INVESTIGATION ON SANITATIONAL ASPECTS (MICROBIOLOGICAL) OF PRAWN PROCESSING FACTORIES

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[Absence of regular cleaning has been found to result in heavy bacterial loads on the surfaces of utensils and other equipments used in prawn processing factories and peeling centres. Instance of high faecal contamination are also sometimes met with. Detailed investigations have shown that a cleaning schedule comprising of treatment of these surface with a detergent followed by application of an effective disinfectant like sodium hypochlorite would prevent such bacterial build up.]

Introduction

During processing, fishery products are subjected to microbial contamination from external sources the extent of which depend upon the hygienic conditions of the factories. The external contamination is mainly from bacteria associated with the surface of the utensils and equipments with which the products come in direct or indirect contact. (Gendron, 1953). The water used for processing purposes,the nature and mode of handling of the utensils by the workers in the processing factories and other external agencies like flies etc. may also become sources of contamination. By continuous use the utensils get a gradual coating of fish slime which harbours large numbers of bacteria and unless properly cleaned from time to time, they will turn out to be a very good source of microbial contamination (Nachenius, 1958).

The water used at various stages of processing viz., washing, glazing and re-glazing in freezing work and cooling in canning processes have to be microbiologically pure in order that it may not cause further contamination of the products.

Disinfectants like Sodium hypochlorite, chloramines Quaternary ammonium compounds etc. have been suggested for washing the utensils in the processing factories (Reddish, 1957). But the most effective and economic disinfectant is sodium hypochlorite, but the difficulty associated with sodium hypochlorite is its corrosive nature (Porkave, 1951; Gendron, 1953).

The studies summarised below were aimed at finding out the normal variation in the bacterial load on the utensil surfaces in the processing factories and at working out a cleaning schedule which could be effective, noncorrosive and at the same time economic.

Experimental Procedure

The collection of the samples from the surface of utensils and the plating were done according to Tanner (1950). The sea water agar for plating was prepared according to ISI specifications No. 2237 of 1962.

Results and Discussion

A general survey of the bacterial load on the surface of the utensils used in the fish processing factories before the commencement of the days work revealed that they are highly contaminated with bacteria in spite of the normal cleaning resorted to by the respective factories. The results of the survey carried out at different fish processing factories in and around Cochin are given in the TABLE I.

TABLE — 1

A GENERAL SURVEY OF BACTERIAL LOAD OF UTENSILS USED IN THE FISH PROCESSING FACTORIES WHERE A STRICT CLEANING SCHEDULE IS NOT MAINTAINED

SURFACE	Factory—1		Factory—2		Factory—3		Factory—4		Factory—5		Factory—6		Factory—7		Factory—8	
	Nos analysed	Range of bacterial load/sq. in	Nos analysed	Range of bacterial load/sq. in	Nos analysed	Range of bacterial load/sq. in	Nos analysed	Range of bacterial load/sq. in	Nos analysed	Range of bacterial load/sq. in	Nos analysed	Range of bacterial load/sq. in	Nos analysed	Range of bacterial load/sq. in	Nos analysed	Range of bacterial load/sq. in
Concrete table	5	6.5×10^{6} 1.0×10^{8}	4	4.0×10^{7} 5.2×10^{7}	—	—	—	—	—	—	3	2.1×10^{6} 6.1×10^{7}	—	—	—	—
Galvanized iron table	—	—	—	—	—	—	10	4.5×10^{4} 6.2×10^{7}	—	—	12	5.0×10^{6} 7.0×10^{8}	6	1.1×10^{7} 7.5×10^{7}	5	6.6×10^{5} 7.2×10^{8}
Wooden table	—	—	—	—	7	1.4×10^{5} 2.0×10^{7}	—	—	—	—	—	—	—	—	—	—
Aluminium basin	8	2.7×10^{4} 6.7×10^{7}	6	1.7×10^{6} 2.3×10^{7}	9	5.2×10^{5} 4.7×10^{7}	8	4.0×10^{4} 2.9×10^{7}	10	8.7×10^{4} 2.9×10^{7}	—	—	7	9.9×10^{5} 2.1×10^{7}	5	3.5×10^{4} 4.0×10^{6}
Steel basin	—	—	—	—	—	—	—	—	5	5.0×10^{3} 1.7×10^{4}	—	—	—	—	—	—
Perforated Aluminium basin	—	—	5	1.6×10^{6} 7.2×10^{7}	2	1.6×10^{7} 1.7×10^{7}	2	$1{\cdot}0\times20^{5}$ 2.6×10^{7}	8	5.0×10^{5} 6.6×10^{8}	—	—	—	—	—	—
Galvanized iron freezing trays	—	—	—	—	9	1.0×10^{5} 1.5×10^{7}	63	2.6×10^{4} 9.6×10^{7}	—	—	10	1.9×10^{5} 2.0×10^{8}	—	—	42	9.7×10^{4} 6.2×10^{8}
Aluminium trays	4	1.75×10^{4} 6.7×10^{6}	—	—	—	—	—	—	10	5.0×10^{5} 6.0×10^{8}	5	7.7×10^{5} 9.0×10^{7}	5	2.0×10^{6} 9.0×10^{7}	—	—
Galvanized iron tubs	4	5.0×10^{5} 6.8×10^{8}	3	7.2×10^{4} 3.0×10^{6}	6	2.3×10^{5} 2.5×10^{7}	8	5.0×10^{4} 5.0×10^{8}	4	2.4×10^{5} 6.1×10^{8}	4	2.2×10^{4} 2.0×10^{8}	2	1.0×10^{5} 3.2×10^{9}	6	1.0×10^{4} 1.0×10^{8}
-do- Porous	—	—	—	—	—	—	4	1.1×10^{6} 6.6×10^{7}	6	1.0×10^{6} 6.9×10^{8}	—	—	—	—	—	—
Aluminium tub	3	4.0×10^{4} 7.7×10^{7}	—	—	—	—	—	—	3	1.0×10^{5} 4.9×10^{6}	—	—	—	—	—	—

