3 months, 9 months and 24 months of storage (Table VII). The results showed that the values decreased to 43.8% and 21.6% after 3 months and 9 months of storage and increased to 69.7% after 24 months of storage than in the frozen blanched meat.

The frozen blanched meat canned in oil after 3 months, 9 months and 24 months of storage had 33.812 mg/100 gm, 35.829 mg/100 gm and 62.257 mg/100 gm of calcium respectively (Table VII). The results showed that the calcium content decreased to 23.2% and 18.6% after 3 months and 9 months and increased to 41.4% after 24 months of storage than in the frozen blanched meat.

The difference between the meat packed in oil and in brine of the same storage period were 36.6% and 3.8% more in the meat packed in oil after 3 months and

9 months and 20.0% more in brine packed meat after 24 months (Table VII).

The smoked oyster meat in oil had 43.221 mg/100 gm, 49.655 mg/100 gm, 65.688 mg/100 gm and 77.042 mg/100 gm of calcium respectively after 1 month, 8 months, 26 months and 41 months of storage (Table VII). The calcium content was 42.1%, 33.5% and 12.1% less after 1 month, 8 months and 26 months of respective storage and 3.1% more after 41 months of storage than in the frozen meat.

The smoked oyster meat in tomato sauce had 226.793 mg/100 gm calcium after 41 months of storage (Table VII). The result showed that the calcium content was 203.6% more than for the frozen meat and 194.4% more than in the oil packed meat of the same storage period.

The smoked oyster meat in the wine pack had 58.423 mg/100 gm calcium after 41 months of storage (Table VII). The result showed that the value was 21.8% less than that of the frozen meat and 24.2% less than that of the oil packed meat of the same storage period.

3.2.2.3.4. Phosphorus

The fresh meat had 40.574 mg/100 gm of phosphorus. The fresh meat after blanching had 26.571 mg/100 gm phosphorus, which after canning in brine had 23.285 mg/100 gm and 14.602 mg/100 gm respectively after 3 months and 9 months of storage (Table VII). The phosphorus content of the fresh meat after blanching decreased to 34.5% and further decreased to 12.4% and to 45.0% after 3 months and 9 months of storage in brine. The meat in oil had 25.841 mg/100 gm of phosphorus after 3 months of storage (Table VII). The result showed that the phosphorus content decreased to about 2.7% in oil packed meat after 3 months of storage.

The frozen meat had 43.778 mg/100 gm of phosphorus and the meat after blanching contained 43.111 mg/100 gm (Table VII). The results showed that the phosphorus content increased to 7.9% than that of the fresh meat. But it decreased to about 1.5% after blanching. The phosphorus content was 62.2% more in the frozen blanched meat than for the fresh blanched meat.

The frozen blanched meat canned in brine contained 25.758 mg/100 gm, 22.444 mg/100 gm and 19.333 mg/100 gm

respectively after 3 months, 9 months and 24 months of storage (Table VII). The results showed that the phosphorus values decreased to 40.3%, 47.9% and 55.2% respectively than for the frozen blanched meat.

The frozen blanched meat in oil contained 41.114 mg/100 gm, 26.444 mg/100 gm and 25.959 mg/100 gm of phosphorus respectively after 3 months, 9 months and 24 months of storage (Table VII). The results showed that the phosphorus content of the meat decreased to about 4.6%, 38,7% and 39.8% respectively than the frozen blanched meat after the above storage period.

The values of the canned meat in oil and in brine showed that the phosphorus content was 59.6%, 17.8% and 34.3% more in the oil packed meat of the same period of storage (Table VII).

The smoked meat canned in oil contained 65.848 mg/100 gm, 70.738 mg/100 gm, 76.000 mg/100 gm and 81.918 mg/100 gm respectively after 1 month, 8 months, 26 months and 41 months of storage (Table VII). The results showed that the meat in oil contained 50.4%, 61.6%, 73.6% and 87.1% more phosphorus than in the frozen meat of the same storage period.

The smoked oyster in tomato sauce had 37.587 mg/100 gm of phosphorus after 41 months of storage (Table VII). The result showed that the value for phosphorus was 14.1% less than for the frozen meat but 117.9% more for the oil packed meat of the same storage period.

The smoked oyster meat in wine had 31.599 mg/100 gm of phosphorus after 41 months of storage (Table VII). The result showed that the phosphorus content was 27.8% less than in the frozen meat but 159.2% more in the oil packed meat of the same storage period.

3.2.2.3.5. Iron

The average value of iron content of the fresh meat was 7.886 mg/100 gm. After blanching the fresh meat had 11.392 mg/100 gm of iron content. The meat in brine had 8.667 mg/100 gm and 8.788 mg/100 gm respectively after 3 months and 9 months of storage (Table VII). The iron content of the fresh meat after blanching increased to 44.5%. In the meat canned in brine the iron decreased to 23.9% and 22.9% after 3 months and 9 months of storage than in the blanched meat. The meat canned in oil after 3 months of storage contained 13.551 mg/100 gm of iron (Table VII). The result showed that the iron content increase to 19.0% than in the blanched meat.

The frozen meat had 7.815 mg/100 gm iron. After blanching the value increased to 11.310 mg/100 gm (Table VII). The results showed that the iron content of the fresh meat after freezing decreased to about 0.9% and the blanching caused to increase the iron content to 44.7%.

The frozen blanched meat in brine contained 10.138 mg/100 gm, 9.407 mg/100 gm and 4.940 mg/100 gm of iron respectively after 3 months, 9 months and 24 months of storage (Table VII). The results showed that the iron content decreased to 10.4%, 16.8% and 56.3% than for the frozen blanched meat after the above storage period.

The frozen blanched meat in oil contained 13.747 mg/100 gm, 17.358 mg/100 gm and 12.466 mg/100 gm of iron after 3 months, 9 months and 24 months of respective storage period (Table VII). The results showed that the iron content was 21.5%, 53.5% and 10.2% more than in the frozen blanched meat after the above storage period.

The difference between the oil and the brine packed meat showed that the iron content was 35.6%,

84.5% and 152.3% more in the oil packed meat of the same storage period as shown above (Table VII).

The smoked oyster meat in oil had 15.173 mg/100 gm, 20.605 mg/100 gm, 23.480 mg/100 gm and 19.531 mg/100 gm of iron after 1 month, 8 months, 26 months and 41 months of storage respectively (Table VII). The results showed that the iron content was 94.2%, 163.7%, 200.4% and 149.9% more for the canned and stored meat than for the frozen meat.

The smoked oyster meat in tomato sauce had 15.103 mg/100 gm of iron after 41 months of storage (Table VII). The results showed that the iron content was 93.3% more in the canned and stored meat in tomato sauce than in the frozen meat and 29.3% more in oil packed meat of the same storage period.

