STUDY OF A HAZARD ANALYSIS CRITICAL CONTROL POINT SYSTEM RELATED TO THE PROCESSING OF FISH AND MEAT PRODUCTS

by

N.P. EDIRISINGHE [1], T.S.G. FONSEKA [1] ana S. JAYARATNE [2]
[1] Dept. of Food Technology - Faculty of Agriculture, Rajarata University of Sri Lanka
[2] Keells Food Products Ltd., Ekala, Ja-ela, Sri Lanka

ABSTRACT

A Hazard Analysis Critical Control Point (HACCP) system was developed for Chinese fish rolls and skinless chicken sausages. The production process of the above products were studied at the processing factory. Microbiological tests were carried out to assess the status of the products during the production process. The tests were also repeated after taking some corrective measures.

The processing stages, namely blending, chilling, battering, crumbing and packing of the final products showed some level of microbial contamination with *E. coli*, in Chinese fish rolls. In chicken sausages the production line receiving area and equipment workers hands, mincer plates, meat chopper, filled sausages and many other areas showed contamination with *E. coli*. *Staphylococcus aureus* contamination was also noted in certain stages but no *Salmonella* contamination was detected at any stage of processing.

Based on the results of monitoring the chilling, battering and crumbing equipment in the production line and during packing was considered important in Chinese fish roll production while in skinless chicken sausage production, cooking, casing and packing were considered for further improvement of quality.

The suggested modifications: chilling temperature, thorough cleaning and disinfecting of the production line and hygienic practices of the food handlers in the processing line for Chinese fish rolls and washing the peeling machine with boiling water, providing effective disinfectants for hand washing and cleaning the equipment of the chicken sausage processing line led to drastic reduction of *E. coli.* and *Staphylococcus* contamination resulting in very satisfactory improvement of the quality of products. Use of disinfectants illuminated *E. coli.* and *Stapylococcus* from work surfaces.

INTRODUCTION

It is accepted that the traditional quality control methods cannot eliminate hazards at the correct time. The development of the Hazard Analysis Critical Control Point (HACCP) system, which is based on a preventive strategy based on a thorough study of existing conditions, is considered a better method to ensure quality and to reduce the cost of production. The HACCP system has seven main elements identifying potential hazards including determining the critical control points, establishing controls, establishing monitoring systems, establishing corrective actions when the CCP is not under control (Huss 1994).

During this study a food processing factory producing Chinese fish rolls and chicken sausages was selected to continuously monitor production process using a HACCP system with a view to improving the quality. Special emphasis was given to cleaning and disinfection procedures.

Procedure

Flow charts for the production of:

(a) Skinless chicken sausage
(b) Chinese fish rolls

were prepared. Each step was carefully analyzed with available data and more analytical results obtained by further examination of samples taken at different control points.

MATERIALS AND METHODS

In a month, ten samplings were carried out at following points in the production lines of Chinese rolls and skinless chicken sausages.

Sampling method

Details of the product/swab samples taken for microbial analysis of each processing step in skinless chicken sausages processing line are given in Table I. Sampling details on Chinese fish roll processing line are given in Table II.

Based on the results of analysis from samples taken in the chicken sausage processing line corrective actions were taken at following points:

a) Cooking
b) Showering
c) Peeling
d) Packing

The sample taken from the Chinese fish rolls did not imply any major corrective action except for the disinfection procedure.

Both production lines were subjected to an alteration in cleaning procedures using two disinfectants:

(a) Sumabac 3% (Quaternary Ammonium Compounds);
(b) Halamid 0.2% (Chloramine T).

Cleaning procedure

The detergent and disinfectant were used together. The contaminated surfaces were rinsed with water and then the detergent and the disinfectant mixture was applied. For Halamid disinfectant mixture, 0.9 g of Halamid was mixed with 100 ml of water and 50 ml of M-100 soap was added and made up to 4.5 L.

For Sumabac disinfectant mixture 135 ml of Sumabac was mixed with water and filled up to 4.5 L(Sumabac has detergent in it).

This mixture was applied on the contaminated surfaces and left for 20 min. Then the surfaces were rinsed off with water.

Method of sampling

Swab samples were taken from packing tables, processing machines, baskets etc. in the sausage processing plant as well as in the Chinese fish roll processing plant.