Apart from the multiplication of the above bacteria further accumulation will also take place from the slime carried by the raw material that comes on the processing line. The rate of accumulation of bacteria on the surfaces of these utensils during the course of the days work is shown in Table II.

TABLE II

INCREASE IN THE BACTERIAL LOAD ON THE UTENSILS AS WORK PROCEED

Sample	Table surface — Bacterial load per sq. inch			Basins — Bacterial load per sq. inch	
	Table I	Table II	Table III	Basin 1	Basin 2
0 hr.	8.1×10^6	2.8×10^7	1.2×10^6	6.6×10^6	7.0×10^6
1 hr.	3.3×10^7	3.7×10^7	9.7×10^6	7.0×10^6	7.9×10^6
2 hr.	5.3×10^7	4.1×10^7	9.7×10^6	9.9×10^6	3.1×10^6
4 hr.	5.6×10^7	6.6×10^7	6.7×10^7	1.0×10^7	8.3×10^7

In attempts to check this rapid accumulation of micro-organisms, sodium hypochlorite solution (ph 8.0 — 9.0) of strengths ranging between 50-200 ppm residual chlorine was sprayed and allowed to be in contact with the utensils for varying lengths of time. But this was found ineffective to reduce the bacterial load substantially (Table III) and the average reduction was only to 10^6 per sq. inch from 10^7 per sq. inch.

TABLE III

EFFECT OF DIFFERENT CONCENTRATIONS OF SODIUM HYPOCHLORITE ON DIFFERENT TIME INTERVALS

strength of the solution pH (8.0-9.0)	15 mins. Bacterial load sq. in.		30 mins. Bacterial load sq. in.		45 mins. Bacterial load sq. in.		1 hour Bacterial load/sq. in.	
	Before	After	Before	After	Before	After	Before	After
50	3.5×10^7	3.5×10^6	3.0×10^6	4.2×10^5	6.0×10^6	5.0×10^6	3.7×10^6	3.0×10^4
100	1.2×10^6	1.0×10^7	1.2×10^6	5.0×10^4	1.2×10^6	4.0×10^4	9.3×10^7	2.8×10^4
150	4.8×10^5	2.2×10^6	1.6×10^7	2.9×10^5	6.5×10^6	5.2×10^6	2.9×10^7	1.7×10^5
200	9.0×10^7	3.0×10^5	9.5×10^7	4.9×10^4	1.0×10^7	9.8×10^6	9.7×10^7	6.1×10^5

The apparent ineffectiveness of the disinfectants when applied direct was found to be due to the presence of varied amounts of slime usually adhering to the utensil surfaces. In order to remove this slime, washing with detergents like sodium carbonate, vim powder, trisodium phosphate, teepol etc., was introduced before applying the disinfectants. The comparative effectiveness of these detergents are given below.

