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Contamination sources of coliforms in two different types of frozen ready-to-eat shrimps

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ABSTRACT

The sources of coliform contamination were studied in two types of processed ready-to-eat (RTE) shrimp products: half-slitted cooked without head-on shrimp for topping on rice as sushi product and cooked peeled with head-on shrimp.

The objective of this study was to determine the processing and environmental factors which contributed to the coliform contamination of these two product types. The samples from each step of the processing lines (5476 samples), finished products (1331 samples) and environment (3624 samples) were collected during January–December, 2006. The samples were then analyzed for presence of coliforms and the results were further analyzed using statistical methods. The results of samples from processing lines showed that cooked shrimps for sushi product were frequently contaminated during slitting step (15.05%) because of the improper design of the slitting equipment. 3.85% of the environmental swabs of slitting equipment were contaminated. In addition, rowing (7.23%), sizing (6.93%) and peeling (6.27%) also contributed to coliforms contamination in the product. In case of cooked peeled with head-on shrimp, the rowing step (8.43%) appeared to be the major contributor of contamination, whereas spraying with cooled water also played a considerably significant part as seen from the environmental swab results which showed 14.06% presence of coliforms at the spraying nozzles. In addition the result of workers' gloves swab also revealed 7.20% of contamination. Using the Monte Carlo Simulation, the correlation of coliform prevalence of finished products, products from processing steps and environmental swab were obtained. The results of both products demonstrated that coliform prevalence of the total samples collected from processing steps and coliform prevalence from environmental swabs correlated with the coliform prevalence in finished products. Identifying these sources helped the plant manager to improve several procedures (such as personal hygiene, cleaning and temperature control including staff supervision) to minimize the coliform contamination in the final products.

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1. Introduction

The Thailand shrimp export industry has seen growth in recent years due to increased consumption of RTE shrimps. In 2006 Thailand exported 147,912.78 tons of shrimps and shrimp products, which were equivalent to USD 1998.85 million. In the same year, the value amount of exported chilled and frozen fresh shrimps increased by 5.95% while exported RTE shrimps increased as high as 24.22% compared with year 2005 (Thai Frozen Foods Association, 2006).

RTE cooked shrimps are often consumed without further heat treatment and it has been pointed out that cooked shrimp could represent a serious health or economic threat if not manufactured under stringent conditions and control. Hence Microbial pathogens could be particularly prevalent in these products and give rise to considerable concerns. It has also been shown that the microbiological status of cooked peeled shrimps is primarily a reflection of the hygienic conditions in the processing plants as the heat treatment reduces the bacterial load to very low levels. Thus, it is very important to prevent contamination after the heat treatment step (Valdimarsson, Einarsson, GudbjÖrnsdottir, & Magnusson, 1998).

Coliforms, especially *Escherichia coli* are microorganisms of concern in almost every food product, since high counts of coliforms and presence of *E. coli* in foods usually reflect unhygienic handling during production process, improper storage conditions and post-process contamination (Blood & Curtis, 1995; de Sousa, Tamagnini, Olmos, & Gonzalez, 2002; Gonzalez, Tamagnini, Olmos, & de Sousa, 2003). Therefore, the acceptable levels of coliforms and *E. coli* have been set up in most countries' national standards to ensure the safety and hygienic conditions of the food products. For example, in USA, the standard of *E. coli* for cooked shrimp which is consumed without further cooking is <3.6 MPN/g; however, standard for coliforms is not specified. European Union standards for cooked

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shrimps includes both faecal coliforms and *E. coli*, i.e., for faecal coliforms, the standard is $n = 5$ $c = 2$ $m = 10$ $M = 100$ MPN/g while *E. coli* is $n = 5$ $c = 1$ $m \leqslant 3$ M = 10 MPN/g. For Japan, one of Thailand's major shrimp importers has a very stringent standard on coliforms. The Japan Food Sanitation Law specified zero tolerant policy for coliforms (Nil (<3) MPN/g) in frozen foods including cooked shrimps (Department of Fisheries, 2004).

HACCP (Hazard Analysis and Critical Control Point) is a powerful system tool to ensure food safety. However, Tompkin (1983) has indicated that the combination of development of good manufacturing practices (GMPs) along with an HACCP program are better alternatives to control microbiological contamination in finished products. The Thai Department of Fisheries, Ministry of Agriculture and Cooperatives, which is the competent authority for certifying fisheries products for export, therefore requires Thai exporters to implement GMPs and HACCP in order to reduce the risk of microbiological contamination which includes coliforms as well as other pathogenic bacteria that can cause food-borne illnesses.

For coliforms, although they can be effectively destroyed at pasteurizing step, coliforms can still be found occasionally in products after cooking even though GMP and HACCP programs are implemented. As contamination can come from various sources in the processing environment, identification of these sources is necessary, in order to establish effective control measures and strengthen the GMP and HACCP programs. This study aimed to investigate sources of coliform contamination in two kinds of frozen cooked RTE shrimp, i.e., cooked shrimps for sushi (cooked peeled shrimp with the head cut-off, the stomach slit and spread) and cooked peeled with head-on shrimps. The processing steps, as well as other probable sources from production environment, were analyzed to determine their degree of contribution to coliform contamination.

