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HACCP MODEL FOR MICROBIAL CONTROL OF POULTRY MEAT IN POULTRY PROCESSING PLANTS IN JAPAN

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INTRODUCTION

Poultry meat and poultry products have often been incriminated in outbreaks of *salmonella*, *campylobacter*, *staphylococcus aureus* and *clostridium perfringens* food poisoning in Japan (Table 1.). With the contamination rate, and the number of pathogenic microorganisms on poultry meat, extremely high (Cunningham, 1982), attention is being focused on avoiding contamination of poultry meat with *salmonella*, *campylobacter*, *staphylococcus aureus* and *clostridium perfringens* in poultry slaughtering plants. To achieve this, the microbiological quality of poultry meat must be improved by applying sanitary processing procedures.

The purpose of this study was to determine the occurrence of contamination during poultry processing and to establish a microbial contamination control system for poultry using the Hazard Analysis Critical Control Point (HACCP) concept. We therefore examined the total aerobic bacteria counts and total coliforms counts, and the incidences of *salmonella*, *campylobacter* and *S.aureus* on the surfaces of poultry carcasses during processing. From this data we have assessed the hazards and preventative methods to be applied at each processing stage, determined critical control points (CCPs) to control identified hazards, established the critical limits which must be met at each identified CCPs, established monitoring procedures for each identified CCP, established corrective actions to be taken where there is a deviation identified by monitoring of CCPs, established effective record-keeping systems that document the HACCP plan, and established procedures for verification that the HACCP system is working correctly.

MATERIALS AND METHOD

The number and incidence of microorganisms on the surfaces of carcasses during processing were examined two or three times at each of six poultry slaughtering plants. They produce 1500 to 3000 birds per day with scalding tank capacities of 1.5 to 3.0t and chilling tanks of 1.5 to 6.0t. The chilling waters contained 0 to 100ppm NaClO.

Samples

The swab method was used for collecting the samples. The swab samples were taken from the surface (breasts and thighs) of carcasses during processing by cotton swabs (10cm in diameter). Samples of water used for processing, from the scalding tank, pre-chilling tanks, chilling tanks and chilling tanks containing the NaClO, were taken after 1000 to 1500 birds had been processed.

Enumeration and incidence of microorganisms in samples

Total aerobic bacteria counts: These bacteria were enumerated on plate count agar (Nissui Pharm. Co., Ltd., Japan) incubated at 32°C for 48 hours.

Total *Coliform* counts: *Coliforms* were enumerated on Desoxycholate agar (Nissui) incubated at 32°C for 48 hours.

Salmonella (Tokumaru *et al.*, 1992): 1- and 10-ml samples were inoculated into 10- and 100-ml *enterobacteriaceae* enrichment-mannitol (EEM) medium respectively. After pre-enrichment at 37°C for 18 hours, 1ml of each culture was transferred to 15ml of Selenite-Brilliant Green (SBG) enrichment medium (Nissui) which was incubated at methylblue (MLCB) agar (Nissui) which was incubated at 35°C for 18 to 20 hours. Presumptive colonies were picked and inoculated into Triple-sugar-iron (TSI) and Lysine-indole-motility (LIM) media (Nissui) for confirmation.

Campylobacter (Tokumaru *et al.*, 1992): 1- and 10-ml samples were inoculated into 10- and 100-ml Preston medium respectively. The tubes were incubated microacrophilically at 42°C for 24 hours. For isolation of *campylobacter*, Butzer agar (oxoid blue-base agar No.2, Cm-271) plus *campylobacter*-selective supplement incubated at 42°C for 48 hours was used. Suspected colonies were picked and transferred to blood agar plates which were incubated at 42°C for 24 hours and the identities of the isolates were confirmed by typical reactions.

S. aureus: Coagulase positive *staphylococci* were counted by the surface plating technique on mannitol salt agar (Nissui) containing 3% egg yolk. Colonies surrounded with an opaque zone after incubation at 35°C for 24 to 48 hours were counted (Shinagawa *et al.*, 1988). Isolates were confirmed on the basis of coagulase production.

RESULTS AND DISCUSSION

The fact that the skin of live poultry is heavily contaminated with microorganisms has been reported by many researchers (Cunningham, 1982). In our data, contamination levels of total aerobic bacteria counts (10^6 to $10^7/cm^2$) and coliform counts (10^2 to $10^4/cm^2$) on the skin (breast) of live birds were extremely high (Table 2.) and the levels were the same at the six different poultry processing plants. Also, the incidences of salmonella (4 to 12%) and *campylobacter* (30 to 43%) were high (Table 2).