TABLE — IV

EFFECTIVENESS OF DIFFERENT DETERGENTS

Bacterial load Sq. in Before washing	Bacterial load Sq. in After washing	Detergents used for washing
6.00×10^7	5.98×10^5	Na_2 Co_3
7.50×10^7	5.00×10^5	VIM
2.02×10^7	2.02×10^4	Tri–Sod. Phosphate
7.50×10^6	1.90×10^3	Teepol (0 5%)

In order to study the combined effect of detergents and disinfectants different concentrations of sodium hypochlorite at neutral and alkaline pH were used on utensils and table surfaces which were given a preliminary wasing with detergent solutions.

The results obtained from two series using tri. sod. phosphate in one case and Vim powder on the other are shown in Table V and VI. The results show that neutral and alkaline hypochlorites are equally effective.

TABLE — V

DISINFECTANT EFFICIENCY OF THE SAME CONCENTRATION OF SODIUM HYPOCHLORITE WITH DIFFERENT DETERGENTS

Chlorine dose ppm pH 8.5 — 9.5	Vim powder as detergent and sodium hypochlorite as disinfectant for 15 minutes		Tri. sod. phos as detergent as sod. hypochlorite as disinfectant for 15 minutes	
	Bacterial load/sq in.		Bacterial load/sq. in.	
	Before washing	After washing	Before washing	After washing
1000	4.54×10^6	2.71×10^3	2.02×10^7	4.05×10^3
900	8.00×10^6	1.45×10^3	9.62×10^6	3.09×10^3
800	2.40×10^7	3.05×10^3	3.98×10^6	2.02×10^3
700	7.50×10^6	2.05×10^3	7.60×10^7	3.09×10^3
600	7.05×10^7	2.08×10^3	6.50×10^7	$3{,}08 \times 10^3$
500	5.0×10^7	3.07×10^3	4.00×10^7	2.04×10^3
400	4.03×10^7	9.02×10^3	5.50×10^7	2.08×10^3
300	3.68×10^7	1.04×10^4	8.02×10^6	8.09×10^3

TABLE VI

COMPARATIVE EFFECTIVENESS OF ALKALINE AND NEUTRAL SODIUM HYPOCHLORITE ON UTENSILS THAT ARE GIVEN A PRELIMINARY WASHING WITH TRISODIUM PHOSPHATE

Chlorine dose ppm	Bacterial count sq. in. Sod. hypochlorite pH 8.5		Bacterial count/sq. in. Sod, hypochlorite pH 7.0	
	Before washing	After washing	Before washin5	After washing
1000	2.02×10^7	4.5×10^3	$1{,}75 \times 10^6$	5.75×10^3
800	3.98×10^6	2.25×10^3	$1{,}00 \times 10^8$	$1{,}12 \times 10^3$
600	4.45×10^7	3.80×10^3	1.00×10^8	1.02×10^3
500	4.00×10^7	$2{,}04 \times 10^3$	3.06×10^7	2.01×10^3

Period of Treatment: The rate of decomposition of sodium hypo-chlorite during treatment on the utensils was studied after cleaning the trays with detergent by the ordinary process and it was found that the reaction time can be fixed as four minutes by which period 80% of the strength of the sodium hypochlorite is lost. (Table VII). It has been further observed that there is no substantial reduction in bacterial load with further increase in the time of contact with the disinfectant.

TABLE VII

THE RATE OF DECOMPOSITION OF SODIUM HYPOCHLORITE WHEN APPLIED ON TRAYS

Strength of solution	100 ppm	900 ppm	800 ppm	200 ppm	100 ppm
Immediately after pouring into the tray	1000	900	800	200	100
After one minute	500	386	520	120	41
After two minutes	290	265	420	60	16
After three minutes	200	186	298	20	Nil
After four minutes	125	186	156	15	Nil
After five minutes	110	68	68	Nil	Nil

TABLE — VIII

PERCENTAGE REDUCTION IN BACTERIAL LOAD BY APPLYING SODIUM HYPOCHLORITE FOR 15 MINUTES AND 4 MINUTES

Chlorine dose for 15 minutes 300 ppm			Chlorine dose for 4 minutes 300 ppm		
Bacterial load/sq. in.			Bacterial load/sq. in.		
Before cleaning	After cleaning	% reduction	Before cleaning	After cleaning	% reduction
8.0×10^5	4.0×10^1	99.999	8.2×10^6	8.9×10^2	99.999

In these trials however, it was found that the alkaline nature of detergents like sodium carborate, Vim powder, trisodium phosphate etc., used for the preliminary washing, caused corrosion to some metallic surfaces especially aluminium. However when a neutral detergent like "Teepol" was used there was no corrosive action on the vessels. The same effect was noticed in the case of alkaline sodium hypochlorite as well. In the case of hypochlorite an acidic solution at a pH 4.0 — 5.0 was found to be more suitable. It not only proved to be more efficient (Table IX) but also did not produce any corrosive action on aluminium vessels.