Microbiological analysis

(a) Product Sample Analysis

For sampling of the product for total bacterial counts (TBC), *Escherichia coli* and *Staphylococcus aureus*, 10 g samples were blended with 90 ml pre sterilized peptone water in sterile stomacher bags for 30 seconds. The serial dilution were made by aseptic transfers.

(a) Total bacterial counts - determined by plating appropriate dilution in nutrient agar plates;

(b) Total coliform counts - were determined by plating appropriate dilution in duplicate plates of MacConkey agar.

(c) *Escherichia coli* - determined using MPN - (3-tube) technique, using MacConkey broth. Gas and acid positives at 35°C for 24 hr incubation were transferred to brilliant green bile broth and incubated at 44°C. Gas positives were further confined with IMVIC tests.

(d) *Staphylococcs aureus* - was detected by plating appropriate dilutions on Baird Parker plates incubated at 37°C for 48 hr. Black colonies with a clearing zone were considered positive for *S. aureus*.

(e) *Salmonella* - Samples were pooled to get a composite sample and 25 g were added to lactose broth 225 ml.

Pre enrichment -	lactose broth 30oC - 24 hrs
Enrichment -	tetrathionate broth
Selective Agars -	brilliant green agar and SS agar

Presumptive colonies were confirmed with following bio-chemical tests
TSI slants, urease test, ONPG test.

(b) Cotton Swab Sample Analysis

Cotton swabs were prepared and sterilized at 121oC for 20 min.

Sterilized swabs were taken aseptically and rolled over the surface once and inserted into peptone tube (sterilized).

Sterilized 1 ml of inoculated peptone was used for swabbing was introduced to 9 ml sterilized peptone. This constituted the 10^{-1} dilution. The serial dilution prepared were used for testing for *E. coli*, *S. aureus* and *Salmonella*.

RESULTS

Fig. 1 represents the Flow chart for processing of skinless chicken sausages while Fig. II represents the Flow chart for processing of Chinese fish rolls.

Table I represents the results of the samples analyzed in the chicken sausage processing line.

Table II represents the results of microbial analysis of samples taken from the Chinese fish roll processing line.

Table III shows comparison of the results of microbial analysis of chicken processing plant before and after the same corrective measures.

Fig. III shows the results of cleaning with and without disinfectant on the processing equipment of chicken sausages processing plant when assessed for the presence of *E coli*.

Fig. IV gives the details of the results of cleaning with and without disinfectant on the processing equipment of the chicken sausage processing plant when assessed for the presence of *Staphylococcus aureus*.

Fig. V represents the details of the results of cleaning on tables with and without disinfectant in the Chinese fish rolls processing plant in relation *E. coli*, while Fig. VI represents the same details in relation to *S. aureus*.

DISCUSSION

In the processing of skinless chicken sausage, cooking, peeling, vacuum packing, blast freezing and frozen storage were assessed as critical control points. Cooking completely eliminated *E. coli.* and *S. aureus* present in the sausage. Extension of cooking time by 3 min. also reduced the total bacterial count by about 1 log cycle. All steps prior to cooking are control points, while all the steps from then should follow good manufacturing practices. As cross-contamination cannot be eliminated, in later steps, extra precautions for consumer safety and product acceptability are a must.

In the processing of Chinese fish rolls steps prior to flash frying was considered control points. The process of flash frying tended to eliminate most of the microorganisms. All steps following the frying should be done with extra care to prevent any contamination and cross contamination.

The results analysis of swab samples after cleaning without using disinfectants do not seem to have much effect on removal of *E. coli* and *S. aureus* on work surfaces in the chicken processing areas as well as in fish processing areas. However the use of Halamid and Sumabac both had a remarkable effect in the cleaning and disinfectant process. None of the swab samples tested was positive for *E. coli* and *S. aureus* after use of disinfectant.

The active agent in Sumabac is a Quaternary Ammonium Compound while that of Halamid is chloramine-T. Most quaternary ammonium compounds are classed as germicidal cationic-detergents. The bacteriocidal power of the quaternaries is exceptionally high against Gram-negative organism. Bacteriocidal concentrations range from dilutions of one part in a few thousand to one part in several hundred thousand. They are also known to manifest bactoriostatic action far beyond their bacteriocidal concentration (Pelezar *et al.*, 1986). QUATS are reported to be less effective than those of halogens while they are less affected by pH and organic matter (Shapton and Shapton, 1991).

