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A study on *Campylobacter jejuni* cross-contamination during chilled broiler preparation

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Abstract: Studies indicate that bacterial cross-contamination occurs during food preparation where bacteria can retent on the food contact surfaces and cause illness. The study evaluated the adherence of *Campylobacter* spp. to cutting boards, blades of knives and hands after cutting chilled, raw broiler parts (thighs + drumsticks, wings and livers). The adherence to cucumber cuts that were cut using the unwashed boards and knives was also analyzed. Generally, utensils have higher mean of *Campylobacter* spp. retained to them (1.4-223.3 MPN/ml rinse) than hands (0.7-43.4 MPN/ml rinse); however, Mann-Whitney U test showed no significant differences in the bacterial numbers found among the different surfaces. The transfer rates of *Campylobacter* spp. from utensils to cucumber cuts varied from 0% to more than 100%. The bacteria detected could be from the utensils and cucumber contamination before purchase or due to other factors where further investigation is required. The possibility is there for *Campylobacter* to spread to contact surfaces during chilled broiler handling; therefore, utensils and hands involved should be washed thoroughly especially before ready-to-eat food preparation.

Keywords: ***Campylobacter*** **spp., cross-contamination, adherence, raw broiler, food contact surfaces**

Introduction

As *Campylobacter* is killed at normal cooking temperatures, the significantly high prevalence and numbers of *Campylobacter* in chicken (including skin) show that cross-contamination with *Campylobacter* between raw and cooked products, ready-to-eat foods (edible without washing, cooking or additional preparation) or contact surfaces during food preparation represents a higher consumer risk than consumption of undercooked chicken meat (Guzewich and Ross, 1999; Scherer *et al*., 2006-a).

Kitchens are used communally in many places, for example, schools, student accommodation, youth hostels, hospitals, nursing homes, prisons and shared houses (Martínez-Tomé *et al*., 2000; Sharp and Walker, 2003). With many people sharing one kitchen, the risk of food safety errors is likely to increase. The risk of cross-contamination may exacerbate owing to the number of individuals using the kitchen, confined space, lack of responsibility, and differing standards of knowledge and hygiene (Sharp and Walker, 2003). Although restaurants, hotels and take-aways are the most frequently cited sites of outbreaks of foodborne disease, foodborne illness is initiated in private homes three times more frequently than in commercial operations (Jackson *et al*., 2007). An investigation on domestic food preparation practices found that 96% of householders make at least one critical food safety violation that could lead to foodborne illness (Sharp and Walker, 2003).

Campylobacter-contaminated chicken carcasses can have the bacteria exceeding 10^8 cells per carcass. The bacteria can be isolated from the outer wrapping of chicken purchased from retail outlets too (Humphrey *et al*., 2001). Therefore, it can be difficult for consumers to control the spread of this bacteria as the preparation of meals using raw chicken will result in widespread dissemination of *Campylobacter* spp. where many hand- and chicken-contact sites including the sinks, dishcloths, utensils and ready-to-eat foods will become contaminated (Rusin *et al*., 1998; Humphrey *et al*., 2001; Luber *et al*., 2006). Humphrey (2001) reported that the average bacterial count in a dishcloth in Wales is about 10^{10} bacteria.

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This is not surprising as a dishcloth is used for almost anything. Another survey reported that 26% of American consumers do not bother to clean cutting boards after cutting raw meat such as chicken (Zhao *et al*., 1998).

Several outbreaks of *Campylobacter* enteritis associated with cross-contamination of food have been reported by various sources (Raupach and Hundy, 2003; Graham *et al*., 2005; Jiménez *et al*., 2005; Mazick *et al*., 2006). In May 2005, an outbreak of *C. jejuni* occurred among company employees in Copenhagen, Denmark. Cases were reported from seven of eight companies that received food from the same catering kitchen. Interviews with kitchen staff indicated the likelihood of cross-contamination from raw chicken to the chicken salad during storage (Mazick *et al*., 2006). A retrospective cohort study associated custard made with ultra high temperature (UHT) milk with campylobacteriosis in May 2003 in a school in Madrid, Spain. The custard was probably contaminated with *C. jejuni* from a raw chicken prepared a day previously in the same kitchen (Jiménez *et al*., 2005). Graham *et al*. (2005) investigated a small outbreak of campylobacteriosis in Christchurch, New Zealand caused by precooked sausages. It is likely that the sausages were contaminated after the retailer had cooked them where they were not reheated prior to consumption. Raupach and Hundy (2003) described an outbreak of *C. jejuni* among delegates attending a 10-day international academic meeting at a large hotel in metropolitan Adelaide, South Australia in May 2001. In this outbreak, a definitive source could not be determined. Cross-contamination of several banquet dishes might have occurred.

