

PART I

GENERAL

QUALITY CONTROL IN THE INDIAN FISH PROCESSING INDUSTRY

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Quality control is defined as the continuing assessment of a current operation. It is usually the responsibility of an individual or a department directly responsible to the management. In the case of fish and fishery products, quality control includes all the steps taken to protect the quality of the material since catch till it reaches the consumer.

Quality is commonly thought of as degree of excellence. It may be defined as the composite of those characteristics that differentiate individual units of a product and have significance in determining the degree of acceptability of that unit by the buyer. In considering the quality of fish and fishery products, significance is attached to physical, biochemical, organoleptic and bacterial characteristics.

The objectives of quality control are: reduction of rejects, maintenance of uniform quality, increased customer satisfaction and employee morale, and minimising costs. The responsibilities of quality control department are the following: (1) Formulation of specifications for raw materials, supplies, inplant processes,

containers and finished products including shelf-life. (2) Development of test procedures. Quality levels and production variables are to be tested on some scale. (3) Development of sampling schedule: Since 100% inspection is not feasible or desirable, it is the function of quality control department to establish the number of units and frequency of sampling so that quality may be evaluated with maximum reliability at minimum cost. (5) Forms for recording and reporting, preparation of quality control charts etc. Attending to troubles and advice stoppage of production or rectification of defect. (6) Attending to special problems regarding quality and complaints. (7) Training of personnel.

Before going into the details of quality control of fish and fishery products, it is to be noted that there is a lot of difference between the quality control of meat products and that of fish. Meat and meat products are harvested under ideal conditions - that is, the right type of animal is slaughtered at the right time and at the right place. In the case of fish, they are harvested from stocks of unknown identity as to age, sex etc. under the most difficult

conditions. Hence the intrinsic quality varies in all possible combinations. Even with fish, quality control is comparatively easier in certain parts of the world, where there is limited species of fish in very large quantities. This is not so as far as the tropical fisheries are concerned. There are very large number of species in very limited quantities making quality control measures more difficult.

Though quality control is in principle the responsibility of the industry, major contributions in this field have been made in our fish processing industry by Governmental Agencies. This happened to be so because of the peculiar nature of the birth and growth of the fishery industry. Even today our fish processing industry is cent percent export oriented with only a few types of products. The credit of establishing the industry as what it is today goes to the private sector. Their limited financial resources and the good export earning created environments for establishment and active participation of Governmental Agencies in the industry. One such Agency is the Central Institute of Fisheries Technology, Cochin, which has been actively engaged in the quality control programmes related to fish and fishery products with the full co-operation of the industry.

It is worth examining to what extent the responsibilities were carried out so as to achieve the objectives.

SPECIFICATIONS FOR FISH, FISHERY PRODUCTS AND PROCESSES

The national standard specifications are published by the Indian Standards Institution. The standard specifications on fish, fishery products and processes are developed by the committees on fresh and

frozen, canned, and dried products under the Division Council of Agriculture and Food products. The committees are represented by Institutions / Organisations engaged in research, trade organisations, industry, Government and ISI. The draft standard specifications for several of the standards were worked out by the Central Institute of Fisheries Technology. So far the following standard specifications have been brought out by ISI (Table I).

In addition to these standards, new ones are being formulated and some of the existing ones are being revised. These national standards formed the basis for the preshipment inspection at present being carried out by the export Inspection Agency.

SALIENT FEATURES OF THE NATIONAL STANDARDS

The Indian Standard specifications for fish and fishery products have the following parts: (1) Scope of the standard (2) Terminology (3) Grades (4) Preparation of the material (5) Requirements (6) Packing and marking (7) Sampling (8) Tests.

The requirements of the products can be divided under four heads as follows: (1) Requirements for physical aspects like weight, size etc. (2) Chemical characteristics like sodium chloride content, acid content, metal content, sand content etc. (3) Microbiological requirements relating to the maximum total numbers of bacteria and particular types of bacteria (3) Organoleptic criteria relating to appearance, colour, texture, odour and flavour.