The chloramines represent another category of halogen compounds used as disinfectants, sanitizing agents or antiseptics. They are stable (more stable than hypochlorite) in terms of prolonged release of chlorine (Pelezar *et al.*, 1986). However, QUATS are more expensive than chloramine compounds but both cleaning and disinfection were found to be equally effective for cleaning of both processing plants.

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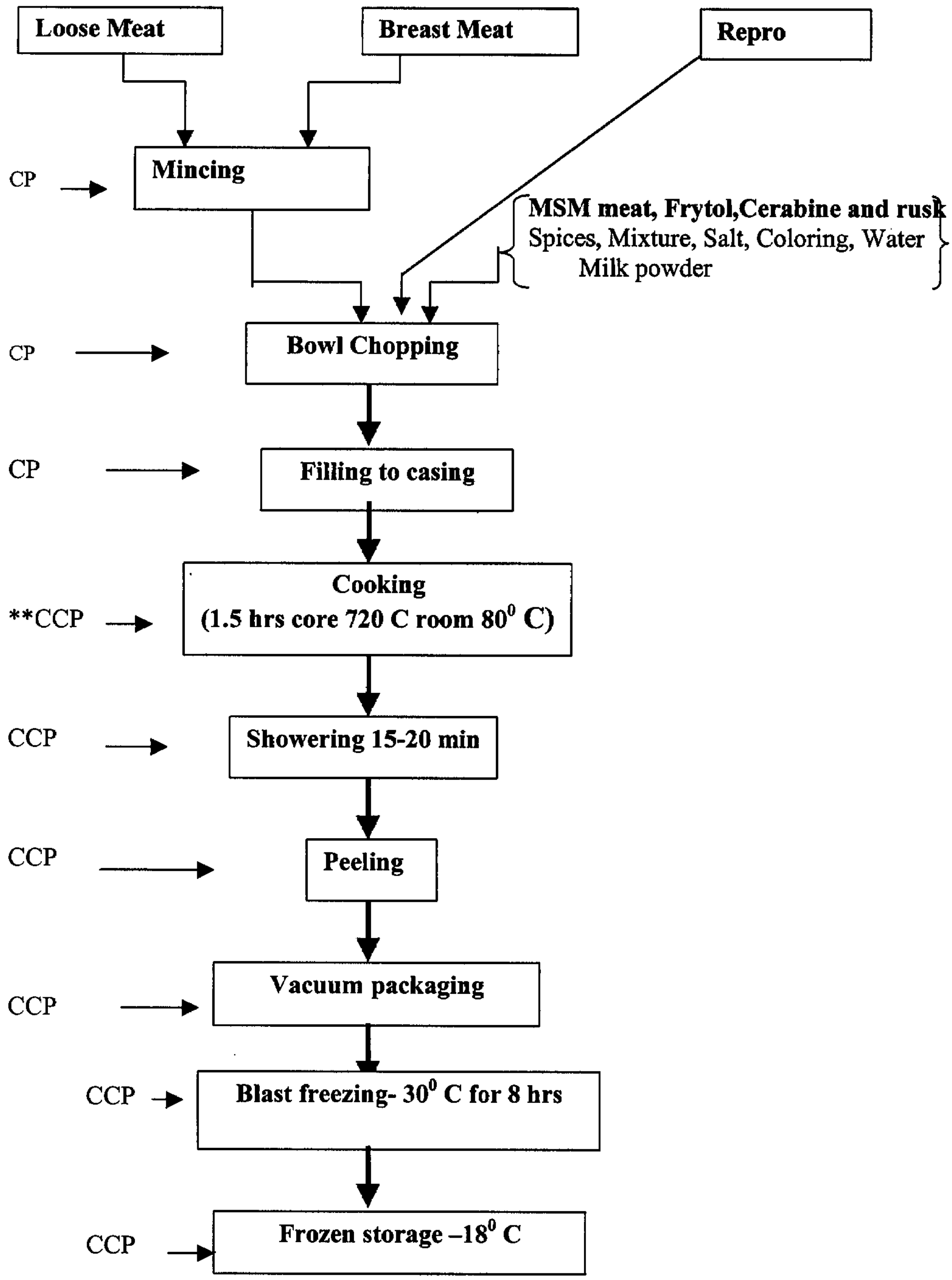

Fig. 1. Flow diagram for skinless chicken sausage.