The smoked oyster meat in wine had 17.645 mg/100 gm of iron after 41 months of storage (Table VII). The stored meat had 125.8% more iron than in the frozen meat but 9.7% less than in oil packed meat.

TABLE - I

CUT OPEN TEST FOR THE CANNED FRESH OYSTER MEAT

Details	In brine		In Oil
Storage period (months)	3		3
Size and type of can	76.5 x 51.6 (301 x 203)	76.5 x 51.6 (301 x 203)	76.5 x 51.6 (301 x 203)
Actual weight of the content (gm)	293.20	247.00	237.00
Weight of meat when packed (gm)	98.00	90.00	106.00
Drained meat weight(gm)	87.45	78.40	97.80
Drained can liquid (ml)	108.75	127.10	110.5 (94 + 16.5)x
Appearance	Good	Good	Good
Colour	Cremy white with brown liver.	White with brown liver.	Greenish white with brown liver.
Flavour	Sea weedy	Mild sea weedy	Oily and sea weedy
Texture	Soft and firm	Soft and firm	Soft and firm.
Sulphur reaction	NIL	NIL	NIL
Saltiness	Mild to taste	Mild to taste	Slightly higher to taste.
Colour of the liquid	Slight opalescent	Opalescent	Opalescent with light yellow colour oil.

* - Millimetres

x - Volume of drained oil + liquid.

TABLE - II

CUT OPEN TEST FOR THE CANNED FROZEN OYSTER MEAT

Details	In brine			In oil		
Storage period (months)	3	9	24	3	9	24
Size and type of cans	103 x 74 x14* (QD/112 gm.)	103x74x14* (QD/112gm)	103x74x14* (QD/112gm)	103x74x14* (QD/112gm)	103x74x14* (QD/112gm)	103x74x14* (QD/112gm)
Actual weight of the content (gm)	131.20	132.50	133.00	130.40	131.50	126.20
Weight of meat when packed (gm)	78.00	90.00	90.00	78.00	78.00	85.00
Drained meat weight(gm)	72.80	82.50	80.00	64.75	63.20	66.75
Drained can liquid (ml)	39.7	32.2	35.5	47.6 (35.5+12.1)x	49.5 (36.0+13.5)x	45.8 (36.0+9.8)x
Appearance	Good	Good	Good slightly sticking	Good	Good	Good
Colour	Cremy white with slight brown liver	White with brown liver.	White dark brown liver.	Greenish	Greenish with slight brown liver.	Greenish with slight brown liver
Flavour	Sea weedy	Sea weedy	Slight sea weedy	Oily sea weedy.	Oily	Oily
Texture	Soft and firm	Soft,breaks due to pressure	Soft,breaks due to pressure.	Soft and firm.	Soft and firm	Soft and tender.
Sulphur reaction	NIL	NIL	NIL	NIL	NIL	NIL
Saltiness	To taste	To taste	Mild to taste	To taste	To taste	To taste.
Colour of the liquid	Opalescent	Opalescent	Opalescent and turbid	Opalescent with slight yellow oil.	Opalescent liquid with yellowish oil	Opalescent with yellowish green oil.

x Volume of drained oil + liquid. * In millimetres.

TABLE - III

CUT OPEN TEST FOR THE CANNED SMOKED OYSTER MEAT

Details	In oil				In T.S.[1]	In wine
torage period (months)	1	8	26	41	41	41
ize and type of cans	103x74x14* (QD/112 gm)	103x74x14* (QD/112 gm)	103x74x14* (QD/112 gm)	103x74x14* (QD/112 gm)	103x74x14* (QD/112 gm)	103x74x14* (QD/112 gm)
ctual weight of the content (gm)	132.20	132.50	132.20	131.20	132.80	130.00
eight of the meat when packed (gm)	85.00	85.00	85.00	85.00	85.00	85.00
rained meat weight(gm)	81.50	81.50	78.70	76.20	83.20	65.00
rained can liquid (ml)	37.2 (35.0+2.2)[x]	38.3 (36.5+1.8)[x]	37.1 (36.0+1.1)[x]	37 (36.7+0.3)[x]	22.6 (20.1+2.5)[2]	46.0
pearance	Good	Good	Good	Fair, sli-ghly, sti-cking each other.	Fair	Fair
lour	Golden brown	Golden brown	Greenish brown	Slight dark brown.	Chilly masked cremy meat	Pale
avour	Oily and smokey	Moderate smokey	Moderate smokey	Slightly smokey	Chilly and smokey.	Wine and smokey.
xture	Soft and firm	Soft and firm	Soft and tender	Soft and brittle	Soft and tender	Soft and brittle.
lphur reaction	NIL	NIL	NIL	NIL	NIL	NIL
ltiness	To taste	To taste	To taste	More salt	To taste	Sweety wine
lour of the liquid	Opalescent crime oil	Opalescent greenish yellow oil	Dark opa-lescent greenish yellow oil	Thick opa-lescent dark yell-owish green oi.	Dark brown T.S. with brownish oil	Pale

- T.S. - Tomato Sauce 2 - Volume of drained tomato sauce + oil
- Volume of drained oil + liquid. * - in Millimeters.

T A B L E - IV

MOISTURE AND PROTEIN CONTENT OF THE DRIP/LIQUID COLLECTED DURING DIFFERENT STAGES OF PROCESSING

Sampling Stage	Storage period (In months)	Moisture (gm/100 gm)	Protein (gm/100 gm)
I Fresh meat			
Nectar	-	94.966	1.286
Blanched liquid	-	95.245	1.017
Dipping solution	-	94.150	0.470
Can liquid (Brine)*	3	91.400	1.405
Can liquid (Brine)*	9	92.120	1.772
Can liquid (oil)*	3	82.550	5.163
II Frozen meat			
Thawed drip	1	90.820	1.645
Blanched liquid	-	94.920	0.669
Can liquid (Brine)*	3	91.240	2.749
Can liquid (Brine)*	9	90.260	3.114
Can liquid (Brine)*	24	89.620	4.470
Can liquid (oil)*	3	85.350	3.838
Can liquid (oil)*	9	83.150	4.900
Can liquid (oil)*	24	79.900	7.121
III Smoked meat 1			
Can liquid (oil)*	1	73.600	4.119
Can liquid (oil)*	8	N. D.	5.400
Can liquid (oil)*	26	N. D.	10.555
Can liquid (oil)*	41	N. D.	19.104

1. Can liquid from Tomato sauce [illegible] and Wine were not estimated for protein & moisture.

* Canned Products. N.D. - Not detected.