Each group of products and their minimum requirements are, in general, as follows:

TABLE I

INDIAN STANDARD SPECIFICATIONS RELATED TO FISH,
FISHERY PRODUCTS AND PROCESS

S. No.	Name of specification	Specification Number & Year of Publication
1	2	3
<i>A. Fresh fish</i>		
1.	Fresh silver pomphret and brown pomphret	IS: 4780 — 1968
2.	Fresh threadfin	IS: 4781 — 1968
3.	Mackerel, fresh	IS: 6032 — 1971
<i>B. Frozen fish & shell fish</i>		
4.	Frozen prawns (shrimp) (first revision)	IS: 2237 — 1971
5.	Frozen froglegs	IS: 2885 — 1964
6.	Frozen lobster tails	IS: 3892 — 1966
7.	Frozen silver pomphrets and brown pomphrets	IS: 4793 — 1968
8.	Frozen threadfin	IS: 4796 — 1968
9.	Mackerel, frozen	IS: 6033 — 1971
10.	Seer fish (<i>Scomberomorus</i> spp), frozen	IS: 6122 — 1971
<i>C. Canned fish & shell fish</i>		
11.	Pomphret canned in oil	IS: 2168 — 1962
12.	Prawns (shrimp) canned in brine (first revision)	IS: 2236 — 1968
13.	Mackerel (<i>Rastrelliger</i> spp) canned in oil	IS: 2420 — 1963
14.	Sardines (<i>Sardinella</i> spp) canned in oil	IS: 2421 — 1963
15.	<i>Lactarius</i> spp. canned in oil	IS: 6121 — 1971
16.	Mackerel (<i>Rastrelliger</i> spp) canned in brine	IS: 3849 — 1966
17.	Tuna canned in oil	IS: 4304 — 1967
<i>D. Dried fish & shell fish</i>		
18.	Dried prawn pulp	IS: 2345 — 1963
19.	Dried white baits (<i>Anchoviella</i> spp)	IS: 2883 — 1964
20.	Dried and laminated Bombay duck	IS: 2884 — 1964
21.	Dry salted mackerel	IS: 4302 — 1967
22.	Dry salted seer fish	IS: 5198 — 1969
23.	Dry salted shark	IS: 5199 — 1969
24.	Dry salted suran (tuna)	IS: 5736 — 1970
25.	Dry salted threadfin (Dara) and dry salted jew fish (Ghol)	IS: 3850 — 1966

1	2	3
26.	Dry salted cat fish	IS: 3851 — 1966
27.	Dry salted leather jacket (<i>Chorinemus</i> spp)	IS: 3852 — 1963
28.	Dry salted horse mackerel (<i>Caranx</i> spp)	IS: 3853 — 1963
29.	Dried shark fin	IS: 5471 — 1969
30.	Fish maws	IS: 5472 — 1669
E. Miscellaneous		
31.	Code for sanitary conditions, handling and transport in fish industry. Part I. Preprocessing stage	IS: 4303 — Part I 1967
32.	—do— Part II. Sanitary conditions for fish processing units	IS: 4303 — Part II 1967
33.	Recommendations for maintenance of cleanliness in fish industry	IS: 5735 — 1970
34.	Fish meal as livestock feed	IS: 4307 — 1967
35.	Shark liver oil for veterinary use	IS: 3336 — 1965
36.	Sardine oil	IS: 5734 — 1970

A) FRESH FISH

There are only three products for which specifications are available under this group. They are pomphrets, threadfin and mackerel. Though this group must have received more attention, it did not, because of the lack of an organised trade. As a rule, fresh fish in our country move only in internal trade and till recently it was rather of local or regional importance because of lack of technical knowhow or lack of facilities for fast movement required for much a perishable commodity like fresh fish. The unlimited number of species available in very limited quantities also make application of uniform methods for preservation impracticable thus indirectly making quality control more difficult.

The quality requirements for fresh fish

relate to the species, size, temperature of the fish, method of icing, freedom from spoilage as examined visually - the gills, eyes, belly cavity, elasticity of the muscle, flavour, colour and odour of cooked muscle. The microbiological requirements are shown in Table II.

B) FROZEN FISH AND SHELL FISH

Indian Standard specifications are available for shrimp, froglegs, lobster tails pomphrets, threadfin, mackerel and seer fish. The first three items are important export commodities while others are of importance in internal trade only. Because of the export performance shrimp, frog legs and lobster tails received better attention with regard to quality.

The main quality requirements for these frozen commodities relate to dehy-

TABLE II

MICROBIOLOGICAL REQUIREMENTS FOR FRESH & FROZEN FISH AND SHELL FISH
(Bacterial count maximum/g.)

