SOURCES OF MICROBIOLOGICAL CONTAMINATION ON BEEF FROM CARCASSES DRESSED WITHOUT DECONTAMINATION AT A SMALL PACKING PLANT

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Abstract – A small meat packing plant slaughters up to 200 cattle on Fridays each week. Beef carcasses chilled for 2 or 3 days before they are fabricated to primal cuts. Groups of 25 swab samples were collected from carcasses before and after chilling, and from primal cuts, trimmings, and equipment used for meat production. Numbers of aerobes, coliforms and *Escherichia coli* on carcasses were reduced during chilling by about 1 and 2 log units, respectively. However, product was recontaminated with all three groups of bacteria during carcass fabrication, with the contaminating bacteria originating from a conveyor belt. The numbers of aerobes on cuts and trimmings at the end of the dressing process were about 2.6 log cfu/cm^2, while the numbers of coliforms and *E. coli* were about 1 cfu/cm^2 and 1/100 cm^2, respectively.

Key Words – Recontamination, Fabrication process, Conveyor belt.

I. INTRODUCTION

A recent study showed that a large beef packing plant which employs multiple carcass decontaminating treatments produced chilled carcasses with numbers of aerobes about 2 cfu/cm^2, and coliforms and *Escherichia coli* at numbers of <1cfu/10,000 cm^2 [1]. The meat was recontaminated during carcass fabrication with bacteria from fixed equipment and the personal equipment of workers. Even so, the numbers of aerobes and coliforms on both cuts and trimmings were, respectively, about 1 log cfu/cm^2 and 1 cfu/100 cm^2. Numbers of *E. coli* on cuts and trimmings were 1 cfu/100 cm^2 and 1 cfu/1000 cm^2, respectively.

Small meat packing plants are generally unable to subject carcasses to multiple decontaminating treatments, and many use no such treatments, particularly when customers prefer or require that decontaminating treatments are not used. Whether control over microbiological contamination similar to that attainable at large plants is possible at smaller plants is then uncertain. Therefore, for better understanding of the matter, the microbiological effects of beef production process at a small packing plant that was expected to produce meat of good microbiological quality were investigated.

II. MATERIALS AND METHODS

The Canadian packing plant involved in the study slaughters a variety of domestic and farmed game animals, with much of the meat being exported overseas. Cattle are always slaughtered on a Friday, with carcasses being held for 3 or 4 days before they are fabricated to primal cuts. Carcasses are divided into portion, all of which are dropped to a single conveyor belt from which the portions are removed to cutting board for fabrication to primal cuts. Cuts are returned to the belt for conveyance to a station for vacuum packaging while trimmings are collected into bulk containers. Twenty five samples were collected from each of: randomly selected sites on carcasses [2] at the end of the carcass dressing process and chilled carcasses immediately before fabrication, strip loins immediately before packaging, trimmings before they were placed in bulk containers, the operating conveyor belt before meat was processed, the conveyor belt during processing, steel mesh gloves before and after processing, and latex gloves after processing. Each group of samples was obtained by collecting 8 or 9 samples on each of 3 days. Each sample from carcasses, cuts, trimmings, and the conveyor belt obtained by swabbing an area of approximately 200 cm^2 using two synthetic sponges, each moistened with 7 ml of 0.1% w/v peptone water. Gloves were each

sampled by rinsing in 100 ml of peptone water. Each pair of sponges was pummeled with an additional 20 ml of peptone water using a stomacher. Suitable dilutions of each stomacher and rinse fluid were spread on plates of tryptone soy agars (TSA; Difco, Becton Dickinson, Sparks, MD, USA) that were incubated at 25 °C for 3 days, for enumeration of total aerobic counts. An 8.5 ml portion of each fluid was filtered through a hydrophobic grid membrane filter, and the filter was placed on a plate of lactose monensin glucuronate agar (LMG; Oxoid, Mississauga, Ontario, Canada), which was incubated at 35 °C for 24 h. Blue colonies on the filter were counted, and a most probable number of coliform was calculated from that count. The filter was transferred to a plate of buffered methylumbelliferyl-β-D-glucuronide agar (BMA) which was incubated at 35 °C for 3 h. Blue colonies that fluorescenced when illuminated with UV light were counted, and a most probable number of *E. coli* was calculated from that count.

All counts were transformed to log values. When bacteria were recovered from ≥ 20 of 25 samples, values for the mean ($\bar{\times}$) and standard deviation (SD) of the log counts were calculated, with values of -0.5 log cfu/cm^2, or 0 log cfu/100 cm^2 being assumpted, respectively, for samples from which aerobes, or coliforms or *E. coli* were not recovered. When values for $\bar{\times}$ and SD were calculated, a value for the log mean (log A) was also calculated from the formula $\log A = \bar{\times} + \log_n 10.SD^2/2$. The log of the total number of bacteria recovered was calculated for each set by summing the counts and obtaining the log of the sum.