Although the role of cross-contamination in the cause of foodborne infections is generally known, limited quantitative data on *Campylobacter* cross-contamination are available in the literature (de Boer and Hahné, 1990; Luber *et al*., 2006). So far, there is no standard method to quantify *Campylobacter* from kitchen surfaces. As far as it is known, no cross-contamination studies on *Campylobacter* from chicken at retail level were carried out in Malaysia at the time when the study was done. Exposure assessment at a consumer level, which includes food handling, is of particular interest because it is less controlled than the other phases in food processing. At this point, the degree to which foods are contaminated is directly related to the public health (Kusumaningrum *et al*., 2004).

This study was undertaken to analyze the number of *Campylobacter* spp. detected on critical surfaces (cutting board, knife blade, bare hands and cucumber cuts) involved in a preparation of chilled broiler parts.

Materials and Methods

Sample collection

Random, independent packages of chilled broiler thighs + drumsticks, wings or livers were purchased from October to November 2006 at various supermarkets in Serdang and Seri Kembangan, Selangor, Malaysia. The broiler parts were sold in Styrofoam trays which were over-wrapped with polyvinylidene film. Samples were transported to the laboratory in separate ice containers. Samples were processed within 2 hours of being collected. Fresh and damage-free cucumbers, packaged in Styrofoam trays that were over-wrapped with polyvinylidene film, were also bought from the various supermarkets. The cucumbers were not waxed.

Cross-contamination scenarios

Two different cross-contamination scenarios were simulated by adapting the method of Zhao *et al*. (1998) and Luber *et al*. (2006). All experiments used five broiler parts, with each of them from a different package; packages were bought from different random outlets. Each experiment started with washing both hands thoroughly with soap and warm, sterile distilled water and drying them thoroughly with paper towels. New knives and plastic cutting boards ($325\ cm^2$, divided into 13 areas of $25\ cm^2$ each using a fine-tipped permanent marker) were scrubbed and rinsed thoroughly using commercial detergent and warm sterile distilled water, and rinsed thoroughly again with sterile hot distilled water (100^oC). The knives and boards were dried thoroughly with paper towels and placed under ultraviolet (UV) light for 1 hour in a laminar flow hood.

Scenario 1 (Cross-contamination of cutting board, knife blade and hands)

Five broiler parts of one type (thighs + drumsticks, wings or livers) from five different packages were placed on a fresh cutting board and cut (± 1.0 cm thick) with a fresh knife and clean hands. The slices were then removed from the board by using a pair of sterile forceps. The number of *Campylobacter* genus and species (*C. jejuni* and *C. coli*) on the unwashed hands, board and knife blade were determined. Five experiments were performed.

Both hands were sampled by rinsing them for 30 seconds in a sterile stomacher bag containing 100 ml sterile Maximum Recovery Diluent. Bacterial enumeration was done by adapting the method of Lindquist (2001) and Whyte *et al*. (2004) where a ten-fold most-probable-number (MPN) dilution series (three dilutions with three tubes per dilution) from the solution was prepared in Bolton selective enrichment broth. After incubation at 42°C for 48 h under microaerophilic condition, the MPN tubes were observed for the presence or absence of growth. Those showing the presence of growth were subjected to genus and species-specific polymerase chain reaction (PCR), and the counts of positive tubes were deduced from a three-tube MPN table (Lindquist, 2001) to determine MPN per ml of hand rinse.

Seven swab samples were taken for each 100-cm^2 square of the board by using sterile cotton buds. The swabs for the board were placed in a sterile tube holding 20 ml of Bolton selective enrichment broth and vortex mixed for 10 seconds. Bacteria were enumerated to obtain MPN per ml of board rinse.

The blade of the knife was sampled by rinsing it thoroughly in a sterile stomacher bag containing 50 ml of Bolton selective enrichment broth. Enumeration was done to determine MPN per ml of blade rinse.

