CROSS-CONTAMINATION OF *AEROMONAS* SPP. FROM CHILLED PORK TO *BRASSICA CHINENSIS* UNDER DIFFERENT FOOD-HANDLING SCENARIOS

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Abstract - The purpose of this paper was to quantify the cross-contamination of *Aeromonas* spp. from chilled pork to Chinese cabbage（*Brassica chinensis*）through cutting boards, knives and hands in the kitchen. Transferring experiments were performed to mimic the food preparation process of consumer under laboratory conditions. The pork sample was inoculated with *Aeromonas* spp. before splitting, to determine the transfer rate of *Aeromonas* spp. from chilled pork to cutting boards, knives and hands, respectively. Meanwhile, transfer rates from cutting boards, knives and hands to *B. chinensis* under various food-handling scenarios were also determined. Scenario 1(after cutting pork, cutting boards, knives and hands were also used for cutting *B. chinensis* without any cleaning) was taken to simulate cross-contamination. The results showed that each set of transfer rates varied over experiments significantly ($p<0.05$) and the analogue simulation showed that cross-contamination of foodborne pathogens from raw meats to ready-to-eat foods might bring some potential risks for consumers. Combined with cooking stage assessment and dose-response relationship, these results could provide theoretical references for complete establishment of *Aeromonas* spp. risk assessment.

I. INTRODUCTION

Food-contact surfaces are highly contaminated with foodborne pathogens. According to World Health Organization[1], 32% of foodborne outbreaks are closely associated with cross-contamination events involving deficient hygiene practices, contaminated equipment, or inadequate storage. *Aeromonas* spp. is one of the dominant spoilage bacteria in chilled pork [2], also proved to be a kind of bacteria that can cause gastroenteritis and septicemia [3]. Yet, studies on *Aeromonas* spp. is relative lack, especially in the field of cross-contamination.

The objective of our study was to assess the cross-contamination and transfer rates of *Aeromonas* spp. from contaminated chilled pork to Chinese cabbage *Brassica chinensis* through cutting boards, knives and hands to *B. chinensis* under various food-handling scenarios and take scenario 1(after cutting pork, cutting boards, knives and hands were also used for cutting *B. chinensis* without any cleaning) for example to simulate cross-contamination. We expected that our study could provide a theoretical reference for building a complete risk assessment system of *Aeromonas* spp.

II. MATERIALS AND METHODS

The test organism used in this study was

Aeromonas spp. (CICC 23564) and the food products were chilled pork and *B. chinensis*, which were purchased from local supermarket in Shanghai. P.R. China. The food contact surfaces included cutting boards and stainless steel knives and hands.

We evaluated the cross-contamination and transfer rates of *Aeromonas* spp. from contaminated chilled pork to *B. chinensis* through cutting boards, knives and hands under various food-handling scenarios. Firstly, approximately 25 g chilled pork were surface inoculated with *Aeromonas* spp. and the inoculum was spread by turning over the chilled pork pieces for several times, then the inoculated chilled pork pieces were allowed to place under a bio-hood for 10 min to let the bacteria attach to the surface. Secondly, inoculated chilled pork pieces were placed on a sterilized cutting board (5×5cm^2) and cut 10 times using a sterile knife. During this process, *Aeromonas* spp. on chilled pork was transferred to cutting board, knives and hands, respectively. Before cutting *B. chinensis*, six food-handling scenarios were considered as follows: Scenario 1, cutting board、knife and hand used to cut chilled pork were also used for cutting *B. chinensis* without any washing; Scenario 2, cutting board、knife and hand were washed with 500mL sterile water separately after cutting chilled pork; Scenario 3, after cutting chilled pork, contaminated cutting board was taken away and a new sterile one was used to cut *B. chinensis*; Scenario 4, contaminated knife was changed for a new one as scenario 3; Scenario 5, contaminated hand was washed thoroughly before cutting *B. chinensis*; and scenario 6, cutting board、knife and hand used to cut chilled pork were washed thoroughly using washing-up liquid before cutting *B. chinensis*.

The initial contamination level of chilled pork was quantified by sampling inoculated chilled pork pieces immediately after the attachment of *Aeromonas* spp. [4]. Recovering method used for quantifying bacterial transfer between surfaces is the most popular non-destructive method, namely swabbing method [5].The contamination level of *B. chinensis* was also determined by Chinese national standard [4].

The transfer rates were calculated as follows:

$$T\% = \frac{Nr}{No} * 100 \qquad (1)$$

where *T*: transfer rates; *No*: CFU on source (CFU/g or CFU/cm^2); *Nr*: CFU on destination(CFU/g or CFU/cm^2).

III. RESULTS AND DISCUSSION

Table 1 shows the mean, standard deviation and variation range of % transfer rates that occurred from chilled pork to cutting boards, knives and hands. Through the test of significance, we found that T_{MB} and T_{MH} showed no significant difference (P > 0.05), but T_{MH} and T_{MB} were significantly different to T_{MK} (P < 0.05), which meant the transfer rate from chilled pork to cutting boards and hands were much higher than to knives.