III. RESULTS AND DISCUSSION

As compared with the numbers on dressed carcasses, the numbers of aerobes on chilled carcasses were about 1 log unit less, while the numbers of coliforms and *E. coli* were about 2 log units less (Table 1). However, the meat was recontaminated during carcass fabrication, with numbers of all three groups of bacteria on both cuts and trimmings being similar to the numbers of dressed carcasses. The numbers of aerobes, coliforms and *E. coli* are considerably higher on chilled carcasses and cuts and trimmings than the numbers of all three groups in the previous findings at a large packing plant [1].

It has long been known that if carcass surfaces dry during cooling, the number of bacteria on the surfaces will decline, with Gram negative bacteria being more affected than Gram positive organisms [3]. Thus, the extended chilling of the carcasses without spraying evidently achieved reductions similar to those obtained elsewhere by spraying with 5% lactic acid solution [1] or pasteurizing [4]. The recontamination of meat from decontaminated carcasses also occurs at other plants.

Table 1. Statistics for sets of log values for total aerobic counts (cfu/cm^2), coliform counts (cfu/100 cm^2) and *Escherichia coli* counts (cfu/100 cm^2) recovered from beef carcasses, cuts and trimmings at a small beef packing plant.

Count	Product	Statistics				
		$\bar{\times}$	SD	No	log A	N
Aerobes	Carcasses, dressed	1.62	1.14	2	3.11	3.77
	Carcasses, chilled	-	-	8	-	2.62
	Cuts	1.58	0.93	1	2.58	3.50
	Trimmings	2.24	0.60	0	2.67	3.97
Coliforms	Carcasses, dressed	-	-	14	-	2.64
	Carcasses, chilled	-	-	24	-	0.30
	Cuts	-	-	10	-	2.81
	Trimmings	1.45	0.63	2	1.95	3.14
E. coli	Carcasses, dressed	-	-	15	-	1.92
	Carcasses, chilled	-	-	24	-	0.30
	Cuts	-	-	20	-	1.34
	Trimmings	-	-	13	-	1.76

$\bar{\times}$, mean log; SD, standard deviation; No, number of samples from which bacteria were not recovered; -, insufficient data for calculation of the statistic; log A, log mean; N, log of the total number recovered from 25 samples.

At many North American meat packing plants the cleaning of personal equipment, such as steel mesh gloves, knives, etc., is left to the discretion of the individual worker. Also, the wearing of cotton gloves is usual, with or without rubber gloves

being worn over the cotton ones. At the plant involved in this study, cleaning of personal equipment is carried out by cleaning staff; and disposable latex gloves are worn over cotton gloves whether or not steel mesh gloves are worn also. Consequently, the only source of the contaminants found on the finished products appeared to be the conveyor belt; on which numbers of bacteria were high before work started and declined during working as bacteria were removed on the meat (Table 2).

Table 2. Statistics for sets of log values for total aerobic, coliform and *Escherichia coli* counts recovered from a conveyor belt (cfu/100 cm^2) or steel mesh or latex gloves (cfu/glove) used during fabrication of beef carcasses, before the start of work and after working for 2 h.

Count	Equipment	Stage of processing	Statistics				
			$\bar{\times}$	SD	No	Log A	N
Aerobes	Conveyor belt	Before work	5.32	0.88	0	6.21	7.23
		After work	4.66	0.85	0	5.48	5.81
	Mesh gloves	Before work	-	-	22	-	3.48
		After work	5.62	0.63	0	6.08	7.79
	Latex gloves	After work	6.69	0.6	0	5.11	6.47
Coliforms	Conveyor belt	Before work	1.41	0.45	5	2.46	3.34
		After work	1.38	1.02	2	2.60	3.72
	Mesh gloves	Before work	-	-	25	-	-
		After work	2.07	0.65	1	2.55	3.82
	Latex gloves	After work	-	-	11	-	2.91
E. coli	Conveyor belt	Before work	-	-	15	-	1.86
		After work	-	-	17	-	1.53
	Mesh gloves	Before work	-	-	25	-	-
		After work	1.22	0.63	22	1.67	3.27
	Latex gloves	After work	-	-	16	-	1.74

$\bar{\times}$, mean log; SD, standard deviation; No, number of samples from which bacteria were not recovered; -, insufficient data for calculation of the statistic; log A, log mean; N, log of the total number recovered from 25 samples.

Steel mesh gloves as well as the disposable latex gloves were largely free of bacteria before work. After working the numbers of bacteria on latex gloves were comparable with the numbers on the conveyor belt; while the numbers on the mesh gloves that retain much detritus were about 1 log unit more, as would be expected. The numbers on the final products were similar to the numbers on the belt after work. These findings contrast with the previous findings at a plant where latex gloves are not worn over cotton gloves when mesh gloves are worn also; and personal equipment is cleaned by the individual workers. In that case, the mesh gloves and bacteria growing, during processing, in

the cotton gloves contaminated by the mesh gloves were apparently a major source of the contaminants on the final products.

IV. CONCLUSION

With careful attention to carcass dressing processes and assured drying of carcass surfaces during chilling, beef carcasses with low numbers of aerobes and very few *E. coli* can be produced without use of carcass decontamination treatments. However, careful attention to ensure thorough cleaning of all equipment used during carcass breaking is necessary if the microbiological condition of the carcasses is to be maintained for the final products.

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