Scenario 2 (Cross-contamination of cucumber cuts)

Preliminary experiments showed that all broiler parts in a single package have approximately equal levels of bacterial load (Luber *et al*., 2006). A transfer experiment was performed for each of the five experiments in Scenario 1. A broiler part of the same type from each of the five different packages in Scenario 1 were placed on a fresh cutting board and cut (± 1.0 cm thick) with a fresh knife and clean hands. The slices were then removed from the board by using a pair of sterile forceps. Both hands were washed thoroughly with soap and warm, sterile distilled water and dried thoroughly with paper towels. However, the board and knife remained unwashed. A 10-g portion of cucumber (skin unpeeled and unwashed) was placed on the board and cut into pieces using the knife. The cucumber cuts were placed (using a pair of sterile forceps) in a sterile stomacher bag containing 90 ml of Bolton selective enrichment broth and paddled for 1 minute in a stomacher. The homogenate was enumerated for *Campylobacter* genus, *C. jejuni* and *C. coli* to obtain MPN per gram of cucumber cuts.

Data analysis

From the five experiments done for each case (thighs + drumsticks, wings and livers), the mean for the number of *Campylobacter* (genus and species) found on the cutting boards, knives and hands were determined and compared. Mann-Whitney U test was used to analyze significant differences between the number of bacteria found on cutting board and knife; on cutting board and hands; and on knife and hands. The transfer rates of *Campylobacter* (genus and species) from utensils to cucumber cuts were determined based on the formula: (organisms on target/organisms on source) × 100 = transfer rate (%) (Chen *et al*., 2001).

Results

There were no significant differences between the number *Campylobacter* genus or *C. jejuni* found on cutting boards and knives; on cutting boards and hands; and on knives and hands in all cases (Table 1 and Table 2). The mean in Table 1 showed that the number of *Campylobacter* genus transferred from thighs + drumsticks, wings and livers to cutting board were the highest compared to those transferred to blades (second highest) and hands. The transfer rates of *Campylobacter* genus to cucumber cuts in experiments involving the thighs + drumsticks, wings and livers varied from 10.8% to more than 100% (in certain experiments [Table 1]); the transfer rate was as high as 649.4% in experiment 5 of thighs + drumsticks. However, the transfer rate to cucumber cuts in experiment 3 of livers was unable to be determined since the bacteria were found in the cucumber cuts although none was detected on the board and knife.

In Table 2, the mean showed that the number of *C. jejuni* transferred from wings and livers to cutting boards were the highest compared to those transferred to blades (second highest) and hands. However, for thighs + drumsticks, the mean of *C. jejuni* transferred to the boards and blades were the same but lesser than that transferred to the hands. The transfer rates to cucumber cuts were from (0-52.6)% in wing experiments, from (6.9-252.8)% in liver experiments, and from (0-416.7)% in thigh + drumstick experiments. The transfer rates to cucumber cuts in certain experiments of thighs + drumsticks and livers were unable to be determined as *C. jejuni* were detected in the cucumber cuts, despite the fact that none was found on the utensils.

Statistical analysis was unable to be performed for *C. coli* (Table 3). No *C. coli* were transferred from thighs + drumsticks and wings to the boards, blades and hands. Zero number of *C. coli* was found in the cucumber cuts. Although *C. coli* were found to be transferred from livers to blades and hands, the data obtained were not sufficient enough to perform an analysis. *C. coli* were found in the cucumber cuts only in experiment 1, despite the fact that none was

Table 1. Number and number comparison of *Campylobacter* genus found on different surfaces during chilled broiler preparation and the bacterial transfer rate from utensils to ready-to-eat food