T A B L E - V

GENERAL COMPONENTS OF OYSTER MEAT AND THEIR VALUES DURING DIFFERENT STAGES OF PROCESSING

Sampling Stage	Storage period (In months)	General Components (gm/100 gm)			
		K.cal.	Moisture	Ash	Insoluble Ash
Fresh Meat	-	97.669	76.422	2.755	N I L
Blanched Meat	-	140.006	68.998	3.397	N I L
Blanched Meat (brine)*	3	124.468	75.193	2.589	0.041
Blanched Meat (brine)*	9	118.582	73.542	3.382	0.018
Blanched Meat (oil)*	3	167.259	65.101	3.616	0.060
Frozen Meat	1	109.754	75.411	2.088	N I L
Blanched Meat	-	148.219	68.715	2.448	0.044
Blanched Meat (Brine)*	3	150.651	70.507	2.337	N I L
Blanched Meat (Brine)*	9	140.693	70.586	2.416	N I L
Blanched Meat (Brine)*	24	138.180	71.139	2.475	0.043
Blanched Meat (oil)*	3	180.642	65.234	2.431	N I L
Blanched Meat (oil)*	9	175.549	65.313	2.443	0.013
Blanched Meat (oil)*	24	169.118	65.430	2.490	N I L
Smoked Meat (oil)*	1	205.998	57.019	4.003	N I L
Smoked Meat (oil)*	8	219.951	53.163	4.314	0.009
Smoked Meat (oil)*	26	222.057	51.623	4.746	N I L
Smoked Meat (oil)*	41	224.237	49.864	5.301	N I L
Smoked Meat (T.S.)*1	41	188.308	59.698	3.692	N.D.
Smoked Meat (wine)*	41	186.306	58.990	2.045	N.D.

* Canned Products. T.S. - Tomato Sauce. N.D - Not detected.
NIL - Not present.

T A B L E - VI

NUTRITIONAL COMPONENTS OF OYSTER MEAT AND THEIR VALUES DURING DIFFERENT STAGES OF PROCESSING

Sampling Stage	Storage period (In months)	Nutritional Components (gm/100 gm)			
		Protein	Alpha-amino nitrogen (mg/100 gm)	Lipid	Glycogen
Fresh Meat	-	11.188	176.400	2.485	7.638
Blanched Meat	-	14.366	100.800	4.342	10.866
Blanched Meat (Brine)*	3	15.331	20.160	4.580	5.481
Blanched Meat (Brine)*	9	17.177	49.200	4.518	2.303
Blanched Meat (oil)*	3	21.058	50.400	5.483	8.420
Frozen Meat	1	13.515	156.800	2.890	7.421
Blanched Meat	-	17.010	89.600	4.175	10.651
Blanched Meat (Brine)*	3	20.830	42.600	4.459	6.800
Blanched Meat (Brine)*	9	23.145	86.800	4.109	2.783
Blanched Meat (Brine)*	24	24.438	120.800	3.760	1.647
Blanched Meat (oil)*	3	22.560	38.720	6.342	8.331
Blanched Meat (oil)*	9	23.231	64.400	5.565	8.135
Blanched Meat (oil)*	24	24.013	95.000	4.862	7.327
Smoked Meat (oil)*	1	23.251	42.560	7.190	12.071
Smoked Meat (oil)*	8	26.045	91.200	7.663	11.701
Smoked Meat (oil)*	26	27.731	112.200	7.901	10.006
Smoked Meat (oil)*	41	29.361	128.800	8.089	8.498
Smoked Meat (T.S.)*	41	26.518	159.200	5.292	8.652
Smoked Meat (wine)*	41	28.780	103.600	5.242	6.002

* Canned Products.

T.S. - Tomato Sauce.

T A B L E - VII

MINERAL COMPONENTS OF OYSTER MEAT AND THEIR VALUES DURING DIFFERENT STAGES OF PROCESSING

Sampling Stage	Storage period (In months)	Mineral Components (mg/100 gm)				
		Sodium	Potassium	Calcium	Phosphorus inorganic	Iron
Fresh Meat	-	769.832	98.217	346.542	40.574	7.886
Blanched Meat	-	985.171	40.153	100.251	26.571	11.392
Blanched Meat (brine)*	3	804.369	11.420	29.592	23.285	8.667
Blanched Meat (brine)*	9	798.422	9.637	27.270	14.602	8.788
Blanched Meat (oil)*	3	844.156	38.338	65.519	25.841	13.551
Frozen Meat	1	673.845	31.813	74.696	43.778	7.815
Blanched Meat	-	831.523	16.219	44.022	43.111	11.310
Blanched Meat (Brine)*	3	863.072	9.831	24.758	25.758	10.138
Blanched Meat (Brine)*	9	814.876	15.533	34.518	22.444	9.407
Blanched Meat (Brine)*	24	789.586	29.479	74.691	19.333	4.940
Blanched Meat (oil)*	3	819.032	12.549	33.812	41.114	13.747
Blanched Meat (oil)*	9	797.205	16.589	35.829	26.444	17.358
Blanched Meat (oil)*	24	792.218	22.412	62.257	25.959	12.466
Smoked Meat (oil)*	1	1561.257	17.551	43.221	65.848	15.173
Smoked Meat (oil)*	8	1661.000	21.877	49.655	70.738	20.605
Smoked Meat (oil)*	26	1742.821	28.992	65.688	76.000	23.480
Smoked Meat (oil)*	41	1833.821	34.669	77.042	81.918	19.531
Smoked Meat 1 (T.S)*	41	992.218	117.405	226.793	37.587	15.103
Smoked Meat (brine)*	41	876.339	28.043	58.423	31.599	17.645

* Canned Products.

1. T.S. - Tomato Sauce.

4. DISCUSSION

The dipping of live oysters in boiling water forced them to open their valves, which in turn helped shucking very easy. The shucked meat had a slight shrinkage and weight loss as observed by Hansen & Aagaard (1969) in the species of oysters O.virginica and C.gigas. Washing in chilled water helped to reduce the drip of the meat due to the 'cold shock' as shown by James & Olley (1974) in Abalone genus Haliotis.

The thaw loss of the meat increased as the storage period increased. This result supported the earlier work of Chinnamma (1973, 1974) in Crab and Mussel.

The blanching of the meat in acid solution reduced weight due to the loss of moisture content because of tissue condensation and salt up take which coincide with the observations of Baumgartner & Hersom (1956), Causeret (1962) and Diyakovskaia & Tenyakov (1983).

The weight loss as well as the colour and flavour changes of the meat during smoking was also observed

earlier in portuguese oyster C.angulata. and C.madrasensis Anon(1965 & 1982).

The increase of sulphur odour for the products in tin cans was noted earlier by Broek (1965) for canned fish.

The loss of weight, changes in texture, odour, firmness etc. observed for canned oyster meat during the storage periods. The same observations were made by authors like Freeman and Sistrunk (1978) for beans in brine and Walker (1984) for vegetable in brine.