2. Materials and methods

This research was carried out in a shrimp production plant in Thailand, which is a manufacturer and distributor of processed shrimp products in domestic market, as well as an exporter to other countries, especially Japan. This plant has been certified on GMP, HACCP and ISO 9001:2000 systems for more than ten years. The two kinds of frozen cooked RTE shrimp products used in this study were cooked shrimp for sushi and cooked peeled with head-on shrimp. Presence of coliforms in products after the heat treatment step was evaluated, as well as coliforms in the production areas designated as "clean areas". Production processes for both types of shrimp products are outlined in Figs. 1 and 2, respectively.

2.1. Sample collection

Sample collection period for this study was from January to December 2006. For each processing step product, 4 shrimps of each product type were collected 2 times per day (morning and afternoon). For cooked shrimp for sushi, a total of 2305 samples were collected from 8 processing steps (Fig. 1), while for cooked peeled with head-on shrimps, a total of 3371 samples were collected from 7 processing steps (Fig. 2).

In order to evaluate the coliform contamination of final products, one sample (195–350 g depends on size of shrimp) per ton of finished product was collected. A total of 1331 samples (476 cooked shrimps for sushi and 855 cooked peeled with head-on shrimps) were collected from January to December 2006.

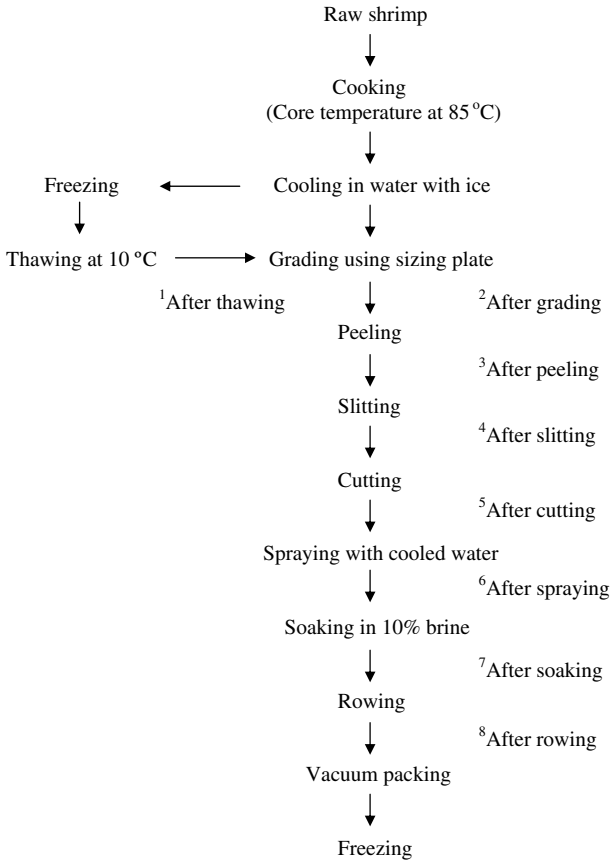

Fig. 1. Process flow for cooked shrimp for sushi product. [1–8] Steps where samplings were taken.

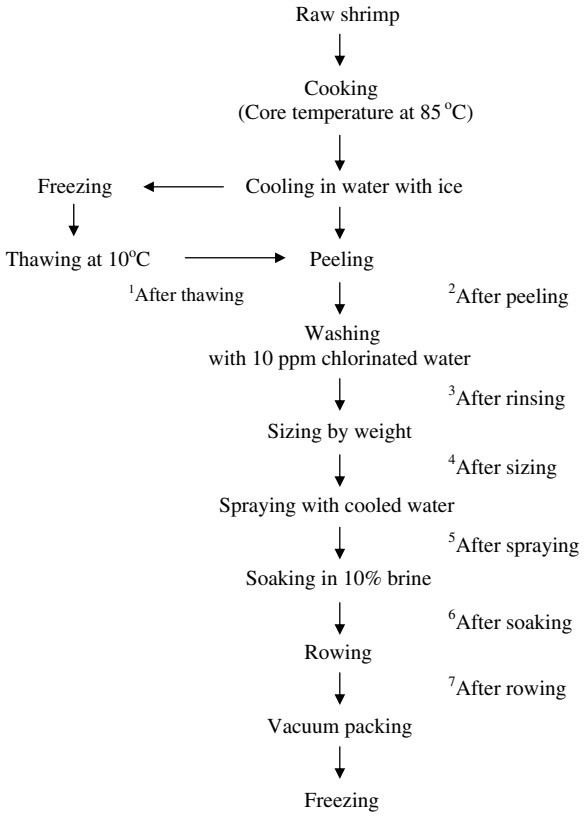

Fig. 2. Process flow for cooked peeled with head-on shrimp. [1–7] Steps where sampling were taken.

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