STUDIES ON TECHNOLOGICAL PROBLEMS ASSOCIATED WITH THE PROCESSING OF COOKED FROZEN PRAWNS

II. HYGIENIC CONDITIONS IN RELATION TO BACTERIOLOGICAL CHARACTERISTICS

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The importance of sanitary practices in the processing of precooked frozen shrimps has been discussed. Several typical examples have been shown to point out the different sources of contamination of the product and the extent to which each of the factors by itself or in combination affect the bacterial quality of the final product. A scheme of processing has also been suggested for controlling the microbial quality.

INTRODUCTION

Rigid schedules of testing precooked frozen foods for bacterial quality are followed in almost all the importing countries. A total bacterial count of $1.0 \times 10^4 - 2.0 \times 10^5$/g has been suggested, in general, as the standard for an acceptance quality of cooked frozen prawn in many countries (Goresline 1959). In addition, limits for *E. Coli* count ranging between 10–20/g and *faecal streptococci* of 100/g with the complete absence of pathogenic organisms have been found in many standards. Certain regions of United States have laid down stricter bacteriological standards for cooked frozen foods viz. 50,000 organisms/g for total plate counts, less than 10 coliforms and no coagulase positive *staphylococci* or *salmonella shigella* organisms (Frechette and Michael 1961). Australian standards put the upper limits at 250,000 for total counts, 20 for *E. Coli* and 100 for *Staphylococci* with absence of pathogenic organisms (Anon 1966, 1967). The standards prescribed by the U. S. Armed forces for precooked frozen foods allow only 100,000 total viable organisms/g, 10 coliforms/g and the complete absence of pathogenic organisms (Raymon *et. al.* 1955). Indian standards for cooked frozen shrimps recommed maximum total plate count of 2.0×10^5/g and 100 *enterococci*/g (I. S. 2237:1962).

Earlier work in the field shows that commercially frozen seafoods seldom satisfy strict bacteriological standards. As for example 85% of the precooked fishery products examined by Proctor and Phillips (1947, 1948) showed total counts exceeding 10^4/g. Very high total bacterial count together with faecal indicator organisms has also been reported by Lekshmy and Pillai (1964) and Pillai and Lekshmy (1961) in cooked frozen prawns. It is more or less recognised by these workers that although partial sterlization is effected during cooking, contamination is bound to happen in the subsequent stages of processing under commercial conditions. This is further substantiated in the present communication which is aimed at studying the nature and extent of contamination throughout the various stages involved in the production of cooked frozen prawns.

Materials and methods

Some of the shrimp freezing factories located in and around Cochin formed the field centres for this study. Bacteriological samples of utensil surfaces were collected using sterile swabs and transferred to sterile buffered water (APHA 1958). Raw materials, water and ice were collected asceptically and brought to the laboratory carefully. Plating was done as usual using tryptone glucose yeast agar as medium for total bacterial count, desoxycholate agar for coliforms (APHA 1946) and KF agar (Kenner *et. al* 1960) for *faecal streptococci*. From the total coliforms *E. coli* type 1 was determined as per the methods prescribed by Indian standard specification (IS 2237, *loc cit*). In the enumeration of total bacterial count wherever food particles interfered with counting, the tetrazolium flooding technique of Solberg and Proctor (1960) was adopted for microbial colony differentiation.

Results

Table I gives the summary of a survey

TABLE I EFFECT OF USING UNCLEAN WATER AND ICE FOR COOLING THE COOKED PRAWNS

	Total count	*Faecal streptococci*	*E. coli*
Table surface /cm²	3,400	Nil	Nil
Al. basin ,,	8,600	,,	,,
GI tub ,,	1,200	,,	,,
Freezing tray ,,	600	,,	,,
Draining basket ,,	14,120	,,	,,
Water (washing) /ml	14,110	5	2
Ice ,,	1,450	15	12
Glazing water ,,	20	Nil	Nil
Reglazing water ,,	25	,,	,,
Water ice mixture in which the cooked material is put for cooling ,,	57,300	3,148	1,500
Raw material /g	5.18×10^6	4,145	3,420
Do after washing ,,	2.18×10^6	4,000	3,210
Do after cooking ,,	9.32×10^3	Nil	Nil
Do after cooling (by putting in water ice mixture) ,,	8.18×10^5	1,110	465
Do after peeling ,,	3.11×10^5	990	385
After washing ,,	8.31×10^5	1,125	380
Do after setting in trays and adding glaze water ,,	4.51×10^5	1,120	380
Do after freezing ,,	$2\ 15 \times 10^4$	1,100	360
Do after reglazing ,,	8.10×10^4	1,110	365

