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A Survey of Process Hygiene in the Sri Lankan Prawn Industry

I. Hygiene Status of Raw Materials and products

By

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Introduction

Although various types of prawn products are exported from Sri Lanka to a number of overseas markets there is scant information on the hygienic status both of these products and of the processing regimes used. In view of the increasingly stringent export requirements imposed by importing countries it was considered desirable to monitor process hygiene in the industry, and where necessary, advise on means of controlling the critical control points. Accordingly, during January and February, 1979, a survey was made involving some fifteen premises ; three premises were not surveyed because, due either to cyclone damage or to renovations, processing had ceased. The results of this survey are presented as three papers :

(I) Hygiene status of raw materials and products.

(II) Hygiene status of personnel.

(III) Critical control points in prawn processing.

Materials and Methods

Sampling Prawn samples (ca. 100g.) were obtained at various stages of the processing line, prawns being placed by the prawn handlers in sterile plastic bags. Samples were cooled on ice prior to analysis at the laboratory, usually within two hours of sampling.

Bacteriological analysis Prawns (20g.) were weighed aseptically into a sterile blender jar (MSE homogeniser) and, after the addition of sterile peptone water (80 ml.), the contents were homogenised for 30 seconds.

Total counts were carried out by spreading diluted aliquots (0 .1 ml.) on duplicate plates of Nutrient Agar, which were incubated at 28 – 30°C / 48h.

Staphylococcus aureus counts were obtained following incubation (37°C/24h) of diluted aliquots (0.1 ml.) on duplicate plates of Baird Parker Agar. Suspect colonies were transferred to Brain-Heart Infusion, incubated (37°/18h), and tested for Coagulase activity.

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Escherichia coli counts were carried out by inoculating triplicate tubes of Brilliant Green Bile Broth with diluted aliquots (0.1 ml.) and incubating at 44.5°C/48h. From positive tubes (containing gas) cultures were inoculated on Eosin Methylene Blue Agar and incubated at 37°C/24h, after which typical colonies, with a metallic sheen, were inoculated in Tryptone broth. After incubation at 44.5°C/18h cultures were tested for the production of indole by adding Kovac's Reagent.

The production of gas at 44.5°C in Brilliant Green Bile Broth; typical colonies with a metallic sheen on Eosin Methylene Blue Agar; and the production of indole at 44.5°C were considered criteria for identification of *E. coli*. Enumeration of *E. coli* was by the Most Probable Number (MPN) method.

Results and Discussion

Bacterial counts on prawns which comprised the raw material for the process were generally high (Table 1) compared with counts on raw prawns from other countries (Table 2, After Cann, 1976). Factors contributing to the higher counts on Sri Lankan prawns were considered to be : the high ambient temperature, coupled with, in some cases, extremely long transport times,e.g,. Jaffna–Colombo; insufficient ice, or ineffective icing during transport ; a delay during marketing at St. John's Market, Colombo, prior to further transport to, for example, Galle ; the use of very old, very dirty fish boxes.

Not surprisingly, as indicated in Table 3, there was a great spread in bacterial loading on raw prawns between individual companies. Each company inspected is referred in this paper by a number as No. 1, etc., without naming it. Interestingly, by far the lowest bacterial loadings were recorded at Company No. 3, the only company which received prawns from its own trawlers, thereby obviating the transport stage.

Following grading, prawns were deheaded, a processing step which saw a significant reduction in bacterial loading (Table 4) though, whether this reduction was due to the deheading phase *per se*, or due to the accompanying washing phase, is not known. Although deheading, in general, gave a reduction in bacterial loading, the degree of reduction was found to vary between different companies (Table 5). The basis of the improved processing at Company No. 11 centered on thorough washing of prawns before and after deheading, as well as more effective temperature control.

The effectiveness of the deheading stage in reducing the bacterial loading of prawns had led to conflicting data (Cann, 1976) ; in the present study, however, the data unequivocally point to a significant reduction.

Following deheading prawns may be packed either without further processing (Shell-on prawns) or peeled undeveined (P.U.D. prawns) or peeled and deveined (P.A.D. prawns).

The shell-on prawn products were found to have a wide range of bacterial loading (Table 6). In the case of one company, Company No. 4, the process was carried out most effectively (Table 7), this company having premises, plant and equipment in good order, together with a good supply of ice.

The peeled, undeveined product (P.U.D. prawns) embraced a further processing stage compared with the shell-on product— the removal of the abdominal carapace. The P.U.D. product therefore received more physical handling by personnel, and was " in process " for longer. The bacterial loading of P.U.D. prawns was found to be higher than shell-on prawns (Table 8).