The colour change of tomato sauce medium after storage was observed earlier by Gerasimov & Antonova (1979) for canned fish. The metallic flavour of the fish meat packed in tomato sauce was indicated in the observations of Durand and Thibaud (1980) for canned fish.

The protein content in the thawed drip was comparatively high. This was discussed by Lovern (1962), Dyer (1969 & 1971) and Frazier (1967) for fish products.

The protein content of the blanch liquid of the present study agrees with the observation of

Venugopalan et al (1970) for the blanched prawn liquid.

The protein value of the can liquid as well as its variation during storage period had the same results as observed by Taguchi et al (1980 a,b) for the canned Sardine and Mackerel.

The chemical analysis of the meat showed that the k.calorie value was mainly depended on the amount of nutritional components ie, protein, lipid and glycogen as well as the amount of moisture content. When ever the moisture content showed higher values the nutritional contents became lesser in value. The k.calorie value was higher in the C.madrasensis (Anon 1971, Burton 1980).

The blanching of fresh meat caused increase in k.calorie value but after canning and storage the value showed decrease. The increase in k.calorie value was due to the decrease of moisture content during blanching and this agrees with the finding of authors like Geiger & Borgstrom (1962) for fishes. The frozen meat had more k.calorie value due to dehydration during storage and further increased during blanching. The k.calorie value was more in the 3 months stored meat canned in brine

due to the hydrolysis of protein and lipid and this has already been discussed by Taguchi et al (1982 b) for Mackerel.

The frozen blanched meat canned in oil had high k.calorie value but it had decreased as the storage period increased. The k.calorie value of the smoked product were more than in the frozen meat.

The moisture content of the meat decreased after blanching which coincide with the observation of Causeret (1962), Geiger & Borgstrom (1962) and Gerasimov & Antonova (1979) for fishes. Since the meat acts as an osmoconformers in the brine medium the value of the moisture content was more in the meat canned in brine. Same observation was made by the authors Ward et al (1983).

The moisture content of the frozen meat had lower value as observed by Chinnamma (1973 & 1974) in crab and mussel. This is because the frozen meat do not reabsorb the moisture after freezing.

It was observed that the quantity of moisture reabsorbed by the frozen blanched meat canned in brine was less than by the fresh blanched meat of the same

media because the osmoconforming effect was less in the frozen blanched meat. It was also observed that in the case of meat canned in oil, the intake of moisture by the meat was reduced by the surrounding media. This was observed earlier by Cheftel (1965) for canned sardine in oil.

The smoking process helped in extruding and minimising the moisture content of the meat. The moisture content of the smoked meat canned in oil, in tomato sauce and in wine was less than that in the meat canned in brine.

The ash content was comparatively higher in the oyster meat when compared with the other shell fishes. The blanching caused ash content to increase eventhough some mineral dissolved in the blanching solution. This has already been reported by Mc Cance & Ship (1933) and Çauseret (1962) for fishes.

The frozen meat had less ash content after storage. This was mainly due to the leaching out process as reported by Lovern (1962) and Dyer (1969 & 1971) for fishes. The frozen meat after blanching showed higher value for ash because of the low initial value.

The ash content of the blanched as well as the smoked canned meat increased as the storage period increased. This was mainly due to the decrease of nutritional components in the meat.

The amount of the acid insoluble ash was negligible because the animals were depurated for sufficient time, an observation already made by Balachandran & Surendran (1984) on clams.

The protein value for the fresh oyster meat was low as reported by Stansby (1962) for oyster. But after blanching the value increased as shown by Geiger & Borgstrom (1962) and Gall et al (1983) for fishes. After canning and storage also the protein value showed increase. This was due to the degradation of protein in the presence of proteolytic enzyme at ambient temperature. The result agreed with the observation of Taguchi et al (1982 a,b) for canned Tuna and Mackerel.

The protein content of the meat increased after freezing an observation already described by Chinnamma (1973, 1974) for crab and mussel and Badonia & Devadasan (1980) for fishes.

The alpha-amino nitrogen content of the fresh meat showed higher value as shown by Borgstrom (1962) for shell fishes. This was mainly due to the long period of starvation. The value deeply decreased after blanching and canning, since the alpha-amino nitrogen dissolve in the blanching liquid as observed by Bramstedt (1962) and Bramsnaes (1962) for fishes. But the value showed increase as the storage period increased as shown by Taguchi et al (1980 a, b) and Taguchi et al (1982 a, b).

After freezing and storage the meat had less alpha-amino nitrogen as observed by Chinnamma (1974) in mussel and Badonia & Devadasan (1980) in fishes.

The smoked oyster meat canned in oil showed less value for alpha-amino nitrogen during the initial storage period. But increased as the storage period increased.

Eventhough the fat content of the fresh oyster meat was low as observed during this study and also stated by Stansby (1962) for oysters the lipid value increased after blanching. This observation was already made by Geiger and Borgstrom (1962) and Gall et al (1983) for fishes. The increase of the lipid content during

the initial stage was due to the active binding of free fatty acid with protein. But the value decreased as the storage period increased. This result agreed with Taguchi et al (1982 b) for mackerel canned in brine.

The frozen meat showed higher value for the lipid because of hydrolysis occured during storage. The works of Shenoy & James (1972) and Chakrabarthi (1984) in frozen stored fishes showed the same result. But the frozen meat after blanching gave less value for the lipid. This was due to the dissolving factor of the hydrolysed lipid. The increase in the lipid value for the meat during canning and storage agreed with the reports of Meesemecker & Sohier (1956) cited (Broek 1965) for Sardine, Bilinski et al (1966) for Salmon and Taguchi et al (1982 a) for Tuna.

The smoked oyster canned in oil had higher value for lipid and increased as the storage period increased. Taguchi et al (1982 a) have made the same observation for Tuna canned in oil.

The glycogen content in the oyster meat was more when compared with other shell fishes. The meat after blanching showed increase in glycogen value due to the

loss of moisture content. But after canning and storage the value decreased. This was due to the maillard reaction during storage and the result agreed with the report of Taguchi *et al* (1982 b) for canned mackerel in brine.

The glycogen value showed decrease during freezing and storage but showed increase after blanching. This was mainly due to the glycolysis. The result agrees with the finding of Tomlison *et al* (1963), Heen & Karsti (1965) and Gould & Peters (1971) for fishes.

The observation showed that the drop in glycogen value was more in the brine packed meat than in the meat packed in oil. The result agrees with the report of Taguchi *et al* (1982 a,b) for canned Tuna and Mackerel.

The smoked oyster meat had more glycogen value but it decreased as the storage period increased as reported by Taguchi et al (1982 a) for canned Tuna in oil.

