STUDIES ON THE POSSIBLE SOURCES OF MICROBIAL CONTAMINATION OF PROCESSED FISHERY PRODUCTS

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An attempt has been made in the present study to estimate and describe in detail the nature and extent of contamination of processed fishery products. In large scale prawn processing when the preprocess preparation is elaborate, the industry in India has found it advantageous to establish the primary processing centres away from the processing factories. The data collected have clearly indicated that if such processing centres are not properly organised there is a possibility of greater contamination of the products at this stage.

The data collected during the course of this investigation have given the basis for the measures to be taken for the maintenance of bacterial quality of prawn during different stages of processing.

INTRODUCTION:

Sanitation is a problem of immense importance to the frozen food industry and more so in the case of fish products where quality deterioration is too rapid and is guided by too many variable factors. The major single factor that causes rapid spoilage in fish products is bacteria. Apart from the organisms present in the raw meat it may pick up bacteria from the surroundings during the different stages of preservation and processing. Contamination can take place from boat decks, at the preprocess centres, from utensils, water, ice etc. and at the processing factories until the raw material is processed into the finished form. The present study deals in detail with these aspects from the point of view of prawn processing industry.

MATERIALS AND METHODS

Four fishing boats, (two 36 ft. and two 30 ft.) 43 primary precessing centres and twenty processing factories including three canning factories figured in this study. The boat of 36' type had a fish hold to carry abont 5 tons of fish while the 30' boat had no fish hold and the catches were usually stored on the deck or in cane baskets. Some of the processing centres selected for the study had no adequate running water facilities. All surfaces in the boats, primary processing centres and processing factories which usually came

into contact with prawn were sampled for bacterial load besides examining the water and ice samples used at each stage.

The utensils and vessels were chosen at random for sampling. A unit area (4sq. inch) was selected and the bacteria associated with it were aseptically transfered to 100 ml of sterile buffered water using sterile swab (Tanner 1950). Decimal dilutions using 9 cc of buffered water were plated into sterile petri dishes. Sea water agar (IS No. 2237–1962) was used for the enumeration of total bacterial count whereas KF agar (Kanner *et al*,, 1961) and desoxycholate agar (APHA 1958) were used for faecal streptococci and coliforms respectively. From the coliforms growing on desoxycholate agar, *E. coli* type-1 was estimated using EMB agar and E. C. medium.

At each stage of processing the raw material were also sampled to study the extent of contamination brought about by the environment. Quantities varying from 30–50gm of raw material were collected at random and sampled according to I S 2237 (1963). Ice and water were sampled according to the methods described in APHA (1958).

Disscussion of results

Stage I Landing.

The survey showed that the boat deck, wooden boxes and cane baskets used in the fisning boats particularly in the smaller ones were not cleaned adequately. Washing was either inadequate or usually done with near shore waters which were often contaminated with bacteria. This was found to result in unusually high bacterial load in the boat deck and fish containers as indicated in Table I.

TABLE I BACTERIAL LOAD ON INADEQUATELY CLEANED BOAT DECKS AND FISH CONTAINERS.

Samples from	Nos Analysed	Total bacterial count/sq. inch	Faecal Streptococci/sq."	E. coli/sq"
Boat deck	10	$1.7 \times 10^8 - 1.9 \times 10^9$	$2.1 \times 10^3 - 3.0 \times 10^5$	25 – 1200
Cane baskets	22	$6.7 \times 10^8 - 2.5 \times 10^9$	$1.5 \times 10^5 - 4.2 \times 10^5$	nil – 600
Wooden boxes	16	$7.7 \times 10^7 - 8.5 \times 10^8$	$800 - 1.3 \times 10^4$	$180 - 1.7 \times 10^3$

The very heavy bacterial load on the fish containers and boat decks will invariably affect the catch. The prawn landed by such boats invariably showed high bacterial counts eventhough landed within 4-6 hours of catch (Table II).

TABLE II BACTERIAL COUNT OF PRAWN SAMPLED FROM INADEQUATELY CLEANED BOAT DECK AND FISH CONTAINERS.

Source	Total bacterial count/g.	Faecal Streptocci/g	E. coli/g.
Boat 1	$7.1 \times 10^6 - 8.20 \times 10^7$	50 – 580	25 – 80
Boat 2	$1.1 \times 10^6 - 9.90 \times 10^6$	110 – 980	15 – 50
Boat 3	$1.3 \times 10^6 - 8.9 \times 10^6$	220 – 770	30 – 96
Boat 4	$3.1 \times 10^6 - 7.79 \times 10^6$	300 – 1200	Nil – 71

Side by side with the above a study was also made on the extent of bacterial build up in materials landed by boats which received proper cleaning. The deck of one of the boats included in the study and the fish containers were cleaned throughly using a detergent and a disinfectant as suggested by Iyer and Chaudhuri (1965). A preliminary rubbing of the surfaces with coir or brush to remove all solid organic matter was followed by the application of the detergent to remove slime. After further washing the surfaces were treated with disinfectant (Sodium hypochlorite - 100 ppm, pH 4-0 - 5.0). The water used for washing purposes was also chlorinated to a level of 5 ppm. Ice used in this study was prepared either from municipal water or chlorinated water. The reduction in bacterial load of the surfaces and fish containers as a result of the treatment is shown in Table III while Table IV gives the bacterial load of fish stored in such surfaces and containers.