TABLE II EFFECT OF DELAYED PROCESSING OF THE COOKED PRAWN ON THE BACT. QUALITY OF THE FINAL PRODUCT

		Total count	*Faecal streptococci*	*E. coli*
Table surface	/cm²	1.3 x 10⁴	Nil	Nil
Basin	,,	9.6 x 10³	,,	,,
Freezing tray	,,	2.5 x 10³	,,	,,
Washing water	/ml	150	,,	,,
Cooling water	,,	6,000	15	10
Ice	,,	3.3 x 10³	130	125
Glazing water	,,	140	Nil	Nil
Reglazing water	,,	140	,,	,,
Raw material	/g	6.4 x 10⁶	1,400	1,800
Do-after washing	,,	3.3 x 10⁶	810	830
Do-after cooking	,,	2400	Nil	Nil
Do-after cooling	,,	8900	12	10
Do-overnight keeping	,,	8.1 x 10⁴	1,350	1,220
Do-after peeling	,,	6.6 x 10⁵	1,410	1,295
Do-after washing	,,	5.2 x 10⁵	1,320	1,230
Do-after grading freezing and reglazing	,,	4.8 x 10⁵	1,300	880

TABLE III INFLUENCE OF PERSONNEL HYGIENE OF THE WORKERS ON THE QUALITY OF THE PROCESSED MATERIAL

		Total count	*Faecal streptococci*	*E. coli*
Table surface	/cm²	8,000	Nil	Nil
Al. basin	,,	2,500	,,	,,
Freezing tray	,,	1.4 x 10⁴	,,	,,
Draining basket	,,	5.1 x 10⁵	,,	,,
-do-	,,	8.1 x 10³	120	50
Worker's hand	,,	9.1 x 10⁵	95	45
-do-	,,	6.3 x 10³	140	50
Washing water	/ml	40	Nil	Nil
Water ice mixture for cooling the cooked prawns		200	,,	,,
Glazing water	,,	44	,,	,,
Reglazing water	,,	1,400	,,	,,
Raw material	/g	5.5 x 10⁶	990	150
Do-after washing	,,	9.1 x 10⁴	210	25
Do-after cooking	,,	800	Nil	Nil
Do-after cooling	,,	1,800	,,	,,
Do-after peeling	,,	3.1 x 10⁴	20	25
Do-after grading	,,	6.1 x 10⁴	30	40
Do-after washing	,,	5.3 x 10⁴	26	30
After freezing	,,	2.2 x 10⁴	15	20
After reglazing	,,	2.5 x 10⁴	20	20

made at a factory where the water-ice mixture used for cooling of the cooked prawn was traced out to be the main source of contamination. The adverse effect of keeping the unpeeled cooked material in ice for processing on the subsequent days, during times of heavy catch is represented in table 2. Table 3 is a typical example of the importance of personnel hygiene of the workers in the processing of precooked food materials. Table 4 depicts the way in which the cooked material got contaminated by using common utensils both for the processing of froglegs and CP. Table 5 shows the effect of reglazing water on the quality of the finished product. The importance of different probable factors responsible for the bacterial quality of the finished product are shown in tables 6 and 7 whereas table 8 gives the ranges of bacteria associated at different stages of handling and processing under the recommended scheme.

TABLE IV THE ADVERSE EFFECTS OF USING THE SAME UTENSILS BOTH FOR COOKED AND RAW MATERIALS

	Total count	*Faecal streptococci*	*E. coli*
Table surface/cm²	6.1 x 10^5	150	175
Al. basin ,,	3.1 x 10^5	1,500	1,200
Freezing Tray ,,	3.6 x 10^5	1,200	170
Draining basket ,,	3.3 x 10^5	Nil	Nil
Washing water/ml	50	,,	,,
Water ice mixture for cooling cooked prawns ,,	120	,,	,,
Glazing water ,,	,,	,,	,,
Reglazing water ,,	200	,,	,,
Worker's hand /cm²	3.9 x 10^4	,,	,,
Raw material /g	8.1 x 10^6	1,300	850
Do-after washing ,,	3.9 x 10^5	920	640
Do-after cooking ,,	1,560	Nil	Nil
Do-after cooling ,,	3,400	,,	,,
Do-after peeling ,,	3.01 x 10^4	425	150
Do-after grading ,,	6.3 x 10^4	440	172
Do-after washing ,,	8.9 x 10^4	400	155
After freezing ,,	2.2 x 10^4	185	140
After reglazing ,,	4.4 x 10^4	190	140