While comparing the nutritive value, a fact generally accepted is that the oyster meat is superior to beef and milk (Borgstrom 1962, Nowak 1970). But in general it appears that the oyster meat canned in brine had less nutritional value.

The value of the sodium content of the fresh meat was more and the blanching caused dehydration to the meat and showed increase in the sodium content. The result agrees with the studies of Causeret (1962) and Gerasimov & Antonova (1979) in fishes. The decrease in sodium content in the meat after canning and storage was due to the moisture intake which has already been described by Lopez et al (1983) for oyster C.virginica.

The frozen meat showed decrease in sodium content as described by Dyer (1972) in fishes due to leaching out process. But the blanched meat showed increase in sodium as shown above. But the increase of scdium was less than in the fresh meat blanched, which may be due to the weak ionic bond of the meat after freezing and storage.

The sodium content had more value for the frozen blanched meat canned in brine during the initial storage period and decreased as the storage period increased. This was mainly due to the pitting process of sodium chloride in the medium. The meat canned in oil had less sodium during the initial storage period and this was due to the fact that the minerals extruded along with

the moisture during sterilization (Cheftel 1965).

The studies showed that the sodium content was high in smoked oyster canned in oil. It increased as the storage period increased due to dehydration. The smoked oyster canned in wine showed less value. This may be due to the dissolving factor of the peripheral sodium in the organic acid medium in the can.

Generally the potassium content was more in oyster. During blanching the potassium content decreased and the result agrees with Mc Cance & Ship (1933) and Gall et al (1983) for fishes.

The frozen meat had less potassium and further decreased after blanching as observed by Gould & Peters (1971) for fishes. The frozen blanched meat canned in brine had low initial value for potassium but it increased as the storage period extended. The same results were observed in the frozen blanched meat canned in oil. The increase in potassium was due to the fact that it was linked with protein (Thurston 1958 cited causeret 1962, Gould & Peters 1971 for fishes).

The smoked oyster in oil had less initial value for potassium than for frozen meat. The increase of the value was due to the dehydration of the meat. The potassium content of the smoked oysters canned in tomato sauce was more than for the frozen meat and for the smoked oyster canned in oil for the same storage period. It was observed that the potassium from the vegetable medium may enter to the meat by osmosis. The smoked oyster canned in wine had less value for potassium than for the smoked oyster in oil. This may be due to the reaction of the organic acid in the wine with potassium.

The fresh meat showed high content of calcium, agrees with the observation of Venkataraman and Chari (1951) for oyster C.madrasensis. The calcium content after blanching showed a steep decrease. The result agrees with the finding of Lopez et al (1983) for ovster C.virginica. The calcium content after sterilization and storage decreased during the initial storage period which was due to diffusion and leaching out process and this result accepts with the report of Lopez et al (1983) for oyster C.virginica.

The frozen meat had low content of calcium after freezing and storage due to the leaching out of the minerals. The result agrees with the report of Arnold (1956) (cited Lawrie 1974) in meat and Dyer (1971) in fishes.

The frozen blanched meat canned in brine and in oil had less initial value but increased as the storage period increased. The same was the case with the smoked oyster in oil. The tomato sauce pack had more value due to the in take of mineral in the meat from the medium by osmosis, during storage. The calcium loss in the wine packed smoked oyster meat was may be due to the dissolving factor of the same in the organic acid contained in wine.

The inorganic phosphorus content of the fresh meat of oyster was high and blanching caused decrease for its value as observed by Mc Cance & Ship (1933), Dyer et al (1972) and Gall et al (1983) in fishes. This has decreased after storage in brine which was mainly due to the acid present in the medium and this mineral was more soluble in the acid (Tarr 1962).

Due to the degradation of organic phosphorus, the value of inorganic phosphorus was increased. The

result agrees with the reports of Lovern (1962) and Dyer et al (1972) in fishes and Chinnamma (1974) in mussel.

The fresh and the frozen blanched meat canned in brine and oil showed more inorganic phosphorus during the initial storage. But decreased as storage period increased.

The smoked oyster in oil had less initial value but increased gradually. This was due to the conversion of organic phosphorus to inorganic phosphorus. The inorganic phosphorus content of the smoked oyster canned in tomato sauce and wine had less value which was due to the dissolving factor of the inorganic phosphorus in the acid medium.

Generally, the iron content showed high value in the oyster meat. Iron value was increased after blanching. The blanching had very slight effect on the iron content and this agrees with the works of Gall et al (1983) in fishes and Lopez et al (1983) in oyster C.virginica.

The iron showed decrease for the frozen meat but increased after blanching. The result agrees with the work of Fenton (1960) in meat.

The iron value decreased due to the in take of moisture in the meat (Lopez et al 1983). The meat canned in brine and in oil showed that the value gradually decreased as the storage period increased. A heavy loss was observed for the brine pack. This was due to the reaction of chloride with the iron content of the meat and agrees with the report of Watts (1954) for meat. The degradation of iron in oil pack was due to the reaction of the solid sodium chloride in the solid state (Mallette et al 1968). The increase of iron content in the smoked oyster in oil was due to dehydration.

In general, it was observed that the oyster in fresh state have adequate mineral, but blanching and freezing cause decrease to these values except in the case of iron.

5. SUMMARY

The study was undertaken with the aim to study the variation of different components in the drip/liquid and meat sampled at different stages of processing. The fresh and the frozen oyster meat were canned in Tin and in Aluminium cans. Various media like brine, oil, tomato sauce and wine were used. Observations were made physically and chemically for the drip/liquids and the meat at different stages of processing. The chemical analysis were made for certain nutritional and mineral components.

The physical observations showed that the nectar, dipping solution, thawed-drip, blanched liquid and can liquid were opalescent. The oplescency of the can liquid increased as the storage period increased and give pink/ purple colour with iodine solution.

The thawed liquid had more protein and the values of the can liquid increased as the storage period increased but the moisture content has decreased. The can liquid from smoked oyster had high content of protein.

The observation revealed that the yield of the fresh meat was about 5.3% and the weight loss after

acid dipping was 1.1%, the thaw loss was about 10.3% and the blanching reduced the weight to its half. But brining increased the weight of the meat about 1.8% and the weight loss after smoking was about 42.3%.

It was observed that the storage caused weight loss and loss in firness, flavour etc. as the storage period increased.

It was observed that the k.calorie value depended on the nutritive value and was influenced by the moisture content. The k.calorie value increased after blanching and freezing. High content of k.calorie value was observed in the oil packed meat. The meat showed that the moisture content decreased after blanching and freezing and the meat acts as a osmoconformer in brine medium and moisture loss occured in oil packed meat. The ash content of the meat increased after blanching but decreased after frozen storage. But the value increased as storage period increased irrespective of the medium.