In the processing of the P.A.D. prawn the gut and gut contents are removed by excising along the dorsal mid-line of the abdomen. In this product the increased handling is balanced, from a hygiene view point, by the removal of the gut with its accompanying heavy bacterial loading. The bacterial loading of P.A.D. prawns was, generally, lower than that of P.U.D. prawns, a major contributing factor, however, being the superior processing regimes of Companies Numbers 10 and 11.

Three companies were engaged in processing cooked, peeled prawn products marketed either in frozen blocks or in " individually quick frozen " (in fact, not a true I.Q.F. product) form. The cooking process takes the temperature of the prawns to almost 100°C on the surface, and around 70°C internally, thereby providing a reduction in bacterial loading of 90–99%. At the same time, however, the cooking process renders the product more vulnerable because, firstly, the cooked product, unless it is cooled effectively, remains in the bacterial growth zone (15–45°C) for a long period allowing regrowth of surviving bacteria; secondly, the lowered bacterial count means reduced competition allowing colonisation by contaminants ; thirdly, during peeling of the cooked product, contamination by Staphylococci is an inevitable consequence.

A comparison of the bacterial loadings during processing of cooked prawns by Companies No. 1, 2 and 3 is presented in Table 10. The bacterial levels of the final products of Companies No. 1 and 2 were found to be rather higher than those normally accepted by importing countries, due in major part to the poor temperature control of the process. The situation at Company No. 3 appeared much better with total counts of 10^4–10^5/g. and *Staph. aureus* and *E. coli* levels below 100 and 6 respectively. Such low counts were found to be due to the 2nd cooking process—a process carried out as part of the buyer specifications—and one which caused a reduction in total count of more than 90%. A feature of *Staph. aureus*, however, is the production of heat stable toxin, which is not denatured by a 2nd cook. The product, then, may have a low count yet still be toxic, and the 2nd cook, therefore, gives a false sense of security.

Overall, the hygiene status of both raw and cooked prawn products was found to be unacceptable, in view of the standards and specifications imposed by importing countries.

A number of processing stages were found to be not adequately controlled in terms of temperature, allowing unacceptable bacterial replication ; critical control points will be considered in detail in Paper 3 of this series.

Summary

A survey of processing hygiene in the Sri Lankan prawn industry has shown that the incoming raw material has extremely high bacterial loadings ; about 50% of samples analysed had a total count in excess of 10,000,000/g. Although deheading reduces the count, ineffective temperature control during processing means that the final total count of raw, shell-on, P.U.D. and P.A.D. prawns, as well as cooked prawns, is in excess of 1,000,000/g.—the maximum level specified by many importing countries.

Reference

CANN, D. C. (1976)

The bacteriology of Shellfish with reference to international trade. *Proceedings of the Conference on Handling, Processing and Marketing of Tropical Fish* (Fish Products Institute, London).

TABLE 1

BACTERIAL COUNTS ON SRI LANKAN PRAWNS AT INITIAL GRADING

Bacterial Range	*Number of Samples*	*Percentage of Samples*
Total count/g. :		
1,000,000 – 10,000,000	31	54%
10,000,000 – 100,000,000	26	46%
Staph. aureus/g. :		
< 100	29	51%
100 – 1,000	25	45%
1,000 – 5,000	3	4%
E. coli/g. :		
< 6	15	28%
6 – 100	17	31%
100 – 1,000	14	26%
1,000 – 5,000	8	15%

TABLE 2

BACTERIAL COUNTS DETERMINED ON PRAWNS FROM OTHER COUNTRIES (AFTER CANN, 1976)

Country	*Bacterial Level/g*
India	10,000 – 10,000,000
Thailand	1,000 – 1,000,000
Australia	1,000 – 100,000
Malaysia	1,000,000 – 10,000,000

TABLE 3

COMPARISON OF RAW MATERIAL QUALITY OF DIFFERENT COMPANIES

Bacterial Count/g	*Company*			
	No. 2	*No. 3*	*No. 4*	*No. 5*
Total count	36,000,000	1,800,000	40,000,000	40,000,000
	30,000,000	1,600,000	20,000,000	24,000,000
	30,000,000	1,600,000	20,000,000	16,000,000
Staph. aureus	200	200	100	1,800
	200	100	100	600
	100	100	100	500
E. coli	2,200	14	4,800	2,200
	2,200	8	920	2,200
	480	8	920	480

TABLE 4

BACTERIAL COUNTS ON DEHEADED PRAWNS

Bacterial Range	*Number of Samples*	*Percentage of Samples*
Total count/g. :		
100,000 – 1,000,000	5 ..	15%
1,000,000 – 10,000,000 ..	26 ..	72%
10,000,000 – 100,000,000	7 ..	13%
Staph. aureus/g. :		
< 100	30 ..	74%
100 – 1,000	9 ..	21%
1,000 – 10,000	2 ..	5%
E. coli/g. :		
< 6	14 ..	33%
6 – 100	21 ..	50%
100 – 1,000	4 ..	10%
1,000 – 10,000	3 ..	7%