TABLE — IX

COMPARATIVE EFFICIENCY OF ACIDIC AND ALKALINE HYPOCHLORITE

Chlorine dose ppm.	Bacterial load/sq. in. 0.5% Teepol as detergent end alkaline sod. hypochlorite for 4 min.		Bacterial load/sq. in. 0.5% Teaspole detergent and acidic sod. hypochlorite for 4 minutes	
	Before washing	After washing	Before washing	After washing
100	5.04×10^7	2.00×10^4	7.95×10^7	1.04×10^3
200	9.46×10^7	$1{\cdot}45 \times 10^3$	8.85×10^7	1.00×10^3
300	8.12×10^7	1.05×10^3	—	—
	Corroded		No corrosion	

Recommended cleaning schedule: Based on the experiments the following cleaning schedule can be recommended for the utensils in the fish processing factories.

1. A preliminary rubbing with coir or brush to remove all solid organic matter.
2. Washing with a detergent (Teepol 0.5%) to remove the remaining slime.
3. Application of a disinfectant — 100 ppm residual chlorine sodium hypochlorite (pH 4.0 — 5.0) for 4 mins. (Rubbing with a coir or brush gives better results).
4. Final washing with fresh water to remove the excess of sodium hypochlorite.

This cleaning schedule not only brings down the high bacterial count but also destroys the pathogenic organisms like E. coli and faecal streptococci as evidenced by Table X.

TABLE X

EFFECT OF THE RECOMMENDED CLEANING SCHEDULE ON THE REDUCTION OF TOTAL BACTERIAL COUNT, FAECAL STREPTO-COCCI AND E. COLI

Utensil	Nos. analysed	SPC/sq. in. Before cleaning	SPC/sq. in. After cleaning	Faecal strep/sq. in. Before cleaning	Faecal strep/sq. in. After cleaning	E. coli/sq. in. Before cleaning	E. coli/sq. in. After cleaning
Table	5	8.2×10^5 to 3.3×10^7	3.8×10^3 to 3.0×10^3	950–1200	Nil	25–300	Nil
Tub	4	1.9×10^5 to 2.1×10^6	3.0×10^3 to 1.9×10^3	50–950	Nil	75–10	Nill
Tray	5	1.9×10^7 to 7.9×10^7	9.0×10^3 to 1.4×10^3	25–350	Nil	50–150	Nil
Basin	6	1.2×10^8 to 7.7×10^7	6.2×10^3 to 1.8×10^3	25–150	Nil	50–100	Nil

Frequency of cleaning schedule: In view of the rapid accumulation of bacteria on the surface during the course of the day's work it was felt necessary to work out the actual frequency of cleaning required during the period. In order to study this aluminium vessels subjected to the new cleaning process were used for regular processing work, and the bacterial build up on these were followed at regular intervals. It was found (Table XI) that even after seven hours of working, the bacterial load in them was only 10^5 as against an initial load of 10^3/sq. in. This clearly indicates that the cleaning schedule is effective for the whole day and need be applied only once in a day.

TABLE — XI

INCREASE IN THE BACTERIAL LOAD IN THE TREATED ALUMINIUM BASINS DURING WORKING

Sample	Basin 1 Bacterial load/sq. in	Basid 2 Bacterial load/sq. in.
Before cleaning	6.5×10^6	9.9×10^6
After cleaning 10 — 15 AM.	8.0×10^3	1.0×10^3
12 — 15 PM	1.0×10^3	1.6×10^3
1 — 15 PM	9.0×10^3	1.2×10^4
2 — 15 PM	2.6×10^4	6.7×10^4
3 — 15 PM	7.5×10^4	8.7×10^4
4 — 15 PM	5.1×10^4	5.9×10^4
5 — 15 PM	1.9×10^5	2.0×10^5

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Discussion

Shri John P. George asked why steam cannot be used for sterilizing the utensils in the factory instead of the procedure suggested by the author. Shri Iyer said that steam will be costly. The Chairman pointed out that the steam by itself will be cheap, but the initial expenditure involved in providing a boiler and other equipment for steaming may be considerable. However it was most desirable, he said, to employ steam for cleaning utensils in the interest of quality.

One of the members suggested that plastic boxes may be used for storage of prawns both on board, vessels and in the factories as they can easily be sterilized by steam at high pressure.