The protein content showed that it increased after blanching, frozen storage and canning irrespective of the medium. The result revealed that the alpha-amino nitrogen content decreased after blanching and frozen

storage. But the value increased as the storage period increased irrespective of the medium. The lipid content of the meat was more after blanching and frozen storage. The value in brine and oil pack of the blanched meat decreased on the storage period increased. But the smoked oyster in oil showed that the lipid content increased as the storage period increased. The glycogen value increased after blanching but decreased after freezing. The value decreased as the storage period increased in the canned meat prepared in different media.

The results showed that the mineral, sodium increased after blanching but decreased after frozen storage. The value decreased in the fresh and in the frozen blanched meat canned in oil and in brine. But the smoked oyster meat canned in oil had high content and was increasing as the storage period increased.

The result showed that the potassium content of the meat decreased after blanching and frozen storage. But the value increased as the storage period increased irrespective of the medium. The observations showed that the mineral, calcium had the same results

as that of the potassium. The phosphorus content of the meat showed that it decreased after blanching but increased after frozen storage. The value decreased after canning and storage except in the smoked oyster meat canned in oil. The iron content of the meat was not affected by blanching but it had slightly decreased after frozen storage. The value decreased after canning as the storage period increased.

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+Not refered in original

Fig. 1. GENERAL VIEW OF THE OYSTER CULTURE BED.

Fig.2. HARVESTED OYSTERS READY FOR DEPURATION.

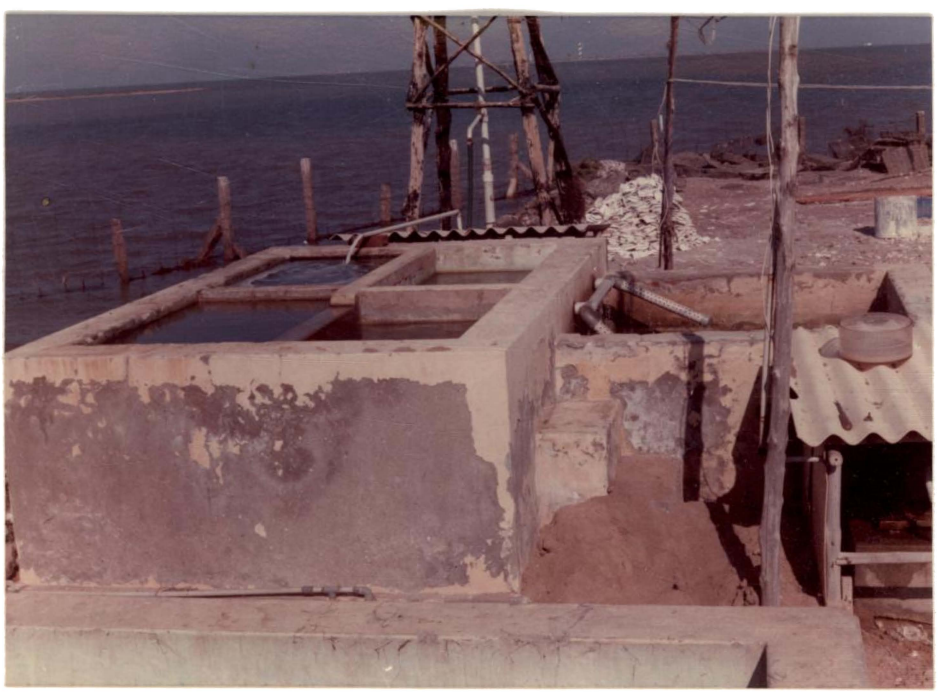

Fig.3. DEPURATION TANK WITH RUNNING FILTERED SEA WATER.

Fig.4. DEPURATED OYSTER READY FOR HEAT DIPPING.

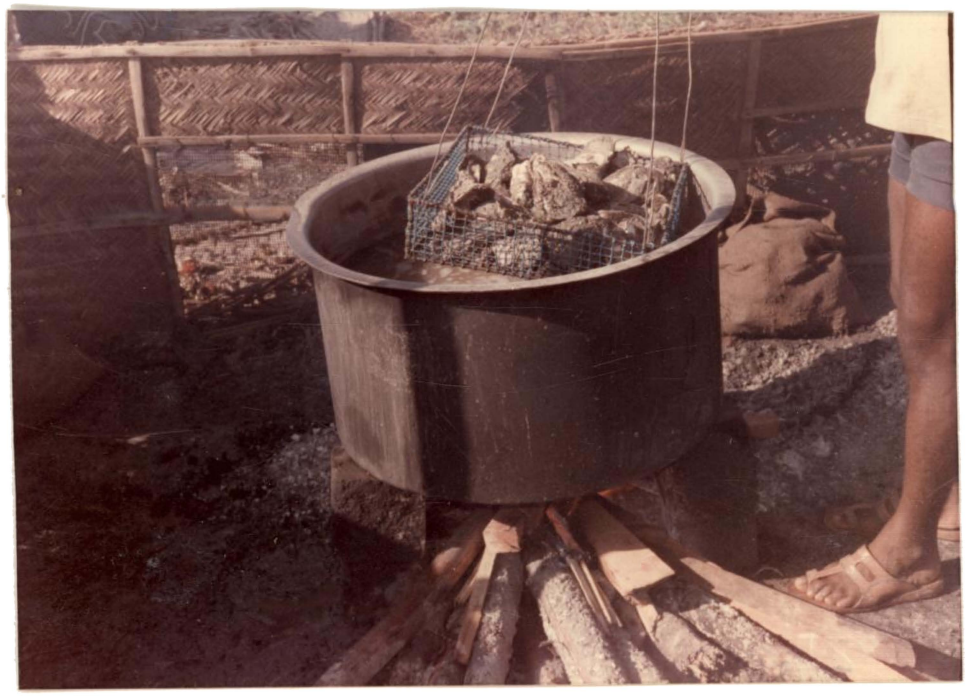

Fig.5. HEAT DIPPING PROCESS.