Total aerobic bacteria counts (10^3 to $10^6/cm^2$) and total coliform counts (10^2 to $10^3/cm^2$) on the surface of the carcasses increased after evisceration. The incidence of *salmonella* and *campylobacter* on carcasses also increased at the evisceration and pre-chilling stages (Table 2).

Almost no microorganisms were detected in the chilling water containing the NaClO.

When we determined CCPs, we drew a flow chart of poultry processing (Table 3) and took bacterial data into account. It was considered that the most important CCPs for microbial control during poultry processing were at evisceration and pre-chilling.

Implementation of the HACCP model

Concerning sanitary control over poultry slaughtering plants, in accordance with the `Poultry Slaughtering Business Control and Poultry Inspection Law', enforced in 1991, sanitary control standards were set. In order to consolidate our strategy for the control of microbial contamination, we established `Sanitary control guidance for poultry processing plants with HACCP concept' and are working with the industry to implement these guidelines.

With the implementation of these guidelines, by identifying and regularly checking those points in the processing chain that have the greatest potential to pose risk, we can achieve better microbial quality on poultry meat and prevention of public health problems.

Task of poultry slaughterer

Employees who have responsibility for control at each processing step have to monitor each CCP with the procedures described in `Monitoring Procedure' in Table 4 and when they identify a deviation, they must enact the corrective action described in Table 4.

We rank CCPs into three categories according to their importance. Designated plant employees must monitor CCP-1 (the most important CCPs) at least once a day; CCP-2 (second rank CCPs) at least twice a week, and CCP-3 (not so critical CCPs) at least once a week. This monitoring frequency was not reliable enough to indicate that hazards are under control, but represents a compromise with industrial resistance to the introduction of these guidelines.

Designated plant employees were also required to record monitoring results. In these guidelines, model record sheets are described but each plant has to develop its own record sheets. In order to verify the HACCP system is working well, daily monitoring results ,must be summarized monthly and annually and analyzed by the quality controller of each plant.

Physical and chemical measurements are used for monitoring because they can rapidly indicate loss of control over processing hygiene. However, we request that microbiological tests be performed at least once a month to identify the actual bacterial situation and to maintain proper documentation of test results. We also established `microbial objective standards for carcasses et al. for each step' (Table 5.). When deviations are identified from monitoring results, the quality control officer must investigate the cause, take immediate corrective action to eliminate the cause and, after a few days operation, retest to confirm the effectiveness of the corrective action.

These guidelines indicate one model HACCP system. Industry will be responsible for developing its own future HACCP plans. HACCP plans for implementation on production lines in plants should be individually tailored to the needs. Every plant will have a different HACCP plan.

CONCLUSION

To reduce microbial contamination of poultry meat during processing, we established a HACCP model which includes critical limits for each CCP, monitoring procedures and corrective actions. It is expected that microbial quality will be improved with the implementation of the HACCP plan.

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Table 1. Outbreaks of food poisoning due to meat and processed meat products in Japan (Statistics of food poisoning Japan, 1977-1990; Ministry of Health & Welfare).

Causative Foods	Number of Incidences	Causative organisms Sal.	Camp.	S.Aureus	C.per	E.coli	others	unknown
Raw meat								
Shasimi								2
liver	8	4	1	0	0	1	0	2
chicken	10	5	3	0	0	0	0	
Roast meat								0
chicken	23	7	5	11	0	0	0	2
pork	17	5	1	8	1	0	0	
Barbecue								0
chicken	10	4	1	4	1	0	0	1
pork	8	5	1	0	0	1	0	0
beef	6	6	0	0	0	0	0	1
others	7	5	0	0	0	1	0	
Fried								2
chicken	12	2	2	3	0	0	3	
Cooked meat	11	4	1	0	4	0	1	1
Dox lunch				47[a]				5
(rice with chicken)	62	3	0		1	3	1	
Total	174	50	15	76	7	6	5	16

[a] Two outbreaks, one due to *S.aureus* and *C.perfringens* and the second due to *Saureus* and *B.cereus*.

Table 2. Numbers of microorganisms on the surfaces of carcasses during the processing of broilers.