Sl. No.	Name of fish / shell fish	Fresh / Frozen	SPC	E. coli.	Salmo- nella	Coagulase positive staphylococci	Faecal strepto- cocci.
1.	Mackerel	Fresh	1,00,000	20	Nil	—	—
2.	Threadfin	Fresh	1,00,000	20	„	—	—
3.	Pomfrets	Fresh	1,00,000	20	„	—	—
4.	Mackerel	Frozen	1,00,000	10	„	—	—
5.	Threadfin	Frozen	1,00,000	10	„	—	—
6.	Pomfrets	Frozen	1,00,000	10	„	—	—
7.	Seer fish	Frozen	1,00,000	10	„	—	—
8.	Froglegs	Frozen	5,00,000	10	„	—	—
9.	Lobster tails	Frozen	4,00,000	20	„	—	—
10.	Praws (whole & headless)	Frozen	5,00,000	20	„	100	1,000
11.	Prawns (peeled & deveined)	Frozen	10,00,000	20	„	100	1,000
12.	Prawns (cooked)	Frozen	1,00,000	20	„	100	1,00

TABLE III
REQUIREMENTS FOR CANNED FISH AND SHELL FISH

Sl. No.	Characteristics	Requirements for						
		Tuna O	Prawns B	Pomfrets O	Mackerel B	Mackerel O	Sardines O	<i>Lactarius</i> spp. O
1.	Can exterior	Shall not be rusted, dented or bulged.						
2.	Vacuum in mm (min) for round cans.	100 in all cases or negative pressure in flat cans,						
3.	Head space mm.	5-10 in all.						
4.	Drained weight of the contents of the can as % of water capacity	70	64	66	65	65	70	65
5.	Proportion of water in drained liquid (max).	5	—	10	—	10	10	10
6.	Disintegrated portion as % of drained weight (max).	5	5	5	5	5	5	5
7.	Trace elements, ppm, (max).	Cu 12	As 1	Pb 5	Zn 50	Sn 250	—	—
8.	Can interior	Normal i.e., free from discolouration, etc.						
9.	Microbiological activity.	Absent in all cases.						

Note: O = Oil pack; B = Brine pack.

dration, drained weight, size, grade, discolouration, deterioration, organoleptic characteristics and microbiological requirements. The microbiological requirements are shown in Table II.

C) CANNED FISH AND SHELL FISH

The products covered by Indian standards in this group are prawns in brine, mackerel in brine and oil, sardine, tuna, *lactarius* spp. and pomfret in oil. Of these, the greatest attention is probably paid to prawns in brine because of the stringent quality specified by the foreign buyers.

The quality requirements of canned products usually relate to the external appearance of the can, vacuum, fill volume, and its nature, drained weight, foreign material, texture, odour, colour and flavour nature of can interior and microbiological requirements. These are shown in Table III.

D) DRIED FISH AND SHELL FISH

Thirteen products are covered by specifications and they are important both in internal and export trade. The requirements mainly relate to size, freedom from infestation with fungus and mites, freedom from excessive sand and salt, absence of deterioration etc. Requirements relating to moisture, salt and sand for these products are shown in Table IV.

E) MISCELLANEOUS

The Indian Standard specification for fish meal as livestock feed specifies maximum moisture and fat contents of 10% each and minimum protein content of 50%. The maximum sand content is 5%. The specifications for sardine oil and shark liver oil for veterinary use relate to the degradation products, colour, taste, saponification and iodine values and of stearin content.

The three recommendations on fish plant sanitation are of paramount importance in keeping the products microbiologically safe. These recommendations specify in clear terms, the sanitary and hygienic precautions to be adopted right from catch till they are shipped. These recommendations are based on the experience gained in our fish processing industry and is found to be effective in producing microbiologically safe products.

COMMON QUALITY DEFECTS IN FISHERY PRODUCTS, THEIR CAUSES AND RECTIFICATION

A) FRESH FISH

Scientifically documented information on this group of products is lacking. However limited observations on our fresh fish trade have brought out the following :- 1) Inadequate bleeding resulting in discolouration of the meat. It is essential that all reasonably large fish are bled immediately after catch. This can be done by cutting the throat of the fish immediately after catch with a sharp knife and allowing it to bleed thoroughly in ice cold water for half an hour. Inadequate bleeding may cause discolouration of fish and enhanced rancidity of frozen fillets prepared from them. 2) Pieces of intestines and liver remaining on the gutted fish which cause discolouration and spoilage. It is essential that the intestines and liver are completely removed during gutting. 3) Squeezed appearance of the fish because of undue pressure on it. When fish are stored in ice, the depth should not be more than one meter. Similarly, when fish are packed, the size of the container shall be such that it can hold the specified quantity of fish and ice without applying external pressure. 4) Improper icing resulting in spoilage of the fish. 5) Spoiled odours due to