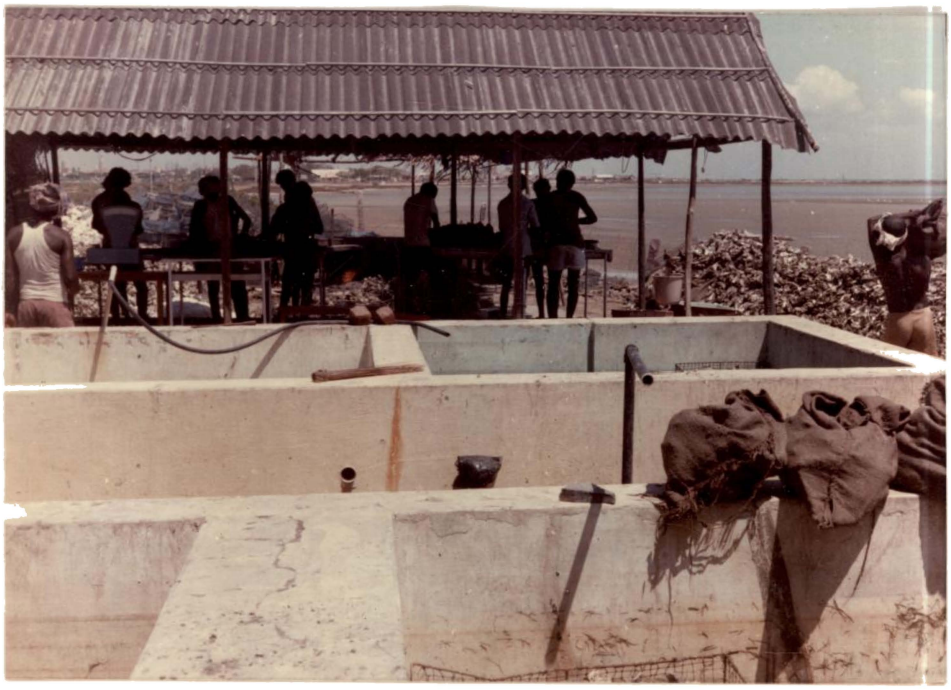

Fig.6. SHUCKING YARD-GENERAL VIEW.

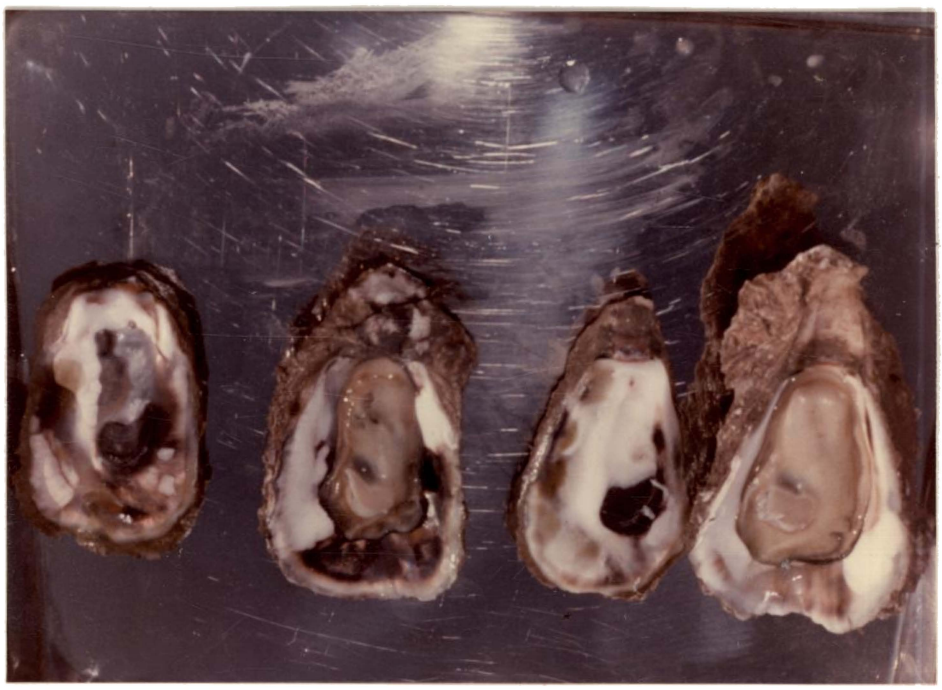

Fig.7. MEAT IN THE SHELL (HALF-SHELL)

Fig.8. SHUCKED MEAT.

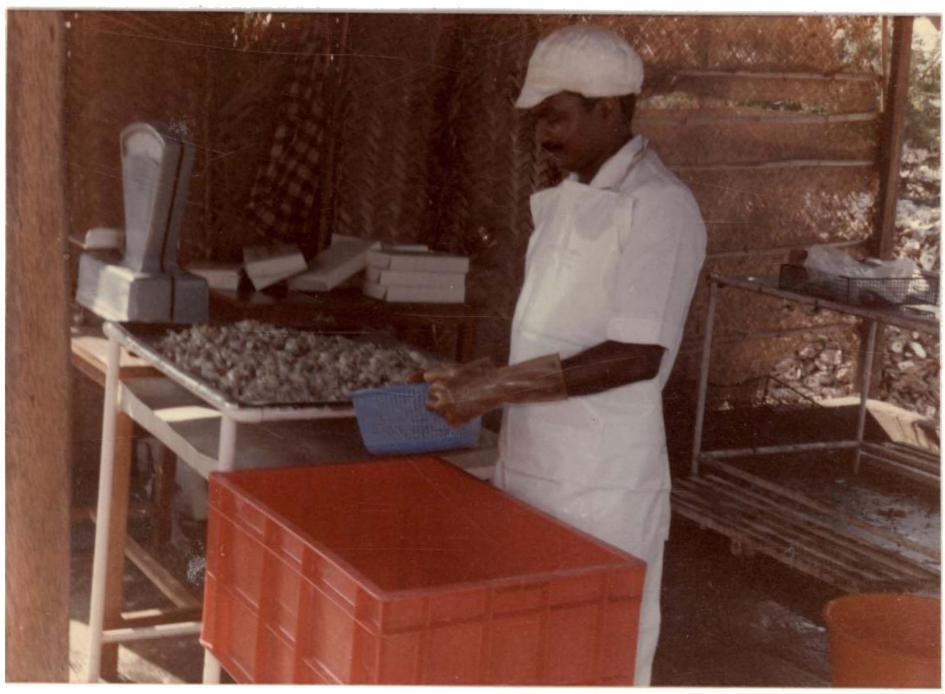

Fig.9. MEAT-READY FOR ACID DIPPING.

Fig.10. ACID DIPPED MEAT ON THE DRAINING TABLE.

Fig.11. PACKING IN 2 kg.PACKS IN POLYETHANE BAG.

Fig.12. PACKING IN 2 kg.PACKS IN WAX COATED CARTON WITH POLYETHANE LINING.

Fig.13. ARRANGING IN TRAYS FOR CONTACT FREEZING.

Fig.14. LOADING IN CONTACT FREEZER.

Fig.15. PACKING IN MASTER CARTON.