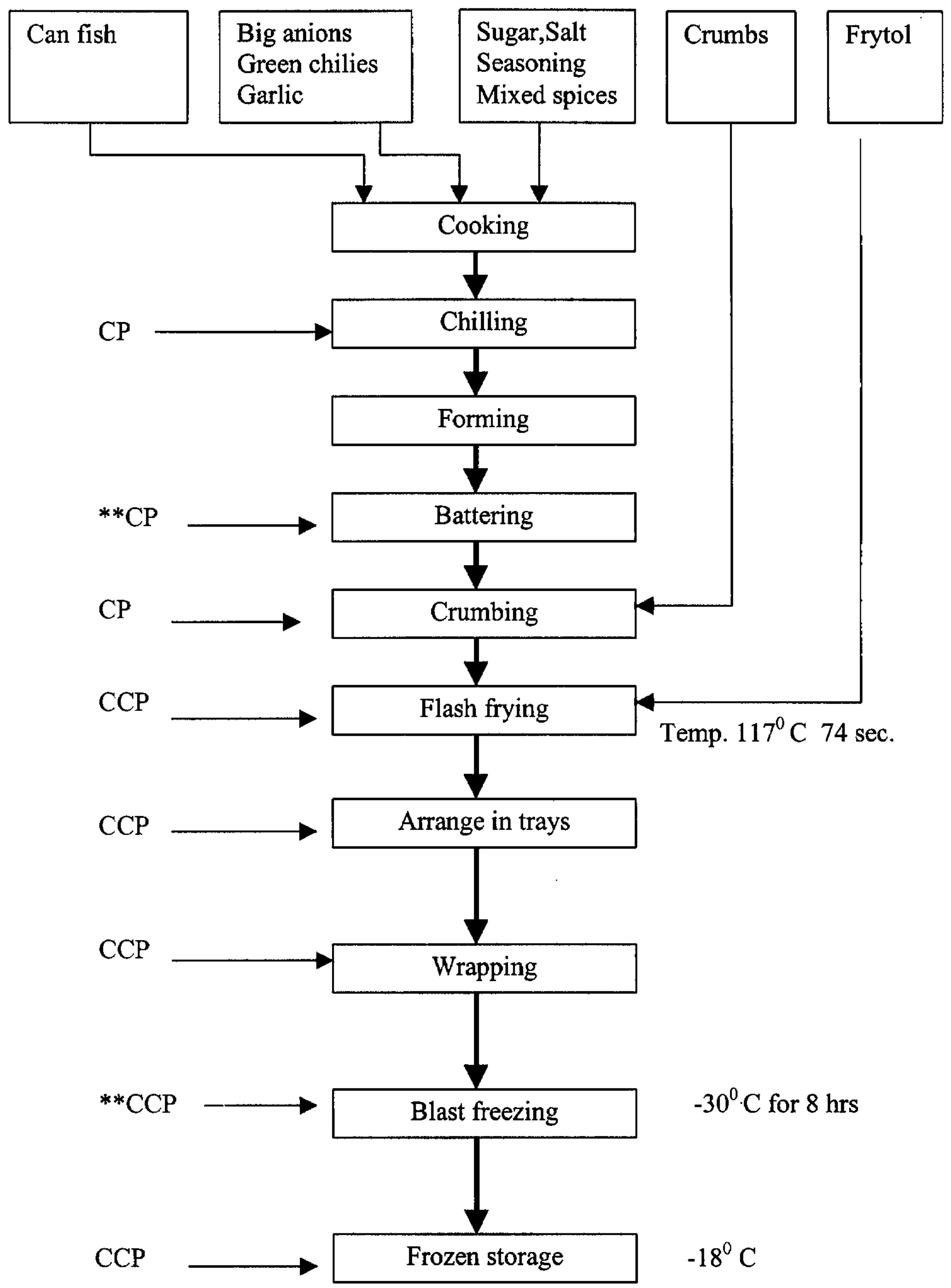

Fig. II. Flow diagram for fish rolls.

Table 1. Results of the samples analysed from the chicken processing line.