preicing spoilage. 6) Contamination of the fish with bacteria of public health significance. This can be controlled by using chlorinated water in washing and maintaining good sanitary conditions on the boat and in the packing centres. 7) Disruption of belly walls in small sized feedy fish such as sardines and mackerels. This is due to enzyme reactions and it has been shown that at least in oil sardines, this can be controlled by dipping in 15% sodium chloride solution for 30 minutes.

In prawns and lobsters, one of the serious problems is black spot development. Removal of the head and icing of the catch immediately after hauling retard this phenomenon considerably. Treatment with sodium bisulphite is effective, but it is not permitted.

B) FROZEN FISH AND SHELL FISH

Much has been studied on quality changes in prawns during frozen storage. 1) One of the defects in thaw-drip loss and shrunken appearance of the thawed sample. This can now be prevented by treatment with phosphate solutions. 2) Dehydration or freezer burn seen on the surface of frozen fish or shell fish can be controlled by proper glazing, packaging and constant temperature of storage. 3) Rancid taste and odour in oily fishes like sardines, mackerels, seer fish, pomfret etc. Though glazing with water containing antioxidants may improve the conditions, the best advisable method is very low temperature storage (-30°C). In fillets, incomplete removal of red meat and improper bleeding may hasten rancidity development. 4) Microbiological defects due to very high total bacterial count or presence of micro-organisms of public health significance. Improved sanitary conditions are necessary. 5) Dete-

rioration and discolouration present even before freezing.

C) CANNED FISH AND FISHERY PRODUCTS

Perhaps prawns canned in brine is the most elaborately studied followed by sardines, tuna and mackerel. The defects usually observed are:- 1) Rusting of can exterior especially at the double seams. This is due to the condensation of moisture at these points resulting in corrosion. The precautionary measures include (a) Processed cans should not be cooled below 37°C . When cooled down to 37°C , the water can evaporate on storage. b) The cans may be wiped free of moisture before storing. c) Use of chemically satisfactory quality of water for can cooling. d) Use of anti-rusting chemicals. e) The labels should not contain corrosive ingredients. 2) Lack of vacuum or bulging:- This may be due to a) overfilling b) lack of proper exhausting c) chemical reaction between product and acid in can producing hydrogen d) bacterial activity e) leakage through the double seam. 3) Under weight or over weight in canned prawns due to under blanching, or over blanching. Time of blanching, concentration of sodium chloride and citric acid in the blanching brine has to be carefully controlled. 4) Colloidal brine due to poor quality raw material or over-processing. 5) Blackening due to formation of Copper and Iron sulphides. This can be prevented by avoiding contamination with Copper and Iron, by adjusting the acidity in the blanching and filling brines and by addition of EDTA. 6) Defects in can interior like pitting, corrosion or blackening. 7) Microbiological defects. Recommendations to improve the bacterial quality include improvement in general sanitary conditions, proper adjustment of time and temperature of processing, chlorination of

TABLE IV
REQUIREMENTS FOR DRIED FISH & SHELL FISH

Sl. No.	Characteristics	White Baits	Tuna (Surai)	Prawn pulp	Dried Bombay duck	Lami-nated Bombay duck	Mackerel (dry salted).	Catfish (dry salted).	Dara (dry salted)	Ghol (dry salted)	Leather Jacket	Horse mack-erel.	Shark	Seer
1.	Moisture % (max)	20	35.0	20	15.0	15	35	35	45	40	40	40	40	45
2.	Sodium chloride % (max)	2.5	25.0	5	7.5	6	25	25	25	20	25	25	30	30
3.	Acid insoluble ash % (max)	7.0	1.5	1.0	1.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5

water used for can cooling and frequent check of the formed seams and seaming machinery. 8) In fish canned in oil presence of higher amounts of water in the drained liquid. This can be controlled by proper precooking. 9) Physical and organoleptic defects like presence of foreign material, poor odour etc. In the case of canned tuna inadequate bleeding of the fish causes formation of very small black dots on the canned product.