TABLE V INFLUENCE OF THE BACT. QUALITY OF REGLAZING WATER ON THE MICROBIAL QUALITY OF THE FINAL PRODUCT

	Total count	*Faecal streptococci*	*E. coli*
Table surface /cm²	1,500	Nil	Nil
Al. basin ,,	400	,,	,,
GI tub ,,	250	,,	,,
Freezing tray ,,	1,100	,,	,,
Draining basket ,,	2,500	,,	,,
Washing water /ml	25	,,	,,
Ice ,,	120	,,	,,
Water used for dipping the cooked prawn ,,	80	,,	,,
Glazing water ,,	30	,,	,,
Reglazing water ,,	3.6 x 10^4	150	35
Raw material /g	4.95 x 10^5	1,240	560
Do-after washing ,,	2.66 x 10^5	900	260
Do-after cooking ,,	1,400	Nil	Nil
Do-after cooling ,,	3.1 x 10^4	,,	,,
Do-after peeling ,,	6.6 x 10^4	,,	,,
Do-after washing ,,	4.1 x 10^4	,,	,,
Do-after setting in trays and adding glazing water ,,	6.0 x 10^4	,,	,,
After freezing ,,	2.1 x 10^4	,,	,,
After reglazing ,,	5.01 x 10^4	150	65

DISSCUSSION

From table 1, it is clear that the cooling operation is the most vital step in the processing of cooked prawns. If the cooling medium, ie, ice cold water is highly contaminated with bacteria, not only the partial sterility which the material has attained during cooking is lost, but also chances of faecal contamination are quite common. Table 2 justifies the arguement that the cooked material should be processed within the minimum possible time. Holding the cooked prawn in ice overnight or for longer periods although useful in maintaining organoleptic quality during peak seasons, may result in re-

TABLE VI CONTAMINATION OF THE COOKED MATERIAL DUE TO UNSANITARY CONDITIONS OF THE UTENSILS

	Total count	*Faecal streptococci*	*E. coli*
Table surface/cm²	6.7 x 10^6	1,400	1,000
Al. basin	,, 8.1 x 10^6	360	400
Freezing tray	,, 6.6 x 10^6	320	240
Draining basket	,, 1.71 x 10^7	1,560	950
Worker's hand	,, 3,000	Nil	Nil
Washing water /ml	200	,,	,,
Cooling water	,, 3,000	35	25
Glazing water	,, 110	Nil	Nil
Reglazing water	,, 120	,,	,,
Raw material /g	6.1 x 10^6	3,260	1,460
Do-after washing	,, 3.8 x 10^6	4,000	980
Do-after cooking	,, 2,400	Nil	Nil
Do-after cooling	,, 3.1 x 10^4	75	45
Do-after washing and peeling	,, 9.3 x 10^4	210	310
Do-after grading	,, 6.1 x 10^5	450	425
After freezing and reglazing	,, 4.5 x 10^5	285	240

TABLE VII EFFECT OF PERSONNEL HYGIENE AND BAD QUALITY WATER ON PROCESSED PRODUCT

	Total count	*Faecal streptococci*	*E. coli*
Aluminium table /cm²	1.4 x 10^4	Nil	Nil
Aluminium basin	,, 9.6 x 10^3	,,	,,
Freezing tray	,, 2.4 x 10^3	,,	,,
Draining basket	,, 3.1 x 10^4	,,	,,
Worker's hand	,, 2.6 x 10^4	40	20
Washing water/ml	2.4 x 10^3	60	30
Glazing water	,, 1.4 x 10^3	10	10
Cooling water	,, 3.6 x 10^3	120	35
Reglazing water	,, 6.1 x 10^3	15	20
Raw material /g	7.4 x 10^6	3,300	410
Do-after washing	,, 5.2 x 10^6	2,400	220
Do-after cooking	,, 1,550	Nil	Nil
Do-after washing	,, 3.2 x 10^4	110	85
Do-after grading	,, 7.2 x 10^4	140	95
After freezing and reglazing	,, 9.9 x 10^4	220	125

contamination, if the bacterial quality of ice is not good. During times of heavy catch if it is difficut to handle all the material on the same day, the uncooked material may be stored for processing on the succeeding days. However, the maximum storage life of prawns in ice in its different forms (whole, headless or PD) prior to cooking and freezing has been worked out and discussed seperately (Iyer and Choudhuri unpublished). It is evident from Table 3 that personal hygiene of the workers is also important in producing and maintaining the quality of the processed product. The hands of the workers should be washed thoroughly from elbow down with a detergent and adequately disinfected using chlorine solution containing a minimum of 200 ppm available chlorine at intervals or after each absence from the processing hall. The disadvantages of handling cooked materials along with froglegs or any other uncooked material in the same room are clearly brought out in Table 4. There should be seperate units for the processing of raw and cooked materials preferably with seperate utensils. All the utensils and equipments used