Broiler part experiment	MPN per ml rinse			MPN per g	Comparison between numbers found on			Transfer rate (%) from per unit rinse of board and knife to per unit cucumber cuts
	Cutting board	Knife blade	Hands	Cucumber cuts	board and knife	board and hands	knife and hands	
Thighs + drumsticks					NS[1]	NS	NS	
1	15.0	14.0	6.1	11.0				37.9
2	44.0	7.2	15.0	28.0				54.7
3	6.1	14.0	3.0	15.0				74.6
4	6.1	3.0	9.1	7.2				79.1
5	14.0	9.1	3.0	150.0				649.4
Mean	17.0	9.5	7.2					
Wings					NS	NS	NS	
1	23.0	14	7.2	23.0				62.2
2	64.0	7.2	3.0	39.0				54.8
3	0	3.6	0	7.3				202.8
4	3.0	0	0	3.6				120.0
5	3.6	6.1	3.0	6.2				63.9
Mean	18.7	6.2	2.6					
Livers					NS	NS	NS	
1	1100.0	240.0	150.0	150.0				11.2
2	7.3	23.0	9.0	9.1				30.0
3	0	0	0	3.6				ND[2]
4	9.1	75.0	43.0	9.1				10.8
5	0	3.6	15.0	9.1				252.8
Mean	223.3	68.3	43.4					

[1]Not significant; [2]not determined

detected on the board and knife.

The number of *Campylobacter* genus and *C. jejuni* transferred from livers to the board in experiment 1 (Table 1 and Table 2) were considered as outliers (numerically distant from the rest of the data). The number of *Campylobacter* genus transferred from livers to blade and hands in experiment 1 (Table 1) and the number of *C. jejuni* transferred from livers to blade in experiment 1 (Table 2) were clearly high too.

Discussion

Cross-contamination is known as the transmission of pathogens from naturally contaminated sources to the finished product (Kusumaningrum et al., 2004). Although some studies (Scott and Bloomfield, 1990; Abrishami *et al*., 1994; Zhao *et al*., 1998; Chen *et al*., 2001) preferred to use artificially contaminated sources to perform microbial cross-contamination in kitchens, Luber *et al*. (2006) and the study used naturally contaminated fresh and chilled raw broiler chicken parts, respectively. There are differences in the behavior of inoculated bacteria compared to naturally found bacteria in foods such as chicken carcasses, and the use of high numbers of *Campylobacter* for inoculation leads to biased transfer rates and thus do not realistically reflect the exposure of the consumer to the pathogenic bacteria (Luber *et al*., 2006).

Campylobacters can survive on environmental surfaces such as sinks, taps, floors, refrigerator door handles, oven door handles, kitchen door handles, counter-tops, draining boards, cutting boards, plates, knives, dishcloths and human hands for a few hours particularly if they come straight from chicken carcasses, despite the fact that they tend to be sensitive to heat, water activity, pH, osmotic stress, and oxygen (Dawkins *et al*., 1984; Cogan *et al*., 1999; Humphrey,

Table 2. Number mean and number comparison of *C. jejuni* found on different surfaces during chilled broiler preparation and the bacterial transfer rate from utensils to ready-to-eat food

Broiler part experiment	MPN per ml rinse			MPN per g	Comparison between numbers found on			Transfer rate (%) from per unit rinse of board and knife to per unit cucumber cuts
	Cutting board	Knife blade	Hands	Cucumber cuts	board and knife	board and hands	knife and hands	
Thighs + drumsticks					NS[1]	NS	NS	
1	3.6	3.6	0	0				0
2	3.6	0	9.1	15.0				416.7
3	0	3.6	0	3.6				100.0
4	0	0	0	3.6				ND[2]
5	0	0	0	43.0				ND
Mean	1.4	1.4	1.8					
Wings					NS	NS	NS	
1	23.0	9.1	3.6	9.1				28.3
2	23.0	3.6	0	14				52.6
3	0	0	0	0				-
4	0	0	0	0				-
5	0	0	0	0				-
Mean	9.2	2.5	0.7					
Livers					NS	NS	NS	
1	1100.0	240.0	23.0	93.0				6.9
2	0	3.6	0	9.1				252.8
3	0	0	0	3.6				ND
4	9.1	75.0	3.6	9.1				10.8
5	0	3.6	15.0	9.1				252.8
Mean	221.8	64.4	8.3					

[1]Not significant; [2]not determined

2001; Gorman *et al*., 2002; Kusumaningrum *et al*., 2003; Meldrum *et al*., 2004; Luber *et al*., 2006). The surface structures of bacterial cells such as flagella, pili and extracellular polysaccharides may affect their adhesion and survival on surfaces. Food residues like chicken liquor and blood on surfaces also improve the survival of campylobacters by giving a protective effect (de Boer and Hahné, 1990; Kusumaningrum *et al*., 2003).