D) DRIED PRODUCTS

Usually observed quality defects in this category of products are: 1) inadequate drying limiting the shelflife, 2) heavy admixture with sand due to drying of the product on the open beach, 3) low salt content and 4) attack by fungus, mites etc. resulting in extreme cases pink and dun and porous appearance of the product.

E) MISCELLANEOUS

The quality defects noted in the fish meal samples are as follows in decreasing importance: 1) heavy sand content, 2) low protein, 3) high salt content, 4) higher amounts of total volatile bases, 5) higher moisture or fat content. The sand content is usually high in samples prepared from dried fish and those mixed with prawn head meal. Low protein content is attributable to the loss of solubles along with press liquor.

In sardine oil, the main defects relate to lack of proper colour or discolouration, high free fatty acid content, and bad odours.

INSPECTION OF FISH AND FISHERY PRODUCTS

Fish inspection consists of the moni-

toring which is necessary to measure the effectiveness of quality control procedure and also those official devices which are used to protect the consumer and facilitate trade. Thus it can be seen that inspection applies to the end products whereas quality control applies to all the steps that lead to the formation of the end product.

The Indian fish processing industry can be proud of possessing a well developed preshipment inspection system for almost all the fish and fishery products exported. The credit of establishing this system goes to the initiative, imagination and hard work of late Dr. V. K. Pillai. Though the quality control measure, quality standards and the inspection system originated in our country because of the stringent quality requirements of our foreign buyers we have now reached a stage when we can supply quality products to any of the sophisticated markets in the world. Important among the products included under the Preshipment Inspection Scheme are frozen prawns, frozen frog-legs, frozen lobster tails and canned prawns. The system was first introduced on a voluntary basis followed by compulsory inspection. Even in the compulsory inspection system, application of quality standards was step-wise, the physical and organoleptic aspects only being looked into in the beginning followed by the microbiological requirements. The step-wise system of implementation has in fact given the processors enough time to come upto the expected standards. The system of preshipment inspection is at present carried out by the Export Inspection Agency under the Export Inspection Council, Ministry of Commerce and Industry, Govt. of India, though it was with the Central Institute of Fisheries Technology, Cochin till the beginning of 1968 under

the able guidance of Dr. V. K. Pillai. The system is well appreciated by the industry and by the foreign buyers. The inspection has helped the industry to produce more uniform and better quality products. Grading mistakes, short weights, presence of foreign materials etc. are almost completely overcome. A small amount of money is collected as inspection fee by the Export Inspection Agency to meet the running expenditure.

However, as the processors always point out, there are certain pre-requisites which are to be guaranteed by the Government when compulsory system of inspection is in practice. These pre-requisites are an abundant supply of potable water and an uninterrupted supply of electricity. These have to be met with to hasten the process of attainment of top quality products. Secondly, the system of inspection and certification should be such that the goods shall be cleared for export very expeditiously. This is very important in view of the difficulties in getting reefer space, etc. and the financial strain on the exporters due to delayed realization of the prices. Thirdly, it should be remembered that an Inspection Officer is primarily a technical adviser to the processor but with reserve powers of an enforcement officer.

INTERNATIONAL STANDARDS FOR FISH AND FISHERY PRODUCTS (CODEX ALIMENTARIUS)

The development of international trade in food products necessitated international standards of purity, identity and quality for these products. This has resulted in the establishment of Codex Alimentarius in 1962 under the joint auspices of the FAO and WHO of the UN. The purpose of Codex Alimentarius is to collect

internationally adopted food standards and present them in a uniform manner. These standards aim at protecting the consumer's health and ensuing fair practices in the food trade. The Codex Alimentarius also includes provisions of an advisory nature in the forms of codes of practice, guidelines and other recommended measures intended to assist in achieving the purpose of Codex Alimentarius. The publication of a Codex standard involves ten steps and is naturally laborious.

The Codex Committees are subsidiary bodies of Codex Alimentarius and the committees are the responsibility of the host countries which provide the Committee Chairman and meet general expenses incurred for such meetings. The Codex Committee on Fish and Fishery products is hosted by Norway and the Chairman is Dr. O. E. Braekken of Govt. Vitamin Laboratory, Bergen, Norway. This committee was able to initiate the preparation of nearly twenty standards. Some of these have been advanced to the final step and others are in various stages of finalization. The proforma for a Codex standard is usually as follows:- name of the standard, scope, description, essential composition and quality characteristics, food additives, contaminants, hygiene, weight and measures, labelling, methods of analysis and sampling. The standards on which work has been initiated/finalised are the following:- canned salmon, canned shrimp, canned tuna, canned crab meat, canned mackerel, canned sardines, frozen gutted pacific salmon, fillets of cod, haddock, ocean perch, fillets of flat fish, blocks of cod, haddock and ocean perch, codes of practice for fresh fish, frozen fish, canned fish, smoked fish, and molluscan shell fish.