TABLE 5

BACTERIAL COUNTS ON RAW MATERIAL AND ON DEHEADED PRAWNS FROM COMPANIES Nos. 9 AND 11

	Total Count/g	
	Company No. 9	*Company No. 11*
Raw material	6,000,000 ..	38,000,000
	3,000,000 ..	24,000,000
		20,000,000
		20,000,000
Deheaded prawns	2,400,000 ..	800,000
	2,000,000 ..	600,000
		600,000

TABLE 6

BACTERIAL COUNTS OF PACKED, SHELL-ON PRAWNS *

Bacterial Range	*Number of Samples*	*Percentage of Samples*
Total count/g. :		
100,000 – 1,000,000	2	13%
1,000,000 – 10,000,000	13	80%
10,000,000 – 100,000,000	1	7%
Staph. aureus :		
< 100	13	76%
100 – 1,000	3	18%
1,000 – 10,000	1	6%
E. coli/g. :		
< 6	6	35%
6 – 100	10	59%
100 – 1,000	1	6%

* Companies packing shell-on prawns :—Nos. 4, 5, 6, 8, 9 and 15.

TABLE 7

PROCESSING OF SHELL - ON PRAWNS BY COMPANY No. 4

Process Stage	*Bacterial Count/g*	
	Total	*E. coli*
Raw Material	20,000,000	920
	20,000,000	920
	40,000,000	4,800
After Deheading	10,000,000	4,800
	3,000,000	4,800
	1,600,000	4,800
Final Product Shell-on	2,000,000	86
	1,000,000	46
	800,000	42

TABLE 8

BACTERIAL COUNTS OF PEELED, UNDEVEINED (P.U.D.) PRAWNS*

Bacterial Range	*Number of Samples*	*Percentage of Samples*
Total Count/g. :		
1,000,000 – 10,000,000	10	55%
10,000,000 – 100,000,000	5	28%
100,000,000 – 1,000,000,000	3	17%
Staph. aureus/g. :		
< 100	3	17%
100 – 1,000	14	78%
1,000 – 10,000	1	5%
E. coli/g. :		
< 6	8	45%
6 – 100	10	55%

TABLE 9

BACTERIAL LOADING OF PEELED AND DEVEINED (P.A.D.) PRAWNS†

Bacterial Range	*Number of Samples*	*Percentage of Samples*
Total Count/g. :		
100,000 – 1,000,000	3	13%
1,000,000 – 10,000,000	14	64%
10,000,000 – 100,000,000	5	23%
Staph. aureus/g. :		
< 100	14	64%
100 – 1,000	5	23%
1,000 – 10,000	3	13%
E. coli/g. :		
< 6	9	41%
6 – 100	8	36%
100 – 1,000	3	13%
1,000 – 10,000	2	10%

* Packed by Companies Nos. 1, 7,8, 11, 12, and 13.

† Packed by Companies Nos. 10, 11, 12, and 13.

TABLE 10

PROCESSING OF COOKED, PEELED PRAWNS BY COMPANIES Nos. 1, 2 AND 3

Processing Stage	*Company No. 1*			*Company No. 2*			*Company No. 3*		
	Total count	*Staph. aureus*	*E. coli*	*Total count*	*Staph. aureus*	*E. coli*	*Total count*	*Staph. aureus*	*E. coli*
Raw Material	8,000,000	1,200	<480	36,000,000	200	480	1,400,000	<100	8
	8,000,000	400	300	30,000,000	100	300	1,200,000	<100	8
	6,000,000	100	300	30,000,000	<100	2,200	1,100,000	200	14
	6,000,000	200	30	17,000,000	200	2,200	—	—	—
After Wash in Chlorinated Water	Process not done by Company No. 1			Process not done by Company No. 2			1,000,000	<100	<6
							1,000,000	<100	<6
							400,000	<100	<6
After Cooking	2,800,000	<100	14	6,000,000	800	<4,800	600,000	<100	<6
	2,000,000	200	28	4,000,000	500	220	400,000	<100	<6
	1,800,000	300	86	3,000,000	100	480	200,000	<100	<6
After Overnight Storage	Process not done by Company No. 1			Process not done by Company No. 2			2,000,000	<100	<6
							1,600,000	<100	<6
							1,400,000	<100	<6
After Peeling	4,000,000	100	6	10,000,000	200	150	4,000,000	200	<6
	1,800,000	500	8	2,000,000	900	300	2,000,000	1,400	<6
	1,600,000	1,500	8	1,000,000	300	30	2,000,000	100	<6
After Second Cook	Process not done by Company No. 1			Process not done by Company No. 2			200,000	<100	<6
							80,000	<100	<6
							60,000	<100	<6