TABLE III BACTERIAL LOAD ASSOCIATED WITH THE BOAT DECK AND FISH CONTAINERS BEFORE AND AFTER CLEANING SHEDULE

	Total count per sq. inc h	Faecal strep- tococci/sq."	E. coli/ sq. inch
	(Before cleaning)		
Boat deck	$1.1 \times 10^6 - 6.6 \times 10^6$	1200 - 1900	Nil - 120
Cane basket	$3.9 \times 10^7 - 9.9 \times 10^8$	$780 - 3.3 \times 10^5$	40 - 720
Wooden boxes	$1.5 \times 10^7 - 1.8 \times 10^8$	$990 - 7.1 \times 10^3$	200 - 580
	(After cleaning)		
Boat deck	$2.1 \times 10^4 - 3.6 \times 10^4$	Nil	Nil
Cane basket	$1.1 \times 10^4 - 3.1 \times 10^4$	30 - 40	Nil
Wooden boxes	$2,0 \times 10^4 - 2.7 \times 10^4$	Nil	Nil

TABLE IV BACTERIOLOGICAL QUALITY OF PRAWNS LANDED UNDER CONTROLLED SANITARY CONDITIONS OF THE BOAT

	Total count/g	Faecal streptococci/g.	E. coli/g.
	(Controlled conditions)		
1.	8.2×10^4	Nil	Nil
2.	7.1×10^4	Nil	Nil
	(Uncontrolled conditions)		
1.	890×10^4	260	Nil
2.	720×10^4	860	210

TABLE V BACTERIAL LOAD ASSOCIATED WITH THE UTENSILS, WATER AND ICE OF SOME OF THE PEELING SHEDS SITUATED IN INTERIOR AREAS.

Description	No. of samples analysed	Total count	Faecal streptococci	E. coli
GI Table	35	3.0×10^2 – 1.2×10^8 / sq"	Nil – 1.8×10^4 / sq"	Nil – 150/ sq. "
Al. Table	20	5.5×10^4 – 2.2×10^8 "	Nil – 2.0×10^3 "	Nil – 107 "
Cement Table	10	1.5×10^5 – 1.2×10^8 "	Nil – 50 "	Nil – 50 "
Wooden Table	5	1.5×10^7 – 9.0×10^8 "	25 – 100 "	Nil – 625 "
Al. Basin	125	2.5×10^3 – 1.2×10^8 "	Nil – 1.5×10^4 "	Nil – 1.5×10^3
Al. Tray	12	1.2×10^4 – 1.7×10^7 "	Nil – 300 "	Nil – 800 "
GI Tray	18	1.0×10^4 – 1.5×10^8 "	Nil – 1250 "	Nil – 2400 "
GI Tub	72	2.5×10^3 – 1.3×10^8 "	Nil – 2.0×10^4 "	Nil – 3.0×10^3
Fe Wire basket	8	7.0×10^5 – 2.8×10^8 "	200 – 2.1×10^4 "	Nil – 3600 "
Water	65	21/ ml – 9.0×10^5 / ml	Nil – 240/ml	Nil – 1200/ml
Ice	36	86/ ml – 6.0×10^5 / ml	Nil – 2.2×10^5/ ml	Nil – 3.2×10^3/ml

The data clearly indicate that the bacterial counts of the prawns transported in a clean fishing boat is significantly low with almost complete absence of coliform organisms.

Stage 2:
Peeling at Primary processing centres

In the primary processing centres also the raw material will be subjected to extreme contamination from different sources like water ice, utensil surfaces, broken fish viscera, flies etc., if adequate protective measures are not taken. As the preliminary dressing including peeling of the prawn is carried out at this stage there is greater chance of the meat getting direct contamination.

The data presented in Table V clearly show the extent of bacterial load associated with the utensils, water and ice in some of the primary processing centres where a strict system of cleaning is not adopted.

The data include those collected from well maintained peeling sheds as well as from small sheds situated in the interior of the country where adequate facilities are not provided. In some of these centres also the utensils and surfaces were subjected to experimental cleaning for a comparitive study. It has been observed that the effect of cleaning of the surfaces on the product has been spectacular, the total bacterial plate counts never exceeding 1200/g. (Table VI) while faecal streptococci and coliforms were totally absent.

It was further observed that the efficiency of the cleaning schedule when applied regularly was almost permanent as indicated in Table VII.

TABLE VI BACTERIAL LOAD ON THE UTENSILS AND EQUIPMENTS BEFORE AND AFTER WASHING.