Table1 Transfer rates of *Aeromonas* spp. from chilled pork to cutting boards, knives and hands

T type	T (%)	range
T_{MB}	16.35±12.33a	1.74-36.57
T_{MK}	1.16±0.62 b	0.62-2.85
T_{MH}	12.37±9.69 a	4.01-45.70

Notes: T_x: Transfer rate The subscript x: M: Chilled pork B: Board H: Hand For example: T_{MB} stands for the transfer rate from chilled pork to board

Values in the same column that are followed by the same uppercase letter are not statistically significantly different (p>0.05).

The % transfer rates of *Aeromonas* spp. from cutting boards, knives and hands to *B. chinensis* under six different food-handling scenarios were shown in Table 2. These results showed that washing these contaminated medium in water could remove a large population of *Aeromonas* spp. and as a result lower numbers of organisms (compared to scenario 1) were transferred to the *B. chinensis*. Besides， when boards, knives and hands were washed thoroughly with vigorous mechanical scrubbing using washing-up liquid and brush, none *Aeromonas* spp. were detected on *B. chinensis* (scenario 6). Changing the new boards, knives or washing our hands thoroughly after spliting chilled pork were not ideal methods for reducing cross-contamination for the average % transfer rates to *B. chinensis* could as high as 16.50%, 25.72% , 27.07%， respectively.

Table 2 Transfer rates of *Aeromonas* spp. from cutting boards, knives and hands to *B. chinensis* under different scenarios

Different scenarios	T type	T(%)	range
1	T_{BL1}	18.59±8.80 abc	6.41-34.84
	T_{KL1}	5.30±4.62 d	1.12-13.10
	T_{HL1}	8.86±4.93 cd	3.16-16.89
2	T_{BL2}	0.38±0.21 d	0.10-0.81
	T_{KL2}	0.09±0.07 d	0.01-0.24
	T_{HL2}	0.43±0.52 d	0.12-1.79
3	T_{KHL}	16.50±10.07 bc	5.85-38.49
4	T_{BHL}	25.72±12.18 ab	11.19-46.05
5	T_{BKL}	27.07±18.61 a	11.85-69.42
6	--ND	--ND	--ND

Note：--ND : Not Detected

L: *B. chinensis* For example: T_{BL1} stands for the transfer rate from board to *B. chinensis* in scenario 1; T_{KHL} stands for the transfer rate from knife and hand to *B. chinensis*.

The initial contamination level of *Aeromonas* spp. in chilled pork was from -0.8(lg(CFU/g)) (5% confidence interval) to 7.7(lg(CFU/g)) (95% confidence interval) [6] and it was shown in fig.1.

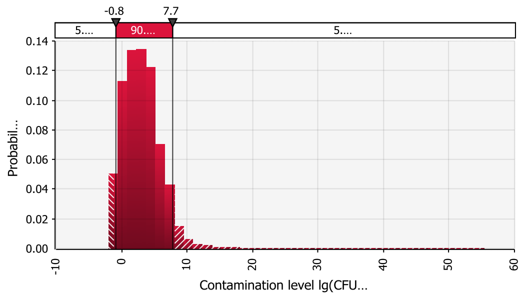

Fig.1 Initial contamination level of *Aeromonas* spp. in chilled pork

Optimal distribution of each transfer rates for scenario 1 were fitted using @Risk 5.5 (Palisade, USA). Then we used Monte Carlo sampling method to simulate the input parameters, and the final contamination level of *Aeromonas* spp. on *B. chinensis* was shown in Fig.2.

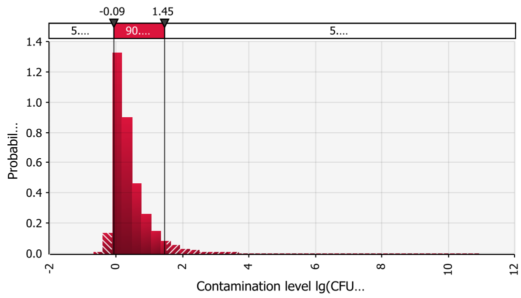

Fig.2 Contamination level of *Aeromonas* spp. on *B. chinensis*

As we can see from Fig.2, the contamination level of *Aeromonas* spp. on *B. chinensis* was from -0.08(lg(CFU/g)) (5% confidence interval) to 1.45(lg(CFU/g)) (95% confidence interval), which indicated that the *Aeromonas* spp. could be partly transformed from chilled pork to *B. chinensis* through cutting boards, knives and hands. Meanwhile, the cross-contamination between food-contact faces might resulted a high contamination level of *Aeromonas* spp. on *B. chinensis* occasionally.

IV. CONCLUSION

The results showed that each set of transfer rates varied over experiments significantly ($p<0.05$) and the analogue simulation of cross-contamination showed that cross-contamination of foodborne pathogens from raw meats to ready-to-eat foods suggesting some potential risks for consumers. Our study also proved that proper washing of contaminated kitchen implements could remove *Aeromonas* spp. effectively.

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