Process step	# of samples	Microbial analysis *E. coli*	Staphs.	*Salmonella*
1). Receiving and storage				
1.1. MSM/MDM, breast meat loose meat	10	<10 *E.coli* for all samples	3 present	Absent
2). Receiving area and equipment				
2.1. Work surfaces	20	15 samples for >10 E. coli, other <10 E. coli	5 present	-
2.2. Workers hands	20	18 samples >10 and others<10	18 present	-
2.3. Knives and baskets	20	Baskets – all >10	absent	-
3). Mincer plate	10			
3.1. Before work		5 samples <10 others absent	absent	-
While working		all present	absent	-
After cleaning		all absent	absent	-
3.2. Minced meat	10	all >10 *E.coli*	absent	-
4). Bowl chopper – working	10	all >10 *E.coli*	absent	-
4.1. After cleaning	10	all absent	absent	-
4.2. Chopped meat	10	all >10 *E.coli*		-
5). Filler nozzle				
While working	10	all <10 *E.coli*	absent	-
After cleaning	10	all absent		
6). Filled raw sausage	15	all >10 *E.coli*	2 present	-
7). After cooking	30	all absent	All absent	-
8). After shower	30	all absent	All absent	-
9.1) Before peel	30	All absent	All absent	-
9.2 After peel	30	20-<10 E. coli other absent	5 present	-
9.3 Environmental	10	3 present	8 present	-

9.4. Peeling table before work	20	10 - <E.coli Others absent	3 present	-
While working	20	All present	10 present	-
After cleaning	20	All absent	all absent	-
9.5. Workers hands	40	All present	20 present	-
10).1.Transfer tube	10	All present	2 present	-
10.2. Transfer worker hands before work	10	5 present	absent	-
11).1. Packing :-				
Before pack	20	all >10 E.coli	3 present	-
After pack	20	all >10 E.coli	5 present	-
11.2. Hands :- Before work	30	all absent	absent	-
While working	30	all >10 E.coli	absent	-
11.3. Baskets, Table				
before use	30	20 present	10 present	-
after clean	30	all absent	all absent	-
11.4. Packing materials	10	all absent	all absent	-

Table II. Results- Microbial Analysis of Processing Steps - Fish Chinese Rolls.

	Process step	# of samples Tested	Microbial parameters		
			E.coli	Staphs.	Salmonella
1).	Bowl chopping	5	All absent	All absent	-
2).	Blending	5	1 present	All absent	-
3).	Chilling before	5	4 present (<10)	All absent	-
	While chilling	5	4 present	All absent	-
	After chilling	5	4 present	All absent	-
4).	Chilling baskets Before and after	10	all present	All absent	-
5).	After battering	5	all present	2 present	-
6).	Crumbing	5	all present	2 present	-
7).	Flash frying	10	all absent	all absent	-
8).	Arranging workers gloves – before work	10	all absent	all absent	-
	While working	10	8 present	3 present	-
9).	Wrapping working gloves before work	5	all absent	all absent	-
	while working	5	all present	4 present	-
10).	Final product	10	4 samples <10 *E.coli*	absent	-

Table III. Results of Microbial Analysis - Chicken Sausage Processing Line.

Corrective action	# of sample tested	Results.	
		Before monitoring	**After monitoring**
1). Extension of cooking time	10	TPC - 10^4 *E.coli* – absent Staphs. – absent	TPC – 10^3 - 10^4 *E.coli* – absent Staphs. – absent
2). Water treatment at showering			
Before shower	20	TPC - 10^4 *E.coli* – absent Staphs. – absent	There was no monitoring
After shower	20	TPC - 10^4 *E.coli* - absent Staphs. - absent	Water quality is high.
3). Peeling Workers' hands	20	*E.coli* < 10 all samples Staphs. present	
After dipping hands with Halamid	20		*E.coli* absent in all samples. Staphs. also absent
Before boil, peeling machine samples	25	*E.coli* <10 all samples Staphs. absent	
After boiling	25		All samples absent for *E.coli* and Staphs
After ½ hr from boiling	5		All samples absent for *E.coli* and Staphs
After 1 hr from boiling	5		All samples absent for *E.coli* and Staphs
After 1½ from boiling	5		2 samples positive for *E.coli*
After peeling sausages	15	TPC - >10^4 *E.coli* <10 Staphs. – absent	TPC - 10^3 - 10^4 *E.coli* – absent Staphs. - absent

Table III. continuation...

