A SURVEY OF THE QUALITY OF SHRIMP SUBSEQUENTLY USED FOR FREEZING

by

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ABSTRACT

With a view to improve the quality of frozen shrimp, investigations were carried out on shrimp at various stages. Sanitary conditions of the shrimp processing plants were surveyed. The bacteriological quality of the raw materials such as fresh shrimp and water used in the processing-plant were examined. Studies on processing-line samples and steps that tend to cause large increase or decrease in the bacterial count, foliform bacteria, *Escherichia coli* and total volatile base contents of shrimp are described.

INTRODUCTION

According to the Statistical Year Book of the Thai Department of Fisheries (Anon. 1966) the value of fish exported from Thailand was 234 million Bahts. More than 80% of the total amount of fish exported was frozen shrimp which was valued at 190 million Bahts per year. However, there is no information concerning the quality of the product and sanitary conditions of the plants producing frozen shrimp. The examination of production-line samples may help to improve the quality of frozen shrimp which in turn will lead to increased exports and earnings of foreign currency.

In general, the degree of freshness of shrimp is based on total volatile bases. However, it has long been recognized that the total bacterial counts can be used as an index of quality and sanitation and therefore bacteriological studies at the freezing plants will provide useful information to evaluate processing practices and plant sanitation. Beside the bacterial counts, the presence of *Escherichia coli* is also a reliable index of the unsanitary quality of the product.

The degree of spoilage of fish is influenced by the number of spoilage bacteria. Their proteinase activity becomes significant when the number approaches 10,000,000 bacteria per gram of fish (Liston, 1965). The microflora of crustacean shellfish seems to be similar to that of fish (Colwell and Liston, 1960). Bacteriological studies of shrimp showed that whole shrimp examined immediately after emptying of the trawl net varied in bacterial count from 1,600 to 1,200,000 per gram (Green, 1949). At the end of 2 day's storage

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the total bacterial count on whole shrimp had increased sevenfold; on headless shrimp, five-dold (Fieger and Novak, 1961). However, fish caught in unpolluted water carry no bacteria of public health significance on their surface and other external surfaces and the flesh and internal organs are sterile (Griffiths and Fuller, 1936; Linda and Slavin, 1960). Sanitation practices in shrimp processing will obviously influence the bacteriological quality of the shrimp reaching the consumers.

COMMERCIAL METHODS OF HANDLING SHRIMP

In Thailand, usually shrimp are transported as whole shrimp in wooden boxes by truck from landing places in the south to the processing plants located in Bangkok. The duration of transportation varies from 10 to 48 hours. Icing of shrimp is usually practiced. A proportion of one part of ice to one part of fish is used for the short distance (10 to 20 hrs.), and one and a half parts of ice to one part of fish for the long distance (more than 24 hrs.). At the plant, shrimp are unloaded and dumped onto the floor of the plant and exposed there in heaps. Sorting and beheading of shrimp are done on the floor in the same area. Beheading merely consists of breaking by hand the shrimp at the junction between the head and the body. The head with the walking legs is discarded or converted to fish meal and the remaining section retained. Beheaded shrimp are deveined, trimmed and sorted by the plant employees to remove any discolored, decomposed, or multilated shrimp. During this operation, beheaded shrimp are washed 2 to 3 times with clean potable water in a washing tank. The next step after the culling is the size-grading of the shrimp. Mostly, in Thailand, this is done by hand on aluminum-covered table except in one large plant where a size-grading machine is used. After sorting, the shrimp are again washed a few more times with clean potable water in another washing tank. Sorted shrimp are then arranged by size in the metal container, then chilled water is added to allow the free water to form a layer of ice covering the shrimp. After the shrimp are solidly frozen, the block of frozen shrimp is taken out from the container and wrapped in a moisture-proof material and then put in a wax-paper carton. The packaged shrimp are packed in master cartons and returned to the freezer for storage until removed for export.

MATERIALS AND METHODS FOR EVALUATING THE QUALITY OF SHRIMP

Shrimp samples at various stages from several plants were collected in polyethylene bags and stored under ice during transportation to the Fisheries Technology Laboratory. Washing water before, during, and after operation were collected in 20 ml. sterile screw-capped test tubes and also kept under ice.

The water samples were analysed for the total viable count, the coliform bacteria, the absence and presence of *Escherichia coli*. For shrimp samples, determination of total volatile bases was also made in addition to the bacterial analyses.