TABLE VIII BACT. QUALITY OF THE MATERIAL PROCESSED AS PER THE SCHEME DEVELOPED

		Total count	*Faecal streptococci*	*E. coli*
Aluminium table	/cm²	200 -4,000	Nil	Nil
Aluminium basin	,,	150-400	,,	,,
GI Freezing tray	,,	100-250	,,	,,
Draining basket	,,	1,100-2,000	,,	,,
Worker's hand	,,	200-2,010	,,	,,
Washing water/ml		20-150	,;	,,
Cooling water	,,	120-220	,,	,,
Glaze water	,,	20-45	,,	,,
Reglazing water	,,	20-50	,,	,,
Raw material	/g	9.3 x 10^6	1,200	2,000
		1.7 x 10^7	1,800	2,900
Do-after washing	,,	7.7 x 10^5	950	1,200
		1.3 x 10^6	1,010	1,300
Do-after cooking	,,	550	Nil	Nil
		1,400		
Do-after cooling	,,	1,400	,,	,,
		2,200		
Do-after peeling	,,	7,000	,,	,,
		1.4 x 10^4	,,	,,
Do-after washing	,,	9,000	,,	,,
		3.1 x 10^4	,,	,,
Do-after grading	,,	6,500	,,	,,
		2.8 x 10^4		
Do-after dipping in 20 ppm chlorine and freezing	,,	3,000	,,	,,
		9,000	,,	,,
After-reglazing	,,	3,000	,,	,,
		1.1 x 10^4		

should be cleaned and disinfected thoroughly as per the cleaning schedule discribed earlier (Iyer and Choudhuri 1965). Table 5 shows the necessity of precautions even after freezing. There is every chance of contamination if the microbial quality of the reglazing water is poor. It should be chlorinated to a residual level of 50 ppm and should be changed intermittently. It is always preferable to reglaze them by pouring water over the frozen bloeks taken in the carton rather than by dipping in water. Tables 6 and 7 illustrate how the material can become contaminated from different sources if adequate hygienic precautions are not taken. The data presented in table 8 are the results of a few series of experiments conducted on a commercial scale as per the scheme charted below.

The data indicate that the bacteriological standards established by various organisations do not appear to be unreasonably stringent for precooked frozen shrimps since there is every scope for expecting product well within limits if adequate sanitary precautions are taken. This will not only increase the wholesomeness of the food but also will produce products free from any health hazard.

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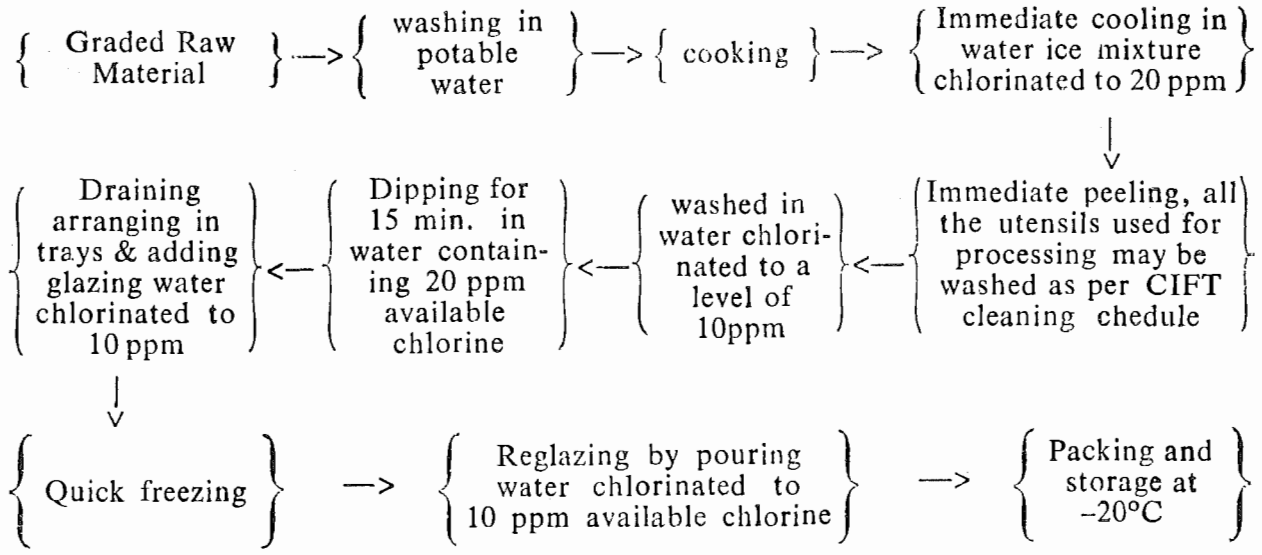

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