Corrective action	# of sample tested	Results.	
		Before monitoring	After monitoring
4). Packing After one hour gloves	20	>10 *E.coli* Staphs. – 10 samples present	
Due to changing of gloves : after 1 hr Baskets and tables	25	>10 E.coli Staphs. - 10 samples	*E.coli* absent Staphs. absent
After practised one way cleaning Baskets and table	25		*E.coli* absent Staphs. absent
5). Final product	20	15 samples were >10 *E.coli* and 3 were staphs Present TPC $>10^5$	Only 3 samples <10 *E.coli* present. Rest of others absent. TPC = 10^4

Table IV. Results of Microbial Analysis - Fish Chinese Rolls Processing Line.

Corrective Action	# of sample	Results	
		Before monitoring	After monitoring
1). Change of gloves after 1 hr utensils and table	10	*E.coli* >10 in all samples Staphs. positive in 7 samples	*E.coli* absent Staphs. absent
2). Disinfecting utensils before battering	10	*E.coli* >10 in all samples Staphs. positive in 2 samples	*E.coli* negative in all samples Staphs. negative in all samples
3). Use of Halamid hand dips before commencement of battering	10	*E. coli* >10 in all samples Staphs. positive in 2 samples	*E.coli* negative all samples Staphs. absent in all samples

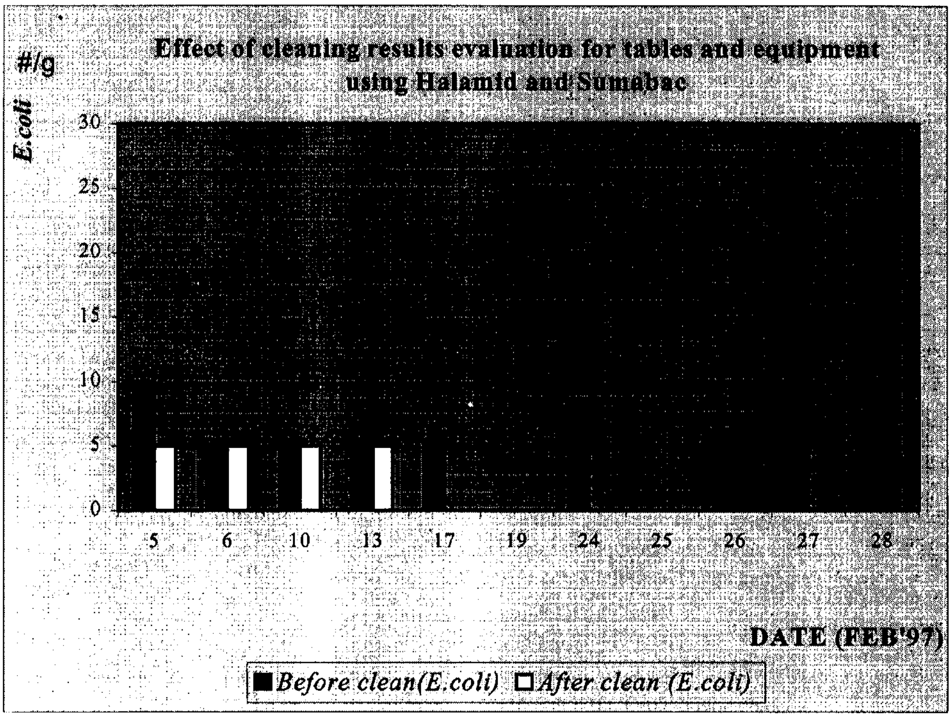

Fig. III. Effect of cleaning with and without disinfectant on the processing equipment of the chicken sausage processing plant when assessed for *E. coli.*