Dilution of shrimp samples were prepared by homogenizing the whole or beheaded shrimp in sterile distilled water (1:3 w/v) in a sterile Waring blender. One ml. of shrimp homogenate was then added to 9 ml. of sterile distilled water to obtain 10^{-1} dilution. The water samples were pipetted directly into sterile distilled water.

Total Viable Count

Serial decimal dilutions were made with sterile distilled water and plates were poured with nutrient agar (Difco). The plates were incubated aerobically at room temperature (27°C ± 3°) for three days after which the number of colonies was counted.

Presumptive Coliform Count

Lauryl tryptose broth (Difco) was used to test for coliform bacteria. The tubes containing the medium were incubated at 35°C for 24-48 hrs. after inoculation. The positive results were confirmed with brilliant green bile broth.

Complete Test for Fecal *Escherichia coli*

Cultures from the Coliform positive tubes were streaked on eosin methylene blue agar medium (EMB agar) plates. The plates were incubated at 35°C for 18 to 24 hrs. The colonies with metallic sheen were transferred into lauryl tryptose broth tubes and incubated at 35°C for 24 to 48 hrs. The positive tubes (gas production) were transferred to nutrient agar slant and incubated at 35°C for 24 hrs. The slants containing the pure culture of gram negative rods are tested for fecal *E. coli*. (Anon, 1955).

Determination of Total Volatile Bases by Microdiffusion Technique

The method described by Conway and Byrne (1933) and modified by Beatty and Gibbons (1937) was used.

RESULTS AND DISCUSSION

As shrimp are transported from various places to the freezing plants, the quality of the shrimp varies considerably. Table I shows the quality differences of raw whole shrimp from four important fishing centres upon delivery at the plants at Bangkok.

Table I

The Quality Differences of Whole Shrimp as They Arrive at the Plants

Location	Transportation time (hrs.) to Bangkok	Total volatile bases mg of N/100 g	Bacterial count per g of shrimp
Kantang	48	20.40	2.6×10^7
		24.00	2.9×10^7
Nakornsri-thammarat	48	26.71	1.4×10^8
		43.50	1.4×10^9
Ranong	12	15.60	1.4×10^6
		18.95	4.3×10^6
Trad	10	18.71	6.0×10^6
		19.68	9.2×10^6

It can be seen from the above table that both the amount of total volatile bases and the bacterial counts in shrimp vary considerably. The quality of the raw material in turn, will influence the quality of the finished product. The quality of shrimp from Nakornsrithammarat is poorer than that from Kantang though the time taken for transport is about the same. This may be due to difference in handling on board the fishing vessel.

Because of poor quality, shrimp from Nakornsrithammarat are sometimes beheaded before shipment to Bangkok. Experiments were carried out to determine the difference in quality of shrimp beheaded before and after transportation. Table II shows the comparison of quality of whole shrimp to beheaded shrimp before and after transportation. Beheaded shrimp, either before or after transportation, were found to be of a better quality than the whole shrimp. Beheading of shrimp at the earlier stage improved the quality significantly.

Table II

Comparison of Quality of Whole Shrimp to that of Beheaded Shrimp from Nakornsrithammarat

Whole shrimp		Beheaded shrimp at the plant		Beheaded shrimp at the landing place	
TVB*	TBC**	TVB*	TBC**	TVB*	TBC**
26.71	1.4×10^8	23.02	6.2×10^7	20.09	9.3×10^6
43.50	1.4×10^9	36.80	7.0×10^8	20.60	2.3×10^8

* Total volatile bases mg of N/100g.

** Total bacterial count/g. of shrimp.

Bacterial analysis of water obtained from 4 different plants in Bangkok and Thonburi showed little variation in the number of total bacterial (Table III). Coliform organisms were found only in one sample. This figure is more or less acceptable because drinking water should not have more than 2.2 of coliform bacteria per 100 ml. (Regulation for drinking water from the Department of Medical Sciences).

Table III

Variation in Number of Bacteria of Tap Water Used in Plants

Source	Total no. of bacteria per ml	Coliform bacteria MPN value/100 ml
Plant 1	1.0×10^3	-
Plant 2	3.0×10^3	-
Plant 3	1.0×10^3	3
Plant 4	5.0×10^2	-

Washing of shrimp in clean water reduced the number of bacteria considerably. Use of chlorinated water could reduce the number further as was found in Plant 4. (Table IV).