QUALITY CONTROL RESEARCH IN THE INDIAN FISH PROCESSING INDUSTRY.

The purpose of research work in fish processing industry is to make available to the consumer a product that is wholesome and palatable at reasonable prices. Quality Control Research is of supreme importance in achieving this objective. Considerable amount of work has been done on this aspect by Central Institute of Fisheries Technology, Cochin. Some of the noteworthy results attained during the years are enumerated below :-

1) Chilled water has been shown to be better than non-chilled water in prawn processing work resulting in lower rate of spoilage and hence better quality finished products (Pillai and Lekshmy, 1961).

2) Spoilage pattern of prawns were studied during storage at room temperature, ice temperature and frozen storage temperature. (Velankar *et.al*, 1961, 1962a; Susamma *et.al*, 1962; Pillai *et.al*, 1961; Lekshmy *et.al*, 1962 & 1962a; Govindan, 1962 & 1962 a). These studies showed that after four hours at room temperature prawns start spoiling and that total bacterial counts, TMA and TVN can be used to assess quality. During storage at 0°C, the rate of spoilage depends on the extent of processing like beheading, peeling and deveining, of the raw material and that the objective indices can be used to assess quality. However, when they are stored in contact with ice, the values of TMA, TVN etc. show erratic trend due to leaching and that these are unreliable as quality indices. Under such conditions, a measure of water extractable nitrogen, total non-protein nitrogen and free α -NH₂-N give a good picture of quality and methods have been suggested for rapid estimation of both the water

extractable nitrogen and free α . NH₂-N. It was also shown that nearly 30% of the solids are lost from peeled and deveined prawns during storage in ice for a fortnight. The quality characteristics of frozen prawns prepared from raw prawns stored in ice for varying periods showed that after 3 days in ice, the material is of little use as raw material for freezing purposes. During frozen storage, the main deteriorative changes were shown to be toughening of the texture, discolouration and loss of flavour. A rapid procedure was standardised for the approximation of bacterial load on raw prawns. (Mathen *et.al*, 1964, 1965, 1965 a)

3) The adverse changes in prawns during frozen storage, mainly the thaw drip loss, could be effectively prevented by phosphate treatment (Mathen *et.al*, 1968, 1970, 1970 a, 1970 b). This treatment was also shown to be good in reducing the cook drip losses. (Mathen *et.al*, 1972) Glazing of frozen prawns with a mixture of 0.5% each of sodium chloride and sucrose was shown to be better than a water glaze or no-glaze (Mathen *et.al*, 1970 c). Glazing with agar-agar was found to extend shelf-life of frozen oil sardines (Mathen *et.al*, 1966).

4) The quality of cooked frozen prawns was exhaustively studied and the conditions were standardised for production of bacteriologically sound cooked frozen prawns. (Iyer *et.al* 1969, 1969 a)

5) A method has been worked out for the manufacture of microbiologically sound froglegs (Iyer *et.al*, 1968; Pillai *et.al*, 1969)

6) Proper cleaning methods were worked out for fishing boats, prawn handling centres and for vehicles used for

transportation of fish and fishery products (Iyer *et.al*, 1965). The sources of contamination of prawns during the different stages of processing have been pointed out. (Pillai, *et.al*, 1965; Iyer *et.al*, 1966). The importance of plant cleanliness, personal hygiene, chlorination of water etc. has been clearly brought out. A pro-forma has been prepared for scoring the factories for sanitary and hygienic conditions (Iyer and Kandoran, 1972)

7) The incidence, methods of detection, isolation and enumeration, survival during different stages of processing and during storage of the frozen material of micro - organisms of public health significance have been studied in detail (Lekshmy, *et. al*, 1969; Iyer *et. al*, 1969 a). The comparative merits and demerits of the different groups of organisms used as faecal indicators have been studied. These studies were of use in interpreting the results of bacteriological analysis.