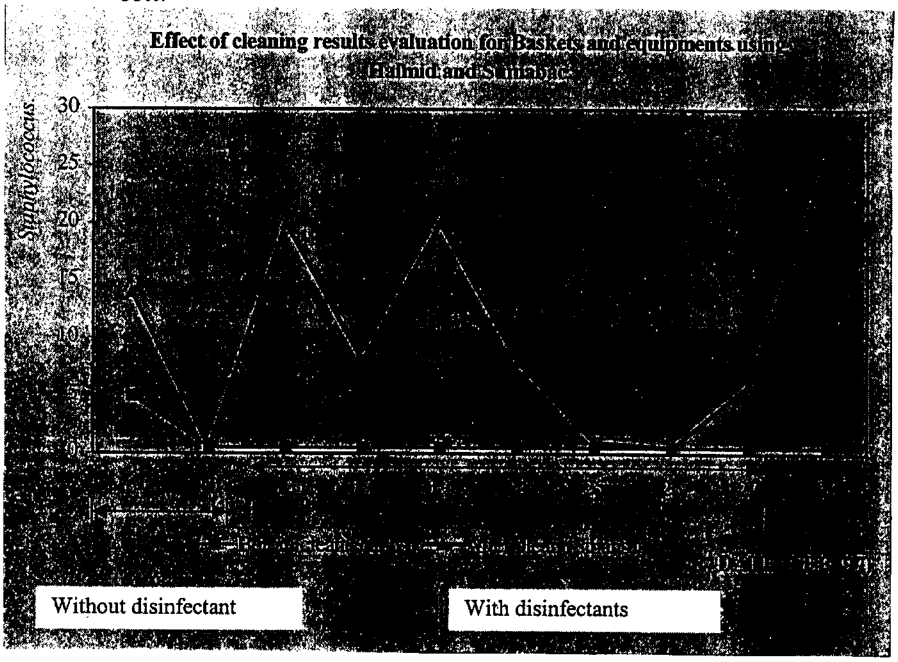

Fig. IV. Effect of cleaning with and without disinfectant on the processing equipment of the chicken sausage processing plant when assessed for *S. aureus.*

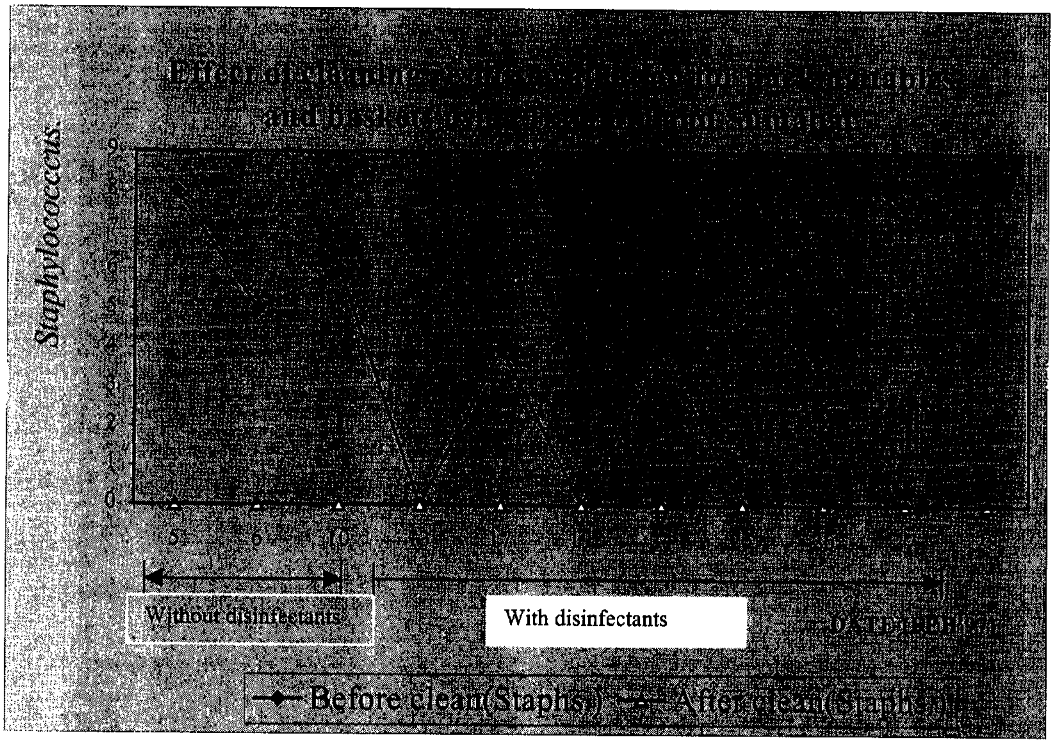

Fig. V. Chinese Rolls Processing Plant.