In all cases except for *C. jejuni* transfer from thighs + drumsticks, *Campylobacter* genus and *C. jejuni* were more adhesive to cutting boards than to blades of knives or hands. Cutting boards are a potential vehicle for cross-contamination in environment where foods are prepared (Gough and Dodd, 1998). The bacteria of greatest concern as cross-contaminants on kitchen cutting boards are principally zoonoses transmitted via foods and able to multiply at room temperature or below. *Campylobacter* meets all of these criteria but does not multiply at room temperature; however, the length of time the cells can survive at ambient temperatures and in refrigerated storage is noteworthy (Ak *et al*., 1994; Kärenlampi and Hänninen, 2004). A preliminary study indicated that the transfer of bacteria from chicken carcasses to stainless steel surfaces is likely lower than that from chicken carcasses to cutting boards (Kusumaningrum *et al*., 2004). Snyder (1997) too revealed that bacteria do not adhere to stainless steel as easily as to plastic or wood surfaces. The surface nature of plastic cutting boards, blades of knives and hands might account for the difference in their *Campylobacter* contamination level. Unlike the blades, plastic boards have a porous surface that can retain more campylobacters and develop as a reservoir for them (Abrishami *et al*., 1994). Scarring the boards with sharp knife-edges

Table 3. Number of *C. coli* found on different surfaces during chilled broiler preparation.

Broiler part experiment	MPN per			
	ml rinse			g
	Cutting board	Knife blade	Hands	Cucumber cuts
Thighs + drumsticks				
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
Wings				
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
Livers				
1	0	0	3.6	3.6
2	0	23.0	0	0
3	0	0	0	0
4	0	0	3.6	0
5	0	0	0	0

in the action of cutting raw chicken parts might further help retain *Campylobacter* (Gough and Dodd, 1998). On the other hand, stainless steel blades are resistant to abrasion or impact damage but may have crevices where some bacteria can be retained (Kusumaningrum *et al*., 2003). Board surfaces have a slower drying rate too compared to stainless steel blades, resulting in a relatively prolonged survival of *Campylobacter*.

Contaminated hands are a major factor for the occurrence of contamination in the foodservice industry (Montville *et al*., 2001). Campylobacters as transient bacteria are loosely attached to the surface of the skin and therefore health risk can be created easily when the contaminated hands come in direct contact with the mouth (by smoking or eating) or ready-to-eat foods (de Boer and Hahné, 1990; Guzewich and Ross, 1999). Since the infection dose for *Campylobacter* is low, direct risks of infection are most probable (de Boer and Hahné, 1990). de Boer and Hahné (1990) discovered that *Campylobacter* can survive a three minute drying period on hands which have held raw chicken parts. Though *Campylobacter* can survive on hands for a rather long time, in practice cross-contamination is likely to occur before the fingers dry. In all cases except for *C. jejuni* transfer from thighs + drumsticks, the amount of *Campylobacter* genus and *C. jejuni* transferred to hands were the lowest compared to those transferred to boards or blades. Factors such as the secretion of bactericidal unsaturated fatty acids (for example: oleic acid) and dermcidin (antimicrobial peptide produced by eccrine sweat glands) may affect the survival of *Campylobacter* on the skin (Coates *et al*., 1987; Wilke *et al*., 2007). It is reported that kitchen utensils may have more impact on cross-contamination leading to consumer exposure than hands (Luber *et al*., 2006).