8) Surveys on the quality of frozen frogs, frozen lobster tails (Mathen and Choudhuri, 1969) frozen prawns, canned prawns, dried prawn pulp (Lekshmy *et. al*, 1962 b), dried and laminated Bombay duck (Kandoran *et. al*, 1969), dried shark (Mathen, 1970 d) etc. were carried out. These surveys were of immense use in drawing up standard specifications for these products and to define the quality characteristics. Surveys were also carried out on quality of water used in fish processing industry with their sources and the influence of chemical characteristics on the quality of the finished product (Mathen, 1971; Francis and Mathen, 1973). These results were of use in interpreting the data on water analysis.

9) The causes for development of blackening in canned prawns and methods

for its prevention were worked out (Nandakumaran *et. al*, 1969, 1970; Choudhuri, 1970). Detailed studies showed that blackening in canned prawns is due to contamination with copper and iron probably from water, ice, utensils etc. and that proper adjustment of acidity can prevent it in marine prawns. In back water prawns, addition of EDTA disodium salt has been found to be useful in preventing blackening (Mathen, 1972)

10) In products canned in oil, say sardines, mackerel, tuna, pomfret, lactarius etc. large volumes of water have been observed in the drained liquid which cause rapid deterioration of both the contents and the container. Conditions have been standardised to prevent the formation of excess water (Varma, *et. al*, 1970)

11) Detailed studies on the optimum condition of blanching and processing of prawns were carried out, revealing the equilibrium moisture level in canned prawns to be 72% and optimum processing time to be 18 minutes at 10 lbs steam pressure. (Choudhuri and Balachandran, 1965; Varma, *et. al*, 1965)

12) Belly bursting - disruption of belly walls - of sardines have been found to be preventable by a pretreatment with NaCl solution, thereby improving its acceptability (Perigreen *et. al*, 1969)

13) For long storage of dried fish and fish products, a suitable preservative have been formulated. Pickled fish could be stored for long time by treatment with propionic acid (Valsan. *et.al*, 1961)

14) A pleasant smelling deodorant for use in fish processing plants and an antiseptic to improve the hygienic conditions of prawn handlers have been for-

mulated and recommended to the industry. (Iyer, 1963)

15) Regular surveys are done on the sanitation of prawn processing factories and on the sanitary quality of frozen prawns, so that both can be improved. It has been noted that during the years there has been drastic reduction in the incidence of frozen prawns with very poor bacterial quality. In almost all plants, regular chlorination procedures, cleaning schedules etc. are carried out.

TRAINING OF PERSONNEL:

Training of personnels in the industry is an integral part of any quality control programme. They have to be made aware of the significance of all the do's and donot's followed in the industry and also of the latest developments. Furthermore, they should be made quality minded. Then only the developments worked out by scientists and technologists will reflect in the industry. Though there are several training schemes under various government organisations, none existed to train entirely the quality control aspects in relation to processing. Personnel sponsored from the industry were being trained for short periods in the C. I. F. T since a decade on an adhoc basis. Ten to twelve persons per year were given such training. Recently, an organised training programme, Refresher Course, has been started at C.I.F.T., the period of training being less than a month for selected topics. This sort of training will surely help to attain better quality levels of the products.

FUTURE LINE OF ACTION

Commendable progress has been achieved in the quality control programmes in the fish processing industry. As the viable industry is based on prawns meant

for export, these programmes were limited to such items. We are at present able to export quality products to any sophisticated market, to the full satisfaction of the buyer. However a strong export market has to be supported by a strong internal market. Concerted effort is necessary to create a viable industry which caters to the needs of the internal market and quality control programmes have to be worked out for the same. Government owned enterprises and corporations are to come forward to create a suitable distribution and marketing system inside the country. The Integrated Fishery Project, Cochin and the various Fisheries Corporations can play a very effective role in this field.

Quality control work has been so far the responsibility of Governmental agencies and it is time that this is shifted to the industry. Individual factories or group of factories should establish their own quality control and testing laboratories which handle atleast the routine check ups. Problems of more serious nature should be referred to research institutes.

The trade should establish uniform processing methods so that more uniform quality products can be produced. Of course this requires co-operation of all the processors. Even channelisation of exports by the trade under a few brand names is also worth considering. In attaining uniform methods and processes, the trade should even consider establishing a worker's training school-cum factory. The Seafood Exporter's Association can probably play an effective role here.

The Government should be able to provide the processing factories with

enough potable water and uninterrupted supply of electricity.

Research institutes have to take up economics of production so that reduction of production cost can be achieved. Higher prices for raw material and higher wages for workers make it essential to narrow down wastage to sustain profits.

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