Table IV

Total Number of Bacteria per ml in Washing Water

Samples	Washing water with ice or without ice			
	Plant 1	Plant 2	Plant 3	Plant 4*
Water before use	1.0×10^3	3.0×10^3	1.0×10^3	5.5×10^2
1st Washing water after dressing & trimming	9.0×10^6	7.1×10^7	1.1×10^7	2.5×10^5
2nd " " "	2.4×10^6	5.7×10^7	1.9×10^6	2.5×10^4
3rd " " "	1.0×10^6	2.7×10^7	1.0×10^6	-
1st Washing water after size-grading	3.3×10^6	7.9×10^7	3.0×10^6	1.0×10^4
2nd " " "	4.0×10^5	5.2×10^7	1.0×10^6	5.0×10^3
3rd " " "	-	1.3×10	1.6×10^5	-

* Plant 4 used Chlorinated water.

Studies of processing-line samples revealed that the quality of shrimp were improving during processing. Although the coliform counts were high *E. coli* was not found. The value of total volatile bases of the finished products ranged from 11.00 to 29.90 mg N/100 g which can be considered to be within the standard limit. As for the total bacterial count the numbers were slightly higher than the allowed figure set up by Japanese importer. However, it should be noted that the frozen shrimp sample used in this study had been in a frozen stage for only one day. Longer storage in the frozen stage would result in further reduction of the number of bacteria.

Table V

Quality of Shrimp at Various Stages During Processing

Samples	Plant 1				Plant 2			
	TVB**	TBC	Coli-form*	*E. coli*	TVB**	TBC	Coli-form*	*E. coli*
Whole shrimp	20.40	2.6×10^7	+	-	26.71	1.4×10^8	+	-
Beheaded shrimp	18.80	8.3×10^6	+	-	23.02	6.2×10^7	+	-
Beheaded shrimp after washing & trimming	14.56	5.3×10^6	+	-	13.58	8.4×10^6	+	-
Beheaded shrimp after sorting	11.72	3.5×10^6	96,000	-	12.12	5.6×10^6	84,000	-
Frozen shrimp (1 day)	11.00	2.0×10^6	3,600	-	11.52	3.0×10^6	38,200	-

+ Over 440,000. * Coliform bacteria. ** mg of N/100 g.

Table V (Cont'd)

Quality of Shrimp at Various Stages During Processing

Samples	Plant 3				Plant 4			
	TVB**	TBC	Coli-form*	*E. coli*	TVB**	TBC	Coli-form*	*E. coli*
Whole shrimp	43.50	1.4×10^9	+	-	29.12	1.5×10^8	+	-
Beheaded shrimp	36.80	7.0×10^8	+	-	24.48	3.3×10^7	+	-
Beheaded shrimp after washing & trimming	32.08	4.5×10^7	+	-	19.80	1.9×10^7	+	-
Beheaded shrimp after sorting	30.12	9.2×10^6	+	-	17.50	6.4×10^6	+	-
Frozen shrimp (1 day)	29.90	8.0×10^6	+	-	16.93	5.0×10^6	184,000	-

\+ Over 440,000.
* Coliform bacteria
** mg of N/100 g.

CONCLUSIONS

The results obtained indicate that the current commercial practices of handling shrimp in Thailand still need to be improved. Although the quality of the product is generally acceptable, measures should be taken to improve it. It must be realized that for freezing, the raw material that arrives at the plant should be as fresh as possible. It is not possible to produce a first rate frozen product from a lower quality raw material. Therefore, maintenance of the quality of the product should start from the very beginning - on board the boat, if possible.

(i) Handling on board: As soon as the catch has been hauled aboard, the shrimp should be iced and stowed in the holds in boxes. The shrimp should not be left on the deck for hours exposed to the sun and also should not be stowed in bulk in the holds as the weight of the upper layer will crush the shrimp.

(ii) Handling at the landing place: Soon after landing the catch should be transported to the processing plant. It should not be left lying exposed to the sun. The investigations indicate that beheading the shrimp immediately after landing reduces the bacterial load. If practicable, the various step such as beheading, deveining and cleaning could be done at the landing place immediately after landing the catch and the shrimp re-iced with fresh ice and transported to the freezing plants.

(iii) Handling at the freezing plant: After beheading and deveining the shrimp should be washed in clean water, preferably the chlorinated water containing about 5 p.p.m. of available chlorine. Higher chlorine contents may confer an odor to the product. The plant premises, working tables, utensils

and other equipment should be washed at the end of each working day with chlorinated water containing 25-50 p.p.m. of available chlorine. The plant premises should be kept absolutely clean and refuse material such as the heads, viscera, etc., should not be left exposed but should be put into covered containers. Measures should be taken to prevent contamination by flies.

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