Processing step:	Total aerobic bacteria counts (CFU/cm^2)	Total Coliforms (CFU/cm^2)	Salmonella (%)[2]
Breast point of carcass (per cm^2)			
Live broiler	10^6 to 10^7	10^2 to 10^4	4 to 12
After scalding	10^5 to 10^5	10^1 to 10^3	6 to 9
After defeathering	10^3 to 10^5	10^1 to 10^3	9 to 12
After feet removal	10^3 to 10^4	10^1 to 10^3	6 to 9
After evisceration	10^4 to 10^5	10^2 to 10^3	12 to 18
After pre-chilling	10^3 to 10^4	10^1 to 10^2	16 to 24
After chilling	10^2 to 10^4	10^0 to 10^1	7 to 9
After chilling (water contained NaClO)[3]	10^1 to 10^3	10^0 to 10^1	4 to 6
Finished product (whole carcass)	10^2 to 10^4	10^1 to 10^2	7 to 9
Processing water (per ml)			
Scalding Water	10^3 to 10^5	10^2 to 10^4	0 to 3
Pre-chilling Water	10^3 to 10^5	10^2 to 10^4	12 to 16
Chilling Water	10^3 to 10^4	10^1 to 10^3	8 to 12
Chilling water (with NaClO)	10^0 to 10^1	Not detected	Not detected

Table 2 (cont). Numbers of microorganisms on the surfaces of carcasses during the processing of broilers.

	Campylobacter jejuni/coli (%)	S. aureus (%)
Breast point of carcass (per cm^2)		
Live broiler	30 to 43	33(6/18)
After scalding	24 to 34	42(5/12)
After defeathering	41 to 44	60(10/20)
After feet removal	41 to 44	60(6/20)
After evisceration	44 to 48	53(8/15)
After pre-chilling	40 to 44	40(4/10)
After chilling	37 to 41	33(6/18)
After chilling (water contained NaClO)[3]	32 to 37	20(1/5)
Finished product (whole carcass)	37 to 41	31(11/35)
Processing water (per ml)		
Scalding Water	Not detected	0(0/8)
Pre-chilling Water	41 to 56	38(6/16)
Chilling Water	29 to 35	27(3/11)
Chilling water (with NaClO)	Not detected	0(0/5)

[1] CFU: CFU per order cm^2.
[2] (%): Ratio of contamination (number of positive samples/number of samples tested.
[3] Chilling water containing 10 to 100ppm NaClO.

Table 4. Objective microbial standards for carcass, equipment and water at each step.

Step	Microbial standards
Washing of batteries (CCP-3)	1. After washing surfaces of the batteries salmonella: negative campylobacter: negative s.aureus: negative TABC: less than $1.0x10^3/cm^2$
Live hanging (CCP-2)	1. After washing surfaces of the shackles TABC: less than $1.0x10^2/cm^2$
Scalding (CCP-2)	1. Scalding tank water TABC: less than $1.0x10^0/cm^2$ 2. Wash, disinfect surfaces of scalding tank TABC: less than $1.0x10^3/cm^2$
Defeathering (CCP-2)	1. After defeathering, carcass breasts TABC: less than $1.0x10^4/cm^2$ 2. Surface of picking machine which carcasses contact directly TABC: less than $1.0x10^3/cm^2$
Evisceration (CCP-1)	1. Surfaces of vent cutter, opening cutter and evisceration machine which carcasses contact directly TABC: less than $1.0x10^2/cm^2$
Harvest of edible parts (CCP-1)	1. After harvest, carcass breasts TABC: less than $1.0x10^4/cm^2$
Final washing (CCP-3)	1. After washing, carcass breasts TABC: less than $1.0x10^2/cm^2$
Preparatory chilling (CCP-1)	1. Chilling tank water TABC: less than $1.0x10^4/ml$ 2. After pre-chilling, carcass breasts TABC: less than $1.0x10^3/cm^2$ 3. After washing and disinfection, surfaces of tank TABC: less than $1.0x10^2/cm^2$
Main chilling (CCP-1)	1. Chilling tank water TABC: less than $1.0x10^3/ml$ 2. After pre-chilling, carcass breasts TABC: less than $1.0x10^3/cm^2$ 3. After washing and disinfection, surfaces of tank TABC: less than $1.0x10^2/cm^2$