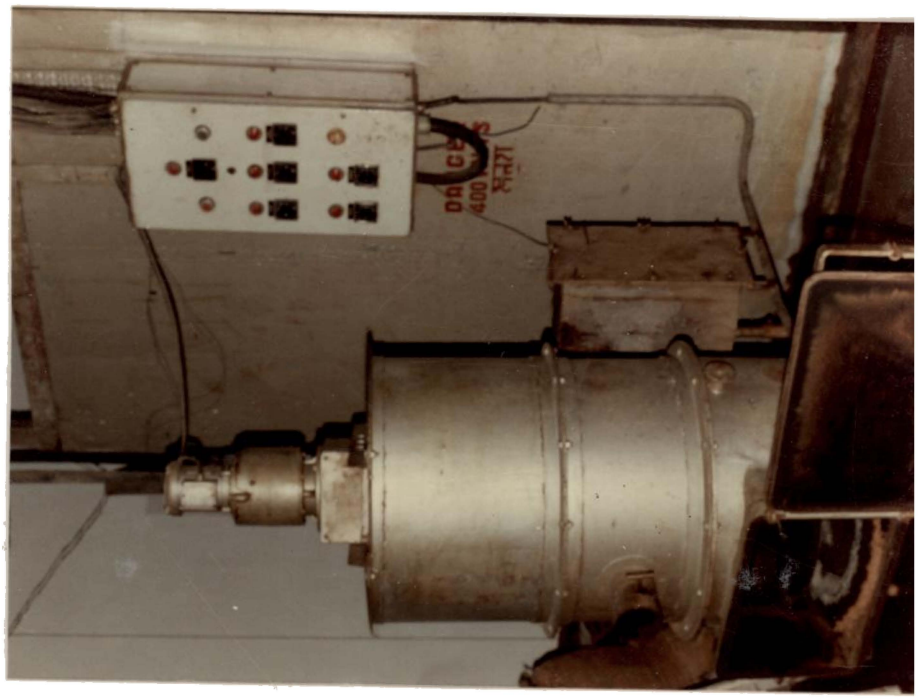

Fig.16. SMOKING CHAMBER.

Fig.17. OYSTERS ARRANGED IN TROLLYS IN THE SMOKING CHAMBER.

Fig.18. SMOKED OYSTER MEAT.

Fig.19. WEIGHING OF OYSTER MEAT
BEFORE CANNING.

Fig.20. ARRANGING OF OYSTER MEAT IN THE CANS BEFORE ADDING THE MEDIA.

Fig.21. SEMI-AUTO SEAMING MACHINE

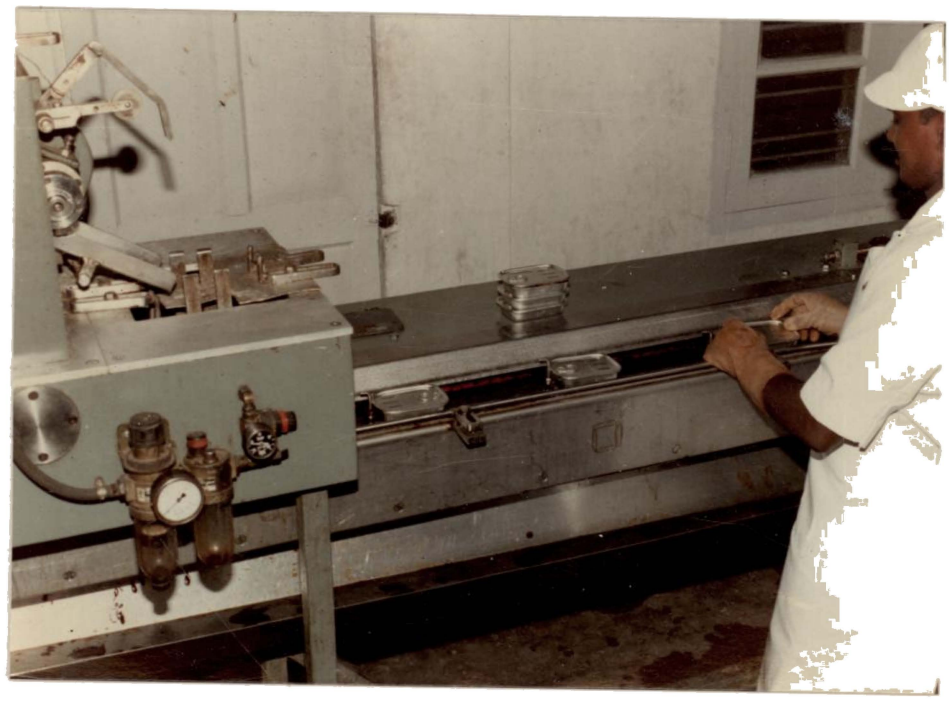

Fig.22. AUTO-SEAMING MACHINE.

Fig.23. LOADING IN AUTO-CLAVE FOR STERILIZATION.

Fig.24. FINISHED PRODUCT WITH LABELLS.

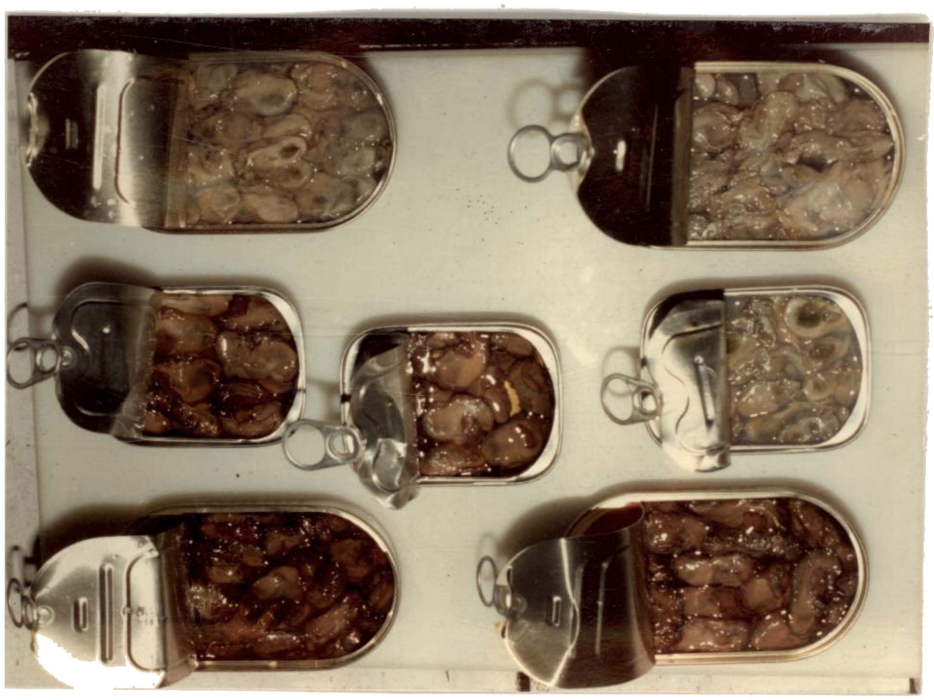

Fig.25. OPENED CANS SHOWING DIFFERENT PRODUCTS OF OYSTER MEAT.