Source	Before washing			After washing		
	Total count per sq. "	Faecal Streptococci/sq."	E. coli per sq."	Total count per sq. "	Faecal strep. per sq. "	E. coli per sq. "
1.	$7.1x10^5$—$6.7x10^6$	50—125	25— 34	500—1200	Nil	Nil
2.	$1.3x10^5$—$7.1x10^6$	100—160	50—300	700—1100	Nil	Nil
3.	$3.3x10^5$—$8.1x10^6$	30— 78	Nil—125	300— 800	Nil	Nil
4.	$6.1x10^6$—$8.9x10^6$	Nil 50	75—210	400— 500	Nil	Nil

TABLE VII DATA REGARDING THE BACTERIAL LOAD OF THE UTENSILS UNDER CONTINUOUS CHLORINATION

	Before the cleaning schedule	After the cleaning schedule	Chlorination for one month	Chlorination for three months	Chlorination for four months
Total Count*	1.6×10^7	1.3×10^3	1.1×10^3	900	50
	2.7×10^6	1.0×10^3	9.0×10^2	800	75
	6.6×10^7	2.8×10^3	3.1×10^3	1300	880
	1.1×10^6	2.8×10^2	1.8×10^3	2100	712
	8.1×10^6	7.0×10^2	3.1×10^2	750	650

* faecal streptococci and *E. coli* were absent throughout the period of study (4 months)

TABLE VIII BACTERIOLOGICAL QUALITY OF THE MATERIAL AT THE TIME OF PACKING TO THE FACTORY AND ON ARRIVAL AT THE PROCESSING FACTORY.

Bacterial load of ice/ml			Time for transport	Total bact. count/g.		Faecal streptococci/g.		E. coli/g.	
A	B	C		At the time of despatch to factory	On arrival at the factory	At the time of despatch to factory	On arrival at the factory	At the time of despatch to factory	On arrival at the factory
1200	40	20	1 hr.	3.4×10^6	4.4×10^6	340	320	25	Nil
7300	15	22	3 hrs.	7.0×10^5	9.7×10^5	55	650	Nil	50
3000	20	12	4 hrs.	1.6×10^6	8.7×10^6	75	820	Nil	20
2800	18	20	5 hrs.	1.9×10^6	9.3×10^6	Nil	710	Nil	125

A: Total count; B: Feacal streptococci; C: E. coli.

Stage 3:
Transportation to processing factories

The dressed raw material generally receives a further mixing with ice before transportation to the processing factories. The quality of the raw material that reaches the factory is once again likely to be affected by the condition of transportation, quality of ice used and the cleanliness of the containers used for transport. It has been observed that due to lack of care at this stage the bacterial load of the material increases considerably. Table VIII gives typical example from actual observations of such contamination.

Stage 4:
Final processing at the freezing factories

It was found that chances of contamination are relatively less in freezing factories which are situated in towns where better quality control measures are adopted by the factories themselves. But in this sector also incidence of pathogenic organisms together with high total bacterial count was seen in cases where a strict system of washing was not adopted. One of the main sources of contamination has been found to be the glazing and reglazing water. Ice used for cooling the glazing water sometimes inadvertantly gets dragged along the slimly floor of the processing hall which results in comparitively high bacterial load in it. The extent of contamination of reglazing water wiih progressive number of dips is shown in table IX.

TABLE IX BACTERIAL LOAD ASSOCIATED WITH REGLAZING WATER

No. of blocks dipped	Total count/ml	Faecal streptococci/ml.	E. coli/ml.
0	15	Nil	Nil
8	280	1	Nil
16	420	3	Nil
24	970	12	1
40	8760	16	12
50	12000	40	20
70	40000	99	30

From the above data it is evident that by the time 16 – 18 blocks are dipped the reglazing water becomes polluted. Dipping trials using chlorinated water have shown that nearly 36 – 40 blocks can be safely dipped if initial chlorine concentration is maintained at 50 ppm.

CONCLUSIONS

The foregoing study indicates clearly that external contamination from unclean surfaces and other environmental conditions is a serious problem to be recokned with in the prawn processing industry. Even if the raw material is processed in the quickest possible time it can result in a product having high bacterial load if handled in unhygeinic surroundings. The study further illustrates the beneficial effects of hygeinic practices at each stage of processing. Control measures should start from the fishing boats. Boat decks, fish holds, fish containers etc. should be

washed with clean water before and after each day's operations followed by treatment with a disinfectant like chlorine at a minimum level of 100 ppm. Similar care is necessary with respect to the vessels and other utensils used both in the Primary processing centres and Processing factories. Ice used at all stages of processing should have been prepared from well chlorinated water and the water used for washing, glazing and reglazing work chlorinated at a level of 5 ppm.

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REFERENCES

APHA (1958) Recommended methods for the microbial examination of foods, New York.

Iyer, T. S. G. and Chaudhuri D. R., (1965) *Fish. Technol.* **2**, 131

Kenner, B. A, Clark H. F and Kabler, P. W., (1961) *Appl. Microbiol.* **9**, 15