As *Campylobacter* is very sensitive to drying, the viability of transferred *Campylobacter* will largely depend on the simultaneously transferred amount of liquid (de Boer and Hahné, 1990). Therefore, in agreement with Kusumaningrum *et al*. (2003), the moisture content of cucumber surfaces in this study might have positively affected the retrieval of *Campylobacter* from surfaces of cutting boards and knife blades. The pH of cucumber (~5.8) also favors the survival of *Campylobacter* (Kärenlampi and Hänninen, 2004). The sources of contamination for the cucumber cuts in the present study were the cutting board and knife blade. However, the number of *Campylobacter* genus and *C. jejuni* in the cucumber cuts exceeded the total amount detected on the cutting board and knife blade (in certain experiments of thighs + drumsticks, wings and livers [Table 1 and Table 2]. In the study of Luber *et al*. (2006), the transfer of *Campylobacter* from chopping board and knife blade to raw cucumber cuts (cut directly without immediate cleaning of the board and blade used for slicing naturally contaminated raw chicken breast fillets) was from 0% to 33.3% only. Its mean (10.3%) was more than the mean (1.1%) of *Campylobacter* transferred from fillets to board and blade, though. It is reported that vegetables can be contaminated with *Campylobacter* through untreated farm water applied to desoil or to clean the produce; soil and manure associated with raw sewage sludge; and infected farmers who harvest and handle the produce (Park and Sanders, 1991). Koseki *et al*. (2004) detected 4.5 log CFU of coliform bacteria per supermarket-purchased cucumber. Meanwhile, Chai *et al*. (2007) found 51.9%, 40.7% and 35.2% of *Campylobacter* genus, *C. jejuni* and *C. coli*, respectively, in raw salad vegetables sold at supermarket I in Selangor, Malaysia; whereas 67.7%, 67.7% and 65.7% of *Campylobacter* genus, *C. jejuni* and *C. coli* were found in those from supermarket II. Poor washing treatments at supermarkets might maintain the contamination; recycling of wash water, a common practice in washing and hydrocooling, can lead to cross-contamination where microorganisms in the water may contaminate the produce through natural openings such as stomata (Reina *et al*., 2002). Cross-contamination from other *Campylobacter*-prone foods such as poultry during the holding and packaging stage is also probable (Chai *et al*., 2007). Tan *et al*. (2008) and Tang *et al*. (2009) have also reported on *C. jejuni* in raw sushi and poultry sources, respectively. Studies have reported the difficulty of killing or removing the surface bacteria of cucumbers (Reina *et al*., 1995; Breidt *et al*., 2000). Washing produce with tap water cannot be relied on to completely remove pathogenic and naturally occurring bacteria (Koseki *et al*., 2004). Therefore, *Campylobacter* detected in the cucumber cuts in this study could be from both utensils and natural occurrence (contamination before purchase) or due to other factors; however, further experiments are required to clarify the real causes.

'Chicken rice' is a favorite dish among all races in Malaysia. Most often sliced cucumbers will be served raw in the dish. In restaurants and street stalls, especially, cucumbers are cut on cutting boards that have been used to cut undercooked chicken previously, where some of the internal *Campylobacter* might survive. Offering contaminated cucumber slices for consumption after extended periods of storage under temperature abuse conditions increases health risk regarding *Campylobacter* since the survival of the bacteria in fresh produce contaminated by chicken rinse or chicken juice is comparable or even remarkably better than in Mueller-Hinton broth or brain heart infusion broth (Castillo and Escartin, 1994; Kärenlampi and Hänninen, 2004).

The livers responsible for the high numbers of *Campylobacter* genus and *C. jejuni* transferred to surfaces in experiment 1 (Table 1 and Table 2) might have been highly contaminated before packed. High levels of contamination seen on chicken carcasses might mean that potentially high numbers of *Campylobacter* could be introduced onto a surface (Humphrey *et al*., 2001).

Bacterial type and species can affect cross-contamination rates (Montville and Schaffner, 2003). *Campylobacter* isolates differ in their ability to survive on surfaces but some are capable of prolonged survival, albeit at a low level of contamination (Humphrey *et al*., 2001). *C. jejuni* was found transferred to surfaces of cutting boards, blades of knives and hands in all cases. Cross-contamination experiments have shown that *C. jejuni* can easily be transferred from raw chicken products to surfaces like cutting boards, plates and hands (de Boer and Hahné, 1990). *C. coli* were found on surfaces only in experiments that involve livers. Livers might be more nutritious and protective on the survival of *C. coli* on surfaces since they contain a lot of blood. Livers have a higher level of moisture too (due to the blood) compared to thighs + drumsticks and wings. Moisture level influences the transfer of bacteria from surface to surface (Montville and Schaffner, 2003).

Conclusion

As a conclusion, there is a possibility for *Campylobacter* to spread from chilled broiler parts to surfaces around a kitchen despite their fragility and sensitivity to environmental stresses. Utensils and hands that have been involved in the preparation of raw broiler ought to be washed properly before put to further use especially before further preparation of ready-to-eat foods like fruits and vegetables. Alternatively, separate utensils for preparing raw and ready-to-eat foods can be used.

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